8th Interdisciplinary World Congress on Low Back & Pelvic Pain
Advances in Multidisciplinary Research for better Spinal/Pelvic Care

October 27 - 31, 2013
Dubai, United Arab Emirates

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This congress has been organized as a workshop in an open forum. It is our intent to share thoughts and ideas; accordingly the material presented in this book is unedited.

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8th Interdisciplinary World Congress on Low Back & Pelvic Pain
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Welcome to the 8th Interdisciplinary World Congress on Low Back & Pelvic Pain here in Dubai, United Arab Emirates

This series of programs, initiated in 1992 by Andry Vleeming and the late Vert Mooney aims to promote and facilitate interdisciplinary knowledge and to create a consensus on prevention, diagnosis and treatment of acute and chronic lumbopelvic pain. Held every three years, this congress welcomes health care professionals, practitioners, academics, researches and policymakers from all continents.

The theme of the 2013 World Congress is Advances in Multidisciplinary Research for better Spinal/Pelvic Care. Like the former Los Angeles congress, this program will be breaking away from the traditional mould of loosely related papers.

The objectives of the congress will be achieved in a four day program, starting Sunday, October 27 with pre-registration. Monday, Tuesday, Wednesday and Thursday will consist of formal ex cathedra, tightly coordinated lectures. These lectures are intended to present and debate what is reasonably known in the field.

Moderators and speakers chosen for their expertise in selected areas will summarize presentations, clearly delineate opposing views and attempt to reach a consensus. They will assist participants in evaluating the information presented. The program will be presented in the format of eight main sessions led by moderators and keynote speakers known for their expertise in selected areas. This will be followed by eight parallel sessions that highlight topic specific research. Eight primary subject areas will address the dominant theme and they include; movement stability in lumbopelvic pain, pelvic girdle pain (diagnostics, risk factors and motor control), cognitive aspects of treatment, evidence based practice for low back pain along with diagnosis and treatment, connective tissue and the role of fascia and surgical management.

The pre and post congress workshops will share clinician experience in the management of lumbopelvic pain. E Poster presentations will illustrate the current worldwide research and innovative ideas in the field.

The congress is supported in cooperation with the North American Spine Society, Emirates Medical Association, Emirates Physiotherapy Society, Gulf Neurosurgical Society, Pan-Arabic Neurosurgical Society, University of New England, Department of Rehabilitation, Sciences and Physiotherapy University of Ghent, Loyola University Medical Center, Vert Mooney Spine and Sport Foundation, Dubai Police Health Center and the Rehabilitation Institute of Chicago as well as a wide array of academic societies from countries around the world.

We welcome you!

Andry Vleeming, Abduladheem Kamkar and Colleen Fitzgerald
Program Chairs

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Spine Stability: Lessons From Balancing A Stick

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Abstract

This paper introduces control concepts that are important for ensuring stability. To clarify these concepts, a series of experiments using a simple task of stick balancing will be performed. The lessons from these experiments will be applied to the spine system and illustrated with clinical examples. Insight into the following will be gained: what information is used to stabilize the spine, how does noise in control affect spine performance, how has the spine evolved to allow it to be stabilized and controlled in a metabolically efficient way, how do delays in control affect spine performance, and how do different goals (i.e., maximizing performance versus minimizing fatigue) affect the logic for controlling the spine?

1. Introduction

The human spine is an extremely complex structure. This complexity makes it particularly difficult to understand how the system works. Fortunately, an approach specifically developed for studying complex systems already exists. Systems Science, or the systems approach, is an interdisciplinary doctrine that elaborates principles that apply to systems in general, irrespective of their particular kind. At the formal end of this approach is systems theory, which provides a framework for studying general properties such as stability, optimality, and goal-directedness in any complex system.

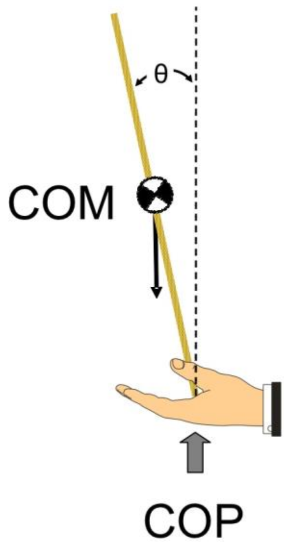

Figure 1: To balance the stick, the center-of-pressure (COP) of the hand must move under the center-of-mass (COM) of the stick.

In a previous paper entitled, "Spine stability: the six blind men and the elephant" (Reeves et al. 2007), we presented the general outline of the systems approach and introduced some basic elements of control theory. The goal of this paper is to clarify and expand on control concepts. We will perform a series of experiments using a simple task of stick balancing to elucidate control characteristics that are important for ensuring stability. The lessons from these experiments will be applied to the spine system and illustrated with clinical examples.

This paper will provide insight into the following questions: what information is used to stabilize the spine, how does noise in control affect spine performance, how has the spine evolved to allow it to be stabilized and controlled in a metabolically efficient way, how do delays in control affect spine performance, and how do different goals (i.e., maximizing performance versus minimizing fatigue) affect the logic for controlling the spine?

With the Spine Stability series of papers, we hope to establish a common understanding regarding spine control and stability, using standard, well-defined concepts. Given the interdisciplinary nature of the systems approach, it is important that all stakeholders (e.g. clinicians, neuroscientists, bioengineers, etc…) share a common understanding for this approach to be effective in advancing our knowledge of spine biomechanics. Therefore, this paper is being published under the banner of "Lecture".

2. Lessons from Balancing a Stick

To balance a stick in the palm of our hand, the center-of-pressure (COP) acting on the hand must be kept under the center-of-mass (COM) of the stick (Figure 1). Therefore, how the hand moves will determine if stick balancing is stable (keeping it upright). Although it is not intuitive, the logic for controlling the position of the hand is based on feedback control. As discussed in the first paper (Reeves et al. 2007), the principal approach to stabilize any system is through feedback control.

2.1. Experiment #1

To stabilize any system, we must first be able to track the system. For instance, balancing a stick with your eyes closed is very difficult, if not impossible. Therefore, we know that vision is very important to make the task stable. Information about the state of the system is fed back through our visual system to the central nervous system (CNS), which then determines where to place the hand. If successful, we have made a system that is inherently unstable, stable with feedback control. To clarify, the plant (stick), which is the object we desire to stabilize, has force acting on it due to the effect of gravity and creates positive feedback. The force from positive feedback is proportional to the stick's displacement (the angle with respect to the upright vertical position) and is applied in the same direction as the displacement. Thus, positive feedback will tend to push the system further away from the equilibrium or desired position resulting in unstable behavior. The controller (CNS) must overcome the destabilizing effect of gravity by using negative feedback control. As with positive feedback, force from negative feedback control is proportional to the displacement, but this force is applied in the opposite direction to the displacement. To ensure stability, the force from negative feedback applied by the controller must be larger than the force from positive feedback of the plant. Stated differently, the overall system (plant and controller) must have negative feedback control. With negative feedback control, any disturbance (e.g., someone tapping the stick, neuromuscular noise, etc…) will be counteracted by stabilizing forces, which in this case are applied through the hand.

What information about the system do we need to stabilize the upright stick? There are two stick balancing scenarios presented in Figure 2. In the first scenario (A), the stick is positioned to the left of the hand with zero velocity. To stabilize the stick would require the hand to move to the left, to bring the COM of the stick under the COP acting on the hand. In the second case (B), the stick has the same starting position, but this time, it is moving to the right with some initial velocity. For the second scenario, it is unclear which direction to move the hand. For instance, if the stick is moving slow, the hand would need to move to the left. However, if the stick is moving fast, the hand would have to move to the right to catch the stick. This simple experiments shows that position feedback alone is insufficient for stabilizing the system, since the entire "state" of the system is not known. For a system with a single mass, there will be two state variables, representing the position and velocity of the mass in each degree-of-freedom (DOF). A system with "n" masses will have n x 2 state variables for each DOF.

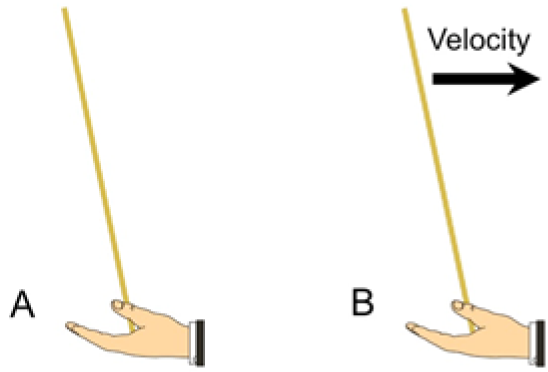

Figure 2: (A) Stick is positioned to the left of the hand with zero velocity. (B) Stick positioned to the left of the hand, but moving to the right.

The concept of system state is very important in control theory. If you know the state of the system, you no longer need to know the past behavior of the system to apply the appropriate control to ensure stability. The current state along with the input into the system can be used to place the system in some desire position or movement trajectory, assuming the dynamics of the system are also known (see section 3.3).

2.1.1. Lesson #1

This experiment teaches us that the CNS monitors both position and velocity of spine movement for each DOF. For the lumbar spine, there are 5 vertebrae each of which can move in 6 DOF (3 rotations and 3 translations). Therefore, the CNS must monitor 5 x 6 = 30 state variables for the lumbar spine.

2.1.2. Clinical relevance

There is one type of sensory receptor that is well-suited for tracking both the position and velocity of the spine. Muscle spindles, which are embedded into the paraspinal muscles of the trunk, are sensitive to muscle length (position) as well as muscle length rate of change (velocity) (Houk et al. 1981). Moreover, given the intersegmental connections of the paraspinal muscles, these embedded receptors are well-positioned to track the vertebrae in all DOF. Therefore, it is not surprising that muscle spindle density is high in the deep intersegmental muscles (Buxton and Peck 1989;Nitz and Peck 1986). This morphology supports the notion that these muscles function as kinesthetic sensors for spine motion. Other sensory receptors also aid in tracking the spine, but it is likely that muscle spindles play a dominant role. Consequently, damage to the paraspinal muscles from injury or in the course of surgery could significantly affect spine function.

It is perhaps appropriate at this stage to address a significant omission in the current state of spine research. Stiffness, which represents position feedback, is often associated with spine stability, but not damping, which represents velocity feedback (Reeves and Cholewicki 2010). Given the static interpretation of stability that has dominated past research efforts, this is not surprising. Clearly, we need to expand our concept of stability. Because the spine represents a dynamic system, it is important that our definition of stability reflects this fundamental attribute (see Reeves and Cholewicki 2010 for further discussion on this matter).

2.2. Experiment #2

The next experiment deals with precision of tracking the state of the system. If you were to balance the stick by focusing closer to the bottom rather than at the top of the stick, you would find that focusing closer to the bottom makes balancing more difficult, as indicated by the larger oscillations of the stick. When looking at the bottom of the stick, your performance is not as good and suggests that your controller is somehow impaired. What is causing this impairment? The impairment, in part, stems from precision in tracking the system. To keep the stick upright we need to monitor its angular displacement and velocity. However, our visual system is tracking linear displacement and velocity of a focal point. When you focus at the top of the stick, a given angular displacement will produce more linear displacement than when focusing at the bottom. Therefore, by looking at the top, the resolution of the visual system is greater, which in turn provides more precise information about the state of the system. The controller having more precise information can send more precise feedback commands, which is reflected in better positioning of the hand, leading to better performance during stick balancing. Also, it is important to note that forces required to stabilize the stick are related to the quality of control. Since force acting on the stick balancing system is proportional to the stick’s displacement and velocity, any impairment in control, which leads to larger and faster stick movement, will also lead to higher forces necessary to stabilize the system.

One additional issue worth noting, when focusing lower on the stick, a larger gain must be used to produce the necessary force to stabilize the stick, than when focusing at the top of the stick. A larger gain means that larger forces will be produced for a given displacement and velocity. This larger gain also magnifies the noise, which propagates through the system to impair performance. So impairment in performance can stem from lower resolution, but also from the magnification of noise in this experiment.

2.2.1. Lesson #2

To improve the performance of the spine system, the CNS must monitor the state of the system precisely. In other words, the CNS must monitor precisely the displacement and velocity of the spine to recruit trunk muscles in an appropriate manner to stabilize the spine. Any impairment in tracking the spine will impair control and will lead to non-optimal recruitment of trunk muscles. This non-optimal muscle recruitment will lead to greater spine displacements and greater muscle forces, which will increase strain and stress on spinal tissue, two potential mechanisms for injury.

2.2.2. Clinical relevance

Do people with LBP have impaired proprioception? The literature on this topic is ambiguous. Some studies report impairment in trunk proprioception in people with LBP (Brumagne et al. 2000; Field et al. 1997; Gill and Callaghan 1998; Leinonen et al. 2002; Leinonen et al. 2003; O'Sullivan et al. 2003; Lee et al. 2010), while others find no such impairment (Asell et al. 2006; Descarreaux et al. 2005; Koumantakis et al. 2002; Lam et al. 1999; Silfies et al. 2007).

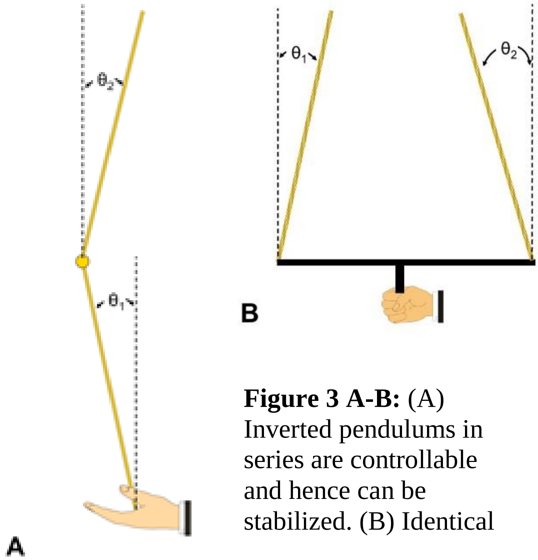

Figure 3 A-B: (A) Inverted pendulums in series are controllable and hence can be stabilized. (B) Identical

However, there are a few problems with the current methodology for testing trunk proprioception. First, these tests primarily assess awareness of trunk position and do not account for velocity-related sensitivity. Perhaps people with LBP have velocity-related sensory impairment and not position–related impairment. Second, these tests are gross assessment of trunk position sense and not segmental precision. Perhaps people with LBP only have impairment in tracking a single segment of the spine. The evidence in support of this statement is that some people with LBP demonstrate aberrant motion at a single spinal level (Cholewicki and McGill 1992; McGill 2002; Teyhen et al. 2007a; Teyhen et al. 2007b). Perhaps segmental muscle wasting, which also can be found in the LBP population (Hides et al. 1994;Hides et al. 1996), can impair the tracking of the spine at that segment level, thus producing aberrant motion. Because the displacement at a given segment level represents only a small portion of the total displacement of the trunk (White and Panjabi 1990), these tests may be insensitive to such segmental impairment. Lastly, trunk repositioning tests rely to a large extent on memory (memorization of the target position) and are not exclusively related to proprioception. Given all of the problems with measuring prioprioception, conflicting results in the literature are not surprising.

2.3. Experiment #3

The next experiment deals with the issues of controllability and observability. In terms of controllability, we would like to know if we can take a system and change its state in some desirable way or, equivalently, take a stick with an initial position and velocity and make it upright and stationary (position and velocity equal zero). To explore the concept of controllability, we will use two different stick balancing systems. Which of the two stick balancing systems presented in Figure 3A-B can be controlled? Both systems are probably impossible for a human controller, but let's assume we are using a robotic system that can respond with fast movements and large forces. Of the two conditions, only the first, in which the sticks are connected in series, can be controlled (Figure 3A). If the controller can track the position and velocity of both sticks, it can use this information to bring them both to the upright position. Even though we are not directly applying control to the top stick, we can still affect its state (position and velocity), and moreover, the state of the top stick can be changed independently of the bottom stick. For the parallel configuration, the state of the two sticks cannot be independently changed if the sticks are the same. In other words, we have a lack of DOF in the application of control. Therefore, if one of the sticks has a slightly different starting position or is bumped, the controller cannot respond in a way that will keep both sticks upright. If we were to change the length of one stick (which would change its natural frequency of oscillation), it would then become possible to independently change the states of the two sticks. With this new configuration, we could use the information about the state of the entire system (position and velocity of both sticks) to apply feedback control to stabilize the system, bringing both sticks to the upright position. One thing to note, the more alike the two sticks are in the parallel configuration, the more force is required to stabilize the system. In addition, the controller must respond faster when the sticks are similar. The arrangement of the sticks in series is such that it also requires fast movements and large forces to stabilize it. For the sticks in series, to minimize the forces, it may be better to apply not only forces to the base of the bottom stick but also directly to the second stick. Or instead of having a frictionless hinge joint connecting the two sticks, perhaps one could have tough elastic bands connecting the two. The point of this line of logic is that there are various ways to design a system to make it controllable and as well to reduce the energy costs associated with stabilizing.

Next, we will discuss the issue of observability using the same two stick configurations Figure 3). Let's assume that we only obtain position information related to the hand and do not know what is happening to the two sets of sticks. Is it possible to predict the state of the entire system (position and velocity of both sticks) from the output of the hand? It depends on the system. For the identical sticks in parallel, it is not possible to predict the entire state of the system; whereas, for the stick in series, it is possible. If we have some prior knowledge about the dynamics of the system, it is possible to use this information to build a model of the system. If the model is an accurate representation of the true system, we can then accurately estimate the state of the entire system from a limited set of information (i.e., estimate the position and velocity of the two sticks from only the position of the hand). But this is only possible for the sticks in series and not in parallel when the sticks are identical. The logic for the observability requirement follows the same logic as the controllability requirement. If you have multiple masses that you wish to observe (predict the state of the masses), then it becomes important that the two masses have different movement characteristics (different natural frequencies of oscillation). Otherwise, you could not predict the state of the two sticks. For the sticks in series, since the sticks have different movement characteristics as a result of different distances from their centers of mass to the palm of the hand, it is possible to predict the state of both sticks. And if you can predict their state, you can then use this information to generate feedback control signals to stabilize the system. Obviously, the accuracy of the model for predicting the entire state of the system is important and will determine if the performance of the controller is good.

To take the controllability and observability example one step further, let's consider balancing a noodle. Is this possible? Yes. We can think of the noodle as an infinite number of independent masses stacked in series. Since each mass will have different movement characteristics, it is possible to predict the state of each mass, assuming we have an accurate model of the noodle. If we can predict the entire state of the system, we can then use this information to apply feedback control to stand the noodle straight-up. If we can do this for a supple noodle, we can also do the same for a flexible column such as the human spine. However, as mentioned already, we also need to consider the energy costs associated with stabilizing. Therefore, it is unlikely that the spine is stabilized through moving just the pelvis (Figure 4A). To make the system more energy efficient, it is likely that trunk muscles are also involved in controlling various spine segments (Figure 4B-C). Moreover, it is unlikely that the entire state of the spine system is estimated from the position of pelvis (Figure 4B). More likely, trunk muscles with their embedded sensory receptors are used to monitor the position and velocity of various spine segments (Figure 4A,C), which in turn can be used to develop a more accurate model of the spine system. This improved neural model of the spine system will also help improve spine performance and efficiency.

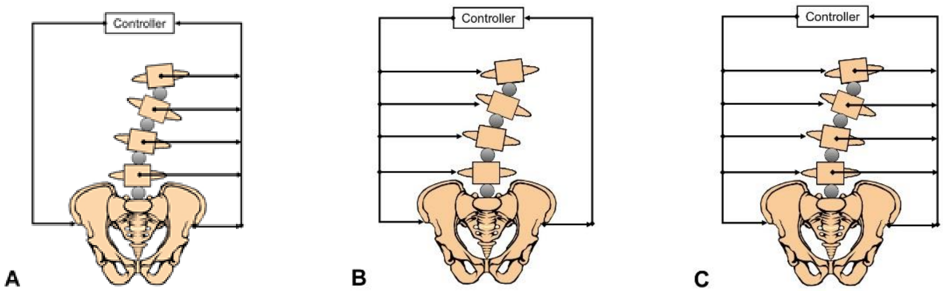

Figure 4 A-C: (A) An example of multiple outputs (system state for various spine segments) used to apply feedback control to a single segment (pelvis). (B) An example of a single output (pelvis displacement) used to apply feedback control to multiple segments. (C) Most likely the spine uses multiple outputs to apply feedback control to multiple segments, thus improving performance while minimizing energy costs.

2.3.1. Lesson #3

The architecture and neural recruitment of the trunk muscles must be such that it allows for independent control of the various spine segments. Most likely, these same trunk muscles also aid in forming accurate neural models of the spine system, which then use sensory signals to predict the entire state of the system. This predicted state can then be used to generate feedback control signals to activate the trunk muscles to stabilize the spine.

2.3.2. Clinical relevance

Most likely, the spine anatomy has evolved over time to ensure that the spine is both controllable and observable, while minimizing metabolic costs to keep it stable. For the spine system that has a limited amount of power and energy, it must be designed to keep stabilizing forces at fairly low levels to allow people to perform daily activities for long periods of time. Considering that it is a redundant system, there is some flexibility in how to apply control to the spine to stabilize it. Some strategies may be better than others for maximizing performance and/or minimizing costs. Later we will discuss the issue of control strategies and goal-directedness in more detail.

2.4. Experiment #4

The next experiment deals with the issue of delays in feedback control. This experiment can be performed with sticks of different lengths (Milton et al. 2009). Starting with a longer stick and progressing through to the smaller stick, you will find that balancing the stick becomes more difficult as the stick becomes shorter. In fact, at some critical height, it will become impossible to balance the stick. As the stick becomes shorter, the size and rate of oscillations of the stick increases, which means that larger and faster hand movements must be used to keep the stick upright.

So why does the stick eventually become unstable as the mass gets closer to the hand? There are a few possible reasons for this: one deals with force saturation and the other with delays. It is possible that the amount of force needed to balance the stick exceeds the force generating capacity of the arm (force saturation). Recall that force applied is proportional to the position and velocity of the stick. Therefore, it is possible that forces required to keep the stick upright exceeded the force generating capacity of the arm. However, for this example, the instability most likely stems from delays in the control system. As the mass height decreases and the system moves faster, delays in feedback control become more problematic. In layman's terms, the stick is moving faster than the CNS can respond. In engineering terms, the plant dynamics are outside the bandwidth of the controller. Therefore, delays inherent to biological systems can impair the controller and in the worst case, if significant, can lead to instability (Reeves et al. 2009).

To explain how a delay can impair control, a car driving example can be used. Imagine trying to drive the car with visual information from 5 seconds in the past. This "old" information, which represents a delay in feedback control, may not accurately represent the current state of the system, which in this case represents the car's position and velocity. If old information does not reflect the current information, the control signal, which represents steering the car, may be inappropriate leading to unstable behavior – poor navigation leading to a crash. The crash is more likely on a windy road than a straight road, because the dynamics of the system are changing faster. It is important to note that delays can originate from delays in obtaining the system state or from delays in the application of control (time to execute the command). However, the effects are the same.

2.4.1. Lesson #4

Delays in feedback control can impair the control of the spine, particularly when the spine system is moving fast (i.e. has higher frequency content).

2.4.2. Clinical relevance

Do people with LBP have longer delays in their controller? Several research groups investigating reaction times (Luoto et al. 1996) and reflex response to sudden unexpected loading support this hypothesis (Magnusson et al. 1996;Radebold et al. 2000;Reeves et al. 2005;Wilder et al. 1996). More recently, it was shown that athletes with longer trunk muscle reflex response are more likely to suffer a low back injury (Cholewicki et al. 2005). It appears that these slightly longer delays found in the LBP group may explain in part their impairment in postural control (Radebold et al. 2001). For instance, model simulations showed that increasing delays in feedback control of the trunk muscles resulted in more spine displacement and trunk muscle effort required to maintain postural stability (Reeves et al. 2009). However, based on the stick balancing experiment, we know that the effects of delays may not impair control for a slow moving system, which could be the case for upright standing. But for large, unexpected perturbations (i.e., sudden load shifts during patient handling), these delays may become an issue. Moreover, there is evidence that, with sustained trunk flexion leading to creep in spinal tissue, delays in reflex activation of back muscles can increase by 50% (Sanchez-Zuriaga et al. 2010), suggesting that these delays are not constant. Therefore, following prolonged exposure to trunk flexion (i.e. laying rebar), a person could also be predisposed to injury from a sudden loading event.

2.5. Experiment #5

The last experiment, which is more of an observation than an experiment, deals with optimal control. If you have never balanced a stick before, the "logic" for controlling the system would not exist. However, with learning, you determine the appropriate feedback gains to stabilize the system. At first, control is poor. But performance quickly improves as you tune your controller, adjusting the feedback gains, until you become an expert stick balancer. In the process of becoming an expert stick balancer, you implicitly learn the dynamics of the system.

There are a number of strategies for balancing the stick, which represent feedback gains that belong to a stable set of solutions. For instance, you can balance using large-slow hand movements or short-fast bursts of activity. In the case of the short-fast burst, you “turn-up” the gains of the system to have stronger, more aggressive feedback control so that the system will respond faster. So for a given displacement or velocity of movement, more force will act on the system. By doing this, you are weighting the importance of performance over energy costs. Therefore, to improve performance, you expend more energy to bring the system back to the equilibrium position. But there may be times when it is more important to conserve energy than to keep the stick close to the upright position. For instance, if someone needed to balance the stick all day, most likely he or she would chose a control strategy that uses less energy. Therefore for any given task, there exists an infinite set of solutions in terms of feedback gains that provide stable behavior. Within the set of stable solutions, certain strategies would be preferred based on the goals of the system. The goal of the system can be to maximize performance (reduce kinematic disturbances), minimize costs (reduce fatigue), or some combination of these and other elements (i.e. reduce or eliminate pain).

2.5.1. Lesson #5

To maintain a stable spine, the CNS must learn the dynamics of the spine system, and then choose the appropriate feedback gains that stabilize the spine and fulfill the goals of the system for a given task.

2.5.2. Clinical relevance

Is there evidence that people with and without LBP have different control strategies? There is some evidence to suggest that control is different in people with LBP. Studies have shown that people with LBP may use greater trunk muscle coactivation than healthy individuals (Lariviere et al. 2000;Marras et al. 2001;van Dieen et al. 2003), which may reflect more aggressive control. However, more aggressive control could be problematic when coupled with delay impairments or noise sensory signals, as discussed before. But there is also some evidence that people with LBP may not be recruiting or coactivating trunk muscles sufficiently, resulting in an “instability catch” (McGill 2002). Therefore, it is possible that different classes of impairments exist, which demand different forms of clinical intervention.

Do LBP patients get stuck in a dysfunctional control strategy? Such a scenario is possible. An interesting study that induced pain in paraspinal muscles with hypertonic saline injection found that neuromuscular control changed in a manner similar to that associated with LBP (Hodges et al. 2003;Moseley et al. 2004). Surprisingly, when this painful stimulus was removed, muscle recruitment did not return to its original pattern, implying that, even following recovery, the CNS may be confined to a non-optimal control strategy. Thus, neuromuscular retraining may be necessary to help reset control to a more desirable strategy. A challenge for a clinician is to diagnose differentially all possible impairments, so that the appropriate treatment can be prescribed. In addition, a clinician must decide at which point during recovery an intervention into the control strategy is warranted. For instance, early neuromuscular adaptation may be functional and may be required to “splint” the injured site. But it is possible that this adaptation may become problematic in the long-term (e.g. excessive spinal loading from coactivation of trunk muscles leading to further tissue damage). A secondary challenge for clinicians is to decide when in the recovery process is an intervention appropriate.

3. Summary

To be capable of performing its intended function, to bear loads and to allow for controlled movement of the trunk, the spine must be stable. However, given the effects of gravity, the human spine is inherently unstable. Therefore, some form of control must be applied to the spine system at all times to give it stable behavior. Stable spine behavior is achieved through feedback control.

Based on the series of stick balancing experiments, we have demonstrated the following:

1. The CNS must be able to track the spine to stabilize it. Muscle spindles appear well-suited and well-positioned to monitor the state of the spine system.
2. Better spine proprioception leads to better spine control, which in turn reduces effort level. However, current methods for assessing spine proprioception appear inadequate. These methods miss important attributes such as velocity-related sensitivity and segmental deficiencies in monitoring the state of the spine.
3. Trunk muscles must have the proper architecture and neural recruitment to independently control each spine segment in all DOFs. Most likely, trunk muscles and their embedded sensory receptors also aid in forming accurate neural models of the spine system, which then use sensory signals to predict the state of the system. This predicted state can then be used to generate feedback control signals to activate the trunk muscles to stabilize the spine.
4. Delays in feedback control can impair spine control, particularly when the spine is moving fast. Longer delays found in people with LBP or those predisposed to injury could be problematic in situations where the spine experiences large unexpected perturbations (i.e., patient handling).
5. Control strategies are chosen based on the goals of the system (minimize kinematic disturbances, metabolic cost, etc…). There is some evidence to suggest that people with LBP may have different control strategies than those without LBP. Furthermore, these control strategies may not be reset following recovery from pain, suggesting that neuromuscular retraining is necessary.

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A DESCRIPTION OF THE LUMBAR INTERFASCIAL TRIANGLE AND ITS RELATION WITH THE LATERAL RAPHE: ANATOMICAL CONSTITUENTS OF LOAD TRANSFER THROUGH THE LATERAL MARGIN OF THE THORACOLUMBAR FASCIA

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Summary
Movement and stability of the lumbosacral region is contingent on the balance of forces distributed through the myofascial planes associated with the thoracolumbar fascia. This structure is located at the common intersection of several extremity muscles (e.g. latissimus dorsi and gluteus maximus), as well as hypaxial (e.g. ventral trunk muscles) and epaxial (paraspinal) muscles. The mechanical properties of the fascial constituents establish the parameters guiding the dynamic interaction of muscle groups that stabilize the lumbosacral spine. Understanding the construction of this complex myofascial junction is fundamental to biomechanical analysis and implementation of effective rehabilitation in individuals with low back and pelvic girdle pain. Therefore, the main objectives of this study were to describe the anatomy of the lateral margin of the thoracolumbar fascia and specifically the interface between the fascial sheath surrounding the paraspinal muscles and the aponeurosis of the transversus abdominis and internal oblique muscles. The lateral margin of the thoracolumbar fascia was exposed via serial reduction dissections from anterior and posterior approaches. Axial sections (cadaveric and MRI) were examined to characterize the region between the transversus abdominis and internal oblique aponeurosis and the paraspinal muscles. It is confirmed that the paraspinal muscles are enveloped by a continuous paraspinal retinacular sheath, formed by the deep lamina of the posterior layer of the thoracolumbar fascia. The paraspinal retinacular sheath extends from the spinous process to transverse process and is distinct from both the superficial lamina of the posterior layer and middle layer of the thoracolumbar fascia. As the aponeurosis approaches the lateral border of the paraspinal retinacular sheath, it appears to separate into two distinct laminae, which join the anterior and posterior walls of the paraspinal retinacular sheath. This configuration creates a previously undescribed fat-filled lumbar interfascial triangle situated along the lateral border of the paraspinal muscles from the 12th rib to the iliac crest. This triangle results in the unification of different fascial sheaths along the lateral border of the thoracolumbar fascia, creating a ridged-union of dense connective tissue that has been termed the lateral raphe (Bogduk and MacIntosh, 1984). This triangle may function in the distribution of laterally-mediated tension to balance different viscoelastic moduli, along either the middle or posterior layers of the thoracolumbar fascia.

ABBREVIATIONS	TERM
ALF	Anterior Layer of Thoracolumbar Fascia
EO	External Abdominal Oblique
IO	Internal Abdominal Oblique
LD	Latissimus Dorsi
LIFT	Lumbar Interfascial Triangle
LR	Lateral Raphe
MLF	Middle Layer of Thoracolumbar Fascia
PLF	Posterior Layer of Thoracolumbar Fascia
PRS	Paraspinal Retinacular Sheath
QL	Quadratus Lumborum
SPI	Serratus Posterior Inferior
TA	Transversus Abdominis
TLF	Thoracolumbar Fascia

Introduction

Effective movement and stability of the lumbosacral region is contingent on the balance of forces distributed through the myofascial planes associated with the thoracolumbar fascia (TLF). The mechanical properties of the fascial constituents of the TLF influence the dynamic interaction of muscle groups stabilizing the lumbosacral spine. Understanding the anatomy of this complex myofascial junction is fundamental to functional anatomical and biomechanical analysis and hence, the design of effective rehabilitation in individuals with low back and pelvic girdle pain.

The TLF envelops the back muscles from the sacral region, through the thoracic region, and is comprised of anterior (ALF), middle (MLF), and posterior (PLF) layers. Of these, the PLF consists of superficial and deep laminae. The superficial lamina of the PLF is continuous with the latissimus dorsi (LD), and partially continuous with the gluteus maximus, external abdominal oblique (EO) and trapezius and contribution from the serratus posterior inferior (SPI). The deep lamina of the PLF has contributions from the SPI, lumbosacral attachments to interspinous ligaments, the long dorsal sacroiliac ligament, and the iliac crest and cranial attachments extending into the cervical paraspinal region (Gracovetsky et al., 1981; Bogduk and MacIntosh, 1984; Gracovetsky, 1985, 1986; Macintosh and Bogduk, 1987; Vleeming et al., 1995; Barker and Briggs, 1999; Barker et al., 2004; Barker et al., 2007). The lateral margin of the TLF is located at the common intersection of several extremity muscles, such as the LD, as well as the intersection of the hypaxial (e.g. ventral trunk muscles) and epaxial (paraspinal) muscles.

The arrangement of fascial compartments in the lumbar spine, created by a fascial sheath encapsulating the paraspinal muscles, has been noted or illustrated by numerous authors (Spalteholz, 1923; Schaeffer, 1953; Hollinshead, 1969; Grant, 1972, plate 481; Bogduk and MacIntosh, 1984; Clemente, 1985; Tesh et al., 1987; Barker and Briggs, 1999; Gatton et al., 2010). Of special note is its designation as an osteofascial compartment (Standring, 2008) since the anteromedial portion is made up by the lumbar vertebrae and the remainder by a fascial sheet. This encapsulating sheath was named by Gray the “lumbar aponeurosis;” however, no attempt to separate deep from superficial layers of the PLF was made (Gray, 1870). Many authors cited above utilize the “deep lamina of the PLF” to describe the posterior wall of this encapsulating sheath and the “MLF” to describe the anterior wall. However, most of these descriptions are based on the assumption that the deep lamina of the PLF is a longitudinally-oriented, flat fascial sheath. The present article has examined the shape of the deep lamina of the PLF in the lumbar region

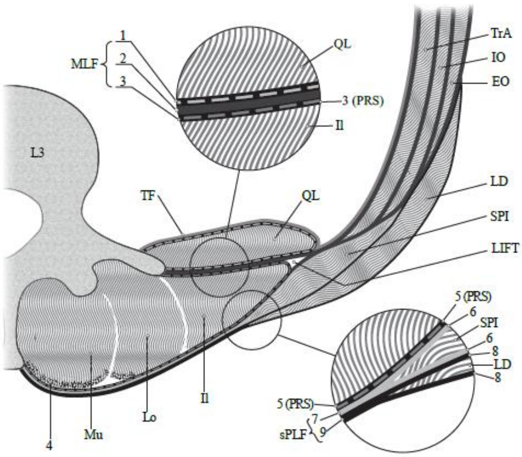

Figure 1: Modified with permission from Willard Vleeming Schuenke: Figure 9 in: The thoracolumbar fascia: Anatomy function and clinical considerations. Submitted to the Journal of Anatomy 2012. This is a transverse section of the posterior (PLF) and middle layer (MLF) of the thoracolumbar fascia (TLF) and related muscles at the L3 level. Fascial structures are represented such that individual layers are visible, but not necessarily presented to scale. Please note that the serratus posterior inferior (SPI) often is not present caudal to the L3 level. The transversus abdominis (TrA) muscle is covered with a dashed line on the peritoneal surface illustrating the transversalis fascia (TF). This fascia continues medially covering the anterior side of the investing fascia of the QL, quadratus lumborum. Anteriorly and medially, the transversalis fascia (TF) also fuses with the psoas muscle fascia (not drawn). The Internal (IO) and External Oblique (EO) are seen external to TrA. SPI is highly variable in thickness and, more often than not, absent on the L4 level. Latissimus Dorsi (LD) forms the superficial lamina of the PLF together with the SPI, when present. The three paraspinal muscles, multifidus (Mu), longissimus (Lo) and iliocostalis (Il) are contained within the paraspinal retinacular sheath (PRS). The aponeurosis (tendon) of the paraspinal muscles (4) is indicated by stippling. Please note that the epimysium of the individual spinal muscles is very thin and follows the contours of each separate muscle within the PRS. The epimysium is not indicated in the present figure but lies anteriorly to the aponeurosis (4). The upper circle shows a magnified view of the different fascial layers contributing to the MLF. The picture shows that MLF is made up of three different structures: (1) This dashed line depicts the investing fascia of QL; (3) This dashed line represents the Paraspinal Retinacular Sheath also termed the deep lamina of the PLF encapsulating the paraspinal muscles; (2) The thick dark line between the two dashed lines 1 and 3, represents the aponeurosis of the abdominal muscles especially deriving from TrA. Numbers 1, 2 and 3 form the MLF. The lower circle shows a magnified view of the different fascial layers constituting the PLF. The picture shows that on the L3 level the PLF is also made up of three layers, since the fascia of SPI is normally present on this level. (5) This dashed line depicts the PRS or deep lamina of the PLF encapsulating the paraspinal muscles; (6) The investing fascia of SPI is seen blending medially into the grey line marked (7) and representing the aponeurosis of SPI- posteriorly to the PRS; (8) This dark line represents the investing fascia of LD blending medially into the black line representing the LD aponeurosis (9) posteriorly to the SPI aponeurosis. Numbers 5,7 and 9 form the PLF. Numbers 7 and 9 form the superficial lamina of the posterior layer (sPLF).

confirming that it does form a sheath surrounding the paraspinal muscles. In the present article, this enveloping structure has been termed the Paraspinal Retinacular Sheath or PRS (figure 1).

Along the lateral border of the PRS, a complex interaction occurs between the attachments of the abdominal muscles. The blending of the aponeurotic sheaths of the transversus abdominis (TA) and internal oblique (IO) muscles along with the lateral margin of the TLF, gives rise to a ridged union of dense connective tissue. This area of fascial fusion exists just lateral to the paraspinal muscles through much of the lumbar region and was coined the lateral raphe (LR) (Bogduk and MacIntosh, 1984). The LR extends from the iliac crest caudally to the 12th rib cranially. Thus, the raphe is formed at the location where abdominal myofascial structures join the fascial structures surrounding the paraspinal muscles. Since Bogduk and MacIntosh's original use of the phrase "lateral raphe," several articles (e.g. Vleeming et al., 1995; Bogduk et al., 1998; Barker et al., 2001; Barker et al., 2004; Jemmett et al., 2004; Urquhart et al., 2005; Barker et al., 2007; Barker et al., 2010) make reference to the LR. Yet to the authors' knowledge, its boundaries and attachments have not been fully characterized.

To date, some of the muscle attachments to the LR have been described. Bogduk and MacIntosh note that the TA and, in some specimens, the IO arise from the LR (Bogduk and MacIntosh, 1984). This arrangement has since been corroborated in several studies (Tesh et al., 1987; Vleeming et al., 1995; Bogduk et al., 1998; Barker et al., 2004; Barker et al., 2007; Barker et al., 2010), and additional attachments proposed: LD (Bogduk et al., 1998) and the EO (Barker et al., 2004). It is important to note that this description of the LR assumes there are anterior (ALF), middle (MLF), and posterior (PLF) layers to the TLF(as described in Bogduk and MacIntosh, 1984; Tesh et al., 1987; Vleeming et al., 1995; Barker et al., 2004; Barker et al., 2006; Barker et al., 2007; Standring, 2008; Barker et al., 2010). According to some reports, the ALF is comprised of the internal abdominal wall fascia, known as the transversalis fascia (specified as 'TF' in figure 1), covering the anterior surface of the quadratus lumborum (Moore and Dalley II, 2006; DeRosa & Porterfield in chapter 2 of and Barker & Briggs in chapter 3 of Vleeming et al., 2007). Therefore, some texts (e.g. Rosse and Gaddum-Rosse, 1997) describe only an anterior layer, that lines the anterior side of the paraspinal muscles (described by most as MLF), and a posterior layer of TLF. Mechanical tensioning studies suggest that the region of the LR may be important for force transmission from the abdominal muscles to the lumbosacral spine. The TA and IO muscles attach to the lateral margin of the TLF via an aponeurosis. (Bogduk and MacIntosh, 1984). That these anterolateral abdominal muscles are involved in spinal stabilization has been implicated in a number of studies (Hodges et al., 1996; Hodges and Richardson, 1997; Hodges et al., 2003; Hides et al., 2011), and altered activation of these muscles is correlated with lumbopelvic pain (Hodges and Richardson, 1996; Hungerford et al., 2003). Using strain gauges and raster photography on unembalmed cadavers, Barker et al. demonstrates that the TA and IO are capable of producing tension in the TLF (Barker et al., 2001; Barker et al., 2004). These articles indicate that much of the tension of these muscles passes through the LR, and they provide valuable insights into the mechanical relationships that govern load transfer between muscles and the TLF.

Recent research has revealed the complexity of connective tissue matrices as they function in load transfer (reviewed in Huijing, 2007). Loose connective tissue is embedded in a larger myofascial support matrix, such as is apparent in the lumbopelvic region, including tendons, aponeurotic sheaths and ligaments (Benetazzo et al., 2011). Forces of muscles are not only transmitted longitudinally (tensile), but also passed to adjacent fibers (shearing transmission) via endomysial connections (Huijing, 2007; Guimberteau et al., 2010). Force also can be passed to antagonistic muscles across interosseus membranes or through fascial compartments. This transfascial transmission of force emphasizes the importance of muscular convergence sites, such as the lateral margin of the TLF.

In light of these findings, to better understand the dynamic stability in vertebrates under constantly changing conditions, fascial structures like the TLF, encapsulating spinal muscles and connecting to the fascia of the abdominal muscles, cannot be viewed as distinct structures. Muscular forces are transmitted to the skeletal system through passive connective tissue structures such as tendons and aponeurosis. The mechanical properties of these tissues thus co-determine the dynamic effects of muscle action. The TLF is itself a composite (Vleeming and Willard, 2010), comprised by layers of fascia, ligaments, loose connective tissue, and muscle (Benetazzo et al., 2011). Without a comprehensive understanding of the complexity of the anatomy of the lateral margins of the TLF it becomes difficult to grasp effective load transfers between tissues or to infer the functional implications of the LR. Therefore, the main objective of this study is to describe the boundaries of, and muscles contributing to form the lateral margin of the TLF.

Materials and methods

Sample Characteristics

Twelve embalmed human specimens (4 male, 8 female; 84.1 ± 11.9 years) were examined of which 11 were embalmed with a standard formaldehyde method (70% isopropyl alcohol, 2% phenol, 1% formaldehyde) and 1 female specimen, embalmed using the Thiel method (17% ethylene glycol, 11% ammonium nitrate, 3% chlorate kersol, 2% formalin). None had evidence of lumbosacral pathology or surgical procedures in the lumbar region, but one female cadaver exhibited a slight scoliosis.

Objectives

1) To test the hypothesis that a single continuous fascia (described in this manuscript as PRS) encloses the paraspinal muscles from the spinous process to the transverse process; 2) to characterize the relationship between the PRS and the anterior and posterior bifurcating lamina of the TA and IO aponeurosis; 3) to describe the tissue residing in between the anterior and posterior bifurcating lamina from the TA and IO aponeurosis; and 4) to corroborate previous data on the constituents of the lateral raphe.

Two formaldehyde embalmed specimens (70yo female; 86yo female) and one Thiel embalmed specimen (82 yo female) were used to dissect the lateral margin of the TLF. Serial reduction dissections from anterior and posterior approaches were used. A total of 27 axial slabs (2cm; levels T12-S1) were sectioned from these specimens. Each axial section was examined both bilaterally and cranially and caudally, to study the lateral margin of the TLF. Therefore, one axial section produces four views of the lateral margin. However, due to variability in vertebral height and imprecision in sectioning, the number of axial sections per vertebral level varied. For example, in cadaver 1418, only one axial section was made at the L2 vertebral level, whereas two axial sections were made at the L3 vertebral level, see table 1.

Table 1: Number of Possible and Observed LIFTs by Vertebral Level of 3 specimens and pooled MRIs

	Vertebral Level						
Specimen	LIFTs	T12	L1	L2	L3	L4	L5
1418	Observed	0	5	4	8	2	0
	Total Possible*	4	8	4	8	4	4
1392	Observed	0	2	5	8	8	0
	Total Possible	4	8	8	8	8	4
Thiel	Observed	0	7	8	8	4	0
	Total Possible	4	8	8	8	4	4
MRIs (pooled)	Observed	0	28	127	250	257	13
	Total Possible	27	32	155	302	296	86

* Total possible is calculated as [number of axial sections] x [number of sides (left and right)] x [number of approaches (superior and inferior)]. Most vertebral levels produced two cadaveric axial sections, therefore total possible for these levels is 8 (2 axial sections x 2 sides per section x 2 approaches). However, at some vertebral levels (e.g. L2 of specimen 1418), only one axial section was produced, in which case only 4 LIFTs are possible (1 axial section x 2 sides per section x 2 approaches). Similarly, MRI sequences are two-dimensional, so it is only possible to see a maximum of two LIFTs per sequence (e.g. no inferior approach).

Findings of the axial-sectioned specimens were compared with photographic images from previous dissections (N = 9; Willard and Carreiro, 2011) that were initiated to characterize the myofascial constituents of the lateral border of the TLF.

Additionally, 37 T1-weighted axial magnetic resonance imaging (MRI) sequences across vertebral levels T12-S1 were examined to compare to the cadaveric findings. These MRI's were made from individuals with no structural evidence of lumbosacral pathology or surgical procedures in the lumbar region. Of the 37 MRI sequences, there were a total of 449 images of the relevant area. Each MRI was examined bilaterally, giving a total of 898 TLF lateral margins of the TLF to be examined. However, not every MRI sequence was through the entire T12-S1 vertebral span, so the number of MRIs per vertebral level varied. For example, there were a total of 302 MRI sequences at the L3 level, but only 155 MRI sequences of the L2 level (see table 1). The MRI sequences were also used to localize the inferior border of the serratus posterior inferior muscle.

To localize the axial level at which the lateral border of the quadratus lumborum widens beyond the lateral raphe (crossover point), 9 axial plane CTs (5 male and 4 female) were obtained from the imaging library at the Department of Anatomy, University of New England. The lumbar spine was examined to insure the absence of gross structural abnormalities. The section where the lateral margin of the QL and the LR were paired in the A-P plane was marked and the associated vertebral level determined.

Results

Paraspinal Retinacular Sheath (PRS) and Lumbar Interfascial Triangle (LIFT)

A primary finding of the present study is confirming the existence of a continuous fascial sheath, from the spinous process to the transverse process, that envelops the paraspinal muscles, referred to as the paraspinal retinacular sheath (PRS; figure 1). The PRS is evident in both cadaveric (figure 2) and MRI (figure 3) axial views and extends from the spinous process dorsomedially to transverse process ventrolaterally. It varies considerably in thickness and is made up exclusively of the deep lamina of the PLF. It is distinct from both the superficial lamina of the posterior layer and the middle layer of the TLF. The epimysium of the individual spinal muscles is very thin and follows the contours of each separate muscle within the PRS. The epimysium is not indicated in figure 1 but lies anteriorly to the erector spinae aponeurosis (indicated as 4).

As the aponeurosis of the TA and IO approaches the lateral border of the PRS, it appears to bifurcate into two distinct laminae, which merge externally to the anterior and posterior walls of the PRS. These two laminae and the portion of the PRS that spans between them, create the boundaries of a previously undescribed

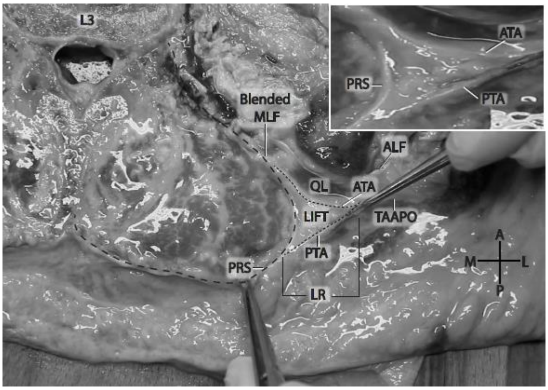

Figure 2: A comparatively large Lumbar Interfascial Triangle (LIFT) at the L3 Vertebral Level. Note the fatty composition of the LIFT. Right pincer is pulling the junction of the anterior and posterior laminae of the TA aponeurosis (small dashed outline). Left pincer is pulling on the PRS (large dashed outline). Inset: Magnified view of LIFT without dashed lines.

TAAPO Transversus Abdominis Aponeurosis, ATA Anterior Lamina of TA Aponeurosis, PTA Posterior Lamina of TA Aponeurosis, LR Lateral Raphe, PRS Paraspinal Retinacular Sheath, LIFT Lumbar Interfascial Triangle, QL Quadratus Lumborum, ALF Anterior Layer of Thoracolumbar Fascia (Transversalis Fascia), MLF Middle Layer of Thoracolumbar Fascia adipose-filled Lumbar Interfascial Triangle (LIFT), situated along the lateral margin of the paraspinal muscles from the 12th rib cranially to the crest of the ilium caudally (figure 1).

The regional distribution of the LIFT in the caudo-cranial axis was examined using axial-plane MRIs and cadaveric sections of the lumbar spine. Of the 27 cadaveric axial sections, 69 LIFTs were identified (out of possible 108; 63.9%). However, when 5 axial sections from levels T12 and L5 were excluded from the data set, due to the presence of a rib or ilium, 69 LIFTs were now identified out of a possible 88 (78.4%). Of the 449 MRI images, 675 LIFTs were identified (out of 898 possible; 75.2%). When 113 MRI sequences from levels T12 and L5 were excluded from the data set due to the presence of a rib or ilium, 662 LIFTs were observed out of a possible 785 (84.3%). Table 1 describes the regional distribution of the LIFT as identified via cadaveric and MRI axial sections. This lumbar interfascial triangle results in the unification of several different fascial sheaths along the lateral borber of the TLF, creating a ridged-union of thickened dense connective tissue, which has been termed in previous studies the lateral raphe (Bogduk and MacIntosh, 1984; see figure 4). The LIFT is positioned at the core of the LR.

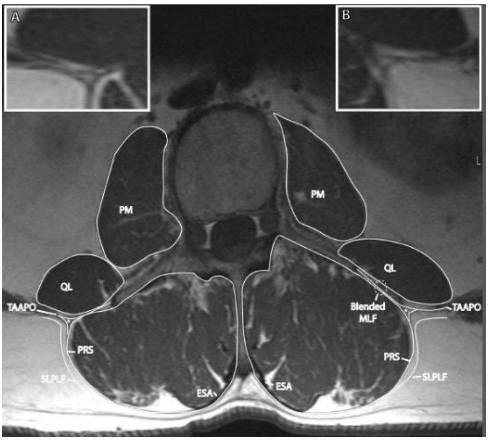

Figure 3: T1 MRI Tracing demonstrating the relationship of the paraspinal retinacular sheath (PRS) and the aponeurosis of the transversus abdominis (TAAPO). TAAPO splits into anterior and posterior laminae which separately join the PRS. The lumbar interfascial triangle (LIFT, indicated by "*") resides in between the laminae of the TAAPO. The anterior lamina of the TAAPO blends with the investing fascia of quadratus lumborum (QL) and the PRS to form a thickened middle layer of thoracolumbar fascia (MLF). Inset A: Magnified view of LIFT from the left side of image, without labels. Inset B: Magnified view of LIFT from the right side of image, without labels. ESA Erector Spinae Aponeurosis, PM Psoas Major, SLPLF Superficial Lamina of Posterior Layer of Thoracolumbar Fascia

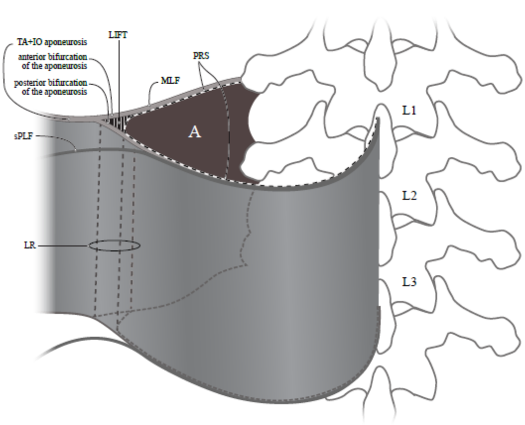

Figure 4: A schematic and simplified view of the bifurcation of the TA and IO aponeurosis and the paraspinal retinacular sheath, creating the lumbar interfascial triangle (LIFT). A represents the empty space normally occupied by the paraspinal muscles and enclosed by the paraspinal retinacular sheath (PRS). The aponeurosis of the transversus abdominis (TA) and internal oblique (IO) bifurcates into anterior and posterior laminae. The anterior lamina contributes to the middle layer of the thoracolumbar fascia (MLF). The posterior lamina contributes to the deep lamina of the posterior layer of the thoracolumbar fascia (PLF). The lateral raphe (LR) represents a thickened complex of dense connective tissue at the lateral border of the PRS, from the iliac crest caudally to the 12th rib cranially. The junction of the transversus abdominis aponeuroses with the PRS creates the lumbar interfascial triangle (LIFT), which is at the core of the LR. Thus, the raphe is formed at the location where abdominal myofascial structures join the PRS surrounding the paraspinal muscles. sPLF superficial lamina of PLF

Components of the lateral border of the TLF

A second objective of the present study was to corroborate and extend previous findings on the anatomical constituents of the lateral raphe. Significant muscles interacting with the LR include the latissimus dorsi (LD), serratus posterior inferior (SPI), transversus abdominis (TA), internal oblique (IO) and quadratus lumborum (QL).

The LD forms a broad, flat aponeurosis that approaches the spine from a craniolateral position. Medially the aponeurosis attaches to the lower six spines of the thoracic vertebrae and the spines of the lumbar vertebrae. Laterally, the muscle attachment has a variable arrangement; in all ten of our specimens, the LD or its aponeurosis attached to the iliac crest, typically from the iliac tubercle posteriorly to the posterior superior iliac spine. In 7 out of 10 specimens, the LD had become aponeurotic more than 5 cm cranial to the lateral-most attachment to the iliac crest. In 2 out of 10 specimens, the LD became aponeurotic less than 5 cm cranial to the iliac crest and in 1 specimen the LD muscle fibers reached the crest at its lateral most attachment. In this latter arrangement, the LD lies over the LR posteriorly.

The SPI is a series of four thin rectangular sheets of muscle attached to the caudolateral margin of the 9th through 12th ribs. Medially the aponeurosis of the SPI inserts between the superficial and deep laminae of the PLF, terminating by attaching to both laminae. Those laminae continue medially to attach to the spinous processes. The inferior border of the SPI is of significance since it will determine how much of the LD and its aponeurosis can contribute to the LR. In 2 out of 4 dissected specimens where the caudal border of SPI could be accurately determined, it was found at approximately the L3 level, in 1 specimen it was at the L4 level and in another at the L2 level. Using axial MRI sequences, the caudal border of the SPI was found to be located at the L3 vertebral level in 57% of specimens, whereas in 30% of specimens, SPI ended at the level of L2. In another 10% of the specimens, the caudal border of the SPI was at the level of the intervertebral disc between L2 and L3, and in the remaining 3%, the caudal border of SPI was located at the level of the L4 vertebra. Therefore, the LD is separated from the LR by the SPI for most of its superior extent (figure 1).

The middle fibers of the TA arise from the rectus sheath anterior and form a thick aponeurosis laterally. This aponeurosis is joined by fibers from the lateral aspect of the IO and wraps laterally around the torso to reach the PRS between the T12 to L4 levels. Between the L2/L3 intervertebral disc level to the L4 vertebral level, as this aponeurosis approaches the PRS, it appears to separate into two layers (figure 1 and 2) that contribute to the formation of the LIFT as previously described.

In no specimen was the EO seen to directly communicate with the lateral margin of the TLF. The caudolateral attachment of the EO on the iliac crest terminates anteriorly to the TLF and the cranial border of the EO attaches to the 12th rib. However the thin, investing fascia (epimysium) of the EO is seen attaching to the aponeurosis of the TA and IO.

The quadratus lumborum (QL) resides anterior to the MLF extending from the iliac crest to the 12th rib. Like all muscles, the QL is surrounded by a thin investing fascia (histologically termed the epimysium; figure 1). The anterior surface of the QL is also covered by a thin, velvety layer of transversalis fascia, which has been termed the ALF. Moving from cranial to caudal, the lateral border of the QL expands laterally as it approaches the crest of the ilium. The location at which the lateral border of the QL becomes lateral to the lateral border of the paraspinal muscles (crossover point) varies. In the series of 9 abdominal CT scans, the lateral border of the QL typically passes lateral to the paraspinal muscles at the level of the L2, being seen as high as the L1/L2 intervertebral disc in 2 scans (1 male and 1 female) and as low as the caudal border of L2 in 2 scans (1 male and 1 female). Cranial to the cross-over point, the transversalis fascia and the

MLF merge at the anterolateral border of the QL, thereby contributing to the anterior border of the LIFT and the LR (see figure 1).

Discussion

The purpose of the present study is to confirm the presence of a retinacular sheath surrounding the paraspinal muscles and to characterize the boundaries and contents of the lateral margin of the TLF.

Components of the lateral border of the paraspinal muscles and their relationship with the lateral raphe

The present dissections confirm that the so-called TA aponeurosis is actually created by the TA and IO. These findings support most existing literature on the relationship between the TA and the IO (Bogduk and MacIntosh, 1984; Tesh et al., 1987; Vleeming et al., 1995; Barker et al., 2004). The findings are in contrast to Jemmett and colleagues (Jemmett et al., 2004) who described the TA aponeurosis as bypassing the LR and as contributing solely to the ALF. However, their data are derived from a single dissection, and the authors acknowledged that their results may well been indicative of simple variation in the normal anatomy.

In the present study, no direct contribution of the EO aponeurosis to the lateral border of the TLF was found. This is in contrast to the findings of Barker et al, who report a connection of the EO to the LR superior to the L3 vertebral level (Barker et al., 2004). The loose attachment of the muscle to the underlying aponeurosis of the transversus abdominis does not support a major role of the EO in load transfer to the lumbar spine.

The QL is a hypaxial muscle, located anteriorly to the paraspinal muscles. It extends from the 12th rib cranially to the crest of the ilium caudally. Its medial border attaches to the transverse processes of the lumbar vertebrae, and its lateral border is free. Typically this border begins cranially from a point medial to the lateral border of the paraspinal muscle and angles from craniomedial to caudolateral as it descends towards the ilium. At some point along this line, the free border of the QL widens lateral to the lateral margin of the paraspinal muscles. In this study, this cross-over point has been determined to occur approximately at L2. Thus below L2, the structures forming the lateral margin of the paraspinal muscles (TLF, LR and LIFT) are reinforced internally by the presence of the QL and its associated fascia (see figure 1); above L2 the lateral margin of the paraspinal muscles is reinforced only by the transversalis fascia.

Paraspinal Retinacular Sheath

The present study demonstrates that the paraspinal muscles are invested by a paraspinal retinacular sheath with variable thickness. This PRS is distinct from and external to the very thin epimysial layer covering the individual lumbar muscles. The PRS is distinct and can be separated from the bifurcating laminae of the TA aponeurosis. Based on embryological observations (Bailey and Miller, 1916), the muscles of epaxial origin, such as the paraspinal muscles, develop encased in an intact fascial sheath (the PRS) from the spinous processes to the transverse processes. Furthermore, it would be expected that hypaxial muscles, such as the TA, will attach to the PRS but not penetrate into it (Willard et al., 2012).

At this time, to effectively conceptualize the PRS, is to view it as the deep lamina of PLF extending around the lateral border of the paraspinal muscles and joining the MLF to reach the transverse processes of the lumbar vertebrae. Barker and colleagues report a significant thickening of the MLF as it approaches the transverse processes medially (Barker et al., 2007). Based on the present data, we interpret this medial thickening as resulting from blending initially between the anterior lamina of the aponeurosis of the TA and IO and the posterior investing fascia of the quadratus lumborum; subsequent addition of the PRS to this combined layer creates the medial thickening (figure 1). In this interpretation, the thinner, more lateral part of the MLF is comprised of the anterior lamina of the TA and IO aponeurosis and the QL fascia, while the thicker, more medial portion is composed of three fascial sheets. Further, the present dissections indicate that the anterior surface of the QL (commonly referred to as the ALF) is lined by transversalis fascia, in agreement with Hollingshead (Rosse and Gaddum-Rosse, 1997) and Barker and Briggs (Barker et al., 2007; Vleeming et al., 2007).

If the paraspinal muscles were only enveloped by the MLF and PLF, rather than one continuous PRS, lateral expansion of the paraspinal muscles could cause a split all the way to the lateral edge of the TA and IO aponeurosis. Because the PRS is a complete fibro-osseous ring, there is no such point of weakness. Tesh and colleagues did not describe such a separation during inflation of intra-paraspinal balloons (Tesh et al., 1987). Furthermore without a PRS, it is unlikely that a paraspinal compartment syndrome could develop (Carr et al., 1985).

The PRS could play a vital role in spinal stabilization via the hydraulic amplifier mechanism (Gracovetsky et al., 1981; Bogduk and MacIntosh, 1984; Gracovetsky, 1985, 1986, 2008). In brief, as paraspinal muscles contract, the PRS and the associated fascial layers connected to it, such as the MLF and the superficial layer of the PLF, are tensed in all directions, thereby compressing the sheath against the paraspinal muscles and creating a hydraulic effect that aids in erecting the spine from a flexed position.

Formation of the Lumbar Interfascial Triangle along the lateral border of the paraspinal muscles

The anterior and posterior laminae of the TA and IO aponeurosis diverge approximately 0.5-2 cm lateral to the PRS and become continuous with the anterior and posterior margins of the PRS, respectively. The two laminae of the TA and IO aponeurosis and the PRS form the boundaries of an adipose-filled region that is coined in this article the lumbar interfascial triangle (LIFT). To the authors' knowledge, the LIFT has not been not been discussed in previous literature. However, the LIFT has appeared in previous diagrams (Figure 2 in Carr et al., 1985; Figures 1 and 5 in Tesh et al., 1987), but was not addressed or specified in the text of these articles

The existence of the LIFT explains why a ridged union of connective tissue is formed called the LR. This region of increased fascial density receives direct and indirect contributions from several muscles associated with the anterolateral abdominal wall, superficial and deep back, and the gluteal region. Huijing describes force transmission of muscles across the extracellular matrix to neighboring muscles, both synergists and antagonists (Huijing, 2007). Similarly, the LIFT may function in the distribution of laterally-mediated tension to balance different visco-elastic moduli, along either the MLF or PLF. The converse may also be true: tension in the anterior and posterior laminae of the TA aponeurosis is likely dependent on contraction of muscles within the PRS. In this scenario, the function of the LIFT may be to reduce friction of adjacent fascias under high-tension (Theobald et al., 2007). Alternatively, the LIFT may accommodate lateral expansion of the paraspinal muscles during contraction. Nevertheless, the present study has made no attempt to determine the effect of tension on the PRS or LIFT, and these should be areas of future research.

Relationship of the Lumbar Interfascial Triangle to the Lateral Raphe

Based on the present findings, the following updated definition of the lateral raphe is proposed:

The lateral raphe (Bogduk and MacIntosh, 1984) represents a thickened complex of dense connective tissue at the lateral border of the PRS, from the iliac crest caudally to the 12th rib cranially (figure 1). It marks the junction of the aponeurosis of the TA and IO with the PRS. This junction creates the formation of the LIFT. The blending of the bifurcating anterior and posterior laminae from the TA and IO aponeurosis to the PRS forming the LIFT, gives rise to a ridged union of dense connective tissue, which has been named the lateral raphe. It is through this dense connective tissue complex (raphe) that the tension, generated by the abdominal myofascial girdle, dissipates across the paraspinal sheath.

This definition is in general agreement with the original definition proposed by Bogduk and MacIntosh. The contributions of the TA and IO are consistent with the original definition. Also, the proposed definition agrees that the MLF and deep lamina of the PLF contribute to the LR. However, the concept of the MLF and deep lamina of the PLF splitting to create the PRS is implicit in the original definition, whereas the proposed definition in this article suggests that the PRS, formed by the deep lamina of the PLF, is a separate entity that receives contributions from the anterior and posterior bifurcations of the TA aponeurosis (figure 1).

The strength of the LR is demonstrated by two structures described in the clinical literature as the superior (also known as Grynfeltt's) and Inferior (also known as Petit's) Lumbar Triangles (Guillem et al., 2002; Astarcioglu et al., 2003; Armstrong et al., 2008; Lillie and Deppert, 2010). Petit's triangle overlaps the caudolateral portion of LR. Grynfeltt's Superior Lumbar Triangle overlaps the superolateral portion of the LR. These triangles are common sites of visceral herniation in the lumbar region. Herniations typically take the path of least resistance. Thus, passage of the herniation just lateral to the LR may speak toward the robustness of the ridged union known as the LR. Again, the strength of the LR was not assessed in the study, and should be the focus of future studies.

Conclusion

A significant finding in this study is the confirmation of a paraspinal retinacular sheath (PRS) surrounding the paraspinal muscles between the spinous and transverse processes. This sheath is a continuation of the deep lamina of the PLF around the lateral border of the paraspinal muscles and its subsequent fusion with the MLF. The lateral margin of the TLF represents the junction between the PRS and the aponeurosis of the TA and IO. It forms a triangular-shaped space, the lumbar interfascial triangle (LIFT), deriving from the anterior and posterior bifurcation of the TA aponeurosis, and the portion of PRS that spans between them. This LIFT may act as a fulcrum distributing laterally-mediated tension to balance different viscoelastic moduli, along either the middle or posterior layers of the TLF. It may also serve to reduce friction between those two entities. The lumbar interfascial triangle (LIFT) has not been discussed in detail in previous literature. The existence of the LIFT elucidates why a ridged union of connective tissue is formed, called the lateral raphe (LR).

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Keywords

Lateral Raphe, Thoracolumbar Fascia, Paraspinal Retinacular Sheath, Lumbar Interfascial Triangle, Lumbar Spine, Pelvis, Transversus Abdominis

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Altered Intra-Compartmental Pressure Within The Thoracolumbar Fascia Container; Its Effect On Force Transfer To The Common Tendon Of The Transversus Abdominus Muscle To The Middle And Posterior Layer Of The Paraspinal Muscle Compartment

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Introduction

Stabilization and movement of the lumbosacral spine is contingent on the complex interaction between muscles, ligaments and fascia surrounding the torso. The thoracolumbar fascia (TLF) represents a girdling structure consisting of several aponeurotic and fascial layers that separates the paraspinal muscles from the muscles of the posterior abdominal wall. Understanding the complex function of the TLF and its associated fascial compartments is critical to anatomical and biomechanical analysis and implementation of effective treatment in patients with lumbopelvic pain.

The TLF envelops the back muscles from the sacral region, through the thoracic region and plays an important role in posture, load transfer and respiration1-17. The TLF is comprised of three layers of which both the fibrous posterior layer (PLF) and the middle layer (MLF) have a significant biomechanical function1-10,12,14,15,18. The delicate anterior layer (ALF) merely represents the thin transversalis fascia lining the deep surface of transversus abdominus and the quadratus lumborum muscles 1.

Superficial lamina of the PLF

The PLF is a composite of two embryologically different layers of connective tissues. The superficial lamina derives from the aponeurosis of the latissimus dorsi, an extremity muscle, while the deep lamina represents the epaxial fascial sheath that surrounds the developing paraspinal muscles tissue1,3,6,7,10,18. Superficial to the deep lamina is a collective sheath of fascia, bridging from the first rib down to the xiphoid process anteriorly, and from the cranial base to the sacrum posteriorly1,19,20. This fascial sheath contains muscles such as the pectoralis major and minor, rhomboid major and minor, trapezius, serratus anterior1,8 and the latissimus dorsi (LD). The expansive LD muscle reaches far caudally and forms the superficial lamina of the PLF. In addition, the aponeurosis of this muscle partially crosses the midline to connect to the fascia of the contralateral gluteus maximus muscle (GM)6,8,10.

Deep lamina of the PLF

The deep lamina extends from the spinous processes to the transverse processes and is distinct from both the superficial lamina of the PLF and the middle layer of the MLF. Rostrally the deep lamina most likely begins on the occipital bone and extends caudally to its fusion with the superficial lamina over the sacrum. The lateral margin of the deep lamina of the TLF is located at the common intersection of the hypaxial (e.g. ventral trunk muscles) and epaxial (para-spinal) muscles1. Several authors have studied the deep lamina of the posterior layer of the TLF3,6,7,10. Bogduk & Macintosh6 described the deep lamina as having alternating bands of dense fibers, which they termed accessory ligaments and proposed that the deep lamina stems most likely from the crossed fibers of the aponeurosis tendon of the LD. Vleeming et al.10 and Barker & Briggs7 describe the same fascial bands, however typically characterizing the deep lamina of the PLF as being mainly formed by the aponeurosis tendon of the serratus posterior inferior muscle (SPI).

The arrangement of a fascial compartment in the lumbar spine, created by a fascial sheath encapsulating the paraspinal muscles, has been noted or illustrated by numerous authors3,6,8,10,18,21-27. Standring28 described a designated osteofascial compartment for the

paraspinal muscles. Many authors cited above, utilize the deep lamina of the PLF to describe the inner posterior wall of this encapsulating sheath and the MLF to describe the anterior wall. However, most of these descriptions are based on the assumption that the deep lamina of the PLF is a longitudinally oriented, flat fascial sheath1.
The lateral border of the deep lamina contributes to the lateral raphe3,6,8,10,24. Spalteholz25 describes the lateral border as curving around the paraspinal muscles to join anteriorly to the MLF. Tesh et al.3 describes the deep lamina as encircling the paraspinal muscles. Likewise, Carr et al.12 measured intracompartmental pressure and concluded that sustained pressure within the TLF is only possible if the paraspinal muscles are enclosed by a continuous fascial sheath.
A recent study has examined the extend of the deep lamina and confirmed that it forms a sheath surrounding the paraspinal muscles, which has been coined the paraspinal retinacular sheath (PRS). This sheath represents the innermost part of the deep lamina of the PLF2 and is attached to the spinous process posteriorly and the transverse process anteriorly. Laterally, the PRS forms a junction with a common aponeurosis derived in main from the transverses abdominis but also containing variable contributions from the external oblique above the transverse process of L315 and the internal oblique below the transverse process of L3 6,8,29. This common aponeurosis (termed CTrA) forms a strong anchor or seam for the transmission of force between the abdominal muscles anteriorly and the paraspinal muscles posteriorly (see fig.1)

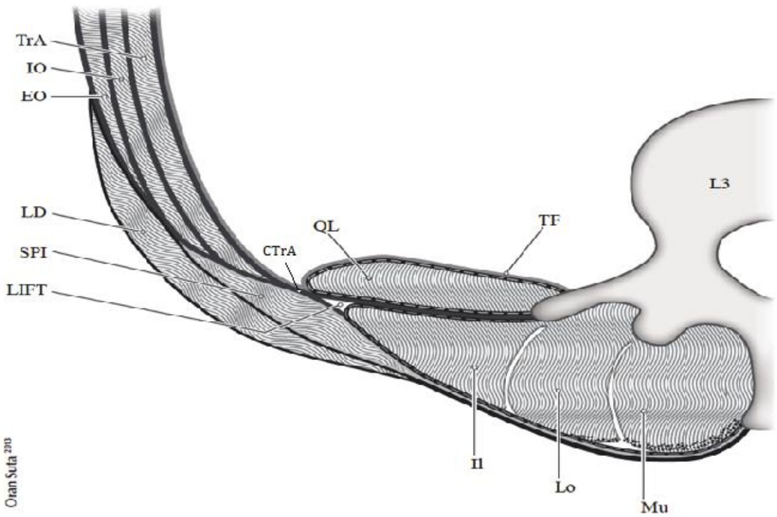

Figure 1. Modified with permission from Fig 9 in Willard et al 2012 1. This is an axial section of the posterior and middle layer of the thoracolumbar fascia and related muscles at the L3 level. Fascial structures are represented such that individual layers are visible, but not necessarily presented to scale. Please note that the serratus posterior inferior (SPI) often is not present caudal to the L3 level. The transversus abdominis (TrA) muscle is covered with a light grey line on the peritoneal surface illustrating the transversalis fascia (TF). This fascia continues medially covering the anterior side of the investing fascia of the quadratus lumborum (QL). Anteriorly and medially, the transversalis fascia (TF) also fuses with the psoas muscle fascia (not drawn). The internal (IO) and external oblique (EO) are lying superficial to the TrA. Latissimus dorsi (LD) forms the superficial lamina of the PLF together with the SPI, where present. The three paraspinal muscles, multifidus (Mu), longissimus (Lo) and iliocostalis (Il) are contained within the paraspinal retinacular sheath. As the common aponeurosis of the TrA and IO (CTrA) approaches the paraspinal retinacular sheath (PRS), it bifurcates into anterior and posterior laminae, creating a lumbar interfascial triangle (LIFT). An approximation of the aponeurosis (tendon) of the paraspinal muscles is indicated by stippling. Please note that the epimysium of the individual spinal muscles is thin but follows the contours of each separate muscle within the paraspinal retinacular sheath. The epimysium is not indicated in the present figure but lies anteriorly to the aponeurosis.

To better understand low back and pelvic girdle pain it is essential to develop a detailed understanding of how abdominal and spinal muscles cooperate to influence lumbopelvic motion and postural stability. Specifically, how activation of the middle parts of the TrA and OI muscles influence force transfer to the PLF and MLF. The aim of the present study is to analyze the effect of incrementally raising inflation within the paraspinal muscle compartment (simulating paraspinal contraction), without and combined with, simultaneous CTrA tension (simulating TrA/IO contraction), on force transfer through the PLF and MLF.

Materials and methods

Specimen characteristics and preparation

Seven embalmed (70% isopropyl alcohol, 2% phenol, 1% formaldehyde) human specimens (three male, four female; 69.9 ± 17.3 years) were studied. On one specimen, the skin and superficial fascia had been dissected before axial sectioning. In comparison to the other six specimen, there were no statistically significant differences, and the data of seven specimen was pooled.

A total of 14 axial slabs were sectioned (approximately 2 cm thickness) using an industrial band saw (Hobart 5801, Troy, OH. USA). Prior to sectioning, the lumbar region of each cadaver was assessed with a C-arm fluoroscope (Exposcope 7000, Ziehm Imaging Inc, Orlando, FL, USA) to identify planes that contain transverse processes bilaterally. The transverse processes were marked by the transverse placement of a needle and axial sections made between the needle positions. Left and right TLF compartments of all seven specimen were analyzed individually, resulting in N=14. None of the samples revealed evidence of lumbosacral pathology or surgical procedures in the lumbar region. Conducting the measurements at the level of the transverse processes is essential, because the MLF partially loses its insertion at intertransverse levels in order to create a passageway for the dorsal neurovasculature. Only axial sections through levels L2 and L3 were used in this study, because sections including L1 contained rib fragments. Similarly, sections through the L4 level were not included, because they contained portions of the iliac crest see fig.2).

Objectives

1. To test the hypothesis that changes of intra-compartmental pressure within the paraspinal muscle compartment (mimicking incremental contraction of paraspinal muscles) alters the load transfer between the PLF and MLF. In order to test this:
   A. A: the perimeter of the left and right fascial paraspinal muscle compartment (PMC) (from transverse process to spinous process) was measured at three stages of intra-compartmental pressure without tension to the common transversus tendon (CTrA).
   B. B: using the same pressure increments (as in 1A), the perpendicular straight-line distance without CTrA tension was measured from the lateral tip of the transverse process to the posterior border of the PLF, to analyze posterior displacement of the PLF1
2. To test the hypothesis that with tension of the CTrA and incremental PMC pressure, the fascial tension is primarily transferred to the PLF, rather than the MLF. In order to test this, measurements similar to those described in 1A and 1B were repeated with 8.5 N tension being exerted bilaterally through the CTrA (see fig 3).
   A. A: Load cells were used to measure unidirectional tension along anterior and posterior CTrA laminae with CTrA tension (see figure 2). This was repeated under three incremental stages of intra-compartmental pressure.
   B. B: Only one single load cell was used in experiment 2A, to measure unidirectional tension for each anterior lamina (MLF) and the posterior lamina (PLF) during CTrA tension while incrementally inflating the paraspinal muscle compartments. After finalizing the experiments (2A), it became obvious that especially the posterior part of the PLF became extended. It is reasonable to expect that during each incremental inflation, the rubber tubes (simulating paraspinal contraction) impose a posteriorly-directed force on the PLF. However, for most experiments, the load cells were oriented to quantify force in the anterolateral direction during CTrA tension, to differentiate force transfer between the MLF and PLF. Subsequently, the load cell would not directly measure inflation-induced tension in the posterior direction because inflation has the biggest effect on the posterior part of the PLF, partially minimizing the force in the unidirectional load cell with each incremental inflation. Therefore, to quantify this

inflation-induced, posteriorly-oriented force, an additional set of experiments (bidirectional tension along the posterior CTrA lamina with CTrA tension) was conducted bilaterally on two axial slabs (measuring in total 4 compartments per inflation condition). One load cell was positioned as before along the PLF in the posteromedial direction, additionally a second load cell was positioned along the PLF in an anterolateral direction The CTrA was tensed with the same load of 8.5N, along the CTrA and the same incremental inflation stages as in experiment 2A.

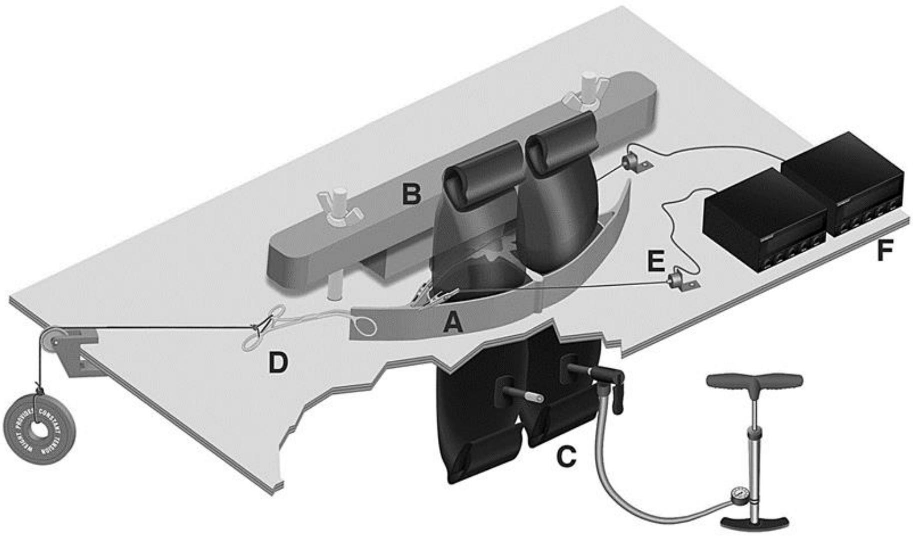

Figure 2. Experimental Apparatus Design. Cadaveric slab (A) is placed on a wooden platform with holes to accommodate inflatable tubes (C) attached to a positive displacement pump (note: jagged cut-out is to demonstrate spatial context). To prevent vertebral rotation, a crossbar (B) is placed across the vertebral body and clamped down using wingnuts on threaded bolts. A hemostatic clamp (D) attaches the common aponeurosis of the transversus abdominis and internal oblique muscles (CTrA) to a constant load. Aligator clips are attached to the anterior and posterior laminae of the common aponeurosis to load cells (E) that connect to load cell meters with digital display (F).

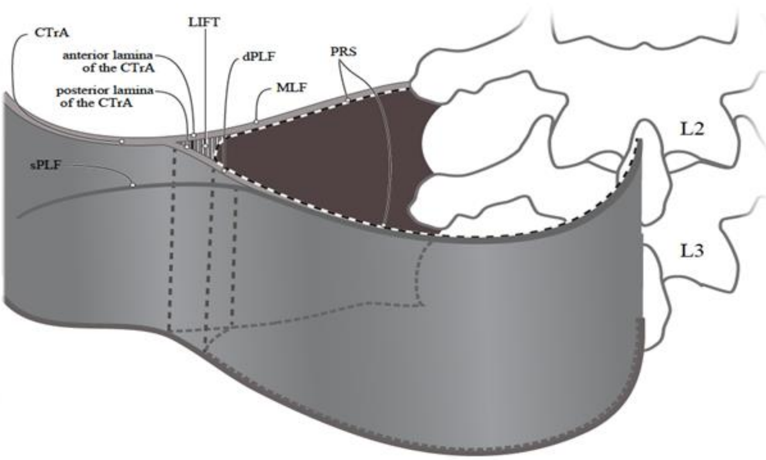

Figure 3. Modified with permission from Fig 4, Schuenke et al 2012 2. An axial sectioned view of the TLF on L2-3 level. The CTrA bifurcating into anterior and posterior laminae, together with the thin paraspinal retinacular sheath (PRS; indicated by the black and white dashed line) form the boundaries of the lumbar interfascial triangle (LIFT). The anterior lamina contributes to the middle layer (MLF). The posterior lamina contributes to the deep lamina of the posterior layer (dPLF): sPLF, superficial lamina of PLF.

Testing methods

Preventing vertebral displacement

The vertebral body of the cadaveric slab was selectively clamped to a customized baseboard, to prevent movement of the vertebra, but not to impede any soft tissue movement. Also, the board was designed in such a way to permit insertion of inflatable tubes through the TLF compartments (see drawing). A 2.54x2.54 cm customized compression bar was tightened in place over the vertebral body thereby eliminating unwanted motion of the bony structures (see figure 2).

Marking the perimeter of the PMC

In order to track perimeter changes of the fascial compartments, copper beads (2-8mm, Sigma-Aldrich Co., USA) were affixed (methyl 2-cyanoacrylate Loctite, Henkel Corp., USA) at approximately 1.5 cm intervals along the anterior and posterior lamina of the MLF and PLF and the paraspinal retinacular sheath (PRS). Care was taken to ensure that beads adhered only to fascia and not to adjacent muscles (see fig. 3 and 5)

<u>M1. Loading the CTrA</u>

M1a.

Two load cells (LCMFD-10N, Omega Engineering Inc., Stamford, CT, USA) each attached to left or right CTrA were pulled anterolaterally (mimicking the curved shape and direction of the TrA and IO muscles) to generate bilateral forces of 8.5 N. (see figure 2). A tension of 8.5N was selected, based on the work of Barker et al8 who demonstrated that the CTrA in cadavers could strain at 10N.

M1b.

The CTrA was loaded with 8.5N of tension anterolaterally, via self-locking hemostats, simulating the normal function of the CTrA (see figure 2 and 3). Tension load cells were either attached respectively to the anterior (MLF) and posterior lamina (PLF) of the CTrA, using alligator clips (objective 2C) or both attached to the PLF in opposite directions (objective 2D).

<u>M2. Simulation of paraspinal muscle contraction</u>

Paraspinal muscles were carefully removed not to damage the surrounding fascia. Custom-made inflatable butyl rubber tubes (uninflated diameter 2.54 cm, length 10cm) were placed inside the right and left PMC. To simulate contraction of the paraspinal muscles, the tubes were inflated. Due to inter- and intra-specimen variation of paraspinal muscle size, a standard initial pressure could not be used. Instead, the first inflation (Inf1) was the minimum pressure required to hold the tube in the container. Subsequent inflations were set at 1.5 cm increments above the circumference of the initial inflation. All circumferential measurements were taking using a soft, tailor's tape measure immediately above the superior surface of the axial section. The average intra-tube pressure for Inf1, Inf2 and Inf3 were 79.1mm Hg, 99.8 mm Hg, and 106.5 mm Hg respectively. A study of healthy young individuals showed that the mean submaximal muscle contraction pressure was 175 mm HG, during isometric and concentric extension exercises30. Compared with the present study, the average inflation pressure is on average 50% less.

<u>M3. Measuring the perimeter of the TLF</u>

The pre-tensed (neutral) position of the copper beads was imaged using a C-arm fluoroscope. During tensioning the CTrA with 8.5N, a second image was captured. In order to compare the positioning of the beads between the neutral and tensed
CTrA , the opacity of the tensed image was reduced to 40%. The tensed image was superimposed to the neutral image using Adobe Illustrator (Adobe Systems Inc, San Jose, CA, USA). For every increment of inflation, new pre-tensed and tensed images were captured and compared.
During superimposition, vertebral processes from each image were aligned. Subsequently, a curved line was drawn, connecting all of the beads for a given inflation condition to measure perimeter changes (NIH ImageJ software) around the PMC. There was no statistical difference

between the right and left MLF nor for the right and left PLF, for a given inflation condition. Therefore, lengths of the left and right MLF and PLF were pooled for each inflation condition.

M4. Analyzing posterior and lateral displacement of the PMC

The straight-line perpendicular distance from the lateral-most tip of the transverse process to the posterior part of the PLF in the x-plane (figure 5) was measured using ImageJ software with MTrackJ plug-in 31. The distance from the aforementioned straight line to the lateral most point of the border of the PMC was also measured with MTrackJ. These measurements were taken under the same inflation increments as described in M3 and performed without CTrA tension (objective 1B) and with 8.5N CTrA tension (objective 2B).

M5. Differentiating MLF/PLF force transfer resulting from CTrA tension

Tension load cells were attached to the anterior and posterior laminae of the CTrA, continuous with the MLF and PLF respectively, using alligator clips (see figure 2 and 3).

A reading of each load cell was recorded without tension (neutral). A load (8.5N, after accounting for frictional and drag components) was then applied anterolaterally to the CTrA, using self-locking hemostats, and was suspended on a pulley (see enlargement Oran). Each step of incrementally pressurizing the PMC, with custom made inflatable butyl tubes, was recorded with the load cells, analyzing the relative force transfer between MLF and PLF. The differential in load transfer through the anterior and posterior laminae of the CTrA is calculated by:

$MLF_{tension} = MLF_{tensed} - MLF_{Neutral}$

$PLF_{tension} = PLF_{tensed} - PLF_{Neutral}$

M6. Analyzing the effect of inflation on PLF force transfer

To quantify the subtractive effect of incremental inflation on specifically PLF tension, two axial slabs (measuring 4 compartments per inflation condition) were tested. One alligator clip connected to a load cell was positioned as before along the PLF in the posteromedial direction and another alligator clip connected to a second load cell was positioned along the PLF in an anterolateral direction. The same CTrA load (8.5N) and incremental inflations (as described in M2) were used.

Results

Fascial perimeter without CtrA tension

The perimeter of each MLF and PLF was measured (M3) with muscles intact and at each inflation increment (M2). There was no statistical difference in perimeter length between the right and left MLF, nor right and left PLF for any given inflation condition. Consequently, measurements of the right and left MLF were pooled and likewise for the PLF (see figure 4). The perimeter length of the MLF did not change significantly with inflation (p=0.78). In contrast, the length of PLF increased significantly with inflation (p=0.046). Post-hoc analyses revealed that the length of the PLF increases significantly between the muscles intact condition (before inflation) and Inf3 (p=0.012). There was a trend towards significance between muscles intact and Inf2 (p=0.051) and between Inf1 and Inf3 (p=0.092).

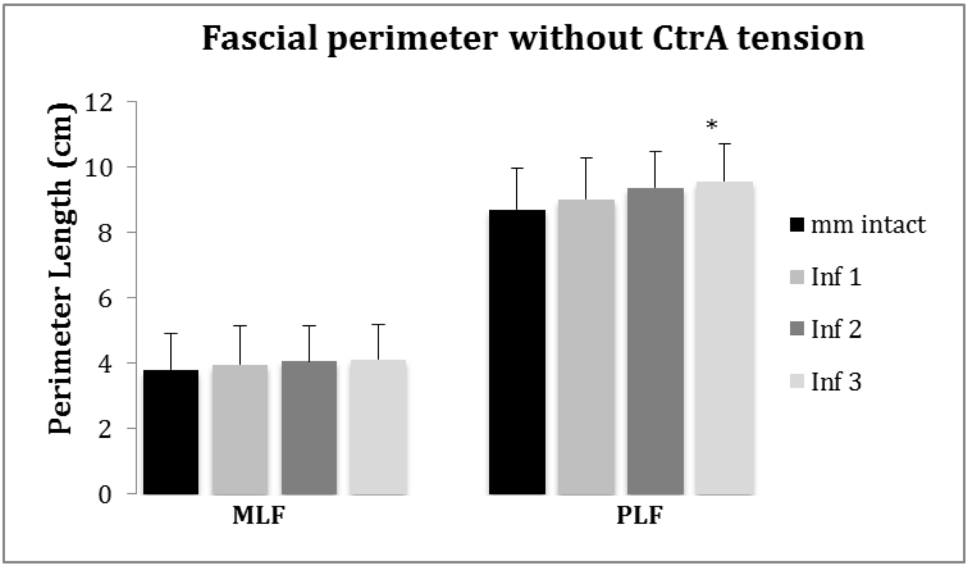

Figure 4. The length of MLF and PLF at each increment of intra-compartmental pressure without CrTA tension. There is statistical significance (*) between the muscles intact and Inf3 conditions.

Analyzing posterior and lateral displacement of the PLF
Without CTrA tension

The perpendicular straight-line distance in the posterior direction (SLDpost) was measured from the lateral tip of the transverse process to the PLF (M4; see figure 5). The SLDpost increases with inflation (p = 0.0005). Post-hoc analyses indicate that the SLDpost in the muscles intact condition, is significantly shorter than the SLDpost in Inf1 (p=0.0086), Inf2 (p=0.0011), and Inf3 (p=0.0001). The SLDpost does not significantly differ between the three inflation conditions (Inf1 vs Inf2, p=0.52; Inf1 vs Inf3, p=0.18; Inf2 vs Inf3, p=0.49).

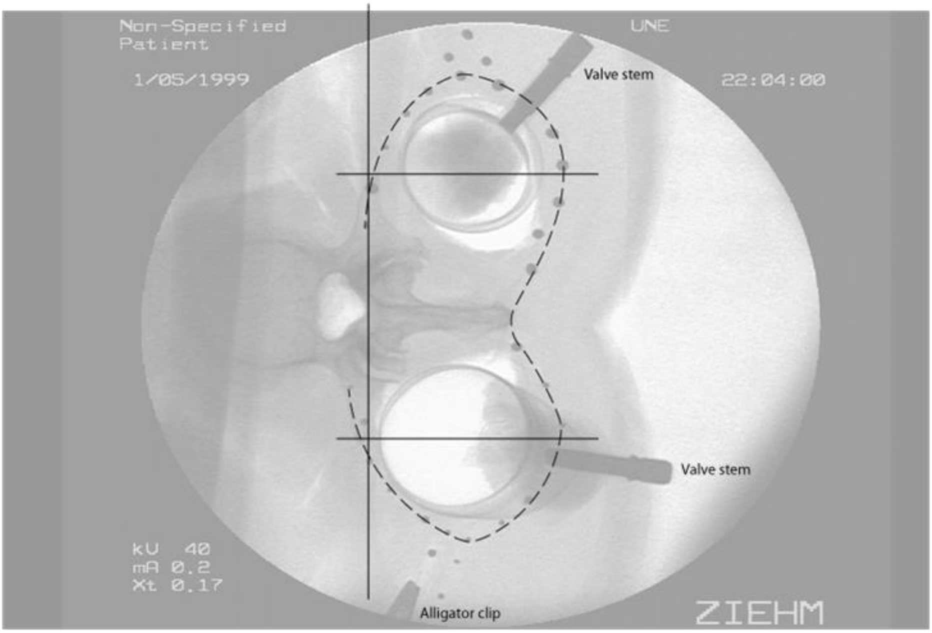

Figure 5. Analyzing posterior and lateral displacement of the borders of the PMC with incremental inflation. Posterior displacement of the posterior border was measured on a perpendicular straight line from the lateral most point of the transverse process to the posterior border of the PLF (M4; indicated by black x's). This line was then used as a reference line for measuring medial-to-lateral displacement of the PMC (SLDlat). This was measured from the perpendicular straight line to the lateral most point of the paraspinal muscle compartment (indicated by white x's). These measurements were done with (M1a) and without (as shown) CTrA tension.

The aforementioned line drawn perpendicular to the lateral tip of the transverse process (described above; see figure 5) was then used as a reference line from which to measure the straight line lateral displacement (SLDlat) of the PMC. The SLDlat was measured perpendicularly from that reference line to the lateral most point of the PMC. The SLDlat did not significantly differ between the muscle intact condition and any of the inflation increments ($p = 0.68$).

With CTrA tension

To determine the net effect of CTrA tension (M1a) and inflation (M2) of the PMC (i.e. co-contraction of TrA/IO and paraspinal muscles), the perpendicular SLD_{post} of the baseline condition (M4; no CTrA tension, no PMC pressure) was compared to 8.5N CTrA tension at each inflation increment. For example:

$SLD_{diff} = SLD_{0N,\ mm\ intact} – SLD_{8.5N,\ Inf1}$

Predictably, when the CTrA is tensed with no pressure in the PMC, the PLF moves anteriorly. However, with each incremental inflation, the amount of anterior movement due to CTrA tension is significantly reduced ($p = 0.0001$). In fact, the anterior movement due to CTrA tension is negated by the inflation-induced posterior movement, such that the net displacement of the PLF is in the posterior direction. The amount of CTrA-induced anterior movement of the PLF is also significantly reduced in inflations Inf2 ($p = 0.024$) and Inf3 ($p = 0.0008$), relative to Inf1. There was no significant difference between Inf2 and Inf3 ($p = 0.32$).

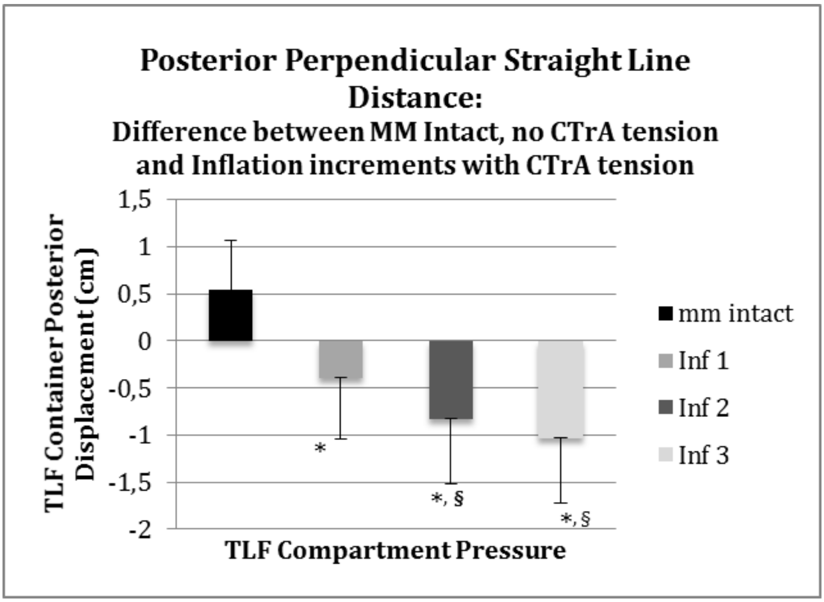

Figure 6. Straight-line distance from the tip of the transverse process to the PLF under different inflation increments (see also figure 5): Comparison of baseline condition (mm intact, no CTrA tension) with 8.5N CTrA tension and incremental inflation. A positive value indicates anterior displacement. A negative value indicates posterior displacement. * indicates significant difference from mm intact. § indicates significant difference from inf1.

Similarly, to determine the net effect of CTrA tension and inflation of the PMC (i.e. co-contraction of TrA/IO and paraspinal muscles), the SLDlat of the baseline condition (no CTrA tension, no PMC pressure) was compared to 8.5N CTrA tension at each inflation increment (figure 7). With muscles intact (no PMC pressure), 8.5N CTrA tension resulted in lateral movement of the SLD_{lat} relative to muscles intact without CTrA tension. With inflation (pressure in PMC), the amount of lateral movement due to CTrA tension is significantly reduced ($p = 0.047$). In fact, the lateral movement due to CTrA tension is negated by the inflation-induced medial movement, such that the net displacement of the TLF is in the medial direction. This supports the concept that co-contraction of the TrA/IO and the paraspinal muscles transfer forces mainly through the PLF. Post-hoc analyses indicated that the amount of CTrA-induced medial movement of the PLF is significantly reduced during inflations inf2 ($p = 0.03$) and inf3 ($p = 0.0063$), relative to mm intact. There was no significant difference between Inf1 and mm intact ($p = 0.14$). There were no significant differences in SLD_{lat} between the three inflation increments.

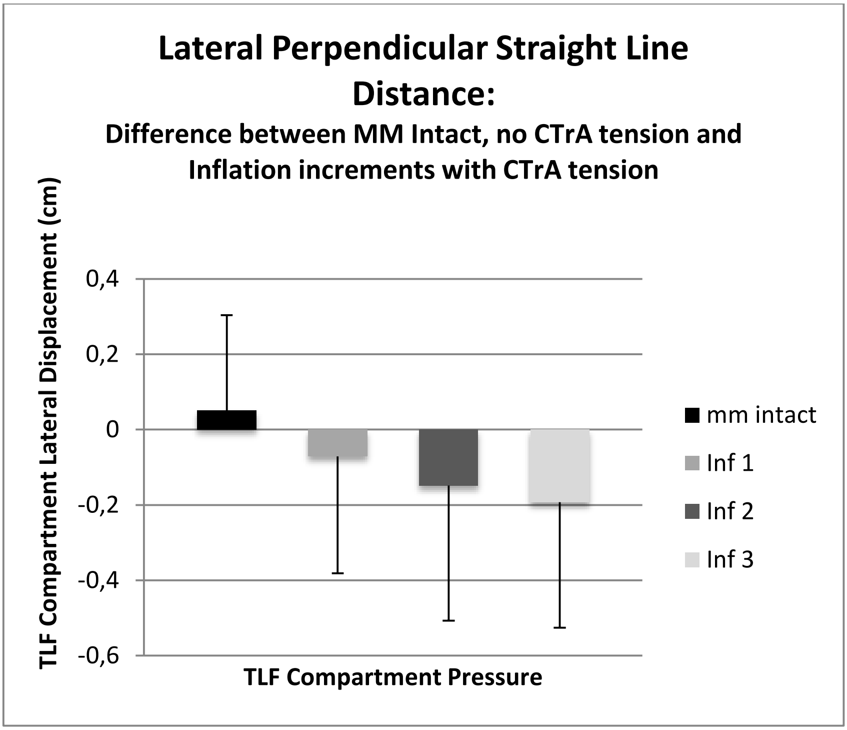

Figure 7. Perpendicular straight line distance from the lateral most point of the PMC to a sagittal plane through the tip of the transverse process under different inflation increments (see also figure 5): Comparison of baseline condition (mm intact, no CTrA tension) with 8.5N CTrA tension and incremental inflation. A positive value indicates lateral displacement. A negative value indicates medial displacement. * indicates significantly different from mm intact.

To determine whether a relationship exists between the inflation-induced posterior displacement vs medial displacement of the walls of the PMC, a medial displacement: posterior displacement ratio was calculated for each inflation increment. The ratios were 0.182, 0.180, and 0.187 for Inf1, Inf2, and Inf3, respectively. This indicates a consistent medial displacement of the lateral wall of the PMC of approximately 0.18 cm for each 1 cm of posterior wall displacement.
The combined effect of CTrA tension and inflation on the changes in perimeter of the PMC is somewhat variable, as evidenced by the tracings (M3) in figure 8. However, combining data from figures 6 and 7 indicates that increasing PMC pressure (e.g. simulating paraspinal muscle contraction) can counteract the tension generated by the pull through the CTrA. In this case, a theoretical point of equal tension between the paraspinal muscles and the TrA and IO muscles is reached.

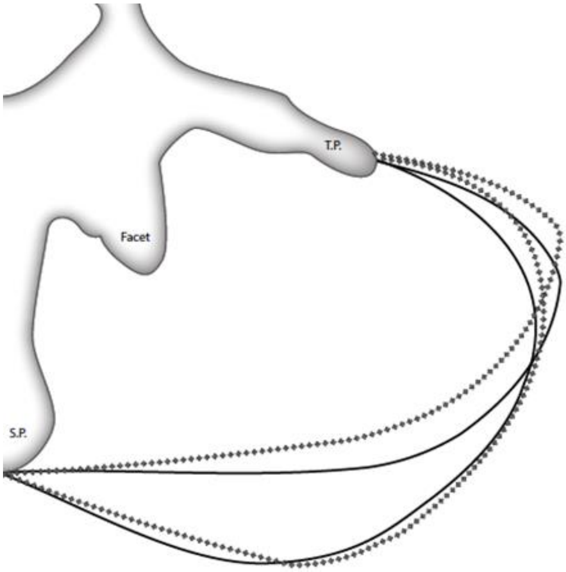

Figure 8. Composite drawing of the paraspinal muscle compartment (PMC) during incremental inflation, without (solid) and with (dotted) CTrA tension. In the absence of inflation with CTrA tension (anterior dotted line) results in anterior and lateral displacement of the MLF and PLF, relative to the non-tensed condition (anterior solid line). Without CTrA tension, incremental inflation (Inf 3, no CTrA tension – posterior solid line) displaces the MLF and PLF posteriorly and medially relative to a neutral baseline (muscles intact, no TrA tension – anterior solid line). The medial -to-posterior displacement ratio is 0.18cm: 1cm. With sufficient inflation (Inf 3 with CTrA tension – posterior dotted line), the posterior and medial displacement nullifies the anterior and lateral displacement associated with CTrA tension and becomes similar to inflation alone (posterior solid line). This may imply a balance of tension has been achieved between PMC pressure and the CTrA tension.

Differentiating MLF/PLF force transfer: Unidirectional tension measurement along anterior and posterior CTrA laminae in the presence of tension of the CTrA and inflation of the PMC

The amount of force transmitted through MLF and PLF (M5) was measured while applying 8.5N through the CTrA (M1b) at each inflation increment (M2). At each level of inflation, a significantly greater proportion of the force was transmitted through the PLF, relative to the MLF ($p = 0.0001$) (figure 9). The force transmission through the MLF did not differ significantly between each increment of inflation ($p = 0.74$). Conversely, force transmission through the PLF is elevated at Inf1 and then declines with further incremental inflation ($p = 0.013$). Post-hoc analyses indicate that force transmission through the PLF in Inf3 is significantly lower than Inf1 ($p=0.0068$). There was also a trend toward significance between Inf1 and Inf2 ($p=0.087$). There was no significance between Inf2 and Inf3 ($p=0.2$). It should be noted that it was not possible to obtain this measurement in the muscles intact condition, because there was no space to place the alligator clips.

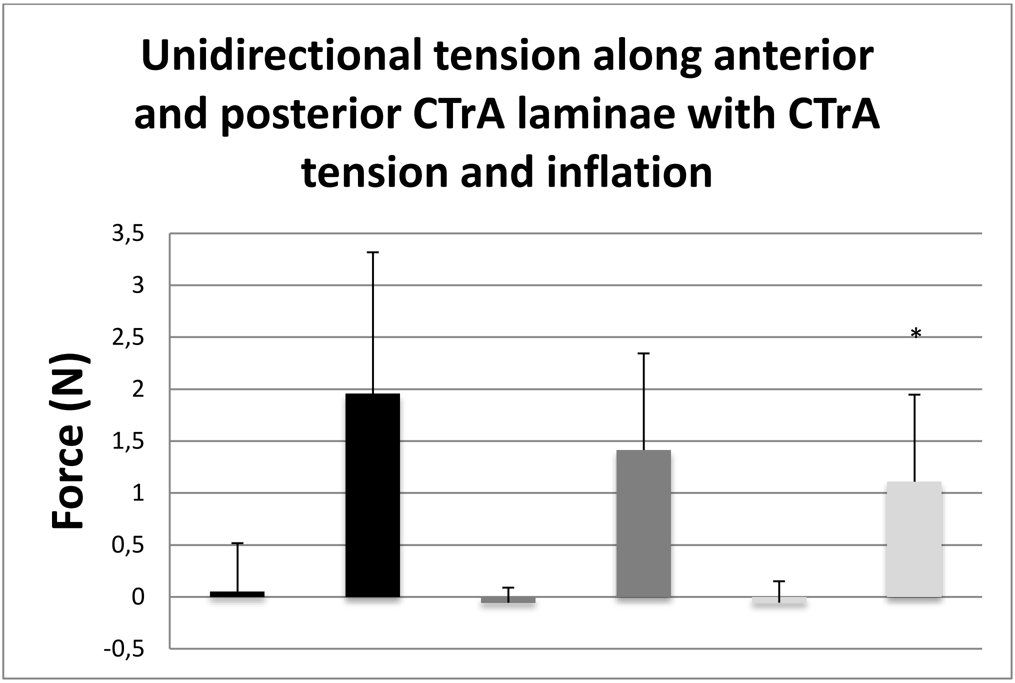

Figure 9. Unidirectional tension measurements along anterior and posterior CTrA laminae with CTrA tension and inflation. The amount of CTrA-mediated force directed through the PLF appears to decrease with incremental PMC pressure, yet the amount of CTrA-mediated force directed through the MLF appears basically unaffected by incremental PMC pressure. The * indicated statistical significance between Inf1 and Inf3.

The data presented in figure 9 (M5) corresponds with the data in figure 6 (M4). Because the load cells are unidirectional, they only measured tension in the direction of the CTrA. Inflation moved the posterior part of the PLF in the opposite direction from the load cell measuring CTrA pull (figure 6), thereby having a subtractive effect on force measured through the PLF (figure 9).

Bi-directional tension measurements analyzing the effect of inflation on PLF force transfer with CTrA tension

To better understand the subtractive effect observed in figure 9, two uni-directional load cells were placed on the PLF: 1) one measured tension in the anterolateral direction (i.e. in the direction of pull for the TrA and IO); 2) the other measured tension in the posteromedial direction (i.e. along the PLF toward the spinous process) (M6). An 8.5N load was then suspended from the TrA/IO, as described previously (M1b). As inflation increased, the amount of posteromedially-oriented tension in the PLF decreased (black bars, figure 10). Also, the amount of anterolaterally-oriented tension in the PLF increased as a result of the CTrA pull but only with increased inflation (gray bars, figure 10). The sum of anterolateral and posteromedial forces did not differ between levels of inflation. This confirms the subtractive effect described above.

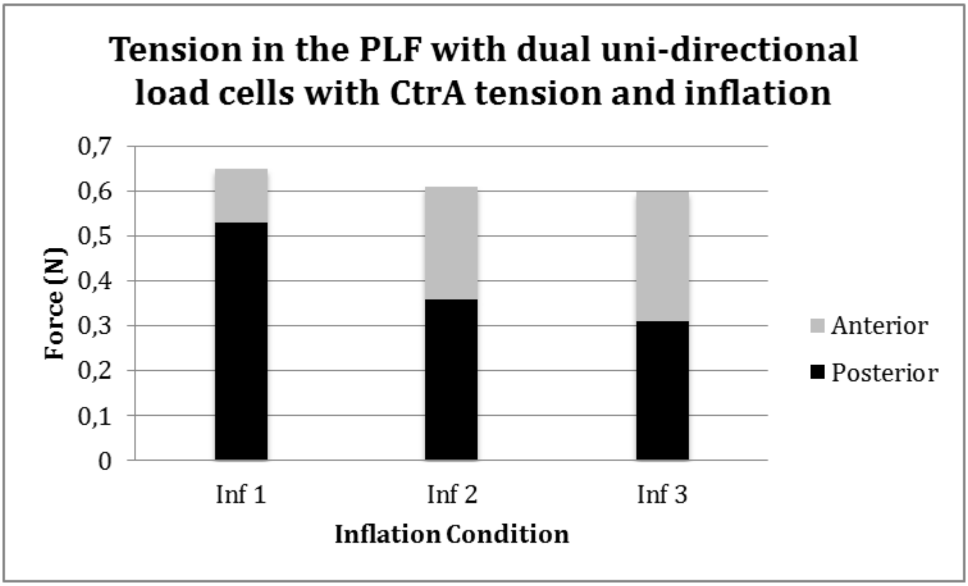

Figure 10. Analyzing the effect of inflation on PLF force transfer (MVI). The sum of anteriorly and posteriorly directed forces do not differ across the three inflation increments.

Discussion

This is the first study in which incremental contraction of the paraspinal muscles within the TLF container is simulated, combined with tensing the common tendon (CTrA) of the TrA and IO muscles, to examine the relative force transfer through the anterior (MLF) and posterior part (PLF) of the paraspinal muscle compartment (PMC).

Analyzing the measurements of TLF perimeter changes (evaluating posterior and lateral displacement of the TLF by Roentgen C-arm) combined with tension measurements of load transfer through the PLF and MLF lamina, showed the following: in the absence of TLF container inflation, CTrA pull results in anterior and lateral movement of especially the PLF (black bar in fig.6 & 7). Combining TLF inflation with CTrA pull, displaces the PLF substantially posteriorly and slightly medially.

The force transfer to the PLF leveled off with each incremental inflation and pull to the CTrA, indicating that a point of equal tension between paraspinal muscles and CTrA is reached, in which pressure within the TLF container counters tension created by the CTrA. This indicates that with increasing TLF inflation, particularly the angle of load transfer between the anterolateral pull of CTrA to the PLF is optimized, creating an increasingly linear pull to the PLF. This in contrast to the MLF, where the angle of pull from the CTrA to the MLF becomes less optimal with increased inflation. It could be hypothesized that a less optimal angle of pull to the MLF leads to decreased strain, however neutralized by increased TLF compartment inflation pushing the MLF anteriorly. Throughout each incremental inflation of the TLF, the ratio between the horizontal and longitudinal expansion of the PLF perimeter, showed a consistent small medial displacement of the PLF of approximately 0.18 cm relative to each 1 cm of posterior PLF displacement. This indicates that the lateral portion of the TLF is not expanding and even slightly displaced medially, compared to a much larger posterior displacement of the PLF being longitudinally tensed. This tension effect could be explained by the fact that submaximal Inflation (inflation 3), of the TLF container is counteracting the strain of pulling the CTrA. In this case, a theoretical point of equalized tension between paraspinal muscles and the TrA and IO muscles is attained.

These results show that activation of the deep abdominal muscles tensing the CTrA, combined with TLF inflation, significantly tenses the PLF in comparison to the MLF. One possible explanation for this difference could be that the mean perimeter length of the PLF is 8.7 cm versus 3.8 cm for the MLF. Hence, TLF container inflation will have a bigger effect on the much longer

PLF. Comparing test situation -muscles intact and no CTrA pull, to CTrA tension with submaximal inflation level 3 (Figures 4-6), the posterior expansion of the PLF is on average increased with 1.56 cm.

The findings of the present in vitro study, that combining TLF inflation with CTrA pull predominantly tenses the PLF, can only be equated to in vivo flexion and extension movements in the sagittal plane. In activities of normal daily life and sport, sagittal plane movement like spinal extension and flexion is combined with different levels of lateroflexion in the frontal plane and rotation in the axial plane, therefore beyond the scope of this study. Lateroflexion will also increasingly strain the contralateral MLF, located predominantly in the frontal plane9.

Conclusion

In the present study, the relation between evoked incremental inflation within the TLF container, combined with CTrA tension reveals a critical codependent mechanism between these structures. The data in this study demonstrate that when the PLF displaces posteriorly with increased TLF inflation and CTrA pull, reciprocal strain to the CTrA is augmented until a point of equal tension is reached. This phenomenon indicates that pressure changes within the epaxial TLF- and hypaxial abdominal container are conversely linked through the CTrA tendon and can augment the “passive” extensor moment in the spine while flexing.

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REFLEX CONTRIBUTIONS AND ANATOMICAL CONSIDERATIONS

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Introduction

The burdens of back pain, especially chronic back pain are immense for patients and the society, and the influencing factors for chronic back pain are highly complex. Besides others, the stability of the spinal column is an often-mentioned need for a proper function of the spine.

The present paper is a review of a series of studies regarding reflex contributions and anatomical considerations related to chronic back pain. At first, we focus on the spinal reflexive control of the spine in reaction to single perturbations as well as cyclic perturbations up to 8Hz. The influence of delayed muscle reflexes and the reflex amplitude on spinal stability were analyzed. Furthermore, it will be shown that the lumbar lordosis is influencing the stability of the spine and the loading on the deep and superficial muscles.

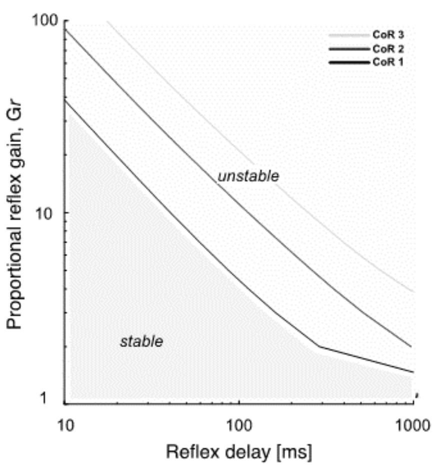
Spinal Reflexive Stabilization of the Spine

The influence of time-delayed reflexes on the stability of a simple biomechanical model that incorporated nonlinear musculoskeletal properties were analyzed. Model-based predictions in terms of reflex time-delay and reflex amplitude were compared with experimental data from patients with chronic back pain and healthy controls (Liebetrau, Puta, Anders, de Lussanet, & Wagner, 2013).

A two-dimensional musculoskeletal model of the spinal column in the coronal plane was extended with a time-delayed reflex model (Franklin & Granata, 2007). This model can predict stability boundaries in terms of reflex time-delay and reflex gain.

Hence, predictions of the stability of a two-dimensional lumbar spine model for lateral perturbations of a spinal equilibrium were compared with measured surface-electromyography (5-700 Hz, Biovision, Wehrheim, Germany) of three trunk and two paraspinal muscles to unpredictable lateral perturbations to the upper body. All surface-electromyography signals were centered and high-pass filtered (4th-order Butterworth filter, 40 Hz). The reflex latency and reflex amplitude were determined automatically with a custom-made Matlab-algorithm.

The simulations based on the biomechanical model as well as the experimental results indicate that increasing reflex amplitudes require shorter reflex latencies. In other words, delayed reflexes – as often seen in patients with chronic back pain –require reduced reflex amplitudes (Figure 1).



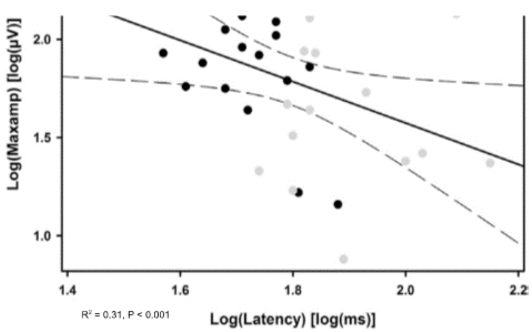


Figure 1. The influence of reflex latency and reflex gain on the stability of the musculoskeletal system of the spine. Increasing reflex amplitudes require shorter reflex latencies. Left: Results of the biomechanical model. Right: Experimental results from patients with chronic back pain (open cycles) and healthy controls (filled cycles).

Whole body vibrations are an important cause of musculoskeletal disorders such as chronic back pain. Therefore, the reflexive postural control during external perturbations at different frequencies was studied. Twenty healthy subjects were asked to maintain their upright standing position, while sudden loadings at different frequencies (1-8 Hz) were applied via a handle and the arm to the upper body. During the perturbations, the activities of ten trunk muscles were recorded by surface electromyography.
As a result, the muscle response at 6-8 Hz was significantly reduced compared to the range of 1-5 Hz (Figure 2). The physiological reason for the inhibition of the reflexive postural control remains unclear.

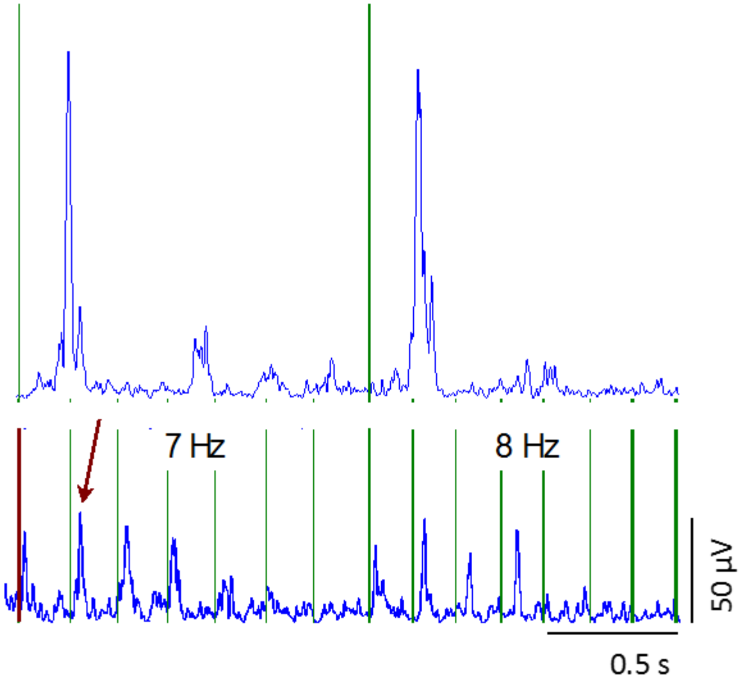


Figure 2. Examples of surface-electromyography signals at 1 Hz (top) and 7/8 Hz (bottom left and right, respectively). The reflex amplitudes are reduced at perturbations with 7/8 Hz. The vertical green lines display the perturbation onsets.

Spinal Lordosis Optimizes the Requirements for a Stable Erect Posture

Lordosis is the typical convex bending of the human lumbar spine. The development of a lumbar lordosis in humans is not genetically determined, e.g. children develop a lordosis as they are learning to walk bipedal. Here, we show that stability control is central to the lumbar spine, and that the motor system selects a configuration in which the required local stabilizing torques on each of the lumbar joints is minimal (Liebetrau, Puta, Schinowski, Wulf, & Wagner, 2012; Wagner, Liebetrau, Schinowski, Wulf, & de Lussanet, 2012). We developed a 2D-model of the lumbar spine in the sagittal plane, such that every degree of freedom of each of the five joints must be self-stable at any time. The curvature of the lordosis Λ was gradually increased and the eccentrically position of the spine E in the sagittal plane was shifted (Figure 3).
As a result, for a given arrangement of eccentricity and spinal curvature, a minimum physiological cross-section area of the global musculature can be computed to obtain self-stability. On the other hand, the local counter torques are critical to guarantee an equilibrium posture. The simulations

of the present model require an eccentricity of E ≈ 3 cm and a lumbar lordosis of Λ ≈ 4 cm. Both values are within the physiological range.

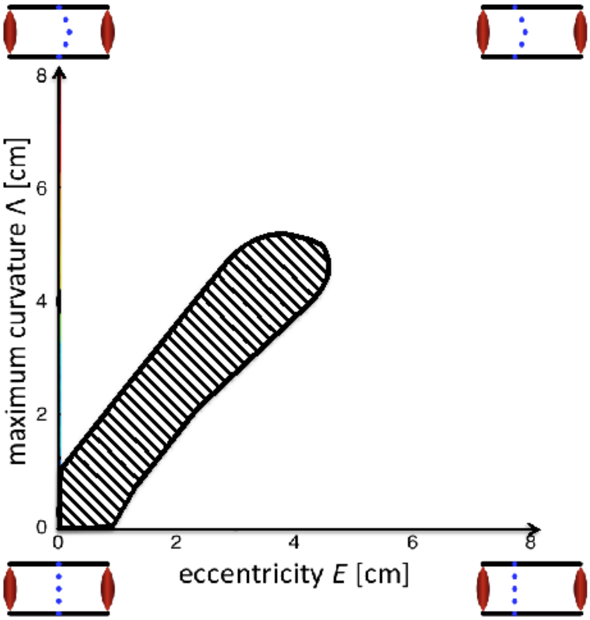


Figure 3. Schematically representation of the spinal arrangement where the local joint torques are within ±30 Nm at any spinal segment.

Conclusion

The results show that for certain biomechanical changes, increasing the lordosis is helpful to decrease local reaction torques and to ensure the stability of the spine, while minimizing the load on the lumbar segmental muscles. These results support the opinion that the risks for low back pain can be reduced when the deep lumbar muscles are trained. Furthermore, the simulations support the hypothesis that an optimally adjusted triad of reflex latency, reflex amplitude and the co-activation of agonistic and antagonistic muscles is crucial for the stability of the human spine, especially for chronic low back pain patients with increased reflex delays. Possible therapies should therefore take into account both a reduction in reflex latency and an increase in reflex amplitude.

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Precision control of trunk movement in low back pain patients

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Introduction

Precise motor control is hampered by neuromuscular noise. The exact origin of this noise is still unknown (Christakos, Papadimitriou, & Erimaki, 2006; De Luca, LeFever, McCue, & Xenakis, 1982; Jones, Hamilton, & Wolpert, 2002), but synaptic noise resulting in fluctuations in motor unit firing rates and firing intervals is suggested to be one of the main causes (Matthews, 1996; Selen, Beek, & van Dieën, 2005). Neuromuscular noise is signal-dependent, in that force variability increases with muscle activation level (Allum, Dietz, & Freund, 1978; Christou, Grossman, & Carlton, 2002; Jones et al., 2002; Newell & Carlton, 1988; Sherwood, Schmidt, &Walter, 1988; Slifkin, Vaillancourt, & Newell, 2000; Tseng, Scholz, Schöner, & Hotchkiss, 2003; Visser et al., 2003). The effects of neuromuscular noise become apparent in a lack of precision, for example in aiming and tracking tasks. Performance on such tasks reflects the ability to reduce kinematic variability and can be used as a measure of quality of motor control.

Precise motor control appears to be impaired by pain. Huysmans and colleagues found larger upper limb tracking errors in subjects with shoulder pain compared to pain-free controls (Huysmans, Hoozemans, van der Beek, de Looze, & van Dieën, 2010). It has been suggested that this is due to the effect of nociceptive afference on muscle spindle feedback, which would impair proprioception (Pedersen, Sjolander, Wenngren, & Johansson, 1997). In addition, chronic pain has been shown to cause reorganization in the primary somatosensory cortex (Flor, Braun, Elbert, & Birbaumer, 1997), which may modulate the processing of both noxious and nonnoxious input (Moseley & Flor, 2012). In the study on shoulder pain the reduced precision indeed coincided with a reduced proprioceptive acuity in the pain group (Huysmans et al., 2010). Proprioceptive impairments in low back pain (LBP) patients have been demonstrated using lumbar muscle vibration, which is known to perturb proprioceptive feedback from muscle spindle afferents by inducing a lengthening illusion (Burke, Hagbarth, Lofstedt, & Wallin, 1976; Roll, Vedel, & Ribot, 1989). Brumagne and colleagues found reduced trunk repositioning accuracy in LBP patients compared to healthy controls and, interestingly, paraspinal muscle vibration negatively affected trunk repositioning accuracy in healthy controls, but not in LBP patients (Brumagne, Cordo, Lysens, Verschueren, & Swinnen, 2000). Also, in a variety of postural tasks with vision occluded, the relative effects of lumbar muscle vibration and calf muscle vibration on postural sway differed between LBP patients and healthy controls (Brumagne, Cordo, & Verschueren, 2004; Brumagne, Janssens, Knapen, Claeys, & Suuden-Johanson, 2008; Claeys, Brumagne, Dankaerts, Kiers, & Janssens, 2011). LBP patients tended to use a more ankle-steered strategy, in that their response to calf muscle vibration was larger than their response to lumbar muscle vibration, which might point at a lower weighting of proprioceptive information from lumbar muscle spindles. Moreover, individuals with LBP have been shown to have increased levels of co-activation (van Dieën, Selen, & Cholewicki, 2003), which may indicate a compensatory joint stiffening strategy to deal with impaired proprioception.

Indeed, joint impedance modulation by antagonistic co-activation has been suggested as a means to counteract kinematic variability due to neuromuscular noise. Modeling work suggests that, by activating antagonistic muscle pairs around a joint, joint stiffness increases and kinematic variability decreases in spite of an increase in force variability of each of the muscles separately (Selen et al., 2005). In upper extremity tracking tasks, increased precision indeed coincided with increased joint impedance (Selen, Beek, & van Dieën, 2006; Selen, van Dieën, & Beek, 2006) and EMG activity (Huysmans et al., 2010), suggesting that the tracking error was successfully reduced by antagonistic co-activation. Thus, whereas increased agonistic muscle activation can reduce precision, antagonistic co-activation can increase precision. In the trunk, however, no evidence for the use of such a co-activation strategy was found in static positioning tasks (Willigenburg, Kingma, & van Dieën, 2010). Instead, feedback control appeared to be used to regulate precision. Given this stronger reliance on feedback instead of co-activation to modulate precision in the trunk compared to the upper extremity and given the proprioceptive impairments associated with pain, we expect LBP to have pronounced effects on precision control of the trunk. While tracking tasks are often called visuo-motor tasks, proprioceptive feedback is an important source of information in controlling tracking movements (Eidelberg & Davis, 1976; Nagaoka & Tanaka, 1981). In the present study, we therefore used a tracking task that required precise trunk movement with varying levels of trunk inclination, to investigate the effects of muscle activation level, lumbar muscle vibration and pain on kinematic error, as a measure of quality of trunk control. Subjects with and without LBP performed this tracking task with and without disturbance of proprioception through paraspinal muscle vibration. Muscle activity was continuously monitored by means of surface-electromyography (sEMG). We hypothesized that subjects with LBP would make larger tracking errors and that, as patients may rely less on proprioception, muscle vibration would have a larger effect in subjects without LBP. Furthermore, we hypothesized that tracking errors would increase with trunk inclination, and thus with the level of agonistic muscle activity. Ratios of antagonistic co-activation were hypothesized to be higher in the patient group.

Methods

Subjects

Eighteen subjects with non-specific LBP (31 ± 14 [M ± SD] years old, BMI 23.4 ± 2.4 kg/m2, 11 male) and 13 healthy controls (34 ± 12 years old, BMI 22.9 ± 2.4 kg/m2, 9 male) with no (history of) LBP participated in the experiment. No significant differences between the LBP and control groups were found in age and BMI and all subjects had normal or corrected to normal sight. One LBP patient was not able to participate due to a very limited range of lumbar motion. The protocol was approved by the local medical ethics committee and all subjects provided written informed consent before participating. Inclusion criteria for the LBP patient group were self-reported LBP for the last 6 weeks or longer, specific diagnosis excluded by general practitioner or physical therapist, no previous surgery on the spine, score 6105 on yellow flags screening questionnaire (Linton & Hallden, 1996), no other conditions (e.g., neurological or mental disorders, allergy to plaster) hindering participation or performance and age between 18 and 65. LBP patients scored 15.2 ± 4.2 at the Oswestry pain and disability index (10 = minimal disability, 60 = maximal disability) and 26.8 ± 18.9 at the visual analogue scale (0-100) for pain intensity before participation.

Experimental setup

Participants maintained a semi-seated/kneeled position with their pelvis fixed and their lower legs supported by a frame (Fig. 1). Subjects placed their hands on top of their head, in order to minimize upper limb contributions to trunk postural control. Opto-electronic markers (Optotrak 3020, Northern Digital Inc, Canada; 100 samples/s) were placed on the spinous process of T12 and on the frame (fixed point in space) at pelvis height. Trunk angle was defined as the angle of the line through the T12 marker and the marker on the frame with respect to the vertical. Real-time (delay max. 10 ms) feedback of trunk angle was presented as a black dot (cursor) on a 17 inch computer screen, which was located 120 cm in front of the subject, at chest height. Trunk angle changes in the frontal plane corresponded to movements of the cursor along the x-axis (left-right) and trunk angle changes in the sagittal plane corresponded to movements of the cursor along the y-axis (up-down). The origin of the display was defined by each individual's neutral trunk angle (self-chosen, as described in the next section). The x-axis ranged from -30° (lateral flexion to the left) to +30° (lateral flexion to the right). The y-axis ranged from -20° (extension) to +40° (flexion). Both height and width of the display were 600 pixels, so 1 pixel corresponded to 0.1 degree of trunk angle. In addition to the cursor (a circle with a diameter of 20 pixels), a target area was presented on the screen. This target area was a yellow square (30 by 30 pixels), which moved following a spiral-shaped trajectory. A yellow line preceded the square, to show subjects the to-be-tracked trajectory 10 s in advance.

Electromyography (Porti 17, TMS, Enschede, The Netherlands; 22 bits AD conversion after 20x amplification, input impedance >1012 X, CMRR >90 dB) of four abdominal and four back muscles was measured, both left and right, using pairs of surface EMG electrodes (Ag/AgCl, inter-electrode distance 25 mm) that were attached to the skin after shaving and cleaning with alcohol. Activation of thoracic back muscles was recorded 4 cm lateral to T9 (thoracic part of m. longissimus (LT)) and 6 cm lateral to T11 (thoracic part of m. iliocostalis (IT)) spinous processes. Electrodes to record lumbar back muscle activation were placed 6 cm lateral to L2 (lumbar part of m. iliocostalis (IL)) spinous process and 3 cm lateral to the midpoint between the spinous processes of L3 and L4 (lumbar part of m. longissimus (LL)). For abdominal muscles, electrodes were placed 3 cm lateral to the umbilicus or somewhat lower when a tendinous intersection was present there (m. rectus abdominus (RA)), 3 cm medial to the anterior superior iliac spine (ASIS) (m. obliquus internus (OI)), in the mid-axillary line between the iliac crest and the 10th rib (lateral part of m. obliquus externus (OEL)) and at the crossing point of a horizontal line through the umbilicus and a vertical line through the ASIS (anterior part of m. obliquus externus (OEA)). Muscle activation was recorded at a sample rate of 1000 samples/ s and a pulse signal was used to synchronize the kinematic and EMG data.

In conditions with lumbar muscle vibration, a motor rotating an eccentric mass (Maxon Graphite Brushes S2326.946 driven by a 4-Q-DC Servo Control LSC 30/2 in a velocity-loop, frequency 90 Hz) was positioned at the lumbar longissimus EMG electrodes; 3 cm lateral of L3/L4 spinous processes, both left and right (Fig. 2). The vibration motor was fixed with neoprene elastic bands and vibration was applied continuously during the experimental task.

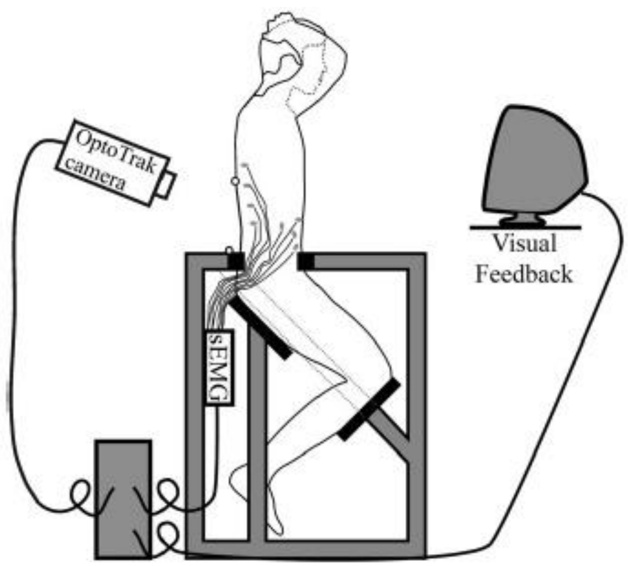

Fig. 1. Experimental setup.

<u>Experimental protocol</u>

To determine each individual's neutral trunk angle, subjects were first asked to sit comfortably with their hands on their head. This neutral angle defined the origin of the computer screen and the inner endpoint of the spiral-shaped trajectory was in

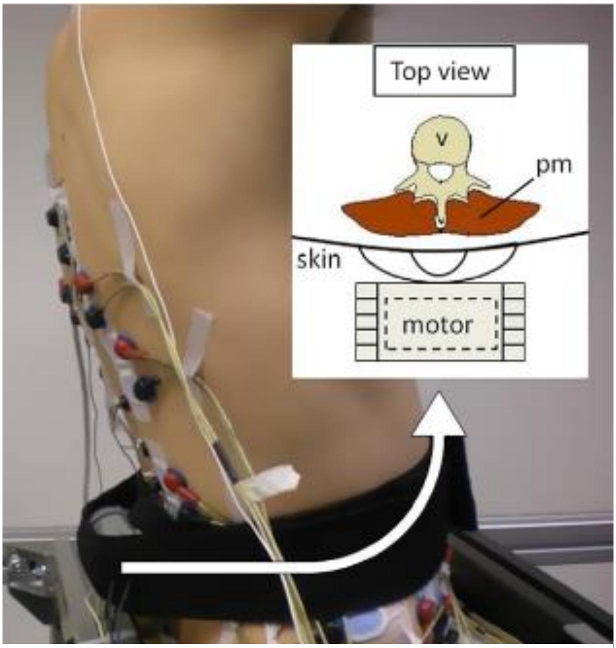

Fig. 2. Vibration device as attached over the paraspinal muscles (pm) at the level of L3/4. The vibrating motor was stored in a plastic cylinder, which in turn was fixed to a solid plastic U-shape to apply bilateral vibration to the paraspinal muscles while leaving the spinous process of the lumbar vertebra (v) free.

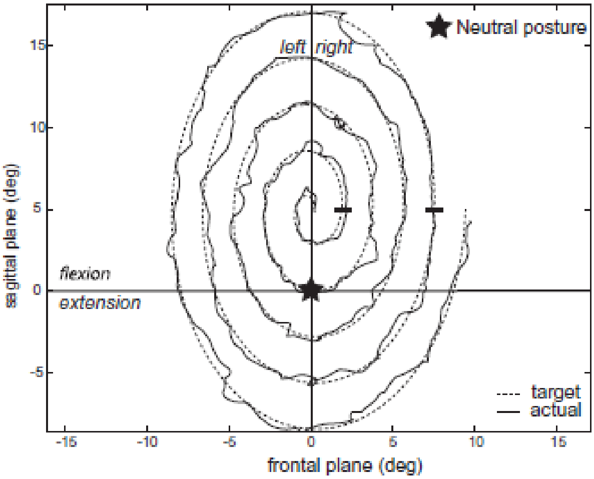

Fig. 3. Example of a single trial without vibration for one (healthy) subject. Black bars indicate the start and end of the part of the trajectory that was used for data analysis.

5———————————— flexion with respect to that neutral posture. Subjects were instructed to adjust their trunk posture in order to stay within the yellow square target area while it followed the spiral-shaped trajectory. The center of the target reflected the target angle. The target angle in the frontal plane was calculated by x = 0.3t * cos(t) and the target angle in the sagittal plane was calculated by y = 0.45t * sin(t) + 5, with t ranging from 0 to 10 * π, in steps of

0.005 radians. Since each rotation of 360° corresponds to 2 * π radians, this resulted in a spiral trajectory that consisted of five rotations (Fig. 3). Speed of trunk movement was normalized to a constant change in trunk angle of 1.76°/s, and the task took about 2 min. The outer boundaries of the spiral corresponded to approximately 10° extension and lateral flexion and 17° flexion. Two trials started in the center of the spiral and consisted of 5 counterclockwise rotations with increasing amplitude. In two additional trials, the target started at the outer endpoint of the same spiral, at about 10° lateral flexion to the right, and thus followed 5 clockwise rotations with decreasing amplitude towards the center of the spiral. These four trials were performed with and without lumbar muscle vibration, resulting in a total of 8 trials. The trial order was counterbalanced between subjects, in that for both groups (with and without LBP), half of the subjects started with vibration and the other half started without vibration. Within these subgroups, half of the subjects started with the clockwise trajectory and the other half started with the counterclockwise trajectory. Subjects were instructed not to rotate around the longitudinal axis.

Data analysis

Matlab R2010a was used for data analysis. Tracking error was defined as the absolute difference between the trunk angle and the target angle at each instant of time. Specifically, we calculated the hypotenuse of the angular tracking error in the frontal (x-axis) and sagittal (y-axis) planes of motion:

$$\text{tracking error} = \sqrt{(x_{angle,target} - x_{angle,trunk})^2 + (y_{angle,target} - y_{angle,trunk})^2}.$$

After 22 bit AD-conversion at 1000 samples/s, EMG data were 30 Hz high-pass filtered to remove contamination from the electrocardiogram (Redfern, Hughes, & Chaffin, 1993) and 49.5-50.5 Hz band-stop filtered to remove any 50 Hz interference. Then Hilbert amplitudes were calculated and 2.5 Hz low-pass filtered (2nd order Butterworth), uni-directionally in order to obtain a linear envelope and to correct for electromechanical delay (Potvin, Norman, & McGill, 1996). Trials with lumbar muscle vibration were discarded from EMG analyses, since some EMG signals were contaminated by the vibration. Both tracking error and muscle activation time series were averaged over two repetitions for each trial.

Since subjects needed some time to catch up with the target at the start of each trial, we only analyzed the inner three rotations of the spiral-shaped trajectory (Fig. 3). In order to be able to use time series as input for our statistical procedures, a 2 Hz running average was calculated from the time series of the tracking error and EMG linear envelopes. Co-activation ratios were obtained by dividing non-normalized antagonist by agonist EMG amplitudes. For the other analyses we normalized EMG amplitudes to the highest value recorded during the four trials without vibration, in order to reduce inter-subject variance. Note that we did not normalize to maximally voluntary contractions as this may introduce a bias, because patients may not activate their back muscles maximally.

Discrimination between agonist and antagonist was based on trunk posture imposed by the target trajectory and the corresponding gravitational moment. Specifically, we discriminated four quadrants of the trajectory in which trunk flexion or extension moments in combination with lateral bending moments to the left or right were required (Fig. 3). Since trunk movements were rather slow, accelerations of the trunk were neglected and agonist and antagonist muscles were defined based on the moments that these muscles generated around the lumbar spine relative to the gravitational moment, i.e., they were considered as agonists when acting against the gravitational moment and hence contributing to the moment required, and as antagonists when acting in the direction of the gravitational moment. We averaged the linear envelopes over muscles within each quadrant, i.e., left abdominal, right abdominal, left back and right back muscles, resulting in 4 muscle groups consisting of 4 muscles each. Then EMG time series were split into periods in which these muscle groups acted either as agonist or as antagonist. So, in parts of the trajectory requiring trunk flexion and lateral bending to the left, where the upper body center of mass was located anterior and left with respect to the lumbar spine, the right back muscles were defined as primary agonists (Rback_ago) and the left abdominal muscles were defined as primary antagonists (Labd_anta). Similarly, for parts of the trajectory requiring trunk extension and lateral bending to the left, where the upper body center of mass was located posterior and left with respect to the lumbar spine, right abdominal and left back muscle activation were defined as Rabd_ago and Lback_anta, respectively. Activation levels were set to zero for periods when muscle groups did not act as primary agonist or antagonist.

Statistics

SPSS version 16.0 was used for statistical analysis. One way ANOVA was performed to compare co-activation ratios between groups after averaging over the four quadrants. In addition, we performed two regression analyses for repeated measures, using generalized estimation equations (GEEs). Linear models with exchangeable working correlation structures, robust covariance matrix estimators and Wald Chi-Square statistics were used. Tracking error was defined as dependent variable, and two different combinations of predictor parameters were defined (Fig. 4).

To detect differences in tracking errors between LBP patients and healthy controls and between conditions with and without vibration, the first GEE model included the factors ‘group’ and ‘vibration’. Healthy controls and conditions without vibration were considered as references. To evaluate the effect of trunk inclination on tracking errors, we included trunk inclination, calculated as the square root of the sum of the squared frontal plane and sagittal plane trunk angles, as a covariate. Interactions with the factor group were included to test whether the effects of vibration condition and trunk inclination differed between groups. When not significant, interactions were removed one-by-one, starting with the highest p-value.

The second GEE model was aimed at elucidating the effects of agonist and antagonist muscle activation on tracking errors, as well as the potential interference of pain with these effects. GEE model 2 therefore included the factor ‘group’, which discriminated between LBP patients and healthy controls (as reference), as well as eight EMG covariates. These covariates reflected time series of the four different muscle groups, acting as primary agonist or antagonist, with zero values for periods when the muscle group did not act in that function. Recall that the trials with lumbar muscle vibration were discarded from EMG analysis, so for GEE model 2 we only used the data without vibration. Again, twoway interactions with the factor ‘group’ were examined, but removed when not significant.

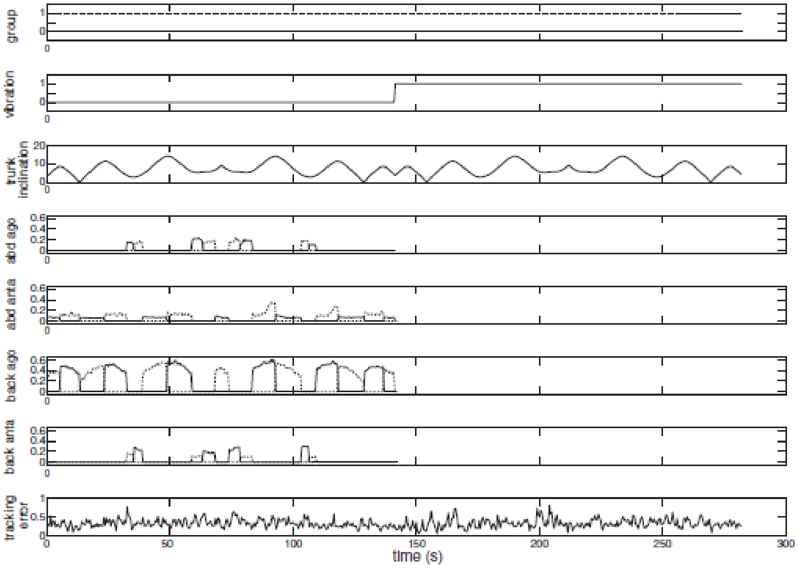

Fig. 4. Typical example of variables of interest against time to visualize the variables that were included in the GEE models. GEE model 1 included the factor group (upper panel), the factor vibration (second panel), and the covariate trunk angle amplitude (third panel). GEE model 2 included the factor group (upper panel) and eight covariates: right (solid) and left (dotted) abdominal and back muscle activation acting as agonist and as antagonist (panels 4–8). Tracking error (lower panel) was the dependent variable in both GEE models.

Table 1

GEE model 1.

	Coefficient	95% Confidence interval	P-value
Intercept	.304	.271 – .337	<.001
Group (LBP = 1)	.090	.036 – .144	.001
Vibration (on = 1)	.035	.006 – .064	.016
Trunk inclination	.004	.002 – .006	.001
Group + vibration	-.048	-.086 – -.011	.012

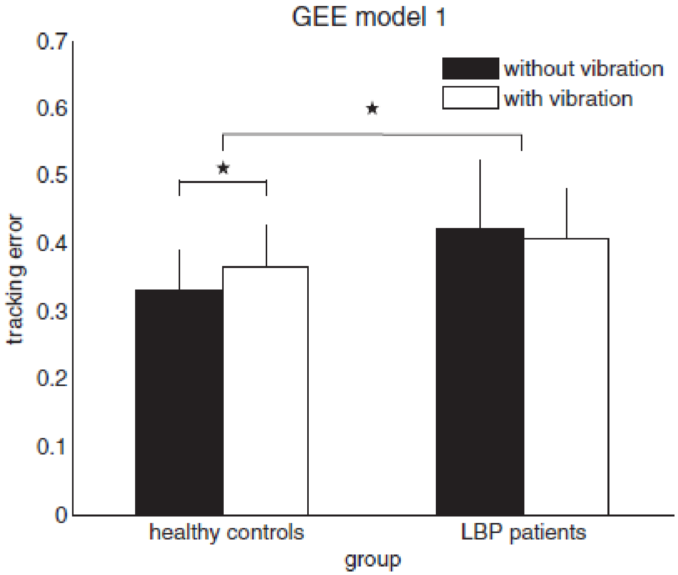

Fig. 5. Averages and SDs (error bars) of tracking errors for both groups and vibration conditions.

Table 2

GEE model 2.

	Mean ± SD	Coefficient	95% Confidence interval	P-value
Intercept		.263	.218 – .307	<.001
Group (LBP = 1)		.112	.052 – .173	.001
Rabd_ago	.25 ± .10	.175	-.071 – .420	.162
Labd_ago	.26 ± .10	.171	-.010 – .352	.065
Rabd_anta	.19 ± .10	.224	.038 – .409	.018
Labd_anta	.18 ± .10	.274	.074 – .474	.007
Rback_ago	.40 ± .11	.001	-.074 – .076	.980
Lback_ago	.41 ± .10	.004	-.065 – .073	.902
Rback_anta	.17 ± .07	.263	-.041 – .566	.090
Lback_anta	.17 ± .07	.270	-.143 – .683	.200

Results

Effects of pain, proprioception disturbance, and trunk inclination on tracking error

Results for GEE model 1 (Table 1), evaluating the effects of group (pain), vibration (proprioception disturbance), and trunk inclination revealed one significant interaction. In the absence of lumbar muscle vibration, the tracking error was significantly larger (27.1%) in LBP patients (0.422°) compared to healthy controls (0.332°, Fig. 5). In line with our hypothesis, vibration affected the performance in the control group more than in the LBP patients. Specifically, the tracking error significantly increased by 10.5% with vibration (to 0.367————————————) in the control group, while the patient group showed a slight (but not significant) decrease in tracking error in conditions with lumbar muscle vibration (to 0.409°). Furthermore, as hypothesized, tracking errors significantly increased with trunk inclination.

To further evaluate the effect of low back pain on tracking error within the LBP group, we calculated the correlation between tracking error (averaged over all trials), and pain intensity (score on the visual analogue scale before the start of the experiment). Interestingly, tracking error and intensity of LBP were positively correlated ($r = 0.48$, $p = 0.042$), indicating that subjects with more severe LBP performed worse on the tracking task.

Antagonistic co-activation

Mean co-activation ratios were 1.68 ± 0.83 for healthy controls and 1.23 ± 0.72 for LBP patients and the difference between groups was not significant ($p = 0.111$). These ratios of antagonistic over agonistic muscle activation levels were rather high, since back muscle activation levels substantially exceeded abdominal muscle activation levels, even when acting as antagonist.

Effects of agonist and antagonist trunk muscle activation and pain on tracking error

GEE model 2 did not reveal any significant interaction with group (all pP.184), so no differences between LBP patients and healthy controls were found in the effects of agonist and antagonist activation on tracking errors. Therefore, interactions were not included in the final model (Table 2). The significant effect of group (again) indicated that LBP patients performed significantly worse than healthy controls. While all coefficients for muscle activation were positive, indicating an increase in tracking error with increasing activation, only two of these covariates (left and right antagonistic abdominal muscle activation) reached significance. Coefficients for Rback_ago and Lback_ago were close to zero, indicating that agonistic back muscle activation did not affect tracking errors.

Discussion

The current study evaluated trunk motor control during a tracking task that required precise trunk movements with varying levels of trunk inclination. This task was performed by subjects with and without LBP, in conditions with and without lumbar muscle vibration. As hypothesized, tracking errors were higher in the LBP patients compared to healthy controls and increased with trunk inclination. Patients with more severe LBP made larger errors than patients with lower pain levels. In addition, lumbar muscle vibration deteriorated performance in healthy controls, but not in LBP patients, while levels of antagonistic co-activation were similar between groups. In contrast with our hypothesis, no significant increase in tracking errors was found with increasing agonistic muscle activation.

Our results showed that the tracking performance of healthy controls decreased in the condition with lumbar muscle vibration, despite the continuous presence of visual feedback. However, LBP patients already performed worse without vibration and their performance did not deteriorate with vibration. This suggests that vibration affected the contribution of proprioceptive feedback from lumbar muscle spindles to tracking performance in healthy controls but not in LBP patients and, hence, that proprioception is impaired or not used as much in LBP patients. Previous studies have already found reduced weighting of lumbar proprioception relative to other sources of proprioceptive information in postural control (Brumagne et al., 2000, 2004, 2008; Claeys et al., 2011), but, to our knowledge, reduced weighting of lumbar proprioception relative to visual information has not been reported before. This reweighting of information sources could be due to reduced quality of proprioceptive information.

LBP patients did not show increased levels of trunk muscle co-activation to compensate for their proprioceptive impairments. Interestingly, previous studies reported trunk muscle activation patterns apparently aimed at trunk stiffening in LBP patients during other tasks (van Dieën et al., 2003). However, we did not find evidence for the use of such a strategy in the current study. Maybe our inclusion criterion of a <105 score at the questionnaire for yellow flags can explain why we did not find increased co-activation in our patient group. The yellow flags questionnaire evaluates psychosocial factors, which may contribute to the chronicity of LBP. LBP patients with high levels of stress and anxiety will score high at this questionnaire. Therefore, this subgroup of patients, who may be more likely to increase muscle activation (van der Hulst, Vollenbroek-Hutten, Schreurs, & Hermens, 2010), did not participate in our study.

The finding that tracking errors significantly increased with trunk inclination seems to support previous findings on signal dependent force variability (Allum et al., 1978; Christou et al., 2002; Jones et al., 2002; Newell & Carlton, 1988; Sherwood et al., 1988; Slifkin et al., 2000; Tseng et al., 2003; Visser et al., 2003). However, in contrast with our hypothesis, GEE model 2 did not reveal a significant relation between agonistic muscle activation and tracking errors. While the positive coefficients of agonistic abdominal muscle activation tended to approach the level of significance, the effect of agonistic back muscle activation was almost zero. This suggests that another mechanism may dominate the effect of muscle activation on tracking error. For instance, this could be related to the differences in anatomical characteristics between abdominal and back musculature. While most back muscles have several segmental insertions, the abdominal muscles span all lumbar segments with their insertions on thorax and pelvis. The segmental insertions of the back muscles may facilitate precise trunk control and could therefore explain why tracking errors did not increase with agonistic back muscle activation.

The finding that antagonistic muscle activation did not reduce tracking error is in contrast with previous findings on precision control in the upper extremity (Gribble, Mullin, Cothros, & Mattar, 2003; Huysmans et al., 2010; Selen, Beek et al., 2006; Selen, van Dieën et al., 2006), but supports a recent suggestion based on static trunk control (Willigenburg et al., 2010), that precision of the trunk is regulated by feedback corrections rather than by a co-activation strategy. This difference between precision control of the trunk and the limbs can be explained by several factors. First, trunk movements are multi-articular, whereas the investigated limb movements occurred in individual joints. Second, the trunk has a large mass and, thus, a high inertia compared to the limbs. Therefore trunk movements are relatively slow, which may facilitate feedback control. Moreover, trunk stiffening may interfere with other functions of trunk musculature, such as breathing.

A limitation of the present study is that we did not specifically measure EMG activity of deep trunk muscles such as m. multifidus and m. transversus abdominis, whereas these muscles have been attributed an important role in trunk motor control (Hodges & Richardson, 1997; Moseley, Hodges, & Gandevia, 2002). However, surface electrodes at the reported locations probably reflected some of these deeper muscles’ activity (Stokes, Henry, & Single, 2003) as well. Furthermore, some variations in task execution were observed. Cursor position in our tracking task corresponded to the frontal and sagittal plane angles of the T12 marker, and did therefore not constrain relative movements between lumbar spinal segments, nor motion in the thoracic and cervical spine. Moreover, the neutral posture was selfdefined by each individual and therefore did not (necessarily) reflect a similar (zero) external moment around L5/S1 for each subject. While these variations in task execution enhance the ecological validity, they caused substantial variations in trunk muscle activation.

Another limitation was the EMG normalization procedure. We did not normalize to activation levels during isometric (sub)maximally voluntary excitation, because this involves the risks of introducing a bias between patients and healthy controls (van Dieën et al., 2003). The current normalization method (to the highest value recorded during four measurements), that we used for GEE model 2, could mask potential differences in EMG amplitudes between groups. Therefore, we could not use the normalized EMG amplitudes to compare trunk muscle activation levels between healthy controls and LBP patients. Since this comparison was not required for testing our hypotheses on effects of agonist and antagonist activation on precision, this limitation did not affect our conclusions. Importantly, in order to compare trunk muscle co-activation ratios between groups, we used the non-normalized EMG amplitudes. This involved the assumption that volume conduction did not differ between groups, which was considered plausible given the successful matching of BMI at the group level.

In conclusion, LBP patients made larger errors in a spiral tracking task requiring circular trunk movements. Lumbar muscle vibration did not affect performance in LBP patients, but caused tracking errors to increase in healthy participants. These results suggest that LBP is associated with proprioceptive impairments. Antagonistic co-activation ratios did not differ between groups and, while tracking errors significantly increased with trunk inclination, no significant relation between agonistic muscle activation and tracking errors was found.

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SONOGRAPHIC CHARACTERISTICS OF THE ABDOMINAL MUSCLES AND BLADDER IN INDIVIDUALS WITH LUMBOPLEVIC PAIN AT REST AND DURING TWO COMMON CLINICAL TESTS

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Introduction

Connective tissues remodel in response to how they are loaded, consequently their morphological characteristics provide insight into their loading history.

Purpose

This study aimed to compare the sonographic characteristics of the abdominal muscles, their associated perimuscular connective tissue (PMCT), and bladder base between individuals with, and without lumbopelvic pain from rest to four points during an Active Straight Leg Raise (ASLR) test and an Abdominal Drawing in Manouver (ADIM).

Methods

B-mode ultrasound (MyLab 25; Biosound Esaote Inc, Indianapolis IL, USA with a 5.0 MHz, 40mm footprint curvilinear transducer) imaging was used to record video clips if the abdominal muscles (rectus abdominis; RA, external oblique; EO, internal oblique; IO, and transversus abdominins; TrA), inter-recti distance (IRD) and bladder base position over the course of the ASLR and ADIM in 25 individuals with (46.6 ± 8.0 years), and 25 without (36.3 ± 9.4 years) LPP. Images were extracted at five points during each manoeuvre (rest, onset of manoeuvre, manoeuvre hold, manoeuvre release and post manoeuvre rest) and measured (Figure 1). Further, the thickness of the PMCT associated with the four abdominal muscles was measured in the resting images. Univariate correlation analysis was used to identify covariates and analyses of covariance were used to compare cohorts (alpha=0.05).

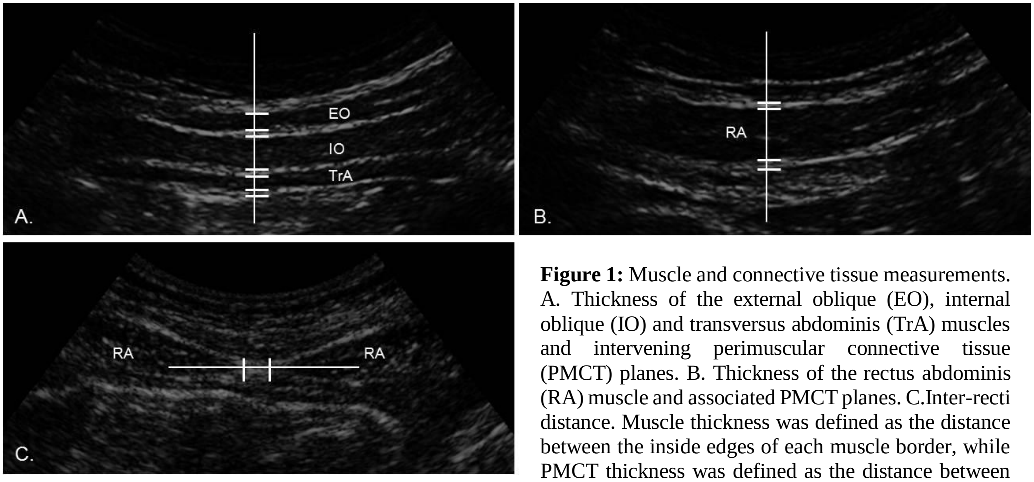

Figure 1: Muscle and connective tissue measurements. A. Thickness of the external oblique (EO), internal oblique (IO) and transversus abdominis (TrA) muscles and intervening perimuscular connective tissue (PMCT) planes. B. Thickness of the rectus abdominis (RA) muscle and associated PMCT planes. C.Inter-recti distance. Muscle thickness was defined as the distance between the inside edges of each muscle border, while PMCT thickness was defined as the distance between the outside edges of each connective tissue layer. Inter-recti distance was defined as the distance between the inside edges of the medial border of the 2 RA muscles.

Results

The LPP cohort had less total abdominal muscle thickness ($p=0.03$), thicker PMCT ($p=0.007$) and wider IRD ($p=0.005$). Analysis of individual muscle thickness revealed no difference between the groups for the EO, IO and TrA, but a significantly thinner RA ($p<0.001$) in the LPP cohort. Fluctuations in the magnitude of the sonographic parameters over the course of the two manoeuvres were observed. There were no significant differences between the two cohorts during the ADIM. During the ASLR the LPP cohort demonstrated smaller increases in TrA thickness throughout ($p < 0.001$-0.05), and greater inferior bladder base position at two points during the task ($p = 0.02$). Further, the percent change in TrA thickness during the ASLR was found to have a fair correlation with pain intensity ($r =-0.44$, $p=0.001$), Oswestry disability score ($r = -0.44$, $p = 0.001$) and pain duration ($r = -0.38$, $p = 0.01$).

Relevance

Individuals with LPP demonstrate unique alterations in motor control and subsequent movement strategies. Accordingly, an informed tailored approach to rehabilitation requires a means to detect the unique characteristics of these alterations. Ultrasound imaging (USI) can monitor changes in muscle and connective tissue morphology, as well as bladder base position, during clinical tests commonly employed when assessing LPP. As such, USI can provide useful information about loading history as well as the loading strategy being employed to control the lumbopelvic region during these manoeuvres.

Discussion

This is the first study to simultaneously compare the morphological difference of all four abdominal muscles, their PMCT, the IRD and bladder base during commonly used clinical tests in individuals with and without LPP. The results bring into question the diagnostic value of the ADIM and point to an altered strategy of control during the ASLR in the LPP cohort. Specifically, the findings are consistent with a strategy involving large increases in intra-abdominal pressure which prevent TrA thickening, displace the bladder inferior and may contribute overtime to a distortion (widening) of the RA and IRD, as well as altered thickening of the abdominal wall PMCT.

Conclusions

Individuals with LPP presented with a thinner rectus abdominis ($p<0.001$), thicker abdominal PMCT ($p=0.007$), a wider IRD ($p=0.005$) and demonstrated smaller increases in TrA thickness ($p\leq0.00$-0.05), and greater BB descent ($p=0.02$-0.03) during the ASLR as measured with B-mode USI.

Implications

The findings of this research emphasize the importance of considering the lumbopelvic region as a function unit and therefore the need to expand our focus beyond individual muscle and structures when assessing and developing rehabilitation strategies for individuals with LPP. Specifically, USI can provide a series of novel findings about various characteristics of the lumbopelvic region, that when considered in combination, assist in the characterization of the dominant loading strategy being used by individuals with LPP.

Keywords

Ultrasound Imaging, Abdominal muscles, Bladder, Connective Tissues, Active Straight Leg Raise

SENSORY AND MOTOR ASPECTS OF LUMBOPELVIC PAIN

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Introduction

Pain in the lumbopelvic area is a growing problem creating a social and economic burden for the sufferer and the society. This problem is especially common in pregnancy where the majority women develop lumbopelvic pain (LPP) at some stage prior to giving birth (72-84%). For most this is a self-limiting problem, resolving within three months post-pregnancy. However, up to 1/10 still suffer from pain and disability two years post-partum. Previous studies have not been able to identify one single dominant risk factor for developing LPP in pregnancy, but a set of physical and psychosocial factors have been linked to the disorder.

The ligamentous tissue around the sacroiliac joint (SIJ) complex is richly supplied by afferent nerves with nociceptive abilities which are similar to what is found in the ligamentous structures of the low back. Enhanced afferent input from sensitized afferents fibres and the spread of cytokines from inflamed tissue can increase the excitability of neurons in the central nervous system (central sensitisation). This might account for the extensive pain referral demonstrated in low back pain and intra-articular SIJ pain as well as for deep-tissue hyperalgesia (primary and secondary). As a result, normally innocuous stimuli can possibly produce pain (allodynia), and an area of heightened pain sensitivity (hyperalgesia) can possibly expand beyond the site of the nociceptive input. Physical strain to the lumbopelvic region associated with changes of body posture (lordodic and sway standing) during pregnancy may result in increased mechanical loading of pain sensitive structures leading to sensitization of peripheral nociceptors because of the release of inflammatory mediators.

In clinical practice various tests are commonly used during physical examination to help identifying the source of symptoms. The active straight leg raise test (ASLR) and a battery of SIJ pain provocation tests are considered valid and reliable tools for diagnostic purposes in LPP and are commonly used both as outcome measures and to assess disease severity in clinical practice and research. The ASLR is considered a useful test to assess the ability to transfer load across the pelvis and the pain provocation tests of the SIJ are considered valuable tools to differentiate between pain originating in the SIJ and low back pain. Previous studies have not looked specifically at the role of pain in the outcome of these tests.

Experimental pain has been demonstrated to reduce the motor output of affected muscles which leads to a reorganisation in the motor systems to compensate for the loss in activity of the prime mover. In clinical lumbopelvic pain it has been suggested that people often use different motor strategies during a functional task when compared with controls. This is also seen during the active straight leg raise test where patients seem to use a more global activation pattern of trunk muscles (bracing) when compared with the more unilateral pattern seen in controls. This may be related to a functional adaptation of the motor system1 during the acute phase which then outlasts the period of tissue healing leading to a mal-adaptive movement pattern.

Purpose/Aim

With pain being the common denominator in this condition it is important to clarify what role pain alone has, especially with regards to clinical decision making. The project was set up as three sub-projects where the aim of the first two was to investigate the basic mechanisms in lumbopelvic pain and how they affect the outcome of diagnostic tests which are commonly used in clinical practice. The third study included a population of pregnant women where the objective was to investigate the relationship between the sensitivity of pain mechanisms and the outcome of clinical tests.

Materials and Methods

An experimental pain model, intended to mimic symptoms of clinical SIJ pain, was developed and used in the first two projects2. This was done to avoid the potential influence of comorbid factors on the outcome of the tests. In the model, experimental SIJ pain was induced by injecting hypertonic saline (0.5 mL, 5.8%) into the long posterior sacroiliac ligament. This has been shown to be a valid, reliable and safe means of inducing pain in humans and creates a transient pain experience and causes hyperalgesia in healthy subjects with a spread in pain locations resembling the clinical condition. In the first two studies 30 healthy subjects of both genders were recruited and the effect of experimental pain SIJ pain on the outcome 5 SIJ pain provocation tests and the ASLR test was assessed. Furthermore, the pain referral pattern and sensitivity of pain mechanisms by determining pressure-pain thresholds (PPT) in the lumbopelvic area and distal to it was assessed.

In the third study thirty-nine pregnant women and 22 non-pregnant pain-free controls were recruited. A battery of QST testing consisting of light brush, pin-prick and PPT was performed in the lumbopelvic region as well as the extremities to account for widespread pain sensitivity. The response to SIJ pain provocation tests was assessed and the ASLR test was performed. The pregnant group was divided into two groups based on disability using the Pelvic Girdle Questionnaire (PGQ), low disability group and high disability group, respectively.

Results

In the first two studies an expansive pain referral pattern was found on the injection side with a majority of subjects demonstrating both distal and proximal referral. PPTs decreased significantly both at the injection site and lateral to the spinous process of S2 compared with baseline during experimental pain which increased after the pain had subsided. Compared with baseline, significantly more SIJ pain provocation tests became positive during pain which correlated significantly with PPT values at S2 and the overall levels of pain. When performing the ASLR test, subjects demonstrated a significant increase in muscle activity compared with baseline and isotonic saline at several trunk muscles when lifting the both legs (ipslateral and contralateral to the injection side). Furthermore, the subjects reported more difficulty on the Likert-scale when performing the ASLR during pain which correlated significantly with the levels of pain. The levels of pain also correlated significantly with the increase in muscle activity.

In the third study the pregnant group demonstrated significantly lower PPTs in the lumbopelvic area and in the extremities and rated the ASLR more difficult compared to the controls. When the groups were divided by disability the high disability group reported significantly more average pain and positive pain provocation tests than the low disability group. Only the high disability group rated the ASLR more difficult than controls.

Relevance

The outcome of this series of studies is of relevance for several reasons. The experimental pain model developed is novel and seems to be useful for investigating the mechanisms underlying lumbopelvic pain. The fact that pain alone can change the outcome of clinical tests in the absence of an underlying pathology or dysfunction inevitably calls for reconsideration with regards to how to interpret the outcome of the clinical tests. Lastly, increased pain sensitivity seems to be a general finding in pregnancy implicating changes in central modulation of normal sensory information from deep tissue. This may be related to the high frequency of reported musculoskeletal pain during pregnancy and can also explain why some women develop a long lasting pain condition post-partum.

Discussion

The pain referral pattern demonstrated in the first two studies is similar to what has been demonstrated in previous clinical studies indicating that the superficial structures of the SIJ complex are capable of generating pain which mimic intra-articular SIJ pain. Furthermore, pain in the ligamentous structures changes the outcome of both the pain provocation tests and the

ASLR towards what is seen in clinical populations indicating the significant role of pain in the outcome of these tests. Interestingly, widespread pain sensitivity seems to be a general finding in pregnancy regardless of pain condition or disability levels and may explain why a vast majority of women report musculoskeletal pain or discomfort during pregnancy. This may be related to the rapid biomechanical and hormonal change the female body undergoes but increased pain sensitivity at the distal sites (deltoideus and gastronemius) may implicate the role of facilitated central processing.

Conclusion

The effect pain has on the outcome of clinical diagnostic tests must be considered when used in research and clinical practice. Widespread and regional lumbopelvic pain sensitivity may lead to increased disability during pregnancy.

Conflict of interest

There is no conflict of interest to report.

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THE ASSOCIATION BETWEEN PELVIC GIRDLE PAIN AND PELVIC FLOOR MUSCLE FUNCTION IN PREGNANCY

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Introduction

The prevalence of pregnancy-related pelvic girdle pain (PGP) is estimated to range from 24% to 50% [1, 2]. Rates may vary depending on definition, mode of reporting, and performance of physical examination for inclusion. Clinical risk factors as well as the intensity and location of the pain during pregnancy predict the persistence of pain postpartum [3]. In addition, almost one in five women who experience lumbopelvic pain during pregnancy report refraining from another pregnancy due to the fear of recurrent pain [4].

Pelvic girdle pain is defined as pain experienced between the posterior iliac crest and the gluteal fold, particularly in the region of the sacroiliac joint. The pain may radiate to the posterior thigh and can also occur in conjunction with or separately in the symphysis. The endurance capacity for standing, walking, and sitting is diminished. Lumbar causes of pain should be ruled out and PGP should be reproducible by specific clinical tests [5].

The exact etiology of PGP during pregnancy is unknown. The hormone relaxin has been identified as the major contributor to joint laxity during pregnancy [6], yet there is inconsistent evidence correlating elevated serum relaxin levels with PGP [7–11]. Due to the enormous musculoskeletal changes that naturally occur during pregnancy, mechanical causes of PGP related to the pelvic joints (sacroiliac and pubic symphysis) and ligamentous and myofascial structures have also been implicated [12].

The contribution of pelvic floor muscles (PFM) to the development of PGP during pregnancy remains unknown. The muscles of the pelvic floor bear the weight of the growing uterus and will eventually allow passage of the fetus [13]. Inherent pelvic asymmetry associated with hormonally induced ligamentous laxity may have effects on muscle length that lead to suboptimal biomechanical alterations including changes in contraction and relaxation patterns and muscle strength [14]. Such disturbances in PFM may cause the muscles to have a less protective effect on the pelvic joints they surround and may result in tenderness of the PFM. Tenderness of the PFM palpated vaginally has not been described in pregnancy-related PGP.

The objective of this study was to determine if women with PGP in pregnancy are more likely to have PFM tenderness, PFM dysfunction (abnormal muscle activation patterns) and/or weakness as compared with pregnant women without PGP. We hypothesized that women with clinically defined PGP would have more abnormalities of the pelvic floor muscles than women without PGP.

Materials and methods

This was a prospective, cross-sectional study of second trimester (between gestational weeks 13 and 28) women with PGP compared with those who were pain free. The study was approved by the Institutional Review Board of Northwestern University and all participants gave written consent to participate prior to entering the study. Study participants were females between the age of 19 and 50, recruited via advertisements placed in and around an urban hospital and academic campus in Chicago, Illinois, USA. The advertisement requested women with low back or pelvic pain in pregnancy to particularly consider enrolling. A research coordinator performed a screening interview on the telephone to determine if the participant was eligible for the study.

For study inclusion, women had to be English speaking, pregnant in the second trimester, under the care of an obstetrician/gynecologist at Northwestern Memorial Hospital, and planning to deliver at Prentice Women's Hospital. Physical examination of all women, in addition to self-report, was utilized to identify women with PGP [5]. Women included in the PGP group had self-reported pain between the upper level of the iliac crests and the gluteal folds in conjunction with or separately from pain in the pubic symphysis of at least 3/10 that was onset since pregnancy; this pain was influenced by position and locomotion, and they had at least two out of four positive maneuvers on physical examination. Four musculoskeletal clinical examination maneuvers were performed including the posterior pelvic pain provocation test (P4), the long dorsal ligament test (LDL) test, pubic symphysis palpation test, and the active straight leg raise test (ASLR). Women who met study inclusion criteria but did not meet PGP criteria were included in the pain-free group.

Exclusion criteria included self-reported pain above the upper level of the iliac crests, history of lumbar or pelvic fracture, neoplasm, inflammatory disease with known sacroiliitis, active urogenital infection or active gastrointestinal illness, current physical therapy for PGP, previous surgery of the lumbar spine, pelvic girdle, hip joint or femur, history or signs of radiculopathy (asymmetric Achilles reflex, hypoesthesia in a radicular pattern (passive), straight let raise restricted by pain in the lower leg), and/or systemic disease of the locomotor system. A brief neurologic examination was performed by the study physician to rule out radiculopathy, including ankle reflexes, sensory examination of the lower extremities with pinprick testing, and the straight leg raise.

Following the preliminary examination for study inclusion, each participant completed seven self-report questionnaires including the Personal Health Information Questionnaire, a pain questionnaire including the Visual Analog Scale (VAS) and a pain diagram, Quebec Back Pain Disability Scale [15], the Patient Health Questionnaire (PHQ-9) [16], the Health Status QuestionnaireShort Form (SF12) [17], the International Consultation on Incontinence Questionnaire-Short Form [17, 18], and the Pelvic Organ Prolapse/Urinary Incontinence Sexual Function Questionnaire (PISQ-12) [19]. Only the personal health information and VAS/pain diagram are reported here.

Next, a single physician (CF) performed each of the clinical examinations. The first part of the examination included 11 musculoskeletal tests [5] including the Stork test [20], modified Trendelenburg for pubic symphysis provocation, the posterior pelvic pain provocation test (P4), the Patrick FABER's test, long dorsal ligament tenderness, pubic symphysis tenderness, the active straight leg raise, rectus abdominis diastasis assessment [21], and three extrapelvic tenderness sites including medial knee, lateral elbow, and second rib [22]. This portion of the examination was then followed by a vaginal examination of the PFM. All tests were performed in the same order. For the vaginal examination, the participant was positioned supine with hip and knees flexed and feet on the examination table in a neutral position to avoid excessive hip external rotation. Using a gloved single digit without the use of stirrups or instruments, muscle tenderness was first examined. This included external vaginal tenderness of the right and left superficial muscles including the ischiocavernosus, bulbospongiosus, and transverse perineal superficial muscles followed by intravaginal tenderness of the deep right and left levator ani and obturator interni palpated between 6 and 9 o'clock (right) and 3 and 6 o'clock (left). Pelvic floor muscle tenderness was defined as patient's report of pain elicited during firm vaginal palpation of right or left pelvic floor muscles. The participant was then asked to perform a pelvic floor contraction using the verbal cues “lift and squeeze” (Kegel) as if she was stopping the flow of urine or gas. Voluntary relaxation following contraction was assessed next followed by involuntary contraction with cough and involuntary relaxation with Valsalva. Quick contractions of the pelvic floor (quick flicks) were also assessed. Each of the muscle function tests was scored as present, absent, impaired, or unable to perform/not tested. Finally the Modified Oxford scale [23] for pelvic floor muscle strength was performed and scored as: 00no discernible contraction of muscles; 10flicker or pulsation is felt, no discernible lifting or tightening; 20weak contraction, no discernible lifting or tightening; 30moderate, some lifting of the posterior wall and some tightening around the examiner's finger, contraction is visible; 40good, elevation of the vaginal wall is felt against resistance, drawing in of the perineum is felt, able to hold for five or more seconds; and 50strong resistance is felt, able to hold for with 10-s hold. Participants were allowed several trials of muscle contraction and relaxation attempts with verbal and tactile cues provided by the examiner on how to perform the muscle activation when needed.

For this manuscript, muscle function tests were recoded as either normal (present) or abnormal (absent, impaired, unable). The Oxford scale was recoded as weak (3 or less) or strong (4 or 5).

Categorical variables were compared using Fisher's exact test and continuous variables with a two sided unpaired t test. Two-sided P values<0.05 were considered statistically significant. Data were analyzed using Stata 11.0 (College Station, TX).

Results

Sixty participants were recruited into the study. Fifty-six women met inclusion criteria (29 with PGP and 26 without PGP) and one had unusable data. The majority of the PGP group experienced posterior pelvic pain (28/29). The groups were comparable in age, gestational weeks at the time of presentation, educational level, parity, and medical history (Table 1). This was a predominantly Caucasian, highly educated sample of pregnant women. African-American women in the study were all in the PGP cohort. The distribution of race in the sample overall was representative of the local maternity hospital data from which participants were recruited. Women with PGP were far more likely to have a history of low back or PGP. Women who were restricted in activity by their physician were low in number but all in the PGP group. As expected, VAS scores for current pain differed by group (FET) P<0.001. Most musculoskeletal clinical examination tests were significantly different between the two groups (Table 2). Overall, women without PGP had negative responses to pain provocation testing. All women had evidence of rectus abdominis diastasis. Extrapelvic tenderness sites were not significant except at the medial knee in the PGP group. Also right Stork test was significantly different however left Stork test was not. Modified Trendelenburg was not different between groups.

Table 1 Patient characteristics

Characteristic	**No PGP (n=26)**	**PGP (n=29)**	**P value**
Age mean, (SD), years	31.5 (3.4)	32.1 (5.1)	0.63
Race			
Caucasian	20 (76.9%)	18 (62.1%)	0.05*
African American	0	6 (10.9%)	
Hispanic	3 (11.5%)	2 (6.9%)	
Asian	1 (3.8%)	3 (10.3%)	
Pacific Islander	1 (3.8%)	0	
Other	1 (3.8%)	0	
Educational level			
<College	2	4	
>College	24	25	0.12
Gestational age, mean (SD)	21.2 (3.3)	21.4 (4.0)	0.85
Parity			
Primiparous	11	7	
Multiparous	15	22	0.25
LBP/PGP history	4	20	<0.001*
Depression history	4	2	0.41
Anxiety history	4	4	1.0
Diabetes history	1	0	0.73
Restricted activity	0	5	0.05*
VAS score	0.62 (0.47)	31.86 (4.77)	<0.001*

LBP low back pain, PGP pelvic girdle pain, VAS visual analog scale

*p≤0.05 statistically significant

Fifty-one women (26 with PGP and 25 without) were included in the PFM analysis. Four women (three PGP and one no PGP) were not included in the analysis because the vaginal exam was unable to be completed (refused or medically prohibited). Most women in the PGP group had deep PFM tenderness of both the levator ani (25/26) and the obturator interni (23/26) compared with few (5/25 for levator ani, 4/25 for obturator interni) in the no PGP group (FET) P<0.001. Neither the PGP group nor the no PGP group had tenderness in the superficial muscles (ischiocavernosus, bulbospongious, and transverse perineal muscles; Table 3). There was no difference between the two groups in PFM voluntary or involuntary contraction or relaxation function or in PFM strength with most women reporting normal PFM function on all examinations except involuntary contraction were about half of each group were classified as abnormal. About half the women in each group were classified as having weak PFM (Table 4).

Discussion

Our study revealed that there is an association between PGP and deep but not superficial PFM tenderness in pregnancy. Specifically, pregnant women with PGP are more likely to have deep PFM tenderness in both the levator ani and obturator interni muscles as compared with pregnant women who do not have PGP. This finding suggests that the bilateral deep PFM may be a factor in pregnancy-related PGP along with other causes such as hormonal, mechanical, and other musculoskeletal (joint/ligament/muscle) influences.

Table 2 Physical examination findings by pain status

	No PGP (n=26) Response		**PGP (n=29) Response**		**P value**
	P	**N**	**P**	**N**	
Examination test					
R. Stork	0	26	11	18	<0.001*
L. Stork	0	26	4	25	0.113
R. P4	1	25	23	6	<0.001*
L. P4	0	26	21	8	<0.001*
R. modified Trendelenburg	0	26	3	26	0.238
L. modified Trendelenburg	0	26	3	26	0.238
R. Patrick FABER	0	26	18	11	<0.001*
L. Patrick FABER	0	26	17	11	<0.001*
R. LDL tenderness	1	25	18	11	<0.001*
L. LDL tenderness	0	26	16	13	<0.001*
PS tenderness	5	21	13	13	0.014*
R. ASLR	1	25	11	18	0.003*
L. ASLR	2	24	12	17	0.005*
Rectus abdominis diastasis	26	0	29	0	NS
Medial knee tenderness	0	26	6	23	0.024*
Lateral elbow tenderness	0	26	3	26	0.238
Second rib tenderness	0	26	4	25	0.113

PGP pelvic girdle pain, P positive, N negative; P4 posterior pelvic pain provocation, LDL long dorsal ligament, PS pubic symphysis, ASLR active straight leg raise *p≤0.001 statistically significant

Table 3 PFM tenderness by pain status

	No PGP (n025)a Location of pain				**PGP (n026)[a] Location of pain**				***P* value**
	N	**R**	**L**	**B**	**N**	**R**	**L**	**B**	
Superficial muscle groups									
Ischiocavernosus	25	0	0	0	23	0	0	3	0.235
Bulbospongiosus	25	0	0	0	24	1	0	1	0.368
Transverse perineal	24	0	0	1	25	0	0	1	0.977
Deep muscle groups									
Levator anus	20								<0.001*
Obturator internus	21	0	0	4	3	1	4	18	<0.001*

PFM pelvic floor muscle, PGP pelvic girdle pain, N no tenderness, R right, L left, B both sides
*p≤0.05 statistically significant
[a] Vaginal exam was unable to be completed (refused or medically prohibited) in four participants (one in the no PGP group and three in the PGP group)

Another possibility is that this tenderness may be a global compensatory muscle response of the deep PFM layer to provide greater lumbopelvic stability to hypermobile joints in pregnancy. The obturator interni which are normally hip external rotators may in this scenario function as stabilizers. Interestingly, the majority of both groups had no tenderness of the superficial layer of PFM including the ischiocavernosus, bulbospongiosus, and the transverse perineal muscles. The lack of superficial PFM tenderness may be due to this muscle layer's relative uninvolvement in lumbopelvic stability.

PFM function was only abnormal in a small number of women and there was no significant difference between the PGP and no PGP groups. Abnormal involuntary contraction was seen in almost half the women but was not associated with PGP status. Additionally, PFM strength did not differ significantly between groups. Abnormal motor control and core weakness is well documented in chronic PGP and low back pain [24, 25] but not in acute pain. Only one study to date has investigated the association of pregnancy-related PGP and PFM dysfunction [14]. Abnormal PFM function (i.e., abnormal timing of voluntary contraction and relaxation) measured by intravaginal palpation and surface electromyography (EMG) was found 52% of postpartum women with chronic lumbopelvic pain that began during pregnancy. We hypothesized that PFM function in general would be abnormal in pregnant women with PGP; however, the hypothesis was not supported in this sample. This may reflect the fact that participants studied had acute PGP, not chronic pain and therefore had not yet gone on to develop more definitive PFM dysfunction [24]. Our study revealed that 20/29 women in the PGP group had a history of low back or pelvic pain. Of these 20 women, 9 had a current onset in the first trimester and 9 had a current onset in the second trimester. Only 2 of these 20 women reported that they had current PGP that started prior to pregnancy. Therefore, for the majority of these women with prior histories, the current pain can be considered acute. This finding is consistent with other evidence citing that a history of low back pain is a risk factor for developing PGP during pregnancy [2, 5]. Current literature suggests that the pelvic joints and surrounding ligaments may be the true pain generators in pregnancy-related PGP [26]. Why some women are afflicted and others are not remains unclear. It is likely that this pain condition is due to a combination of hormonal, mechanical, neural, inflammatory, and genetic factors all of which influence each other. The evidence for the link between musculoskeletal structures namely the sacroiliac joint and the pelvic floor musculature is growing. The PFM or levator ani consists of the pubovisceral/pubococcygeal complex, which includes the pubovaginal, puboperineal, and puboanal portions, the puborectalis and iliococcygeus muscles [27]. The PFM is innervated through direct branches from the S3–5 sacral plexus [28]. Normal baseline activity of the PFM keeps the urogential hiatus closed to maintain continence [29]. The PFM co-activates with abdominal and other core muscles during voluntary exercise to maintain lumbopelvic stability [30]. More upright sitting postures recruit greater PFM resting activity [31]. Simulated tension in the pelvic floor muscles increased the stiffness of the SI joints by 8.5% in females but not in males in a cadaveric study [32]. In a biomechanical model, the PFM appears to reduce the shear of the sacroiliac joint in a standing posture [33].

Table 4 PFM function by pain status

	No PGP (*n*=025)a		**PGP (*n*=026)a**		***P* value**
	Normal	**Abnormal**	**Normal**	**Abnormal**	**FET**
Voluntary contraction	22	3	25	1	0.35
Voluntary relaxation	21	4	20	6	0.73
Involuntary contraction (cough)	14	11	9	17	0.3
Involuntary relaxation (Valsalva)	22	3	23	3	1.0
Quick contraction (flick)	22	3	24	1	0.61
Strength: modified Oxford Score					1.00
3 or less		13		13	
>4		12		13	

[a]Vaginal exam was unable to be completed (refused or medically prohibited) in four participants (one in the no PGP group and three in the PGP group)

The limitations of this study include a small rather homogeneous sample, a single examiner not blinded to pain status, and the use of a subjective clinical physical examination. There is an unequal distribution of racial representation between the two groups. African–American women comprise 10% of the population attending the local maternity hospital from which patients were recruited. Similarly, they comprise 10% of our sample though notably are all in the PGP group. In addition, the lack of difference in certain musculoskeletal tests may be that extrapelvic tenderness is simply not seen in these groups except in knee pain which may be related to PGP. Lack of positive modified Trendelenburg pubic findings may reflect the fact that most women in the PGP group presented with posterior pelvic pain. Differences in the sidedness of the Stork test remains unclear.

EMG was not performed to assess PFM overactivation as had been done in previous work. Future studies with objective measurement devices utilized by blinded examiners (pressure algometer and 3D ultrasound or vaginal surface EMG) should enable more precise measurement of muscle function. In addition, all tests were performed in a supine non-loaded position without performing a functional task given the difficulty in pregnancy of performing a vaginal examination in a standing position. Vaginal examination with ASLR would have been clinically challenging without the use of a device such as a vaginal EMG sensor. The PFM were not tested under load as part of the “core” in a situation which would normally trigger PGP in pregnancy [34].

In the future, examination of PFM tenderness in postpartum women with and without levator injury [35] might help elucidate the primary versus secondary role of the levators in pregnancy-related PGP. Furthermore, studies investigating the acute response to diagnostic anesthetic injections performed under ultrasound guidance may enhance our understanding of the contribution of different musculoskeletal structures in pregnancy-related PGP.

Our study is the first to address the association between PGP in pregnancy and PFM abnormalities. Although there are limitations in the clinical methodology, our findings suggest involvement of the deep PFM in acute PGP in the second trimester. This is important because in the future it may help clinicians delineate the contributing pathoanatomic pain generators in women with pregnancy-related PGP. These structures could then be better targeted in physical therapy and other rehabilitative treatments.

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Conflicts of interest

None.

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THE ASSOCIATION BETWEEN PELVIC FLOOR MUSCLE FUNCTION AND PELVIC GIRDLE PAIN – A MATCHED CASE CONTROL 3D ULTRASOUND STUDY

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Background

There is uncertainty regarding the association between the function of the pelvic floor muscles (PFM) and pelvic girdle pain (PGP), and whether exercises to strengthen the PFM should be recommended for patients with PGP.

Aim and Design

This one-to-one matched case-control study examined whether there is any difference in voluntary PFM function between women with and without clinically diagnosed PGP.

Methods

PFM function was assessed by manometry and three-dimensional ultrasound. Images were saved anonymously and analyses were performed offline by one investigator. A special Cox regression model was used to fit a conditional logistic regression procedure for one-to-one matched case-control studies. Forty-nine pairs of women were successfully matched according to age and parity.

Results

The study showed no difference in voluntary PFM function measured by palpation, manometry or ultrasound. The size of the levator hiatus area, together with BMI, was significantly associated with PGP. Women with PGP had statistically significantly smaller levator hiatus areas and a tendency for higher vaginal resting pressure compared to the control group.

Discussion

A significantly smaller levator hiatus and a tendency for higher vaginal resting pressure may indicate increased activity of the PFM. Hence, no evidence was found to recommend strengthening exercises for the PFM in patients with PGP. It is important to note that in this study we examined only voluntary contractions and not an automatic response of the PFM to a functional activity.

THE AUTOMATIC PELVIC FLOOR MUSCLE RESPONSE TO THE ACTIVE STRAIGHT LEG RAISE IN CASES WITH PELVIC GIRDLE PAIN AND MATCHED CONTROLS

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Background

The active straight leg raise (ASLR) test has been proposed as a clinical test for the assessment of pelvic girdle pain (PGP). Little is known about the activation of the pelvic floor muscles (PFM) during ASLR.

Aims

The main aim of this study was to examine the automatic PFM contraction during ASLR. Specific aims were to compare automatic contraction to rest and to voluntary contraction, to compare PFM contraction during ASLR with and without compression and to examine whether there were any differences in PFM contraction between women with and without clinically diagnosed PGP during ASLR.

Methods

Forty-nine pairs of women participated in a cross-sectional study with individual, one-to-one matched cases and controls. PFM was assessed by reliable and valid 3D ultrasound at rest, during voluntary and automatic contraction. Test-retest data for the levator hiatus during ASLR showed good repeatability.

Results

Significantly automatic PFM contractions occurred when ASLR tests were performed. There was a strong positive correlation between voluntary and automatic PFM contractions. Manual compression reduced the automatic PFM contraction during ASLR by 62–66%. There were no significant differences between cases and controls in reduction of levator hiatus or muscle length from rest to automatic contractions during ASLR. Interestingly, a significantly smaller levator hiatus was found in women with PGP than in controls, at rest, during an automatic contraction with ASLR and during voluntary contraction.

Conclusion

A significant automatic PFM contraction occurred during ASLR, both in cases and in controls. Women with PGP had a significantly smaller levator hiatus than controls.

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Understanding the Active Straight Leg Raise (ASLR): An electromyographic study in healthy subjects

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Introduction

Pelvic Girdle Pain (PGP) affects over 20% of pregnant women (Wu et al., 2004; Mulholland, 2005; Vleeming et al., 2008; Robinson et al., 2010; Gutke et al., 2010; Vermani et al., 2010), and may also occur in athletes with groin pain (Verrall et al., 2001), or after trauma (cf. Kanakaris et al., 2011). Several diagnostic examinations are commonly used, especially the Active Straight Leg Raise (ASLR) (Mens et al., 1999, 2001, 2002), during which the subjects are supine and attempt to raise their leg by hip flexion, with the knee in extension. In subjects with PGP, the test maybe painful or limited (Mens et al., 2002).The ASLR was reported to have good reliability, sensitivity, and specificity (Mens et al., 2001).

The ASLR assesses the ability to transfer load between the spine and the legs via the pelvis (Mens et al., 1999, 2001; cf. Beales et al., 2009a,b; Beales et al., 2010a,b; Hu at al., 2010a,b; Jansen et al., 2010), and can be used to differentiate PGP from hip or lumbar pain (Cowan et al., 2004; Mens et al., 2006; Roussel et al., 2007).

During the test, subjects with PGP sometimes reported that they felt “as if the leg is paralyzed” (Mens et al., 1999). Relatedly, a “catching” sensation during walking was reported (Sturesson et al., 1997). These phenomena remain poorly understood.

The ASLR appears to consist of raising one leg, requiring ipsilateral hip flexor activity. Nevertheless, bilateral activity of muscles in the lumbopelvic region has been reported (Hu et al., 2010a). Snijders and his colleagues proposed that the transversus abdominis (TA), obliquus abdominis internus (OI), and obliquus abdominis externus (OE) stabilize the pelvis by pressing the iliac bones against the sacrum, i.e., sacroiliac “force closure” (Vleeming et al., 1990a,b; Snijders et al., 1993a,b). A pelvic belt maybe used to substitute, or partially substitute, the force required, which could be helpful when the ASLR is painful or limited (Mens et al., 1999). Still, it is not immediately obvious why raising one leg from a supine position would require pelvic stability (cf. Mens et al.,1999; Hu et al., 2010a). Moreover, Liebenson et al. (2009) reported on ipsilateral transverse plane rotation of the pelvis during the ASLR, which was interpreted in terms of lumbar spine stability. However, it remains unclear why the pelvis would rotate during the ASLR, or how this would relate to stability.

Clearly, we need to improve our basic understanding of the ASLR. Several studies have attempted to disentangle symmetric, stabilizing muscle activity from the asymmetric activity that is needed to raise a leg. Some studies assumed that activity is symmetric if no asymmetry is observed (e.g., Beales et al., 2009b; cf. Teyhen et al., 2009), but this may be a moot point (cf. Hodges, 2008 vs. Allison et al., 2008). Abdominal muscles engage in multitasking (Saunders et al., 2004; Hu et al., 2011), and muscle activity contains both symmetric and asymmetric components. Hence, we need to disentangle the various mechanisms that are involved in performing the ASLR. The present study analyzed the ASLR in healthy subjects. Our aim was to improve understanding the mechanisms involved, and thereby facilitate the clinical interpretation of the ASLR.

Methods

Subjects

Sixteen healthy nulliparous females were enrolled, mean ± SD age 27.5 ± 2.7 years, weight 61.2 ± 9.8 kg, height 167.9 ±7.6 cm, and BMI 21.6 ± 2.4 kg/m2. Exclusion criteria were: previous orthopedic surgery, walking-related disorders such as low back pain (LBP) or PGP, or a history of low blood pressure. Participants signed a written informed consent. The protocol was approved by the local Medical Ethical Committee.

Electromyography (EMG)

To reduce the subjects' burden, EMG was measured on one side only. We arbitrarily selected the right side. TA was recorded with CE-marked intramuscular fine-wire electrodes of 40 gauge insulated stainless steel (VIASYS Healthcare, Madison WI, USA). The electrodes were threaded into sterile 50 mm hypodermic needles, and trimmed, with 2e3 mm long "hooks" extending from the tip. After disinfection, the needle was inserted under semi-sterile conditions with ultrasound guidance. Insertion for the transversus abdominis was 2 cm medial to the midpoint of the vertical from the spina iliaca anterior superior (SIAS) to the rib cage (Hodges and Richardson, 1997; cf. Hodges and Richardson, 1999). Some subjects felt anxious when the needle entered the muscle, but no lasting painwas reported. For OI, OE, rectus abdominis (RA), rectus femoris (RF), and biceps femoris (BF), EMG was recorded with pairs of surface electrodes, consisting of 24 mm diameter Ag/AgCl discs, with an inter-electrode distance of 20 mm (Kendall ARBO, Neustadt am Dom, Germany). For OI, electrode placement was 1 cm medial to the anterior superior iliac spine (ASIS), 0.5 cm below the line joining both ASISs (Ng et al., 1998; Beales et al., 2009a,b); for OE, 1 cm above the horizontal line through the umbilicus, 1 cm lateral to the border of RA (McGill and Norman, 1986), and for RA, 1 cm above and 2 cm lateral to the umbilicus. For RF and BF, SENIAM recommendations were used (Hermens et al., 1999). Data was recorded at a sample rate of 2000 samples/ s with a multichannel Porti5 EMG system (TMS-international, Enschede, The Netherlands; Hu et al., 2010a).

Kinematics

Four clusters of three LED Markers each were fixed onto small lightweight custom-made triangular frames, and attached halfway along the upper and lower legs for registration with a 2 x 3 camera system (OPTOTRAK 3020, Northern Digital, Waterloo, Ontario, Canada), connected via a synchronization cable to the Porti5 EMG system. To determine leg movements, the heights of the centers of the clusters were calculated. The kinematic sampling frequency was 50 samples/s.

Conditions

The ASLR was performed in supine position with the feet 20 cm apart (Mens et al., 2001). Subjects were instructed to raise one leg until the heel was 20 cm above the table, without bending the knees, and keeping the leg elevated for about 10 s (“Normal”). To increase statistical precision, this was done three times per leg per condition. After every ASLR, subjects were asked to relax for approximately 10 s. The whole procedure was repeated with a weight added just above the ankle (“Weight”), so that the static moment of the leg with respect to the hip was increased by 50%. To calculate the required amount of weight (Zatsiorsky, 2002; p. 605), manually measured lower extremity anthropometry was used. Finally, the ASLRwas repeated with a non-elastic pelvic belt (“Belt”; 3221/3300, Rafys, Hengelo, The Netherlands), just below the ASIS (Damen et al., 2002; Mens et al., 2006), with a tension of 50 N (Vleeming et al., 1992; Mens et al., 1999), fine-tuned with an inbuilt gauge.

Data analysis

Data was analyzed with MATLAB 7.4 (The Mathworks, Natick, MA, USA). Kinematic data were filtered with a 4th order bidirectional low pass Butterworth filter with a cutoff frequency of 5 Hz. We determined the onset and the peak of leg raise, i.e., the first point with zero velocity before/after a peak in velocity. Leg raise velocity was calculated as the height of peak position divided by the time to reach peak position.

Due to technical problems with the amplifier, TA EMG was not usable in four subjects, which left twelve valid datasets for TA. EMG data were high-pass filtered at 250 Hz (1st order Butterworth; Hu et al., 2010a), then full-wave rectified, and low-pass filtered at 5 Hz (2nd order Butterworth). The median amplitude during ASLR plateau (5 through 10 s after movement onset) was calculated.

To quantify the asymmetry of activity of TA, OI, and OE, an Asymmetry Index was calculated as: (ipsilateral - contralateral) activity/(ipsilateral + contralateral) activity x 100%, “ipsilateral” and “contralateral” referring to the leg being raised. Positive values indicate more ipsilateral, negative values more contralateral muscle activity.

Outliers were identified from box plots (Figs. 2 and 3), and removed. For statistical analysis, generalized estimation equations (GEEs) were used, i.e., repeated measures regression analyses that allow for missing values. First, the impact of Side (ipsilateral vs. contralateral) and Condition (Normal, Weight, Belt) on muscle activity was calculated (cf. Table 1), with contralateral as reference for Side, and Normal for Condition. Since nonnormalized EMG amplitudes of different muscles cannot be compared, these analyses were performed for each muscle separately. Then, to assess if Weight or Belt led, as predicted, to more asymmetry, the impact of Condition and of Muscle (TA, OI, OE) on the Asymmetry Index was calculated (cf. Table 2). Note that the Asymmetry Index is dimensionless, and allows for comparing different muscles. SPSS 16 was used throughout, with $P < 0.05$ as threshold for significance.

Results

The maximum velocity of leg raise was affected by Condition ($P < 0.001$), being faster with the belt (0.25 m/s), and slower with weight (0.22 m/s) than in the normal condition (0.23 m/s). Kinematically, there were no other significant effects.

Muscle activity

Fig. 1 provides a typical example of EMG activity. There was a significant main effect of Side in TA, OI, RF, and BF (P-values < 0.03; Table 1, Fig. 2), with in the first three muscles more ipsilateral, and in BF more contralateral activity. The effect of Condition was significant for all muscles (P-values < 0.01), with more activity with weight, and more RF and BF activity with the belt, but less activity with the belt in TA OI, OE, and RA. There were significant Side x Condition interactions in TA, RF, and BF (P-values < 0.001; Table 1, cf. Fig. 2). Ipsilateral TA and RF activity were higher with weight, but BF lower, and ipsilateral TA activity was higher with the belt, but RF and BF lower.

Symmetry/asymmetry of the lateral abdominal muscles

Box plots (Fig. 3) revealed that most, but not all, subjects had more ipsilateral activity of the lateral abdominal muscles. The median Asymmetry Index ranged from 1.4% (OE with belt) to 35.8% (TA with belt). TA activity appeared to be most, OE least asymmetrical, but inter-individual differences were considerable. Asymmetry increased significantly with weight and with the belt (P = 0.04; Table 2), and there were significant Condition x Muscle interactions (P = 0.01), OI and TA being more asymmetrical with weight or with the belt than OE. No other significant effects were found.

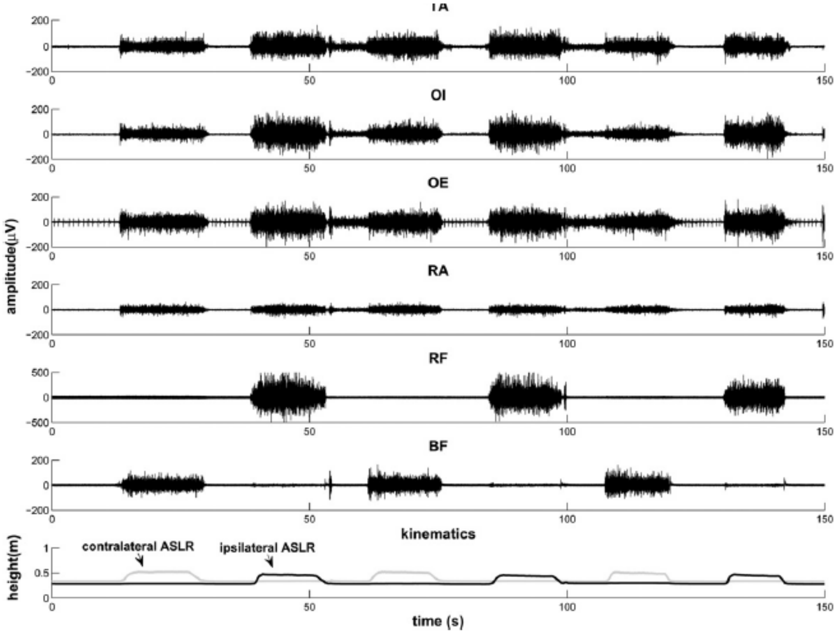

Fig. 1. Raw electromyograms, with signals (µV) over time (s), in one subject during three consecutive repetitions of contralateral and ipsilateral ASLR. Note the scale difference between RF and the other muscles. The bottom panel gives the kinematical pattern, with the height (m) of the leg raise over time. Each ASLR lasted around 10 s, and subjects rested about 10 s between repetitions. Baseline values of contralateral and ipsilateral ASLR are arbitrary. For the abbreviations of the muscle names, cf. Table 1.

Discussion

Mechanisms underlying the ASLR

Muscle activity during the ASLR had considerable interindividual variability, as revealed in the Asymmetry Index of the lateral abdominal muscles (Fig. 3). When subjects perform the same task repeatedly, there are large variations in the force produced (Van Dieën et al., 2001), and it has to be expected that different subjects use different strategies to perform the ASLR (cf. Latash et al., 2002). Nevertheless, many significant results were found, suggesting that most results were large, and related to common mechanisms underlying the ASLR.

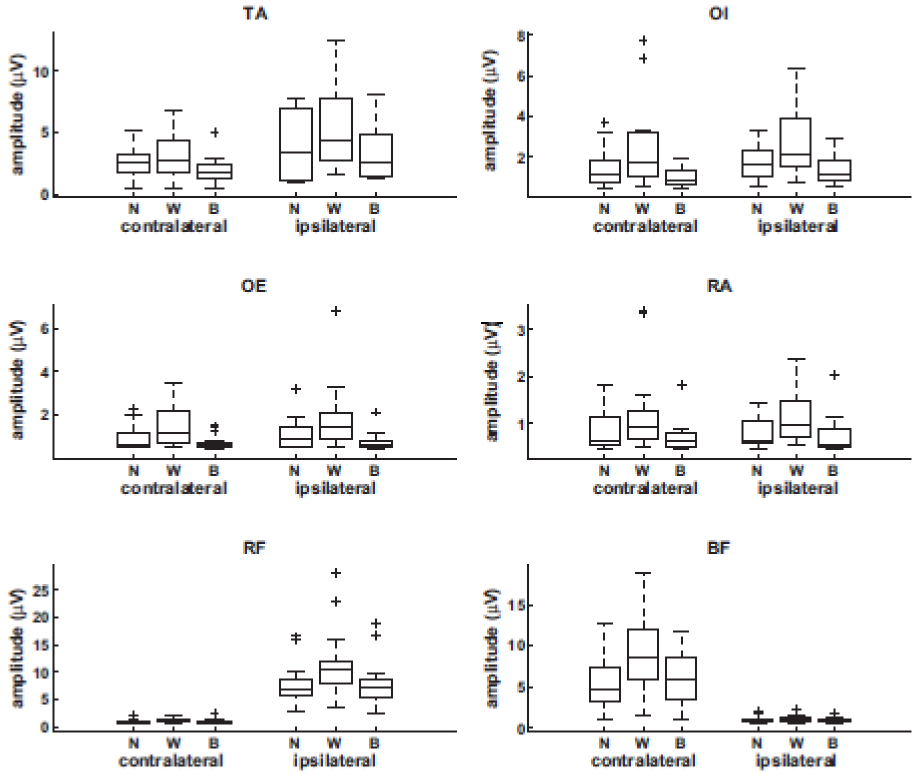

Fig. 2. Box plots of median muscle activity (mV) during ipsilateral and contralateral ALSR in three conditions (N ¼ Normal,W¼ withWeight added, B ¼ with a pelvic Belt). Each box runs from the 25 to the 75 percentile; the transverse line inside the box indicates the median, "þ" represents outliers, and the error bars represent the range, excluding the outliers. Note the scale differences. For the abbreviations of the muscle names, cf. Table 1.

During the ASLR, hip flexors raise the leg, as revealed in the ipsilateral RF activity (Table 1, Fig. 2), which was even larger with weight. In an earlier study, we found that the psoas is involved in bilateral frontal plane stabilization of the lumbar spine during the ASLR, and not in hip flexion (Hu et al., 2010b). For the ASLR, this leaves those hip flexors that also exert a forward pull on the ilium, i.e., iliacus, adductor longus, and RF (Mens et al., 1999; Hu et al., 2010a; cf., e.g., Vleeming et al., 1992, 1996, 2008; Hungerford et al., 2004). Contralateral BF activity, which was even larger with weight, serves to prevent this forward rotation of the ipsilateral ilium (Hu et al., 2010a). Note that the forward pull of ipsilateral hip flexors, and the backward pull of contralateral BF may balance, so that no actual movement of the ilium would occur.

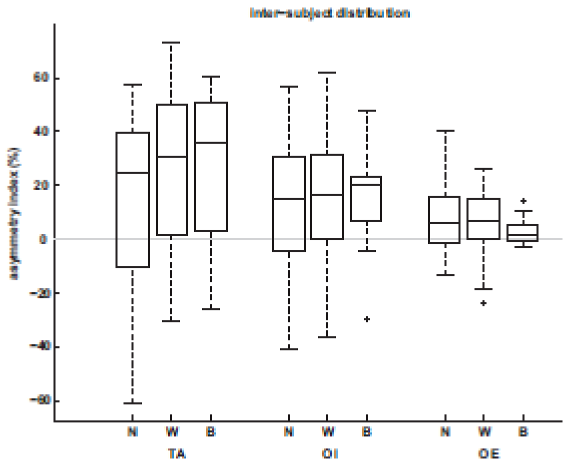

Fig. 3. Box plots of the Asymmetry Index (%) for TA and OI in all three conditions (cf. Fig. 2 & Table 1).

Contralateral BF activity is only useful if the two sides of the pelvis act as a single unit, such as when they are pressed together by force closure. Then, the extension moment produced by the contralateral BF can be transferred toward the ipsilateral ilium (Vleeming et al., 1990a,b; Snijders et al., 1993a,b; Hu et al., 2010a). With a pelvic belt, TA, OI, and OE were less active (Table 1, Fig. 2), which revealed that the belt (partially) substituted force closure. Note that abdominal wall activity may also rotate the pelvis posteriorly, and thus contribute to counteracting the forward rotation of the ipsilateral ilium. With a pelvic belt, the lateral abdominal muscles were less active, which could explain why contralateral BF was more active in conditions with a belt. Note that it is the ipsilateral ilium that is being pulled forward, and, as long as force closure is submaximal, abdominal backward rotation of the pelvis may involve more ipsilateral than contralateral activity ("þþ" in Table 3; cf. Beales et al., 2009a). It remained unclear why RA was less active in conditions with a pelvic belt.

Table 1
P-values, bold when significant, and corresponding regression coefficients (*B*) from GEEs on abdominal muscle activity during the ASLR, with side (ipsilateral vs. contralateral ASLR) and condition (normal, with weight added, or with a pelvic belt) as factors, and including significant interactions. Note that GEEs calculate regression equations, and, for instance, the first line reads as: TA activity (μV) = 2.56 + 1.26 (during ipsilateral ASLR) + 0.47 (when weight is added), or − 0.86 (in the condition with the belt), + 1.24 (in the condition with weight added during the ipsilateral ASLR), or + 0.55 (with the pelvic belt during ipsilateral ASLR).

Muscle activity (μV)	Intercept		Side[a]		Condition[b]		Interaction[c]	
	P	*B*	*P*	*B*	*P*	*B*	*P*	*B*
TA	**<0.001**	2.56	**0.004**	1.26	**0.010**	W: 0.47 B: −0.86	**0.007**	Ipsi × W: 1.24 Ipsi × B: 0.55
OI	**<0.001**	1.29	**0.021**	0.53	**<0.001**	W: 0.74 B: −0.38	0.10	
OE	**<0.001**	0.93	0.393		**<0.001**	W: 0.57 B: −0.23	0.08	
RA	**<0.001**	0.80	0.284		**<0.001**	W: 0.23 B: −0.15	0.15	
RF	**<0.001**	0.59	**<0.001**	5.82	**<0.001**	W: 0.50 B: 0.23	**<0.001**	Ipsi × W: 2.35 Ipsi × B: −0.35
BF	**<0.001**	5.40	**<0.001**	−4.38	**<0.001**	W: 3.59 B: 0.83	**<0.001**	Ipsi × W: −3.32 Ipsi × B: −0.81

Number of datasets used per muscle per condition (after removing data that could not be used, and after removing the outliers, cf. Fig. 2):

	Contralateral			Ipsilateral		
	N	W	B	N	W	B
TA	12	12	11	12	12	12
OI	15	14	16	16	16	16
OE	15	16	13	15	15	15
RA	16	14	15	16	16	15
RF	14	16	15	14	14	14
BF	16	16	16	14	15	15

TA: m. transversus abdominis.
OI: m. obliquus internus abdominis.
OE: m. obliquus externus abdominis.
RA: m. rectus abdominis.
RF: m. rectus femoris.
BF: m. biceps femoris.
[a] The *B*-value is for ipsilateral compared to contralateral activity.
[b] Comparing Weight (W) or Belt (B) with the normal condition.
[c] Ipsilateral (Ipsi) compared to contralateral activity in the Weight (W) or Belt (B) condition, compared to normal.

Contralateral BF activity presses the contralateral heel against the bench (Beales et al., 2009a,b, 2010a), with more pressure when weight is added (Beales et al., 2010b). Pressing down the contralateral heel will cause the pelvis to move upwards on that side, that is, ipsilateral transverse plane rotation of the pelvis, as reported by Liebenson et al. (2009). Note that there is no reason to suspect that such rotation would challenge lumbar spine stability. Nevertheless, it is an "unwanted" side effect, and contralateral pelvis rotators (¼ipsilateral trunk rotators) in the transverse plane, such as ipsilateral TA and OI (Urquhart and Hodges, 2005; Hu et al., 2010a), may counter this pelvis rotation toward ipsilateral. Beales et al. (2010b) did not measure TA, but reported increased ipsilateral OI activity when weight was added. In the present study, more ipsilateral activity was found for both OI and TA with weight (Table 1, Fig. 2). Transverse plane counterrotation of the pelvis appears to be another role of TA and OI in the ASLR.

Table 2
P-values, bold when significant, and corresponding regression coefficients (*B*) from GEEs on the Asymmetry Index of TA, OI, and OE, with condition and muscle as factors, and including their interaction (cf. Table 1).

Asymmetry Index (%)	Intercept		Condition[a]		Muscle[b]		Interaction	
	P	*B*	*P*	*B*	*P*	*B*	*P*	*B*
TA, OI, OE	**<0.001**	8.91	**0.043**	W: 0.84 B: 7.68	0.118		**0.005**	TA × W: 14.67 TA × B: 23.67 OI × W: 3.93 OI × B: 12.71
Post hoc: TA, OI	**<0.001**	9.62	**0.005**	W: 9.00 B: 9.53	0.458		n.s.	

Number of datasets used per muscle per condition (after removing data that could not be used, and after removing the outliers, as identified in Fig. 3):

	N	W	B
TA	12	12	11
OI	15	14	15
OE	15	14	12

[a] Weight or belt compared to normal.
[b] TA or OI compared to OE.

We conclude that the ASLR consists of ipsilateral hip flexion, a contralateral hip extension moment, force closure by the lateral abdominal muscles, sagittal plane pelvis stabilization by the abdominal wall, and activity of contralateral transverse plane rotators of the pelvis.

The notion of “symmetry”

The lateral abdominal muscles were more asymmetrically active with weight and with a belt (Table 2, Fig. 3), apparently because weight increases the ipsilateral task component, and the belt decreases the symmetrical task component. For TA and OI this was more so than for OE (Table 2, Fig. 3), possibly because OE was not used to counter transverse plane rotation of the pelvis. Between TA and OI, no difference was found in degree of asymmetry (Table 2).

Authors tend to report “symmetry” when statistical analysis does not reveal a significant effect of side (e.g., Danneels et al., 2001; Beales et al., 2010b). Strictly speaking, this is inaccurate, because one cannot prove exact symmetry on statistical grounds. More importantly, this tendency distracts from the fact that muscles engage in multitasking (Saunders et al., 2004; Hu et al., 2011), with some task components being symmetrical, and others asymmetrical (Hodges, 2008).

“Symmetry” is a mathematical concept (De Sautoy, 2008). It maybe a property of tasks, as understood biomechanically, not an empirical property of muscle activity or shape. Theoretically, force closure implies symmetric TA, OI, and OE activity. On the other hand, the lack of a statistical effect of side on OE (Table 1) does not prove that OE was engaged in force closure only, as it may also have played a role in sagittal plane control of the pelvis. All four abdominal muscles have different symmetric and asymmetric task components (Table 3). TA and OI, for instance, were expected to have a clear symmetric task component, but were found to have significant asymmetry.

Table 3
Plausible roles of the abdominal muscles during the Active Straight Leg Raise.

Task component	RA			OE			OI			TA		
	I		C	I		C	I		C	I		C
Force closure	−		−	+	=	+	+	=	+	+	=	+
Posterior rotation of the pelvis	+	≥	+	+	≥	+	+	≥	+	−		−
Ipsilateral rotation of the trunk	−		−	−		−	(+)		−	+		−

I: Ipsilateral; C: Contralateral.
− no role; (+) probably a role; + clearly a role.
I = C symmetrical task component.
I ≥ C ipsilateral activity similar to, or larger than contralateral activity.

Clinically understanding the ASLR

Hip flexors exert a forward pull on the ipsilateral ilium, which in the ASLR is prevented, at least in part, by contralateral BF, and force closure is needed to transfer the contralateral extension moment toward ipsilateral. Thus, failing force closure is a likely cause of problems during the ASLR. The sacroiliac joint is more stable with the ilium in posterior rotation (Mens et al., 1999; Vleeming et al., 2008), but in subjects with PGP, actual forward rotation has been observed (Hungerford et al., 2004). Forward rotation of the ipsilateral ilium, and backward rotation contralaterally, can both be established by palpation, which may confirm that failing force closure is the problem. Moreover, forward rotation of the ilium stretches the ipsilateral long dorsal sacroiliac ligament, which then is painful upon palpation (Vleeming et al., 1996). Perhaps the ASLR identifies that subgroup of subjects with PGP who have problems with force closure (cf. Mens et al., 2001, 2006). Note that it is not clear how such problems emerge, maybe a reflex inhibition (Hurley and Newham, 1993) when pelvic compression is painful, but if so, a pelvic belt, which may substitute the force required, could, in principle, cause the same painful compression. Diagnostic manual compression may help to complete the picture, and guide the choice of treatment.

Contralateral BF activity will be visible as the contralateral ASIS moving upwards. This can easily be observed, but the relevance of that observation remains unclear.

In summary, problems with the ASLR may result from failing force closure. Palpation of the movements of both ilia, and of the long dorsal sacroiliac ligaments, as well as manual compression of the pelvis may help to complete the picture.

Limitations

The present study was limited to healthy subjects. Muscles were only studied on the right side, although right and left ASLR were performed. Four sets of TA data could not be used, and outliers were removed before statistical testing. Still, a consistent pattern of significant effects was found, suggesting that power was no major problem. The use of surface EMG for OI and OE in the present study may have affected results. Crosstalk between the OI and OE, and between TA and OI, cannot be excluded. On the other hand, fine-wire EMG of TA would only reflect the activity of the mid region of that muscle, whereas different functional roles of different parts of TA have been described (Urquhart and Hodges, 2005). Finally, only women were measured and generalization of our results to the male population may not be straightforward.

Conclusions

The ASLR consists of ipsilateral hip flexion, a contralateral hip extension moment, force closure by the lateral abdominal muscles, sagittal plane pelvis stabilization by the abdominal wall, and activity of contralateral transverse plane rotators of the pelvis. Problems with the ASLR may result from failing force closure. Other tests are available to confirm, or falsify, the clinical hypothesis that the patient is having problems with force closure.

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SPECT/ CT FINDINGS IN A LARGE COHORT WITH SACRO-ILIAC JOINT INCOMPETENCE (SIJI)

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Background

The sacroiliac joint (SIJ) as a source of low back pain was initially recognised as far back as 1905(1). Unfortunately, the concept was progressively lost from medical consciousness following the classic 1934 paper on the intervertebral disc as a major source of low back pain by Mixter and Barr(2). This paper triggered a vast body of literature and a medical fixation on the intervertebral disc as the principal source of low back pain. An inability to develop a simple reproducible clinical classification and assessment tool for therapy was also problematic for this common symptom (3-6), adding fuel to suspicion of the veracity of non-specific low back pain.
Pelvic Girdle Pain is a specific form of low back pain (LBP). It is common in pregnant women in the pregnancy and peri-partum period (7-9). The focus of these studies was the sacroiliac joint which became dysfunctional and triggered a number of secondary manifestations that led to PGP in approximately 20% of pregnant women. Physical examination techniques have been developed and validated as being reliable and reproducible in identifying dysfunction of the joint to the point where evidence-based criteria have been published (10). Specific treatment has successfully addressed the purported mechanism of dysfunction; mainly physiotherapy and specific exercise therapy (11) with additional response to prolotherapy (12).
A similar constellation of signs and symptoms can be often observed in the setting of a sports medicine practice, irrespective of sex, parity and pregnancy status. We have termed the condition Sacro-Iliac Joint Incompetence (SIJI), as we hypothesize that failure of closure of the joint is responsible for the condition, irrespective of the mechanism.
The findings of the symptoms and signs that define PGP have been shown to have a prevalence of SIJ related pain in at least 13% and perhaps as high as 30% in some studies (13, 14). It indicates that this is a sizable problem that has largely been unrecognised by the medical community in general. We have observed a number of metabolic changes in and around the sacroiliac joints and pelvis utilising hybrid single photon emission computed tomography and x-ray computed tomography (SPECT/ CT) of the bone scan in 100 patients. These findings have a high sensitivity, specificity and reproducibility in comparison to patients with either no low back pain or back pain of other causes (15). We present the finding in a larger group of 252 patients in terms of the purported pathophysiological mechanisms of the condition and make some pertinent observations regarding causation.

Methods

Population. Consecutive patients who fulfilled the established clinical criteria for a diagnosis of PGP/ sacroiliac joint incompetence (10) were entered into the study and underwent bone scintigraphy with SPECT/ CT of the pelvis. Patients with a typical history of low back/ buttock pain in excess of 3 months duration were included in the study.
Ethics approval. The prospective aspect of the study was approved as part of a prolotherapy trial incorporating bone scintigraphy before and after prolotherapy for SIJ incompetence by the Institutional Ethics Committee of the Sydney Medical School, University of Notre Dame, Australia.
Clinical assessment. The 252 index patients were clinically assessed by two experienced Sports Medicine Physicians. All patients were assessed for PGP / SIJ incompetence according to the listed criteria in the Clinical Examination section below.
History. Patients with pain in the lower back at L5 or in the buttock (>3 months duration), with or without radiation to the lower limb were included. Pain was usually in the posterolateral thigh. The aetiology of the pain was either post-pregnancy or post-trauma. Trauma resulted from falls

on to the buttocks, twisting pelvic injury or repetitive micro-trauma during sport setting (repetitive landings on the same leg), and motor vehicle accidents (commonly rear end impact).

Clinical examination. Eight clinical tests were carried out on each patient. These were selected according to the validated European guidelines for PGP (10). Four are evidence based (Group A): Stork test (Gillet test) (25, 49, 58); tender palpation of the long dorsal sacro-iliac ligament (47, 59); posterior pelvic pain provocation test (60) and active straight leg test (50-52, 61-63). The other four are often recommended in the literature and considered valid when used in clusters (Group B) (16): Patrick's Faber Test (25, 49, 58); Gaenslen Test(47, 59); SIJ Glide (60) and Standing forward flexion test (64).

Two different scores were generated, one for Group A tests and the other for Group B.

All Group A manoeuvres were carried out in each patient. If any manoeuvre of Group B could not be carried out (e.g. hip related symptoms in Patrick's Faber test) it was recorded with a score of 0 for this particular test.

SPECT/ CT imaging. Patients were injected with ~1.0GBq of 99m Tc HDP and a dynamic and blood pool image of the anterior and posterior pelvis obtained on the Hawkeye 4 Hybrid Gamma camera/ CT (General Electric, Milwaukee, USA). Delayed planar images of the anterior and posterior pelvis were obtained at 2.5-3.0 hours after injection. SPECT images were acquired at 64 stops of 20 seconds per stop in a circular orbit. CT images were then acquired over 360 degrees at a low dose of 45-50 mAS. CT images were acquired from the level of the lesser trochanters to approximately the L3 level. The SPECT image sets were iteratively, attenuation corrected and fused with the CT images using the Xeleris display software (General Electric, Milwaukee, USA). Images were viewed as SPECT, CT and fused SPECT/ CT in the 3 standard projections of transaxial, sagittal and coronal planes. The SPECT images were viewed on a hot iron colour scale and the CT in standard gray scale. Semi-quantitative analysis was performed by obtaining counts from a standard circular region of interest over the soft-tissues posterior to the SIJ at the level of the S2 segment. Sampling was obtained from the identical site on both sides using the CT study as a guide.

The specific information obtained from each SPECT/ CT study was as follows.

21 Sacroiliac joint uptake usually at approximately the S2 segmental level.
22 Posterior soft-tissue uptake / ligamentous uptake at insertion into the ilium.
23 CT grading of sclerosis/ erosive disease in the upper SIJ as normal, mild, medium or marked.
24 Uptake around the pubic symphysis or at the adductor/ hamstring insertions and the CT appearances of these sites.
25 Evidence of lumbar zygoapophyseal joint uptake or uptake around the disc spaces with comment on CT appearance of the joints and intervertebral discs.
26 Comments on any abnormal uptake and CT appearances of the hips.

Statistical analysis. All ANOVA statistics for the study were calculated with Statistica V8 (Stat Soft, Tulsa, USA). Results were expressed as means and standard deviation or the standard error (SE) of the mean.

Results

Population. The study population of 252 consecutive patients was comprised of 175 females and 77 males with an average age of 42 years (range: 15-73 years, Median age: 41 years). All patients fulfilled the clinical criteria for a diagnosis of PGP/ SIJI (at least 3/ 4 positive clinical tests) (10). The main clinical symptom was of low back or buttock pain of at least 3 months duration. Average length of history was 3.5 years (16 weeks to 26 years). Trauma was implicated in 84% of cases and post-partum back pain in 9%. No specific cause could be established in the remainder. The majority of patients (82%) had MRI studies that were non-diagnostic with frequent reports of intervertebral disc bulge but no neural encroachment. No abnormality of the SIJ was reported. The MRI studies were not formally reassessed as previous studies have not reported a significant abnormality of the SIJ (17, 18). Seventy two per cent of patients had at some time been assessed for the possibility of psychiatric disease. This was not formally assessed in the current study.

Clinical assessment. The mean score for Group A was 3.5 (SD: 0.9) and for Group B 2.8 (SD: 0.9). In the post-treatment analysis, 80% of patients responded to physiotherapy with a significant fall in the clinical scores and improvement in reported symptoms. A further 32 patients improved with prolotherapy and reported significant improvements in symptoms and functional levels. These results have been reported in detail elsewhere (12).

Scintigraphic findings. The blood pool studies demonstrated hyperaemia in the affected SIJ in 22% of cases and the delayed images showed uptake in the superior segments of the SIJ in 27% of cases.

All patients showed upper segment SIJ uptake and loss of the normal "dumbbell" configuration (Figure 1) of joint uptake with ligament/ soft-tissue uptake (Figure 2 & 3) with SPECT/ CT. The difference in the ligament/ soft-tissue count profile for the affected versus the unaffected joint was 47 counts (95% confidence interval: 23 to 78 counts) which was significant ($p=0.009$). Joint sclerosis (Figure 3) was observed in 98.8% with 3 patients showing no sclerosis (symptoms ~ 3 months). Hamstring enthesopathy was present on the ipsilateral side in 39% and on the opposite side in 61% (Figure 3). Adductor enthesopathy (Figure 3) was present on the ipsilateral side in 66% and on the opposite side in 57% with bilateral involvement in 23%. Hip impingement was present in 72% and was ipsilateral. Extra finding were evident in 56% and included 3 cases of sacroiliitis, fractures, intervertebral disc and facet joint disease and other enthesopathies.

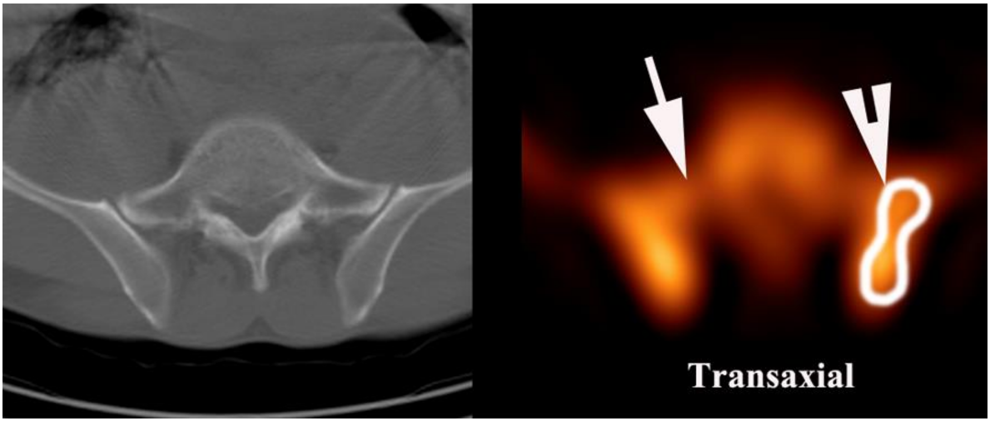

Figure 1. Normal SIJ. The upper SIJ demonstrates a "dumbbell" configuration of uptake (arrowhead) in the upper segments of the joint in the transaxial images. There is no evidence of posterior ligament or soft-tissue uptake (arrow).

Discussion

The concept of dysfunction of the SIJ was first raised as a cause of lower back pain as far back as 1905 (1). Ironically, this was at a time when plain x-ray was the only imaging modality available and most diagnoses were based on history and careful clinical examination with eventual pathological confirmation either ante or post-mortem. That paradigm has become extinct as we have moved to multiple modalities of cross-sectional imaging in radiology and nuclear medicine. Pathology in the bones and joints has been defined in great detail, to the point where failure to detect pathology by the conventional imaging techniques raises the question of a functional or psychiatric disorder, regardless of the clinical findings (3). The fundamental problems in the assessment of the SIJ are twofold.

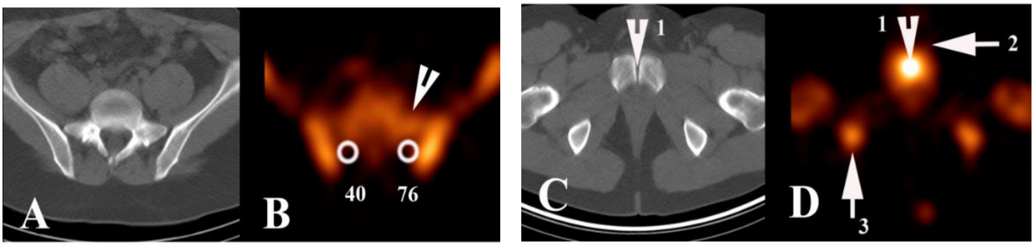

Figure 2. The typical pattern of uptake in a patient with left SIJ incompetence. There is increased uptake in the joint and the posterior SIJ ligaments (arrowhead in B), with a higher number of counts in the posterior soft-tissues (76 V 40 counts). The patient also has osteitis pubis with sclerosis and increased uptake (arrowhead 1 in C & D), left adductor (arrow 2 in D) and hamstring (arrow 3 in D) enthesopathy.

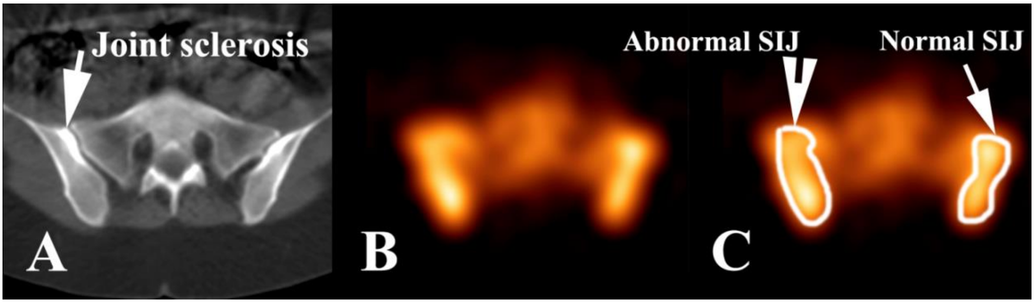

Figure 3. Right SIJ incompetence. A. The CT study shows more intense sclerosis of the right SIJ than the left. Both joint and posterior ligament/ soft-tissue uptake has changed the "dumbbell" configuration of uptake in the right upper joint (B & C).

Firstly, clinical examination is difficult as the joint is relatively inaccessible. Secondly, an important consequence of injury or mechanical pathology involving the joint is an alteration in the sequence of pelvic muscle activity patterns that exposes the joint to abnormal motion (counter-nutation). This motion triggers a nociceptive response from the posterior ligamentous structures that are placed under unaccustomed strain (19, 20). EMG studies in patients with SIJ pain have shown abnormalities in recruitment patterns of the abdominal core muscles (24-28). These findings have changed the manner in which the condition is treated, with a success rate of 70-80% (11, 12).

A review of the normal structure and function of the SIJ is critical to understanding the pathophysiology in the joint (29). Functionally, the SIJ is the linkage between the trunk and lower limbs. The spine connects to the pelvis via the triangular wedge of the sacrum. The weight of the trunk from above and the ground reactive forces from below compress the sacrum into the adjacent iliac bones, completing the ring structure. The “L” shape of the joint and articular surface irregularities provide an interlocking mechanism that allows the sacrum to firmly wedge itself into the iliac bones. The normal force distribution on the sacrum results in a net anterior moment of the sacrum (nutation) deeper into the pelvic ring. The interlacing arrangement of the dorsal sacroiliac, interosseous sacroiliac and sacrotuberous ligaments are critical in the posterior stabilisation of the joint, as there is no posterior joint capsule (29). This combination of the bony shape of the sacrum and iliac bones, the stabilising influence of the ligaments and ground reaction forces provides what has been termed “form closure” of the joint (30).

The integrated action of abdominal and pelvic muscles provides what has been termed “force closure” of the joint by a compressive mechanism on the pelvic ring. There are several EMG and ultrasound studies that demonstrate the importance of the co-ordinated muscle contraction in stabilising the joint (27, 31). Overuse induced muscle fatigue or any damage to the joint / ligament complex due to trauma or laxity of the ligaments in pregnancy may trigger alteration in the sequence of abdomino-pelvic muscle contraction, leading to loss of the force closure component and exposure of the ligaments to further stress. In the past, there was a widely held belief that the nociceptive structure was the joint alone(32). There is now convincing evidence that a significant nociceptive component is derived from the posterior ligamentous structures as well (19, 20, 33, 34). If the ligament damage is severe enough, the sacrum counter-nutation can induce traction on the ligaments and trigger a further nociceptive response.

Not surprisingly, there has been salutary lack of specific findings by either radiology (18, 35-38) or conventional nuclear medicine (39) in SIJ incompetence, apart from the detection of secondary degenerative changes in the joint(35). While the scintigraphic study may demonstrate uptake in the upper joint and posterior ligamentous structures, early cases of approximately 3 months duration do not demonstrate the typical sclerotic changes in the joint on CT studies, indicating that this is a secondary phenomenon (Figure 3). This partially stems from the misunderstanding that the joint is the principal site of pathology and a lack of appreciation of the functional contributions of the abdominopelvic muscles. Scintigraphy is ideally placed to interrogate both components. The advent of hybrid imaging devices with SPECT/ CT integration has allowed precise anatomic localisation of sites of subtle scintigraphic abnormalities. The findings in the current study demonstrate subtle changes in the posterior ligaments of the SIJ at the site of chronic micro-trauma, where scintigraphic uptake occurs. This is best appreciated in the coronal and transaxial slices of the SPECT study. This soft-tissue change can be measured and compared to the unaffected side (Figure 2). As the posterior ligaments are progressively stressed, enthesopathic changes at the site of insertion lead to increased uptake and loss of the normal "dumbbell" configuration of the joint (Figure 1 & 3). Increased uptake in the upper SIJ is due to repetitive abnormal motion (counter-nutation) resulting in sclerosis of the joint (Figure 3). Alterations in the sequence of abdominopelvic muscles manifests as enthesopathy due to overactivity of the adductor and hamstring muscles on the pelvis and less frequently of the gluteus medius attachment to the greater trochanter (Figure 2). Similar alterations in muscle contraction occur around the ipsilateral hip, eventually leading to hip impingement. Co-registration with the CT study allows precise localisation of these scintigraphic abnormalities. In general, enthesopathic uptake is evident at the ipsilateral adductor insertion and contralateral hamstring insertion (Figure 2). Hip impingement is always on the ipsilateral side. These changes are quite distinct from sacroiliitis and degenerative disease which do not change the characteristic uptake pattern in the upper SIJ. The finding of joint, tendon (40-43), and ligament uptake (41, 44, 45) is well documented in nuclear medicine as is the pattern of uptake in hip impingement (46).

Previous work validating SPECT/ CT in patients with SIJ incompetence (15) demonstrated high specificity when compared to patients with either no lower back pain (mainly oncological screening in asymptomatic patients), non-specific lower back pain or patients with facet joint or intervertebral disc disease. The sensitivity was also quite high against the reference standard of history and clinical examination. Sensitivity was 95% and specificity 99%. Positive predictive value was 99% and negative predictive value 94%. Reproducibility of inter/ intra-observer reporting was good with a kappa value of 0.85. The dominant scan pattern observed in both studies is of increased uptake in the upper aspect of the affected SIJ (segments 1 and 2) with sclerosis of the joint. Uptake extending into the soft-tissues/ ligaments posterior to the joint demonstrated a higher count profile. In the receiver operating characteristic (ROC) curve analysis, uptake in the upper joint and posterior ligamentous structures had the best diagnostic criteria, with the area under the curve being 1.0.

The clinical examination palpates the tender posterior ligaments of the SIJ(47, 48), assesses the pattern of intra-pelvic movement (49) and assesses movement with and without pelvic ring compression to aid in lower limb movements (25). The active straight leg raise assesses load transfer through the SIJ (50-52). These are the functional consequences of the posterior ligament injury and the alteration in the sequence of muscle contractility. The average score for the standard clinical testing (Group A) was 3.5 out of 4, fulfilling the established criteria for the diagnosis of SIJ incompetence (10). These tests have been described in the setting of the pelvic girdle pain syndrome in peri-partum women. The term SIJ incompetence has been coined in order to distinguish the population who develop the stereotypic symptoms and signs of SIJ incompetence after trauma, from the condition in the peri-partum period (15). The current series reflects the nature of a sport and exercise medical practice. It is dominantly due to trauma (84%) to the SIJ by direct falls or repeated landings, sudden twisting of the trunk or posterior movement of the flexed femur on the restrained pelvis as in motor vehicle accidents. This is an important finding as it has wide repercussions in the community with both work-related and motor vehicle accident injuries, where the social costs and insurance claims can run into millions of dollars (53). Why do we need an imaging test for the diagnosis of SIJ incompetence if clinical examination is currently the reference standard? There are a number of answers to this question. Firstly, imaging adds a layer of veracity to the clinical findings, reinforcing the functional changes around the pelvis with a metabolic substrate i.e. increased uptake in the chronically stressed posterior SIJ ligaments and at the sites of tendon attachment due to muscle overactivity and secondary joint uptake. Second, the clinical tests are complex, requiring a high level of skill and taking a significant amount of time. Third, reproducibility of the test is high in expert hands (54), but not as good in general usage(55, 56). An equally relevant question is to ask if there is improved patient outcome by making the diagnosis of SIJ incompetence based on physical examination or SPECT/ CT diagnosis. Published results indicate that therapy based on the current accepted model of SIJ incompetence will significantly improve the condition in 70-80% of patients with targeted physiotherapy (11). A smaller proportion with significant posterior SIJ ligament damage will improve with prolotherapy (12).

Conclusion

The concept of sacroiliac joint dysfunction is poorly recognised in the general medical and orthopaedic community even though it may account for up to 30% of non-specific lower back pain. The lack of recognition very likely arises from the inaccessibility of the joint to physical examination and the lack of a valid imaging test. Fundamentally, even repetitive minor trauma to the joint or posterior ligament laxity can trigger a maladaptive change in the sequence of abdominopelvic muscle contraction that no longer provides a compressive force on the pelvic ring, exposing the posterior ligaments to unaccustomed stress and traction forces that trigger nociceptive receptors and progressive ligament injury. SPECT/ CT of the conventional bone scan offers a sensitive and specific test of this functional disorder, reinforcing the findings of the clinical examination with a metabolic substrate.

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A MINIMAL CORE SET OF OUTCOME MEASURES AND CLINICAL TESTS FOR DEFINING PELVIC GIRDLE PAIN IN CLINICAL TRIALS - A DELPHI STUDY

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Introduction

During the last 20 years, research on pelvic girdle pain (PGP) has largely increased. The results are hampered by both a variety of definitions of PGP and use of different outcome measures. This gives heterogeneity in study findings, which creates limitations in comparing results from different studies. In the future, there is a need to conduct multicenter studies to investigate the causes and consequences of PGP. In addition, further needs are to determine possible factors influencing the development, recurrence and persistence of symptoms.

Aim

The aim of this study was to reach consensus on a minimal core set of clinical tests for defining PGP and outcome measures for clinical trials of PGP.

Materials and Methods

A Delphi-study was conducted by a network of researcher within lumbopelvic pain in relation to pregnancy. The network consists of nine researchers from Sweden and Norway. The participants were in mean 53 years of age (rage 34-62 years), they had been professionals for in mean 28 years (range 9-40) and number of years in research was in mean 18 years (range 5-29). At a network meeting in May 2012, the design of the Delphi-study was set. Based on international recommendations from guidelines (1) and studies on clinical tests of PGP (2-7) it was decided to include pain provocation test and a functional test in the core set to define PGP. Published definitions of PGP and outcome measures of clinical trials of PGP were compiled until June 2012. A list of criteria for classification of PGP and for outcome measures in clinical trials within the domains of pain, disability, health-related quality of life (HRQL), sick leave, work ability and outcome of treatment (patient satisfaction) were composed.
Round 1: In a first step, the lists were distributed by mail (word-attachment) on September 3, 2012 to the members of the network. A reminder was sent September 23, 2012. The Delphi participants were asked to mark which criteria that should be included in the core set. The questionnaire offered the opportunity to add new criteria and outcomes as well as to make comments.
Round 2: Distribution of individual scores by the network members in round 1 was established and compiled. All comments made in the first round were added. Criteria that were not chosen by anyone were deleted from the list. Round 2 questionnaires were e-mailed on October 3, 2012 with a reminder on October 12, 2012.
Round 3: The results of round 2 were discussed in a network meeting on October 17, 2012.

Round 4: The results of the network meeting were sent out October 25, 2012 to the network members by mail for additional comments and approval of the preliminary core set.
Round 5: In order to let 10 external experts in the field comment on the preliminary core set, 24 experts that had published in the area of lumbopelvic pain regarding criteria, clinical assessment, and outcome measures in the last 5 years from at least 3 continents were identified.
A web-based questionnaire was constructed and sent out on 28th of January 2013 to the 24 identified experts in the field of lumbopelvic pain. A reminder was sent 21th of February 2013. The questionnaire included the preliminary core set of criteria and of outcome measures. The experts were asked to choose which criteria and outcome measures respectively they believed should be included in a minimal core set for PGP. They had the possibility to add new criteria and outcome measures as well as comments.

Results

All nine members of the network of PGP responded to the four rounds of the Delphi study. Nine international experts responded to round five. A minimal core set for definition of PGP in clinical studies will include:

- pain location by a pain drawing
- posterior pain provocation by the posterior pelvic pain provocation test (P4 test)(8)
- anterior pain provocation by palpation of the symphysis
- severity scored by the active straight leg raise (ASLR) test (4)

A minimal core set of outcome measures in studies of PGP will include:

- pain intensity: Numeric Rating Scale (NRS) for ‘worst pain’ and ‘mean pain’ during the latest 48 hours.
- disability: Pelvic Girdle Questionnaire (PGQ)(9) and/or Oswestry Disability Index (ODI)(10)
- Health-Related Quality of Life (HRQL): Wellbeing NRS
- functional test: ASLR
- work ability: one question from Workability Index i.e. “Current work ability compared with the lifetime best”(11)
- global perceived effect scale

No domain was deleted.

Relevance

A common minimal core set of clinical tests for defining PGP in future studies will improve the potential for comparison between studies on PGP internationally. The possibility of meta-analyses in the field of PGP will improve. This may lead to faster and higher evidence-based steps forward to understand the etiology, prevention and management of PGP.

Conclusions

A minimal core set for use in clinical trials of PGP have been developed and agreed upon. For the definition of PGP, the posterior pelvic pain provocation test, the palpation of the symphysis, a pain drawing and the active straight leg raise test should be included in the core set. A minimal core set of outcome measures should include pain intensity by an NRS, disability by PGQ and/or ODI, HRQL by wellbeing NRS, functional test by ASLR, work ability by one question from the Workability index and patient satisfaction with outcome of treatment with global perceived effect scale.

Discussion

It is important to emphasize that the key goal of this study approach was to bring experts in the field of PGP together to discuss and agree as much as possible on a minimal core set for future studies. The goal was not to present the final definition of PGP or the final core set of outcome measures. Along with that evidence for the validity of specific test emerges, a further development of the core set for clinical tests will be possible. Likewise as further validation of the suggested clinical test and outcome measures emerge, it will allow researchers to improve the core set in the future.

No single definition of a syndrome can meet the needs of definition of a syndrome in all studies. We suggest that where researchers find the core set insufficient, they should consider using the core set in addition to their preferred definition. Similar arguments are relevant for outcome measures. Use of a minimal set of outcome measures can support merging of data from different studies and enhance comparability of effect in clinical studies. The majority of the participants in the Delphi-study proposed that two pain provocation test should be positive for definition of PGP. Although two tests (the sacral thrust test and the palpation of the long dorsal ligament) were finally suggested, the group did not reach consensus on the additional test at this point. More research on the qualities of test was requested and might be a future and important work.

All participants agreed that the suggested domains should be included which supports that the consequences of PGP should be monitored on multiple levels. This is in accordance to published core sets for low back pain (12).

The use of a time frame for pain intensity estimation was claimed essential by several researchers. Since patients with PGP often have high variation of pain intensity during a day and from day to day depending on activity level, 'pain intensity today' was considered incorrect. One suggestion was 'morning pain' and 'evening pain'. Finally 'worst pain' and 'mean pain' during last 48 hours were chosen since it covered morning and evening and thereby a larger span for the estimation will be captured.

Chosen disability measure of PGQ is the only published PGP specific instrument but not yet fully evaluated. The ODI has been used in studies of PGP but is also an instrument widely used within the field of back pain and thereby gives comparability with general back pain research. The disability rating index (DRI) was suggested as an alternative because it may be used in pregnant women without PGP. Since the core set should be minimal and used in patients with pain, the condition specific PGQ and the back specific ODI were chosen.

All chosen outcome measures are published in at least English but a limitation with the core set is that not all are translated into several other languages.

The core set is to be used to study the syndrome of PGP, which mostly occur in relation to pregnancy. The majority of published studies on classification and treatments are on the pregnancy-related PGP although we suggest the core set will be used for all studies on PGP.

The participating researchers have wide experiences in back pain research as well as other research areas. Regarding the experience from studies of PGP, the majority is from studies on pregnancy-related PGP, which might have influenced the result of this Delphi-study.

Implications

The use of this minimal core set is intended to be a standard to include in studies on PGP to enhance comparability in future studies and not to avoid additional use of other clinical test or validated questionnaires and instruments.

Keywords

Pelvic girdle pain, core set, clinical test, outcome measures

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DEVELOPMENT AND MEASUREMENT PROPERTIES OF THE CONDITION-SPECIFIC PELVIC GIRDLE QUESTIONNAIRE

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Background

There is a need for an outcome measure that is reliable and valid for patients with pelvic girdle pain (PGP).

Objective: To develop and test a condition-specific measure, the Pelvic Girdle Questionnaire (PGQ) for pregnant and postpartum patients and to examine measurement properties of other instruments commonly used for patients with PGP.

Methods

Item developed followed a literature review, a focus group of patients with clinically verified PGP and consultation with physical therapists. Face and content validity were assessed by classifying the items according to the WHO's Classification of functioning and disability (ICF). Following a pilot study the PGQ was administered to patients with clinically verified PGP, by means of postal questionnaire in two surveys. The first survey included 94 patients (52 pregnant) and the second, 87 patients (43 pregnant). Rasch analysis was used for item reduction and the PGQ was assessed for unidimensionality, item fit, redundancy and differential item functioning. The second survey included the PGQ, Oswestry Disability Index 2.0 (ODI), Disability Rating Index (DRI), Fear Avoidance Beliefs for physical activity (FABQ), Pain Catastrophizing Scale (PCS), and the 8-item version of the SF-36. Test-retest reliability was assessed in both surveys. Internal consistency was assessed by Cronbach's alpha and test-retest reliability by the Intraclass Correlation Coefficient (ICC), minimal detectable change at individual (MDCind) and group level (MDCgroup). Construct validity based on hypotheses, was assessed by correlation. Discriminant validity was assessed by area under receiver operating curves.

Results

The analysis resulted in a questionnaire with 20 activity and 5 symptom items with a four-point response scale. Items within both these scales showed a good fit to the Rasch model with acceptable internal consistency, satisfactory fit residuals and no disordered threshold. Test-retest reliability showed high ICC estimates of 0.93 (95% CI 0.86, 0.96) for the PGQ activity scale and 0.91 (95% CI 0.84, 0.95) for the PGQ symptom scale, respectively. Cronbach's alpha ranged from 0.88 to 0.94 and the ICCs from 0.78 to 0.94.

The MDCind constituted 7-14% of the total score ranges for the SF-8 items, the ODI and the PGQ-Activity, 18-22% for the DRI, PGQ-Symptom, and PCS, and 25% for the FABQ. Hypotheses were mostly confirmed in the correlations between instruments. PGQ was the only instruments that significantly ($p<0.01$) discriminated both between pregnant and non-pregnant patients and between pain in all three joints compared to their counterparts.

Conclusions

The PGQ has evidence for reliability and validity for both pregnant and postpartum patients with PGP, is simple to administer and feasible for use in clinical practice. Also the other self-reported instruments showed good measurement properties, however, the PGQ was the only instrument with satisfactory discriminant validity. We recommend the PGQ to evaluate symptoms and disability in patients with PGP both for clinical and research purposes. The responsiveness to change of instruments should be concurrently evaluated.

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RELIABILITY AND VALIDITY OF THE TIMED UP AND GO TEST AND TEN-METRE TIMED WALK TEST IN PREGNANT WOMEN WITH PELVIC GIRDLE PAIN

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Introduction
Pelvic girdle pain (PGP) during pregnancy occurs in 20-70% of all pregnancies and often leads to walking difficulties and sick leave. There is a lack of functional objective tests available to measure functional status in this population. Currently there is no available outcome measure of walking function with demonstrated reliability and validity available for use in this patient group.

Purpose/Aim
To evaluate test-retest reliability, intertester reliability and concurrent validity of the Timed Up and Go Test (TUGT) and Ten-metre Timed Walk Test (10mTWT) in pregnant women with PGP.

Materials and Methods
18 pregnant women with PGP were tested on two occasions, one-week apart. Subjects undertook one practice trial and two test trials of the TUGT and 10mTWT at Session 1, and one practice trial and one test trial of each of the walking tests at Session 2. Intertester reliability was established between two assessors at Session 1. Performances on the TUGT and 10mTWT were compared with scores achieved on the Active Straight Leg Raise (ASLR) test and the Pelvic Girdle Questionnaire (PGQ) to establish concurrent validity.

Results
Test-retest reliability ($n = 17$) using the intraclass correlation coefficient (ICC 1,1) was excellent for the TUGT (0.88) and 10mTWT (0.82). Intertester reliability ($n = 14$) was also excellent for both walking tests (TUGT: 0.94, 10mTWT: 0.96). High correlations were found using the Spearman's rank correlation coefficient (rs) between: the TUGT and ASLR (rs = 0.73, $p = 0.001$), the 10mTWT and ASLR (rs = -0.65, $p = 0.003$) and the TUGT and 10mTWT (Session 1 rs = -0.78, $p < 0.001$; Session 2 rs = -0.85, $p < 0.001$). Relationships between the TUGT and PGQ were moderate (rs = 0.41 to 0.52) and between the 10mTWT and PGQ low to moderate (rs = -0.25 to -0.56).

Relevance
Clinical tests need to have demonstrated reliability and validity in the population in which they are intended to be used to ensure they can yield meaningful results.

Conclusions
The TUGT and 10mTWT are reliable and valid objective functional tests of the pelvis in pregnant women with PGP.

Discussion
Currently most clinical tests for PGP are undertaken in a non-weight-bearing position and level of dysfunction is determined using patient self-reported functional abilities. The TUGT and 10mTWT quantify functional mobility and are achievable tests in women at various stages of pregnancy and with varying degrees of walking difficulty.

Implications

Both the TUGT and 10mTWT are feasible for use in the clinical and research setting. It is recommended that one of these two walking tests is included in the clinical evaluation of pregnant women with PGP.

Keywords

Pelvic girdle pain; pregnancy; gait; walking; reliability; validity; Timed Up and Go Test; Ten-metre Timed Walk Test; Active Straight Leg Raise; Pelvic Girdle Questionnaire

MINIMALLY INVASIVE SPINAL DECOMPRESSION AND FUSION

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I. Posterior Decompression

A. Laminotomy/Foraminotomy

1. Indications
   a. Unilateral radicular pain
   b. Lateral disc herniation
   c. Foraminal stenosis
   d. Nerve root decompression (not central decompression)
2. Symptoms
   a. Radicular pain
   b. Isolated to single correlative nerve root
   c. Nerve root injections with temporary relief
   d. EMG/NCS correlative with pathology
3. Approach
   a. Tubular retractor
   b. McCullough retractor
4. Surgery
   a. Localize level
   b. Removal of less than 40-50% of lateral mass/facet
   c. Be careful not to disrupt facet capsule or adjacent facets on exposure
   d. Identify junction of lamina/lateral mass
   e. Removal of disc fragment without retraction on spinal cord
   f. Palpation of foramen to assure of adequate decompression
   g. May need to drill part of pedicle to access disc space
   h. Avoid K-wire to prevent iatrogenic issues

B. MIS Fusion

1. Incision
   a. Midline incision
   b. Bilateral fascial incisions
   c. Dilate muscles from midline to lateral on both sides from midline incision
   d. Dock onto the lateral masses
   e. Starting point is inferior to level to allow for upward angulation
2. Surgery
   a. Neuromonitoring useful
   b. Foraminotomy to decompress root if needed
   c. Exposure of lateral mass for fusion, lamina not exposed to midline
   d. Dilate with expandable retractor to expose lateral masses
   e. Upward angulation for lateral masses, less angulation in inferior spine
   f. May need pedicle screw at C7/T1
   g. Drill pilot holes prior to drilling
   h. Place superior screws first, then inferior screws
   i. Decorticate lateral masses and facet joints prior to placing rod
   j. Place bone graft material around instrumentation

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NOVEL MOTION PRESERVATION TECHNOLOGIES AND THE EVIDENCE FOR EFFICACY FOR THE LUMBAR SPINE

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Introduction

Treatment of Low back pain remains a big challenge despite all available treatment options. Surgical intervention has been used for long time as a last resource when other non surgical options fail. Spinal fusion is considered (with or without decompression) as the gold standard. Concerns with adjacent segment pathology supported the emerging non-fusion techniques.

Treatment of Low Back Pain

- Etiology → multifactorial
- No single treatment is ideal
- Surgery can only potentially alter mechanical derangement
- Non operative treatment *:
    - Acupuncture → fair level of evidence
    - Psychological therapy → good level of evidence for cognitive behavioral , fair for progressive relaxation
    - Exercise therapy → good evidence
    - Rehab → good evidence
    - NSAIDs → good evidence
    - Spinal manipulation → good evidence

    (* Ann Intern Med 2007; 147; 478-491)
- Fusion *
    - 90 yrs history
    - Variable techniques
    - Variable fusion rates
    - Outcome in appropriately selected patients similar regardless of technique or radiographic fusion success.

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<u>Adjacent segment Pathology:</u>

- Lots of controversies, is it the natural history of the disease or is it iatrogenic.? Or both?
- Does it cause symptoms?
- " Same changes in asymptomatic subjects and patients with previous fusion " - Boden et al JBJS 1990
- Evidence (with)
    - Schono et al. (1998) Increased motion at adjacent segment in F/E proportional to length of fusion and rigidity of instrumentation (sheep)
    - Bastian et al. (2001) Increased motion at adjacent segment in F/E proportional to length of fusion and rigidity of instrumentation (human cadaver). Returned to normal after removal of instrumentation. Assumed return to normal activities after fusion.
    - Weinhoffer et al. (1995) Increased intradiscal pressure at adjacent segment proportional to length of instrumentation.
    - Dekutoski et al. (1994) Motion of the transition segment was increased during walking, but pure axial loading was not changed (dogs *in vivo* and in *vitro*)

- Evidence (against)
  - Rohlman et al (2001) No change in movement of adjacent segment compared to non-instrumented fusion. Assumed restricted activity following fusion.
  - Brodsky et al (1989) Only a 2.7 % incidence of adjacent level problems requiring extension of the fusion.
    - 60 % had radiographic changes
    - Did not include 10 patients requiring surgery for "stenosis".
  - Cauchoix and David (1985) No correlation between 79 % radiographic changes at adjacent level and the need for extending fusion after 10 year follow up.
  - Hambly et al (1998) No difference in adjacent level disease frequency between fused and non-operated, age and gender matched controls (with LBP).

Motion Preservation Options

1. Anterior
   - Artificial disc replacement
     - Replaces the whole weight bearing surface
     - Maintains mobility
     - Theoretically decreases risks of adjacent segment pathology
     - Eliminates discobenic pain
     - References
       - Eur spine journal, Aug 2010. review of literature on TDR for symptomatic lumbar disc disease. The conclusion was that initial 2yr had better results of back pain but 5 yr outcome showed return of back pain.
       - Cochrane data base system review 2012 on TDR for chronic pain in presence of disc degeneration, showed no definite difference in comparison with fusion group.
       - Spine, 2012. Do lumbar motion preserving devices reduce the risk of adjacent segment pathology compared with fusion surgery, Wang et al concluded that adjacent segment pathology was high following fusion in comparison to TDR
       - Eur spine J, 2013. 5yr follow up of TDR compared to fusion, a randomised controlled trial. Skold et al concluded that motion was preserved intially in the TDR gp, and back pain reappeared in both groups after 5 yrs.
   - Disc nucleus replacement
     - Trials are on going in nucleus pulposus replacement
     - Prosthethic disc nucleus
     - Hydrogel core in a flexible inelastic woven polyethylene jacket
     - Newcleus disc Spiral coil made of polycarbonate urethane
   - Dynamic Stabilization
     - Aim is to restrict abnormal movement, to protect and restore distribution of load.
     - This system has controlled flexion extension movements, but axial rotation cant be controlled
     - Indicated in degenerative disc disease and lumbar canal stenosis
   - Facet Replacement
     - Still undergoing development
     - Not enough clinical trials
     - Indicated for spinal stenosis where the pain generator is the facet.
     - Types
     - Total facet arthroplasty system (TFAS)
     - In the journal of spinal arthroplasty society, may 2007, the report stated improvement in pain and physical function
     - Total posterior system (TOPS)

- Interspinous spacers
    - Objective: to distract the foramen and unload the interverterbral disc
    - The spinal extension is limited with this implant.
    - indication
        - Age 50yrs
        - Stenosis relieved on flexion
    - Contraindication
    - Neurological deficits
    - spondylolysthesis
    - References: •Spine 2007, new interspinous implant evaluation using in vitro biomechanical study combined with a finite element analysis. Virgine et al concluded that the wallis spacer reduces the motion but it helps lower the stress in the disc
        - Eur spine J, 2009; does wallis implant reduce adjacent segment degeneration above lumbosacral instrumented fusion. Panagiokis et al concluded that the implant prevented ASD for at least 5 yrs in his study
        - Spine , may 2013.interspinous spacer compared with decompression/fusion for lumbar stenosis: complications and repeat operation in the medicare population. Deyo et al concluded that fewer complications occurred compared to fusion surgery but has high rate of revision surgery

SPINE SURGICAL ISSUES IN THE MODERN WORLD: TECHNOLOGY APPROVAL, INSURANCE/REIMBURSEMENT AND EVIDENCE FOR EFFICACY

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Introduction

Spine surgery is undergoing tremendous evolution. New technologies are being introduced in the field of spine surgery every day. Although this recent explosion of innovation has brought advances to patient care, it has also brought concerns regarding safety, efficacy, and increasing costs. Some of these are still not approved for reimbursement. Given the current economic environment, however, the cost of modern approaches, techniques, and technology is rapidly becoming a concern and a central theme among the stakeholders in health care. This shifted the focus away from quality towards the concept of value.

Technology Approval

- Technology must have final approval from appropriate governmental regulatory bodies
- The scientific evidence must provide conclusions concerning the effect of the technology on health outcomes
- The technology must be at least as beneficial as any established alternatives
- The improvement must be reproducible and attainable outside the investigational settings
- FDA: safe and effective
- CMS: Reasonable and medically necessary for Medicare Population
- When is a device eligible for Medicare coverage?
    - FDA clearance
    - IDE or IRB- approved devices (devices for clinical trials, only routine costs of qualifying trial, but not device)
    - Class I or II category B (non-experimental)
    - Class III category A possibly, if used for life threatening conditions)

Insurance / Reimbursement

- Reimbursement: compensation paid for damage or losses or money already spent etc.
- For healthcare technologies, is getting a third party payer (e.g. Medicare, insurance,..etc) to:
    - Pay the end user of the technology
    - An amount at least equal to manufacturer’s price
    - And allows the provider/user to continue the practice of patient care
- FDA approval does not equal reimbursement from third party payer
- Coding is not the answer, only part of the solution
- In the absence of outcome data, physicians and specialty society support is critical to drive reimbursement

Evidence For Efficacy

- The Medical Device Amendments (MDA) of 1976 established the definition of a medical device as anything that is used in the diagnosis or treatment of disease, or alteration in structure of the body, that does not rely on a chemical mechanism or metabolism for its action. At the time that MDA was passed, all existing devices were placed into one of three classes:

Class I (low risk)
Class II (medium risk)
Class III (high risk)

- FDA
- An alternative to the premarket approval for class III devices is the 510(k) premarket notification process. If a manufacturer can demonstrate to FDA that a medical device substantially equivalent to a device marketed prior to Mat 28, 1976, it may be granted exemption.
- Clinical trials
- Professional society opinion
- approval for reimbursement

CONTROVERSIES IN BIOLOGICS FOR SPINE SURGERY

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Types of Bone Graft and Bone Graft Substitutes

Bone grafts and bone graft substitutes are generally classified into one or more of the following groups: osteogenic, osteoinductive, osteoconductive, and structural. Structural grafts, such as a tricortical iliac crest graft or femoral ring allograft, provide mechanical support to the construct. Osteoconductive grafts provide a scaffold for bone formation. Osteoinductive grafts are able to induce osteoblastic differentiation of the progenitor cells. Osteogenic grafts are able to directly contribute cells for bone formation.

Autograft has long been considered the gold standard as it has all of the above properties. However, limited supply of autograft, as well as the morbidity associated with its harvest, has led to the development of a plethora of bone graft substitutes and extenders which may contain one or more of the above properties.

Allografts

Allografts obtained from cadavers provide an osteoconductive scaffold, and are weakly osteoinductive. These grafts do not have any osteogenic potential, as all the cells are killed during the processing aimed to decrease the risk of infection transmission and antigenicity. Still, a minute risk of viral transmission, such as hepatitis, cytomegalovirus, and human immunodeficiency virus, still exists. Allografts may also undergo further processing such a demineralization, leading to demineralized bone matrix (DBM). DBM lacks the structural support of strut allografts, but still has osteoconductive and osteoinductive properties.

Demineralized Bone Matrix

Demineralized bone matrix (DBM) is a bone graft substitute with primarily osteoconductive and some osteoinductive properties. It is formed by acid extraction of allograft bone, resulting in the loss of mineralized component of bone while retaining the type 1 collagen framework and many growth factors. The osteoinductive quality of DBM varies among different products due to the variability in their content of the bone morphogenic proteins (BMPs). It is currently available in multiple forms, including putty, injectable gel, and flex strips.

There is currently strong evidence in the literature supporting its use as both bone graft substitutes and extenders in lumbar fusion surgeries. A prospective study was conducted comparing the efficacy of autograft on one side and a smaller amount of autograft with DBM on other side in 120 instrumented posterolateral lumbar spine fusion surgeries. The authors found nearly identical fusion masses and graft mineralization on both sides, indicating that when autograft is combined with DBM, a smaller amount of autograft needs to be used. Vaccaro et al also found that DBM offers similar results to autograft in posterior spinal fusions.

The evidence for the use of DBM in anterior lumbar and cervical surgeries is not quite as strong as that for its use in posterior surgeries. Currently available DBM products lack the structural stability needed for anterior cervical and lumbar interbody fusion procedures. As such, they have to be used in conjunction with a structural spacer. Thalgott et al evaluated fusion rates and clinical outomes in 50 patients who underwent ALIF with titanium mesh cages, coralline hydroxyapatite, and DBM as part of a circumferential fusion. The authors noted good radiographic and clinical results, with 96% fusion rates. However, a prospective study demonstrated that the use of allograft with DBM composite for anterior cervical fusions resulted in higher rates of graft collapse and pseudarthrosis when compared with autograft. Currently available evidence appears to support the use of DBM in anterior lumbar interbody fusions when used in conjunction with internal fixation; however, the evidence is weaker for anterior cervical fusions as these appear to have better results with structural grafts.

Ceramics

Ceramics are an attractive type of bone graft extenders and substitutes for several reasons. They can be manufactured in large quantities and a variety of shapes and sizes, do not carry a risk of disease transmission, are biodegradable, and are easy to sterilize. On the other hand, they only provide an osteoconductive scaffold, have little shear strength, and are brittle. As such, they cannot be used as structural grafts without the protection of rigid instrumentation. Commercially available forms of ceramics include calcium carbonate and beta-tricalcium phosphate.

The osteoconductive scaffold in ceramics consists of a porous matrix, which allows for bone and blood vessel ingrowth. The optimal pore size has been determined to be between 150 and 500 micrometers. Hydroxyapatite coating available on some ceramics theoretically leads to faster bone ingrowth. Thalbott et al reported 100% fusion rate of HA-coated coral graft used in combination with rigid plating at a two year follow-up in 22 patients who underwent anterior cervical discectomy and fusion.

The results of the use of ceramics in posterior intertransverse lumbar fusion, even with rigid instrumentation, do not appear to be as good. Korovesis et al conducted a prospective randomized study comparing coralline hydroxyapatite mixed with bone marrow versus iliac crest autograft, and found that hydroxyapatite was not appropriate for intertransverse fusions due to small area of bleeding surfaces. However, the authors did note that the use of hydroxyapatite over decorticated laminae with a large bleeding bone surface area is followed by solid fusion within the expected time period. On the other hand, Chen et al did a prospective study comparing calcium sulfate with local autograft on one side of a short segment lumbar fusion with iliac crest autograft on the other side; they found similar fusion rates between the two sides. Thus, the best use for ceramics at this time would be over large decorticated areas of bone with local autograft.

Growth Factors

Marshal Urist discovered BMPs
Cloned by John Wozney
TGF-beta family
Contained in allograft bone
Promote bone formation

BMP-2

FDA approved for anterior spinal fusion
Anterior fusion with interbody cages with high fusion rates
Posterolateral fusion and cervical studies pending
Reports of side-effects with use in anterior cervical fusion

BMP-7

Studies in posterolateral fusion
Carrier issues
Studies compare to autogenous bone graft for posterolateral fusion

BMP-14

Also known as rhGDF-5
Ongoing human trials

BMPs

High dosage used for human fusion
Can have adverse side-effects
Inflammatory reactions
Osteolysis of native bone
Soft-tissue swelling

BMP-Binding Proteins (BBP)

Native human proteins involved in bone formation
Enhance the effects of BMPs
May allow for decreased dosage
May allow for decreased side-effects

BBP Mechanisms of Action

May potentiate effects of BMPs
May bind and keep in site longer
May have additive effect
Future research needed to delineate full effects

Future Developments

- Combinations
  - Osteoinductive combined with osteogenic/osteoconductive agents
- Stem cells
- New osteoconductive materials
- Other factors
  - Time release
  - Combination growth factors
- Novel growth factors
- Novel carriers
- Science of new developments

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CHANGES OF THE STRUCTURAL AND FUNCTIONAL PROPERTIES OF LUMBAR MUSCLES IN RECURRENT LBP

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One factor that may contribute to persistence and/or recurrence of low back pain (LBP) is dysfunction of the back muscles (Arendt-Nielsen & Falla, 2009; Hodges & Moseley, 2003). Optimal function of the back muscles is a prerequisite for static and dynamic control of spinal stiffness and movement. However, a common finding in LBP is compromised function of this system: patients experiencing LBP have changes in the structure of muscle (fatty infiltration, atrophy, fiber typing) and in the coordination of muscle activity by the nervous system (timing & amount of activity) (Danneels et al., 2000; Hodges & Moseley, 2003). Intriguingly, these muscular dysfunctions do not spontaneously resolve when LBP dissipates (Hides et al., 1996) and our previous accomplishments have shown that these dysfunctions are even observable in recurrent patients during periods of remission (D'hooge et al., 2012 2013(a) (b)).
In addition to the observed peripheral findings, changes in motor cortical representation of different paraspinal muscle fascicles were observed in recurrent LBP.

This abstract describes some recent study results about peripheral and central changes in recurrent patients during periods of remission.

Periheral Changes of the Back Muscles in Recurrent Patients during Periods of Remission

Lumbar muscle structure

Structural aspects of the lumbar musculature were cross-sectionally evaluated on T1-weighted Magnetic Resonance Imaging (MRI) images in people in remission of unilateral recurrent LBP, to determine whether divergences from people without any history of LBP were present and whether pain-side related differences were apparent (D'hooge et al 2012). Lumbar muscle size was evaluated by means of total and lean muscle cross-sectional area (CSA). The amount of fatty infiltration was quantitatively assessed by determining the CSA of macroscopically visible fat depositions for each muscle, and simultaneously by determining a relative muscle-fat-index (MFI) in lean lumbar muscle tissue. No differences in total or lean muscle CSA for multifidus (MF), erector spinae (ES) nor psoas (PS), were retrieved between people in remission of recurrent LBP and a control group. In addition, no differences in the amount of fat CSA were found between the recurrent LBP and control group for none of the muscles. In contrast, levels of fatty infiltration (MFI) in lean muscle tissue were higher in people in remission of LBP compared to healthy controls for all measured muscles, on both the previously painful and non-painful sides, at the 2 lowest lumbar levels (L4 upper and L4 lower endplate). None of the parameters yielded differences between the previously painful and nonpainful sides. The results indicate that although muscle quantity is not different, lumbar muscle quality (decreased fiber density) is bilaterally deteriorated during remission of unilateral recurrent LBP. This finding might imply decreased contractile ability of the lumbar musculature because of the replacement with non-contractile tissue.

Next to the above parameters of lumbar muscle structure, alterations in muscle tissue characteristics were evidenced on quantitative T2 MRI measures during remission of unilateral recurrent LBP (D'hooge et al 2013 a). Quantitative T2-measures in the resting condition differed between the recurrent LBP and control group for MF, being lower on both the previously painful and non-painful side in the LBP group on both lumbar levels. No changes were apparent in tissue characteristics of ES and PS, on none of the sides or levels. Alterations in quantitative T2-rest measures reflect changes in the resting metabolic state of the MF muscle. Lower T2-rest values in the LBP group are assumed to indicate higher proportions of type II muscle fiber typing within MF. This would imply that the fiber typing composition of MF has bilaterally shifted towards the glycolytic fiber type spectrum during remission of unilateral LBP. To our knowledge, this is the first study documenting alterations in the metabolic resting state in the lumbar musculature in people after the resolution of a LBP episode, which might probably reflect shifting in the fiber type composition.

To summarize for structural muscle dysfunctions, the results confirm the presence of alterations in structural lumbar muscle characteristics. During remission of unilateral LBP, fatty infiltration was increased in lean muscle tissue for MF, ES and PS, while muscle morphometry and macroscopic fatty infiltration was not altered. In addition, alterations in the metabolic profile of MF were present, possibly indicating a shift towards higher glycolytic fiber type proportions.

A possible hypothesis is that muscle size would have incrementally modified during resolution of LBP and that earlier reductions in size (present during a LBP episode) would have been overcome. This assumption might be underpinned by a preliminary correlation between muscle CSA and the time that elapsed since the last LBP episode (mean= 64±33,6 days, min= 31, max= 144 days)(lean CSA: $r=0.789$; $r^2= 0.622$; $p=0.035$ / total CSA: $r=0.800$; $r^2= 0.640$; $p=0.031$)($n=8$). Further research should confirm this association on intra-individual level. Possibly, alterations in muscle size are mediated by more readily modifiable and reversible factors, in contrast to fatty infiltration and metabolic muscle content. This suggestion is in line with the rapid manifestation of decreased lumbar muscle size with acute LBP reported before (Hides et al 1994 – Hodges et al 2006). Underlying mechanisms that have been proposed are decreased muscle fiber size/number and contractile protein loss, decreased muscle water content or decreased muscular perfusion (Ebenbichler et al 2001 - Hodges et al 2006).

These findings show that after resolution of LBP lumbar muscle quality is deteriorated, in the absence of deficiencies in the macroscopic muscle structure. The different extent of alterations in the different parameters of muscle structure might reflect that different atrophic mechanisms can be underlying. Moreover, during remission of LBP, recovery in some and/or reinforcement of other parameters might be probable, which will be further discussed in relation to alterations in lumbar muscle function below.

Lumbar muscle function

The lumbar spine is continuously moving and dynamic trunk muscle control is needed to ensure a fluent movement over an intended trajectory, while concurrently controlling segmental motion and preventing excessive deviations from perturbations from internal and external forces (Hodges & Cholewicki 2007). Assuming that muscle recruitment is optimally balanced in people without a history of LBP, divergences in dynamic trunk muscle control after resolution of a LBP episode would be sub-optimal and could possibly have negative consequences for spinal health and in the long term contribute to further LBP (Hodges & Tucker 2011). We investigated lumbar muscle recruitment during a voluntary trunk-extension (D'hooge et al 2013 a) and trunk-flexion (D'hooge et al 2013 b) movement in people in remission of recurrent LBP. The amount of lumbar muscle activity was compared to a healthy control group and between the painful and nonpainful side in participants with one-sided localization of LBP. These studies were the first to investigate trunk muscle recruitment during voluntary trunk movements during remission of LBP.

During static-dynamic trunk extension (D'hooge et al 2013 a), MF activity –measured as T2-shift with muscle functional MRI (mfMRI)- was bilaterally increased in people with recurrent LBP during a pain-free period on all levels. Muscle activity in ES and PS was not different from the control group. Interestingly, increased metabolic MF activity (T2-shift) concurred with alterations in metabolic resting state in MF (T2-rest), which might be in keeping with the functional repercussions of alterations in muscle fiber composition towards the glycolytic muscle spectrum, as described above.

During rapid-onset trunk flexion (D'hooge et al 2013 b), trunk muscle electromyographic (EMG) activity was analyzed from several perspectives: from grouped (flex or/extensor co-contraction and summed agonist-flexor and antagonist-extensor activity), to behavior on individual muscle level. Cocontraction was higher throughout the entire exercise in the recurrent LBP group. In addition, antagonistic extensor activity was higher during the forward phase and the last epoch of the reextension phase in the LBP group. In contrast, agonistic flexor activity was lower at the onset of the forward flexion movement compared to the control group. In a similar way, EMG activity was higher for the individual extensor muscles, and lower for the individual flexor muscles. It is remarkable that the only muscle exhibiting higher EMG activity during the baseline and preparatory period (measured before onset of each of the flexion repetitions) compared to the control group, is deep multifidus. For the above results, no conclusions can be drawn with regard to pain-side related dysfunctions, because participants with mixed distribution of LBP (unilateral, middle and bilateral) were included in this study (n=11). Yet, the presence of pain-side related differences was explored in a subgroup of the participants with a history of unilateral LBP distribution (n=6). On the previously painful side, deep multifidus activity was lower and superficial multifidus activity higher, whereas on the non-painful side, deep multifidus EMG was higher and superficial multifidus EMG lower compared to the control group. Activity in the other muscles, was not different from the control group for any of both sides.

To summarize the results with regard to lumbar muscle activity, activity was altered during voluntary sagittal trunk movements in people in remission of recurrent LBP. The observed alterations might have similar repercussions for lumbar muscle activity during low-load dynamic activities of daily living. A common observation from both studies, was the increased activity in MF. Next to alterations in MF, additional changes were apparent in the recruitment of paraspinal and abdominal muscles during rapid trunk flexion. The alterations in dynamic lumbar muscle activity did not completely fit with the predictions from the vicious circle and pain adaptation theory. Moreover, these theories ascribe a key role for pain to explain the motor changes, which cannot be applied to the current population which has been tested during remission of LBP symptoms. In contrast, the observed alterations in lumbar muscle activity seem to be in line with the hypotheses postulated by Hodges & Tucker (2011).

Central Changes in Recurrent Patients during Periods of Remission

Cortical organisation

To investigate whether recurrent LBP is associated with changes in motor cortical representation of different paraspinal muscle fascicles, we have investigated motor cortical organization using transcranial magnetic stimulation (TMS) at different scalp sites to evoke responses in paraspinal muscles. We know that the fascicles of the lumbar paraspinal muscles are differentially activated during function and in a first TMS study we found that, in healthy subjects, this is associated with a spatially separate array of neuronal networks at the motor cortex (Tsao et al 2011 (1)). Interestingly, our findings in a recurrent LBP population highlight that in LBP there is Increased overlap in motor cortical representation of multifidus and lumbar erector spinae which may underpin loss of differential activation in this group (Tsao et al 2011 (2)).

In conclusion, several characteristics of peripheral lumbar muscle structure/function and central cortical re-organisation have been found during remission of recurrent LBP. We suspect that the presence of peripheral and/or central changes (in the absence of pain) could be important predisposing factors that could be contributing to the high recurrence rate of LBP. Current research is examining the effect of exercise on these dysfunctions.

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MOTOR CONTROL: A CRUCIAL FACTOR FOR OPTIMAL FUNCTION OF THE DIFFERENT STRUCTURES

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Introduction

Without a controller the lumbopelvic region is at the mercy of internal and external forces, and it is surprisingly poorly designed to meet these demands with passive forces alone [1]. Fine control of activation of muscle is necessary to meet the demands placed on the spine and pelvis. In this region, coordinated activation of muscle exerts mechanical effects that influence movement and stiffness in multiple ways, including the direct generation of muscle forces via attachments to spine and pelvis segments, tensioning of the complex system of fascia and connective tissue that attaches to the lumbopelvic structures, and modulation of pressures in the abdomen and thorax [2-6]. The challenge faced by the controller would be immense when considering the demand to maintain optimal control of the spine and pelvis for primary motor tasks alone, but this is further is complicated in this region by the multiple other functions that the muscles of the trunk must control simultaneously (e.g. balance, breathing, continence, gastrointestinal function, etc.).

The aim of this paper is to consider the general features of function and dysfunction of the controller to meet the demands of control of the lumbopelvic region, and in individuals not only with lumbopelvic pain, but also conditions of balance, breathing, continence, and so on.

Optimal Motor Control

A key consideration is what constitutes optimal motor control. Although some clinical approaches have taken the simplistic view that optimal motor control is achieved by static activation of muscle to prevent motion, it is critical to consider that control is only optimal when there is an appropriate balance between stiffness and movement, and this balance will depend the task and the individual [2]. Stability is achieved when the objectives of the task are met, despite challenges from internal and external forces, and this objective could be to maintain a position or to maintain a trajectory and to maintain all of the other elements (e.g. breathing, balance) at the same time. Essentially, the nervous system needs a system that develops a plan/objective, determines the status of the system, generates a coordinated pattern of activity that aims to achieve the objective in an optimal manner (“optimal” in this context could refer to a range of features including – optimal energy expenditure, optimal distribution of load, optimal speed, optimal ability to coordinate with other functions, and so on) and then adjusts the output on the basis of feedback of the success in meeting the objective. The opportunity for planning depends on whether the task or challenge is predictable or unpredictable. If predictable, the CNS can deal with this in advance, based on the predicted consequence [7]. If unpredictable, the CNS can engage responses with varying levels of complexity from simple stereotypic reflex adjustments (what they gain in speed they lack in adaptability to exactly match demands), to complex multisegmental responses that involve greater time, but are more capable of matching the exact needs of the system [8]. There is considerable work underway to understand the detail of this system and underlying control mechanisms [9-11].

An area of considerable debate regards which muscles are involved. Although some debate has raged around which muscles are most important [12], the key is no doubt that optimal function depends on integrated function of a whole system of muscles, with flexibility to adapt strategy to meet specific contextual requirements [12]. One element of the system that has been under the microscope is the role of the deeper trunk muscles [13, 14]. Although some work highlights a limited capacity of these muscles to generate trunk stiffness through conventional means, in vivo and in vitro evidence that these muscles make an undeniable contribution via modulation of intra-abdominal pressure [6, 15, 16] and fascial tension [5, 6]. These muscles are not the most important for lumbopelvic control, but they make a contribution, and the absence of this contribution will have an impact on the quality or robustness of spine control [12].

Challenges for Optimal Motor Control of the Lumbopelvic Region

More than any other region of the body, the optimal control of the spine and pelvis is complicated by the need for the trunk muscles to contribute to multiple functions, and these functions need to be controlled at the same time as meeting the demands for balancing movement and stiffness [2]. The trunk constitutes 70% of the mass of the body, thus its control is critical for maintenance of equilibrium [17]. The diaphragm and abdominal muscles are both critical for spine control and are the principal muscles of breathing [18].

Continence is achieved by a tug-of-war between muscles that maintain continence (urethral sphincter and levator ani) and those that challenge it (abdominal and diaphragm muscles), and all of these muscles together are essential for optimal control of the spine and pelvis [19].

Recent work has focused on the outcome of challenges imposed on the ability to coordinate these functions.

There are many examples. People with back pain, are less likely to use movement as a component of spine control [20] and, in addition to the possible consequence of this for damping of applied forces [21], this has consequences for the quality of control of balance (e.g. the time taken to recover balance after a perturbation is longer as a result of this change [22]). It has been known for some time that specific subgroups of people with low back and pelvic pain have compromised ability to coordinate breathing and pelvic floor muscle function [23]. In people with breathing disorders such as moderate to severe chronic obstructive pulmonary disease, activation of large oblique abdominal muscles is increased, in line with the enhanced demand for expiration, and this is associated with compromised balance in the mediolateral direction, which depends on spinal motion [24]. Other work has identified changes in fatigability of diaphragm in back pain and a possible association to postural control [25]. Pelvic floor muscles contribute to spine control [19], but this may be compromised in groups with continence deficits [26], and low back and pelvic pain [27]. The potential consequences of poor ability to coordinate these functions is highlighted by the greater risk for development for low back pain in women who report incontinence and breathing disorders such as allergies, than those how do not, and the converse [28, 29]. This is only the tip of the iceberg and future work is likely to unravel the complexity of function and dysfunction of the challenge that the motor control system faces to coordinate functions, and the implications this has for rehabilitation of individuals within each domain (i.e. low back and pelvic pain, incontinence, breathing disorders, gastrointestinal complaints, to name just a few).

Motor Control and Pain

Motor control is changed in pain, and this is no less true for low back and pelvic pain than any other musculoskeletal pain condition [30]. Motor control changes in low back and pelvic pain present across a spectrum from subtle changes in the coordination between muscles (e.g. redistribution of activity within and between muscles [10]), to frank avoidance of movement (e.g. avoidance of lifting; failure to flex to full range of trunk flexion [31]). Essentially, motor control determines the manner in which the tissues of the body are loaded, both in terms of loads induced by muscle activation and those resultant from external forces applied to the body. Changes in motor control will influence this loading. The relevance of such changes for the onset, persistence or recurrence of pain will depend on many issues, including the type of pain (nociceptive, neuropathic, central) and the time course. In an acute phase motor control may adapt to remove the threat to the tissues. That is, to reduce the load on the painful tissues such that the potential for further nociceptive discharge and injury are reduced. The transition to more persistent pain states may include persistence of nociceptive discharge, and thus relevance of motor adaptation to influence the quality of the loading. A major issue is that the initial adaptation in motor control may have presented short-term benefit to the system, but in the long-term the adaptation could become part of the problem, secondary to increased load from muscle co-contraction, reduced movement, and decreased movement variation [30].

Alternatively, persistence of pain may be not have a nociceptive component and be linked to sensitization in the nervous system (including hyperalgesia, allodynia, cognitive-emotional elements) or be neuropathic in origin [32]. In each case, plastic change in the motor system may be relevant, but the relevance of modification of motor control to contribute to recovery will depend on the individual. Even if the primary reason for maintenance of pain may not be nociceptive, the adaptation in motor behavior may lead to secondary changes at the spine or elsewhere (e.g. increased risk of knee injury associated with modified trunk controls [33]), then there may still be relevance to rehabilitation of motor control of the trunk.

The presentation of adapted control in patients with low back and pelvic pain includes redistribution of activity within and between muscles. There is substantial variation between individuals [10, 34], and this variation is probably related to the classification of patients using contemporary subgrouping methods [35, 36]. One element of the system that is commonly compromised is the contribution of deeper muscles [14].

This is particularly relevant as these muscles have a primary role in tensioning the fascial system, modulation of intra-abdominal pressure, and have key roles in the multitude of other functions controlled by the trunk muscles, in particular – breathing and continence [2]. The delayed and reduced activation of the muscles of this component of the system may present specific problems for optimal function of the system.

Conclusion

Without motor control the spine and pelvis cannot be controlled. Maintenance of optimal control is challenging; it requires the balance between movement and stiffness, it is dependent on multiple muscles and multiple complex structures and mechanisms, and it is dependent on effective coordination of multiple functions of the trunk muscles. When tissue loading is relevant for the onset, persistence and recurrence of pain, attempts to optimize motor control in the face of each of these challenges is likely to be helpful, but this will require individual assessment and individualized training to address the complex combination of issues, and that will be patient-specific.

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INTERACTION BETWEEN SEGMENTS: THE ROLE OF THE HIP IN LUMBAR PAIN AND ITS IMPLICATION FOR EXERCISE THERAPY

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Patients presenting with pain complaints with distributions in the lumbar spine, posterior pelvis, lateral hip, anterior groin, and general pelvic girdle region provide a diagnostic challenge to health care providers for several reasons. First, there are numerous musculoskeletal structures in the lumbar spine, pelvis and hip that, when injured or as they degenerate, can cause pain. Second, there is significant overlap in pain distributions of these structures, which can make diagnosis difficult. Third, the structures themselves may be intact but interplaying movement patterns between the spine, pelvis and hip can be a source of dysfunction and pain. Fourth, health care providers can easily fall into the trap of looking for or attributing symptoms to one source instead of considering coexisting disorders of the hip and spine.

Hip and spine disorders indepent of one another cause significant impairment and disability. The prevalence of these two disorder coexisting, namely the hip-spine syndrome, is unknown. Yet, coexistent disease is commonly observed in the clinical setting. The magnitude of the impact of these coexistent conditions on disease progression and response to treatment is also not known. Further, the healthcare costs of coexisting disorders are unknown. However, if coexisting disorders were identified early in the evaluation process, likely this would provide a favorable impact on patient care and even outcomes. Further, health care costs potentially could be reduced if treatment for the two conditions is coordinated and administered concurrently as compared to common practice where the failure of treatment of one may then lead to a diagnostic evaluation and eventual treatment of the other disorder. A reduction in the delay of diagnosis and evaluation allows for the integration of treatment for both conditions from the onset of care, the setting of appropriate outcome goals, and potentially reduce time lost from work and activities.

Descriptive literature of the hip-spine syndrome are limited to coexisting hip and spine disorders that occur in the setting of degenerative structural changes of the hip and spine found on imaging.[1-8] Bohl and colleagues[2] were the first to describe coexisting of hip and spine disorders. The authors reported the course of six patients with continued pain after a total hip arthroplasty (THA) that was relieved with a lumbar laminectomy. In a similar study, McNamara [5] described symptomatic lumbar spinal stenosis in nine patients following THA. Seven of the patients went on to have a lumbar decompression and the surgeons reported excellent or good outcomes. Saunders and colleagues [7] evaluated 75 patients with hip osteoarthritis (OA) and compared them to a control group of patients without hip OA. Lumbar spine degenerative changes were significantly more common (women p=0.036 and men p=0.001) in the hip OA patients as compared to controls. The hip-spine syndrome term was first published by Offierski and colleagues [6] in 1983. The authors described the course of 35 patients and concluded that patients with concomitant hip and spine disorders need specific diagnostic tests to assess which or if both disorders cause the greatest impairment. If the impairments are “inter-related” the authors concluded that addressing the hip disorder will modify the symptoms from the lumbar spine.

The constellation of symptoms in patients considered to have hip-spine syndrome with degenerative hip disease and spinal stenosis were first described by Fogel[3]. The first study to comment on intervention for this patient population when both were diagnosed prior to treatment was published by Ben-Galim in 2007.[1] In this study, 25 patients were evaluated with the Harris

Hip Score, Oswestry Disability Index, and pain visual analog scales for the hip and spine prior to, three months, and two years after THA. All outcome measures for pain and function reached statistically significant improvement after THA. The authors concluded that THA improved lumbar spine pain. In a retrospective review by Sembrano and Polly[8] the records of 200 patient from a spine surgery service. Patients were evaluated for response to steroid and anesthetic injections in the lumbar spine, sacroiliac joint (SIJ) and hip. Eighty-two percent of cases reported improvement after a lumbar spine injection, 12.5 % of cases reported improvement after a hip injection, and 14.5% reported improvement after an SIJ injection. Seventeen and one-half percent reported pain relief after injections in all 3 locations. These data suggests hip and spine disorders likely more commonly coexist than previously recognized.

Recently, a retrospective review [9] of patients treated between 1996 and 2008, of the 3206 patients who underwent total hip arthroplasty (THA), 565 (18%) were also evaluated and diagnosed with a lumbar spine disorder (LSD) by a spine specialist in the department of orthopaedic surgery within the 2 years prior or following the THA. Patients in the THA+LSD group were more commonly women and significantly older as compared to patients in the THA alone group. Patients in both groups demonstrated significant improvement in the VAS, mHHS, and UCLA activity scores after THA. Patients in the THA alone group had significantly greater improvement in pain and function after THA as compared to patients in the THA+LSD group.

A patient in the THA+LSD group incurred on average $6,098 in billed charges for an episode of care, while a control patient from the THA alone group incurred $4,273 ($1,825 less, a difference of 35%). This difference was significant ($p<0.001$). On average, patients in the THA+LSD group had an episode of care that lasted 2,166 days (5.93 years), 568 days longer than patients in the THA alone group. This difference was also significant ($P<0.001$). To date this is the largest number of patients included in a descriptive study.

Coexisting hip and spine disorders can be difficult to diagnose. This is, in part, due to the similarity of symptoms which may lead to undetected overlap of the two disorders. Lumbar radiculopathy, facet syndrome, sacroiliac joint pain, and piriformis syndrome may present with similar distributions of pain including the lumbar spine, posterior pelvis, lateral hip, groin, and lower extremity.[10-14] Less recognized are the various distributions of symptoms related to hip disorders. Khan 2004[16] reported that 47% of patients with hip OA undergoing THA had pain in the lower extremity below the knee. Lesher[15] reported patients responding to intra-articular hip injection reported pain in the groin, lateral hip and buttock region.

Pre-arthritic hip disorders have also been described to present with buttock and/or LBP.[15-18] Because of the overlap in symptoms and diagnostic imaging, the specialist must often rely on their individual clinical experiences to direct care.

Currently, there is a lack of prospective studies to describe coexisting hip and spine disorders. Patients treated with THA for hip OA represent patients at the end of the spectrum for degenerative conditions of the hip joint. Literature suggests that patients with degenerative hip disorders are likely to have degenerative changes in the lumbar spine.[7] How many of these patients develop or seek treatment for a lumbar spine disorder is unknown but this group represents a specific population affected by coexisting hip and spine disorders. It is important to raise awareness of the prevalence of coexisting hip and spine disorders so that healthcare providers attempt to assess for both in patients presenting with pain in the lumbar spine and pelvic region. Improved awareness will also direct specific treatment for both disorders.

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EXERCISE TRAINING TO FACILITATE ACTIVITY AND PARTICIPATION

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"When you can measure what you are speaking about,
and express it in numbers, you know something about it;
but when you cannot measure it, your knowledge is
of a meager and unsatisfactory kind… "
- William Thomson (Lord Kelvin)

Introduction

Exercise for health and disease management is not a new idea. Claudius Galen's (129-210 A.D.) influence regarding what has been called 'the things non-natural' (clean air, healthy food, appropriate sleep, good working bowels, balanced passions and proper exercise)[1] informed physicians well into the 19th Century to include exercise as an important part of their medical practices.[2] Next to Hippocrates, he was the most influential physician of the ancient world. He taught these principles were interactive, and if used in moderation as dictated by natural law, good health would be the result. It was not until the late 1800s, when western medicine and healthcare became focused on 'sick care and disease' that the emphasis on prescribed exercise slipped into the background of medical practices.[3]

In the 1960s, there was a changing focus in the American population as it related to overall wellbeing. Heart disease was a public epidemic. In addition, smoking and excessive alcohol were seen as deterrents to good health, and people began, once again, to take an interest in their own wellness. While it seemed this shift in focus was a new phenomenon, historically, physical activity served as a platform for good health.[4] Exercise received much more emphasis as healthcare began to find a balance within the monolith of 'disease management and rest' that had dominated medicine in the United States for more than 80 years.

Today, there is little controversy regarding the importance of exercise in healthy lifestyles, longevity, quality of life, mental wellness and the management of many chronic diseases, including low back pain. [5-9] In point of fact, exercise is the only meaningful way to increase functional capacity.[10] Rather than the value of exercise in the management of back pain, there may be more of a question as to its place: alone or in combination with cognitive and/or biopsychosocial strategies.[11-13]

Systematic reviews have consistently provided recommendations for more, rather than less, activity as an aid to recovery.[14,15] Thirteen countries and two international groups, in addition to subgroups within professional societies, insurance companies and other stakeholder agencies, have published clinical guidelines for the treating of low back pain that include exercise as an integral part of the clinical management strategy.[15]

In patients with acute back pain, early activation should ideally begin in the primary care setting. Unfortunately, a large percentage of primary care physicians do not recommend exercise for their back pain patients.[16,17] Some general practitioners cite patient preferences that override their clinical judgment even when they know the importance of recommending increased activity.[18] This suggests a need for improved dissemination of information regarding the value of continuing to be active. It is important to uncover the patient's own motivations and then align them with appropriately active treatment goals; this can be accomplished by skillful practitioners.[19]

There also is good evidence for the use of exercise directed therapy for patients with chronic back pain; such therapy is generally within the context of a rehabilitation setting. [14,20,21] When compared with other therapeutic approaches, exercise demonstrates positive results both by itself and in combination with cognitive interventions. Furthermore, structured exercise has been shown to be cost effective in reducing disability.[22,23]

Functionally directed treatment

Usually, pain is the reason that people seek medical care; however, physiotherapy is focused on the restoration of function. In the United States, insurance companies do not generally pay for pain reduction as an isolated symptom. Rather, they pay for demonstrated increases in function, because pain cannot be effectively measured, and because treatment options are limited to medication, cognitive intervention or surgery. Although pain reduction usually occurs as the result of physiotherapy, functional improvement is the standard both for the payer and for the clinician.

Function and the progressive improvement of function can be objectively measured and can be increased as a result of recognized treatment protocols. Multiple clinical studies have demonstrated the positive effects of aggressive exercise programs. In addition, exercise has favorably compared with surgical intervention,[24-26] and in some cases, has eliminated the necessity for surgery.[27] It is clear that effective clinical therapy should include progressive structured exercise protocols. Such an approach is the centerpiece of successful treatment for the management of complex pain syndromes including spinal pain. [28]

Treatment Strategies

Rational clinical treatment programs should contain four elements: 1) pragmatic frameworks, 2) standardized assessment and treatment methodologies, 3) common therapeutic protocols, and 4) cost effectiveness. Objectively measured therapeutic exercise programs are ideal pathways that can consistently achieve these goals.

A pragmatic framework exercise protocol should follow the principle of progressive overload (increasing intensity, frequency and/or duration of movement to exceed normal activity levels). The exercise science literature contains numerous evidence-based protocols, utilizing the construct of progressive overload, which lend themselves well to the clinical setting for spinal functional restoration.[5,29]

Table 1. Example of Recommended Exercise Activity*

Mode	Frequency	Intensity	Duration
Aerobic	3-5 days/wk	3-5 55-90% of maximum heart rate or 45-90% maximal oxygen uptake	20 - 60 minutes continuous or intermittent
Resistance /Strength: 8 to 10 muscle groups	2- 3 days/wk	10 to 15 repetitions to volitional fatigue	One set is sufficient for non competitive individuals
Flexibility: Stretch major muscle groups	2- 3 days/wk		

*Modified from American College of Sports Medicine Position Statement[5]

Standardized assessment and treatment methodologies are critical if functional improvement is to be objectively measured in order to enhance scientific inquiry and to facilitate the ability to communicate clearly with colleagues. Standardized tests are currently available and should be utilized. The American College of Sports Medicine publishes such testing and prescription methodologies.[5,29,30] These guidelines provide specific assessments and recommendations of appropriate frequency, intensity and duration for endurance, strength, and flexibility, in healthy and clinical populations (Table 1). The underlying purpose of these guidelines is to "…provide the proper amount of physical activity to attain maximal benefit at the lowest risk. Emphasis…placed on factors that result in permanent lifestyle change and…lifetime…physical activity."[5]

If, on the other hand, objective measurement is only for internal clinical use (patient motivation and/or clinician communication), there are any number of fitness testing resources available for the assessment of flexibility, endurance, and strength.[31,32]

Within physiotherapy practices with more than one clinician, it is not uncommon for each therapist to assess and treat patients differently. *Common therapeutic protocols* help by providing a foundation of treatment that enhances consistent clinical understanding of patient care. At the very least, within a defined practice, agreement among clinicians regarding clinical protocols permits objective comparison of therapeutic effectiveness.

Cost effectiveness positively impacts society by decreasing overuse of the healthcare system and interventional procedures; thereby, reducing the overall economic burden of medical care. In addition, a framework for creating efficiencies in the treatment of spinal care lends itself well to larger social issues. This is particularly important in the United States where two-thirds of spinal costs are due to decreased wages and productivity, and where health care is rapidly approaching 18% of the gross domestic product (GDP).[33]

Measurement as the Standard of Care

Measurement as a means of clarifying understanding is a time honored practice. Plato suggested to Euthyphro, "…suppose that we differ about magnitudes, do we not quickly end the differences by measuring? …And we end a controversy about heavy and light by resorting to a weighing machine?"[34]

William Thomson (Lord Kelvin) the Scottish mathematician and physicist expressed it more bluntly,

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, your knowledge is of a meagre and unsatisfactory kind…"[35]

Multiple reasons exist for objective measurement. There is considerable value in the use of normative data, which produces improved clinical understanding and which leads to further research. In addition, an often-overlooked reason is patient motivation. Human beings are interested in 'where they fit in' to whatever category they find of interest. This understanding is the subject of studies in the area of exercise compliance.[36-38] Actuarial health tables provide data related to height, weight, body mass index, cholesterol, blood sugar, and physical performance. Generally, patients demonstrate a desire to know how they are faring in rehabilitation. When patients are shown increases in endurance, strength, range of motion or flexibility over their baseline, they feel a sense of accomplishment, which is very helpful in keeping them motivated throughout their course of treatment.

In chronic back pain patients, measurement can be used, both to encourage compliance and/or demonstrate they have plateaued and are no longer candidates for ongoing treatment. Measured exercise programs provide a broader and more coherent clinical narrative from which therapeutic management can be refined.

Clinical Outcomes

The majority of available measures reflecting changes in back pain are 'patient reported' in the following general categories: Symptoms, Function and Quality of Life. The use of these patient reported outcomes (PROs) in clinical trials reflects the attention being given to patient interests in the evaluation of their health care.

In the late 1980s and early 1990s, there were a few of these measures available. Examples include Analog Pain Scales, Oswestry Disability Index (function), and the Short Form Quality of Life (Sf-36). The difficulty in quantifying these non-dichotomous data in spinal care have led to a proliferation of outcomes measurement tools, about which Chapman noted "…suggest a high degree of sophistication…or a general helplessness in the face of overwhelming odds," and an "…incomplete resolution of the attempts at quantifying many aspects of "health-related quality of life.""[39] Within the clinical setting, the difficulty in agreeing on common measurement criterion has created more opinion than fact.

'Clinician-based' outcomes (CBOs) are another kind of data. These assessments reflect objective physiologic or biomechanical changes such as endurance, muscle strength, range of motion, and measured activities of daily living (e.g. functional capacity testing). CBOs differ from PROs because they are based on measured performance and do NOT involve patient perceptions. Objectively measured protocols provide evidence for restoration of function required by third party payers, and provide timely feedback to the patient.

Unfortunately, at this juncture, most clinicians do not use outcomes in their practices. Thomas Lee of Harvard indicated that less than 10% of all healthcare practices in the United States collect any kind of outcomes data – either PRO or CBO. In addition, practices that do collect and use them for clinical decision making, are in the low single digits.[40]

What Kind of Exercise?

According to the Bureau of Labor Statistics in the United States, estimates of regular lifestyle physical activity range between 13 to 20% in people over the age of 15, with variations based on regional habitat.[41] The physically inactive chronic back pain patient oftentimes develops 'reductive adaptation' of muscle mass (sarcopenia) from disuse, which is aggravated by the physically inhibitive nature of pain.

The goal of therapeutic intervention is to restore patient function to normal activities of daily living: sitting, rising, bending, twisting, lifting, walking and climbing. Pain and reduced function affect normal routines such as doing laundry, dishes, cleaning the garage, working on hobbies, and recreational events. While increasing strength, flexibility, endurance and balance enhance all these activities, only resistance (strength) training has been shown to cause increases in all four domains at the same time. Strength training produces increases in strength, as well as endurance, flexibility and balance.[42-45] It is safe, efficient, easy to quantify and has been shown to reduce kinesiophobia,[13] depression,[46] vertebral fractures,[47] and recidivism rates.[48] Such activity also has the benefit of increasing the integrity of connective tissue within the muscle, joint cartilage, tendons, ligaments in addition to enhancing bone mineral content.[49] Because of its multifactorial contribution to overall health, generalized resistance strengthening and functional restoration should be an integral part of any rehabilitation program for the chronic back pain patient.

Spinal Strengthening

Strengthening of the lumbar extensor muscles has consistently been associated with good clinical success. While core stabilization exercises have been somewhat equivocal in clinical studies,[50-53] lumbar extensor strengthening has been shown to be an effective therapeutic tool, which is as good as, or better than standard physiotherapy.[54,55] Its value over routine standard of care is that it provides objective evidence of physiologic adaptation to the therapy.

Both computed tomography (CT) and magnetic resonance imaging (MRI) scans have revealed that lumbar extensors (and in particular the multifidus) show greater atrophic changes with more severe back pain.[56] Using a modified roman chair, Dickx induced pain in healthy backs by unilateral injection of hypertonic solution. This led to bilateral hypoactivity in both erector spinae and multifidi.[57] Parkkola showed that patients with chronic low back pain (CLBP) have greater fatty infiltration and less muscle mass in their lumbar extensors.[58] This is relevant because multifidus fibers show a natural degree of atrophy in individuals with no history of back pain as well as in patients with CLBP,[59] suggesting that lumbar extensors and the multifidi may be more atrophic in these patients. MacDonald et al demonstrated that unilateral atrophy of the multifidi, occurring in the once symptomatic side, persists even when the patient is no longer symptomatic.[60] Hides and colleagues observing patients with first-time onset of unilateral back pain, found rapid atrophy of the multifidus on the symptomatic side. The atrophy persisted even after spontaneous resolution of symptoms in those patients who did not exercise following recovery from pain.[61,62] Strengthening the low back extensors does not require hi-tech equipment. A simple roman chair or prone 'superman' exercise, where the trunk is extended while in the prone position on the floor, have been shown to be effective in increasing lumbar extensor strength.[47,63]

Rissanen (unpublished dissertation) performed muscle biopsies before and after aggressive back extensor strengthening in patients with a history of chronic back pain. He demonstrated increased diameter of type 2 multifidus fibers and significant increases in strength.[64] The pre and post exercise biopsies demonstrated morphologic adaptation of the multifidi to strengthening in these individuals. This study verified observations made by Mooney et al regarding the importance of aggressive resistance training of the lumbar extensor muscles in patients with CLBP.[65] Their data showed changes in the myoelectric activity of the lumbar extensors as strength and range of motion increased. In addition, Leggett et al, in a multicenter study, revealed that strengthening the lumbar extensors led to a reduction in reuse of the health care system by 87% after one year.[48] Their data also demonstrated increases in quality of life and reduction in perceived pain.

Strength Training

Progressive overload has been called the 'Mother Principle' of exercise training. The three elements of prescribed exercise are: frequency (how often), intensity (how hard) and duration (length of time) of an activity. Under this principle, these three elements are adjusted to gradually increase the amount of work performed until a maximal exercise potential is reached.

Any exercise overload will cause functional capacity to increase; however, the largest gains are achieved by adjusting intensity. Regardless of therapeutic activity, the principle of progressive overload governs the ability to increase one's capacity to perform activities of daily living. This is particularly true of resistance training. How hard one performs strength or endurance training is the greatest contributor to positive changes in performance capability. Applying greater resistance through progressive sessions, results in increased lean muscle mass, decreased body fat, and increased work capacity (function).[66]

If baseline measures are taken prior to beginning a program of progressive exercise, patients readily see improvements during the course of their clinical restoration program. In addition, baseline measures demonstrate overall functional gains patients have made at the completion of the therapeutic program.

Exercise machines are optimal to determine the effects of progressive resistance exercises. Such devices permit measurement of effort, both visually and physiologically. By limiting free axial movement, they are also very safe and reduce the potential for re-injury. Although free weights are less expensive and effective, they must be more carefully supervised. While there is great emphasis in some programs for patients to perform functional activities, such actions do not meaningfully strengthen muscles. For example, it would be dangerous for a tennis player to use a heavily weighted racquet to increase his or her strength of service. Momentum of the swing alone would put the joint's axis of rotation at risk. As a result, much less intense exercise can be performed. This may be better for proprioceptive movement patterns, but not for optimal strengthening.

Motivational issues also detract from functional gains when patients are not given specific measured goals. Therapy that is time based or centered on unmeasured exercise provides little in the way of patient feedback. Without tailored goals (prescribed exercise based on a quantitative assessment), most patients require 'cheerleading' or they will perform the exercise at the lowest common denominator of their capacity. For example, in walking programs without 'time and distance guidelines', patients will engage in progressively less intense exercise. Without a grade, students will not perform well, because most people lack self-motivation in the absence of feedback. Similarly, without measured activity and demonstrated progress, patients find little motivational incentive to perform the desired exercise intensities.

Summary

There is little doubt that exercise is an important strategy in the management of back pain regardless of whether it is acute or chronic. The question is how much exercise is appropriate or enough? Of the various exercise strategies that are available, resistance (strength) training is the most effective and efficient. However, without baseline and follow-up measurement, exercise in the clinical setting is difficult or impossible to assess. In the absence of standard measures, prescribing therapeutic exercise relies on opinion, the results of which are equivocal. While indirect measures (PROs) are typically present in clinical reviews, they are not often used in normal physiotherapy practices. Objective measurement is the key to understanding the value of clinical practice and its predictable impact on patient treatment. Objective numbers in clinical practice are critical to motivate both the clinician and the patient.

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CHRONIC SPINAL PAIN: THE IMPACT OF PAIN MECHANISMS AND PSYCHOSOCIAL FEATURES ON EXERCISE MANAGEMENT

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Much of our current therapy for chronic spinal pain (CSP) is focused on input mechanisms (treating peripheral elements like muscles and joints) and output mechanisms (addressing motor control), while there is less attention to processing (central) mechanisms. Within the context of the management of CSP, it is crucial to consider the concept of pain mechanisms [1]. There is compelling evidence for impaired motor control of spinal muscles in patients with CSP. In addition, there is increasing evidence that central mechanisms, i.e. brain abnormalities (changes in brain structure and function) and hyperexcitability of the central nervous system (sensitisation of the brain) play a tremendous role in CSP patients [2, 3].

Although randomized clinical trials have shown that exercise therapy for improving spinal motor control is effective in reducing pain and disability related to CSP [4-6], the effects are similar to those seen in response to general exercise therapy not addressing spinal motor control [7, 8]. In addition, the effect sizes of exercise therapy for improving spinal motor control in CSP patients are rather small [7, 8], limiting its socioeconomic impact.

In order to adopt the treatment for the brain abnormalities seen in patients with CSP, and increase the effect sizes and socioeconomic impact of treatment for CSP, it seems to be mandatory to address the central mechanisms in CSP as well. This asks for a modern neuroscience approach to CSP using a comprehensive rehabilitation programme comprising of pain neuroscience education followed by cognition-targeted exercise therapy.

Guidelines for enabling clinicians to apply pain neuroscience education in clinical practice are available [9]. As soon as the CSP patient understands that all pain is produced in the brain, and has adopted less threatening perceptions about pain, one can proceed to the next level: cognition-targeted exercise therapy. The latter is not limited to motor control training, but can be extrapolated to whatever type of exercise therapy (including aerobic training or muscle strengthening).

‘Cognition-targeted’ implies a time-contingent rather than symptom-contingent approach to exercise interventions. It accounts for the individual (pain) cognitions that should have been addressed during the individually-tailored pain neuroscience education. Importantly, the cognition-targeted exercise therapy will apply the reconceptualization of pain to exercises (and in a later stage to daily physical activities like gardening and lifting heavy objects). Hence, goal setting should be a central part of the exercise program. In addition, thorough questioning and discussion of the patient’s perceptions about the exercise, before, during and following the exercise is required. The following questions can guide clinicians in doing so: “Is this particular exercise threatening for you(r back)?”; “Are you confident in successfully executing the exercise/movement/activity?”; “Do you feel that the exercise is useful for you(r recovery)?”. In case of irrational fear towards certain physical activities or exercises become apparent, graded exposure in vivo experiments [10] can be applied.

When progressing to a next level of (more difficult) exercises or daily activities, a preparatory phase of motor imagery is mandatory. Given the large overlap of brain areas involved during motor imagery and actual movement execution [11], such a preparatory phase allows for the brain circuitries required for optimal movement execution to (re)develop.

The goal of cognition-targeted exercise therapy is systematic desensitization, or graded, repeated exposure to generate a new memory of safety in the brain, replacing or bypassing the old and maladaptive pain memories. Hence, such an approach directly targets the brain circuitries orchestrated by the amygdale (the memory of fear centre in the brain).

Central sensitization or hyperexcitability of the central nervous system implies increased synaptic efficiency and development of more excitatory synapses. Such brain mechanisms are identical to those seen in learning and memory, for instance in the hippocampus. The mechanism of long-term potentiation of brain synapses is crucial for (re)learning and developing new (pain / movement-related) memories, and hence for retraining brain memories in the brain.

In practice, exercises in the cognition-targeted exercise therapy are allowed to be stressful, as stress, through the availability of cortisol and adrenaline in the brain, facilitates long-term potentiation of brain synapses especially of excitatory synapses [12]. However, care must be taken that the stressful experience leads to an adaptive change in pain memory (i.e. that the movement is experienced as less threatening as anticipated). Thus, cognition-targeted exercise therapy aims at creating a secondary (inhibitory) relationship between body movement and its behavioral consequences [13]. Associative learning, defined as the product of discrepancy between actual and expected outcomes, is required in such exercise interventions, so that learning only occurs for events, or sensory inputs, that the brain did not expect (‘error of prediction’) [14]. Exposure of CSP patients to exercises or daily activities without danger to convince the brain of its error [13] is crucial to cognition-targeted exercise therapy.

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CLASSIFICATION-BASED COGNITIVE FUNCTIONAL THERAPY (CB-CFT) - LONG TERM FOLLOW UP OF PATIENTS WITH NON-SPECIFIC CHRONIC LOW BACK PAIN

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Non-specific chronic low back pain (NSCLBP) disorders have proven highly resistant to change in spite of enormous resources directed at them. There is lack of evidence for single treatment interventions for patients with NSCLBP despite the substantial amount of Randomised Controlled Trials (RCT) evaluating treatment outcome for this disorder (Assendelft 2004;Furlan AD 2005;Hayden et al. 2005;Ostelo 2005;Staal JB 2008). It has been hypothesised that this vacuum of evidence is caused by the lack of sub-classifying the heterogeneous population of patients with CLBP for outcome research. Another reason suggested for the limited evidence is the lack of sub-grouping and managing the disorder from a biopsychosocial perspective (Leeuw et al. 2007).
There is growing evidence that NSCLBP is associated with maladaptive cognitive, movement and lifestyle behaviours that act to promote a vicious cycle of pain. Few classification systems (CS) reflecting a bio-psycho-social model have been validated and tested in RCTs for the management of NSCLBP disorders (Fersum et al. 2010).
Since 1997 Peter O'Sullivan has developed a novel multidimensional classification system and treatment called Classification Based Cognitive Functional Therapy (CB-CFT). CB-CFT directly challenges these maladaptive behaviours in a cognitive and functionally targeted manner to break the vicious cycle of pain and disability. The system is based on the Quebec Task Force Classification (QTFC), incorporating multiple dimensions in the classification of patients into subgroups based on proposed underlying pain mechanisms.
Further detailed description of the system have been done in a recent publication (Fersum et al 2012).
Rather than replacing existing CS this multi-dimensional mechanism-based CS is an additive, attempting to sub-classify the large proportion of patients that sits within the NSCLBP. The OCS incorporates the biopsychosocial model, which subgroups patients based on identification of cognitive (negative back pain beliefs, fear, hypervigilance, anxiety, low mood), lifestyle behaviours (activity avoidance, poor pacing) associated with the disorder and maladaptive movement (loss of movement control and awareness, protective and avoidance behaviours) (O'Sullivan 2000;O'Sullivan 2005). The classification is based on a systematic examination process (subjective history, objective examination and available medical information), using several different classification levels based on the proposed driving mechanism behind the disorder (O'Sullivan 2005;Fersum et al. 2009).
A model has been suggested for accumulating evidence in the validation process of a classifications system (Dankaerts et al. 2004). This model involves a structured build up and consists of different stages of validation, each step dealing with different criteria. The first process involves a hypothesis behind the classification system. Initially this was through the formulation and definition of the 5 distinct subgroups with motor control impairment (MCI) (O'Sullivan 2000). The next step involved testing clinicians ability to discriminate the different patterns and the CS has good inter-tester reliability (Dankaerts et al. 2006;Fersum et al. 2009) and validity based on provocative movement behaviours (Dankaerts et al. 2005;Dankaerts et al. 2007;O'Sullivan et al. 2007;O'Sullivan et al. 2007;Beales et al. 2009;Dankaerts et al. 2009), as well as cognitive domains (Fersum et al. 2009). Once a generally accepted diagnostic classification system has been developed, outcome studies are required to determine the most effective treatments for particular categories of patients.

The next level of the outcome validation has been through a series of case studies (Dankaerts et al. 2007;O'Sullivan et al. 2007;O'Sullivan et al. 2007) adding further validation to this multidimensional CS. The intervention, named classification based 'cognitive functional therapy' (CB-CFT). CB-CFT directly challenges these maladaptive behaviours in a cognitive and functionally targeted manner to break the vicious cycle of pain and disability. However, this classification and management system for NSCLBP disorders has not been formally tested in a randomized controlled trial until now.

At the university of Bergen we performed a RCT to investigate the efficacy of the intervention called 'cognitive functional therapy' (CFT) utilised in the OCS. The intervention aims to address the behaviours often seen in NSCLBP in a targeted, functionally specific and patient focused manner. The RCT was a two-armed study comparing classification based CFT (CB-CFT) with patients receiving traditional manual therapy and exercise (MT-EX). 121 patients with mechanically provoked NSCLBP (>52 weeks) were randomized to either CB-CFT (n= 62) or MT-EX (n= 59). A linear mixed model was used to estimate the group differences in treatment effect and also in the change in outcome from 3 and 12-month follow-up. Primary outcomes were change in Oswestry Disability Index (ODI) score and pain intensity measured with numerical rating scale (PINRS) at 12 months follow-up. Secondary outcomes were the Fear Avoidance Behaviour Questionnaire, the Orebro multidimensional questionnaire, the Hopkins symptoms check list and time off work due to their disorder. After adjustment for baseline scores, the CB-CFT group displayed superior outcomes supported by both statistically and clinically significant differences, compared to the MT-EX group. The degree of improvement in the CB-CFT group for ODI score was 13.7 points from baseline (95% CI, 11.4 to 16.1, P<0.001) and for PINRS scores 3.2 (95% CI, 2.5 to 3.9, P<0.001). In the MT-EX group, the improvement for ODI score was 5.5 points (95% CI, 2.8 to 8.3, P<0.001) and 1.5 for PINRS (95% CI, 0.7 to 2.2, P<0.001). There were also clinically and statistically significant reductions in fear avoidance behaviours (physical activity and work), the Orebro multidimensional questionnaire, the Hopkins symptoms check list and reduced need for ongoing care in favour of CB-CFT. The subjects in the CB-CFT group also reported a 3 times less likelihood to have time off work due to their disorder when compared to the MT-EX group. The results supported the use of classification based 'cognitive functional therapy' for NSCLBP as it produced superior outcomes compared to traditional physical therapies.

In conclusion, the results of this study support the need for sub-classification and targeted treatment for NSCLBP based on a biopsychosocial construct. Further studies are needed to confirm these results also in those with higher levels of pain and disability and in other cultural groups to determine the generalizability of the findings. This is also why we have conducted the long term follow up to be presented at the conference.

12 MONTH RESULTS OF A RANDOMISED CONTROLLED TRIAL COMPARING SUBGROUP SPECIFIC PHYSIOTHERAPY VERSUS ADVICE FOR PEOPLE WITH LOW BACK DISORDERS

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Introduction

Few treatments have demonstrated clinically meaningful benefits for low back disorders (LBD). Clinical heterogeneity in randomized controlled trials may reduce the likelihood of demonstrating treatment effects. Advice has been recommended for LBD in multiple clinical guidelines.

Purpose/Aim

The aim of the Specific Treatment of Problems of the Spine (STOPS) trials was to evaluate the effectiveness of subgroup specific physiotherapy treatment compared to physiotherapy advice for LBD classified into one of five subgroups.

Materials and Methods

Participants with low back pain (≥6 weeks, ≤6 months) and/or referred leg pain were classified into one of five subgroups. They were then randomly allocated to a 10 week intervention of either: two sessions of advice (pathological explanation, prognostic reassurance, and advice on remaining active) or 10 sessions of physiotherapy specific to the pathoanatomical, psychosocial and neurophysiological factors. The primary outcome measures included back pain and leg pain (0-10 numerical pain rating scale) and activity limitation (Oswestry Disability Index) and were followed up at 5, 10, 26 and 52-weeks post baseline. Data were analysed using linear mixed models for continuous outcomes.

Results

Analysis of 300 participants showed that between group differences for Oswestry favoured specific physiotherapy at 10-weeks (4.7; 95% CI 2.0 to 7.5), 26-weeks (5.4; 95% CI 2.6 to 8.2) and 52-weeks (4.3; 95% CI 1.4 to 7.1). Similarly back and leg pain were significantly lower in the physiotherapy group relative to the advice group at 10-weeks (Back:1.3; 95% CI 0.8 to 1.8, Leg:1.1; 95% CI 0.5 to 1.7) and 26-weeks (Back: 0.9; 95% CI 0.4 to 1.4, Leg:1.0; 95% CI 0.4 to 1.6) time points.

Relevance

Our physiotherapy classification and treatment protocol targeting pathoanatomical, psychosocial and neurophysiological factors has the potential to reduce the impact of sample and treatment heterogeneity in clinical trials. Provided the described treatment integrity measures are adopted in clinical practice, outcomes are likely to be clinically important and superior compared to guideline recommended advice.

Conclusions

Subgroup specific physiotherapy leads to greater reduction in activity limitation across a 52-week follow-up period, and faster reduction in back and leg pain, relative to guideline-recommended advice. These differences are clinically important.

Keywords

Low back pain, treatment, classification

EXBEL: PATIENT BELIEFS AND PERCEPTIONS ABOUT EXERCISE FOR NON-SPECIFIC CHRONIC LOW BACK PAIN: A SYSTEMATIC REVIEW OF QUALITATIVE RESEARCH

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Introduction
The global burden of low back pain is now the highest ranked condition contributing the years of living with disability. Exercise is an effective treatment for non-specific chronic low back pain (NSLBP) but, in randomized controlled trials, the mean effect sizes of different types of exercise are comparable and small to moderate. It is likely that adherence to, as measured by attendance, and participation in, the program will improve if participants are more engaged by the programs offered; this may in turn increase the effect size. Identification of the ingredients that enhance effectiveness would enable clinicians to prescribe appropriate interventions for the NSCLBP care-seeking population.

Aims
To identify and synthesize qualitative empirical studies that explored what people with NSCLBP perceive and believe about exercise therapy and physical activity or training for the management of their condition.

Methods
Two independent reviewers conducted a structured review and meta-synthesis of empirical qualitative research informed by Cochrane Back Pain Review group and Campbell Collaboration guidelines, and the PRISMA statement. Two independent reviewers used a priori inclusion and exclusion criteria to screen titles and abstracts, extract data, appraise method quality, conduct thematic analysis and synthesize in narrative format.

Results
The search yield was 3431 titles, 48 papers were read in full and fourteen studies were included for data extraction and method quality assessment. Four key themes emerged from the combined data of the included papers: 1) Perceptions and classification of exercise; 2) Role and impact of the health professional; 3) Exercise and activity enablers/facilitators; 4) Exercise and activity barriers.

Discussion
There is a distinction between general activity, real/fitness exercise and medical exercise. Levels of acquired skills and capability, and experience of the exercise culture require consideration in program design and decisions regarding appropriate exercise type, venue, entry level performance and progression rates. People participating in exercise classes and group work may be more comfortable when matched for abilities and experience. Care-seekers perceive that when an intervention interferes with everyday life, is ineffective or too difficult to implement they will make a reasoned decision to discontinue. Questions suited to systematically recruiting information about patient preferences are presented in a checklist format.

Conclusions

People are likely to prefer and participate in exercise or training programs and activities that are designed with consideration of their preferences, circumstances, fitness levels and exercise experiences.

Implications

Consideration must be given to any factors that facilitate participant engagement into exercise program design and to identify and remove barriers. This experiential knowledge may be used to inform and engage potential exercise participants and research is recommended to test effectiveness of patient preferences input.

Keywords

Non-specific chronic low back pain, exercise, patient beliefs, qualitative research, review

EFFICACY OF MOVEMENT CONTROL EXERCISE VERSUS GENERAL EXERCISE ON RECURRENT SUB-ACUTE LOW BACK PAIN IN A SUB-GROUP OF PATIENTS WITH MOVEMENT CONTROL DYSFUNCTION

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Background

Clinical guidelines recommend various types of exercise for chronic back pain but there have been few head-to-head comparisons of these interventions. General exercise seems to be an effective option for management of chronic low back pain (LBP) but very little is known about the management of a sub-acute LBP within sub-groups. Recent research has developed clinical tests to identify a subgroup of patients with chronic non-specific LBP and movement control dysfunction (MD).

Method/Design

A randomized controlled trial (RCT) was conducted to compare the effects of general exercise and specific movement control exercise (SMCE) on disability and function in patients with MD within recurrent sub-acute LBP. Participants attended for up to five treatment sessions of manual therapy and exercises. The main outcome measure was the Roland Morris Disability Questionnaire (RMDQ). The measurements were taken at baseline and immediately after three months intervention.

Results

Out of the 223 patients initially enrolled, 70 patients met the inclusion criteria and were found eligible to the trial. 64 patients, (SMCE n= 31 and general exercises n= 33) concluded their interventions leaving the drop-out rate 8.6 %. Both groups significantly improved with the respective therapeutic interventions. After adjustment for baseline scores, the SMCE group displayed superior outcomes supported by both statistically and clinically significant differences when compared with the general exercises group. Between the groups comparison: Mean changes of groups in the RMDQ from baseline to three months measurement showed significantly superior improvement for SMCE group ($p<0.01$) -1.9 (-4.5 to -1.1) 95% Confidence Interval (CI). Within the groups comparison: Mean changes in the RMDQ were significantly different between the two groups in the favor of the SMCE group ($p<0.02$). Mean change in disability, measured by RMDQ, was -6.5 (95% CI -7.9 to -5.0) for the SMCE group and -4.6 (95% CI -4.7 to -2.6) for the general exercises group.

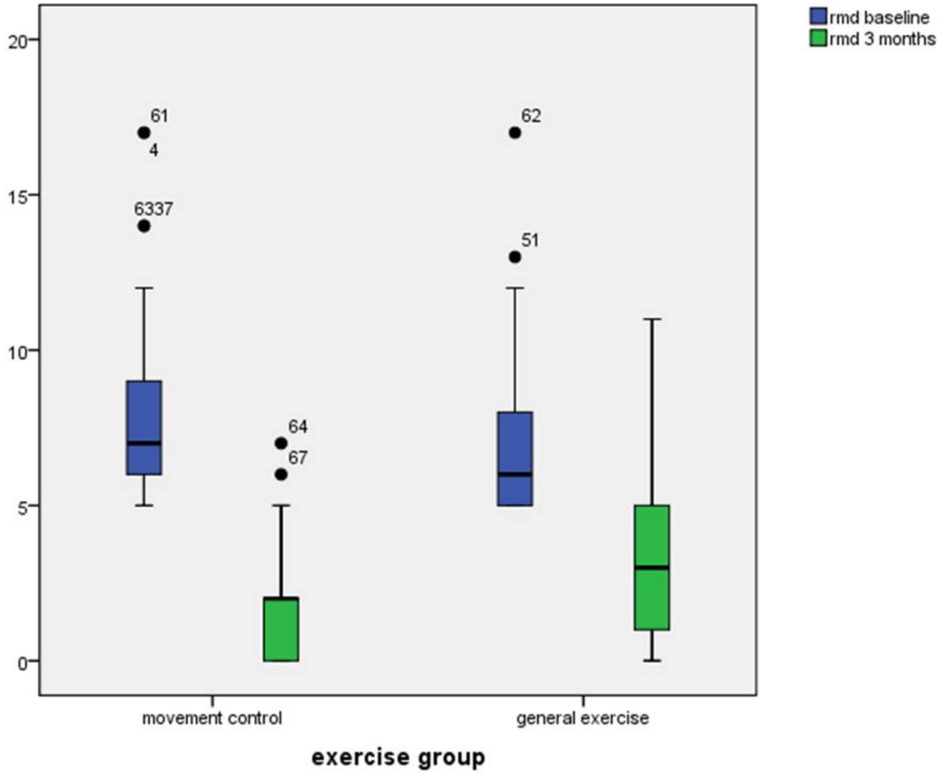
Conclusions

This study indicate that combination of manual therapy and exercises is a superior choice for patients who have predominantly MD, and patients benefit more through a specific individually tailored exercise program than through general exercise immediately after the intervention.

Table 1. Mean Change (SD) in disability and function at three months for treatment groups

	Mean difference in score CI95		Difference CI95	P
	SMCE (n=31)	General Exercises (n=33)		
RMDQ	-6.5 (-7.9 to -5.0)	-4.6 (-4.7 to -2.6)	-1.9 (-4.5 to -1.1)	<0.01
PSFS	8.0 (5.1 to 9.3)	5.3 (3.2 to 6.7)	-2.7 (-4.9 to 0.4)	0.13
ODI	-13.2 (-15.2 to -9.3)	-10.5 (-13.6 to -7.0)	-2.7 (-2.3 to 6.3)	0.35

Figure 1. Scores of the treatment groups measured with RMDQ. On the left side measurement at baseline and on the right side measurement at three months point.



PLASTICITY IN THE SENSORY SYSTEM: PERIPHERAL AND CENTRAL MECHANISMS OF ALTERED PROPRIOCEPTION

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Low back pain represents an important medical and socio-economic problem. Currently, treatments provide modest short-term success due to insufficient knowledge of the mechanisms of non-specific low back pain. Impaired proprioception, the ability to discern body/limb positions and movements, is suggested as a likely mechanism in patients with low back pain.

This paper consists of five parts, in which both the structural and functional aspects of the peripheral and central mechanisms of the proprioceptive system will be discussed in relation to non-specific low back pain.

The Relation Between Proprioception and Low Back Pain

Numerous studies have shown that individuals with low back pain have altered (in most studies decreased) lumbosacral position sense when assuming a variety of postures such as standing, sitting and four-point-kneeling, compared to healthy control subjects [e.g. Gill and Callaghan 1998; Brumagne et al. 2000; O'Sullivan et al. 2003]. However, some studies show no difference in spine proprioception between individuals with and without low back pain [Descarreaux et al. 2005; Asell et al. 2006] or they show only a direction-specific change in proprioception, e.g. decreased acuity in the direction of flexion but not in spinal extension [Newcomer et al. 2000]. Changes in proprioceptive acuity have also been seen in different populations such as young, middle-aged and elderly people, in highly active (e.g. professional ballet dancers) and sedentary individuals, in patients with mild and severe disability, and in patients with non-specific low back pain as well as those with spinal stenosis or disc herniation [e.g. Brumagne et al. 2000; Leinonen et al. 2002, 2003; O'Sullivan et al. 2003; Brumagne et al. 2004a; Brumagne et al. 2004b; Brumagne et al. 2008b]. While older age has also been described as having a negative effect on lumbosacral proprioceptive acuity, this is more manifest in elderly individuals with low back pain [Brumagne et al. 2004a).

The mechanisms that explain the impaired postural control in individuals with low back pain are not clear yet. Supposed mechanisms include pain [Moseley & Hodges 2005], fear [Vlaeyen et al. 1995, 2000], change in co-ordination [van Dieen et al. 2003], muscle fatigue [Johanson et al. 2011] and an impaired ability of the proprioceptive system [Brumagne et al. 2000]. In contrast to healthy subjects who normally use the 'multi-segmental' postural control strategy in more demanding postural conditions, people with low back pain seem to use the more ankle-steered postural control strategy irrespective of the postural demands [Brumagne et al. 2008, Claeys et al. 2011, Mok et al. 2004, 2007]. They show a reweighting of proprioceptive input by increasing the gain of ankle proprioception, even when this was not the most optimal strategy to control posture [Brumagne et al. 2004a, 2008, della Volpe et al. 2006]. As a result, the variability in postural control strategy in people with low back pain is decreased [Claeys et al. 2011], while variability is a prerequisite for optimal functioning of biological systems [Carver et al. 2006]. This might partially explain the high recurrence rate of low back pain.

Until now very few prospective studies investigated the cause-effect relation between altered postural control and the development of low back pain. Increased posterior pelvic tilt and larger lumbar repositioning errors during sitting were shown to increase the risk for developing low back pain in nursing students [Mitchell et al. 2010]. In addition, delayed trunk muscle latencies during sitting contributed to the development of low back pain in college athletes [Cholewicki et al. 2005]. Both prospective studies suggested proprioceptive impairments as a possible mechanism, however, a more direct evaluation of the proprioceptive system was not performed in these studies. A recent prospective study showed that young adults with a strong ankle-steered proprioceptive postural control strategy are almost four times more likely to develop low back pain in the following years compared to individuals who rely on back muscle proprioceptive input for postural control (multi-segmental control strategy) [Claeys et al. 2013].

Peripheral Mechanisms of Altered Proprioceptive Control

Several mechanisms have been described which adversely influence lumbosacral proprioceptive acuity. For one, pain itself can have a direct negative effect on proprioceptive acuity. However, this cannot solely explain the acuity changes. Patients with recurrent low back pain tested during pain-free episodes still showed altered proprioception [Brumagne et al. 2008b; Janssens et al. 2010]. Moreover, experimentally induced acute, deep back pain in healthy individuals did not change the magnitude of stretch-reflexes from their back muscles [Zedka et al. 1999]. Animal studies have similarly indicated that noxious stimulation does not alter proprioceptive signals from lumbar paraspinal muscle spindles [Kang et al. 2001].

In addition to pain, back muscle fatigue and decreased blood supply might have a negative effect on lumbosacral position sense. People with low back pain have been observed to have decreased back muscle endurance [Biering-Sorensen 1984; Brumagne et al. 1999; Taimela et al. 1999; Johanson et al. 2011] and increased fatigue, which is often associated with ischaemia. The build-up of ischaemic metabolites might negatively affect proprioceptive control [Delliaux and Jammes 2006; Johanson et al. 2011]. There is also evidence that loading and/or fatigue of the respiratory muscles may induce an increased reliance on proprioceptive signals from the ankles rather than the back muscles through an elicited metaboreflex that redistributes blood from the trunk muscles to the diaphragm [Janssens et al. 2010, 2012].

Other studies suggest that proprioception may be impaired by action exerted through the sympathetic nervous system on muscle spindle receptors. The sympathetic nervous system may have both an indirect effect on proprioception by decreasing the blood flow to skeletal muscles [Thomas and Segal 2004] and a direct effect on muscle spindles, generally characterized by a depression of their sensitivity to changes in muscle length [Roatta et al. 2002]. Moreover, sympathetic activation may also affect basal discharge rate of muscle spindles [Hellström et al. 2005]. However, most of these results have yet to be confirmed in the human lumbar spine, since sympathetic modulation of muscle spindle activity is mainly documented in animal studies and related to jaw and neck muscles [Passatore and Roatta 2006].

Central Mechanisms of Altered Proprioceptive Control

Currently, only a limited number of studies have investigated central mechanisms (eg. brain mapping) in relation to proprioceptive impairment in low back pain [Flor 2003; Tsao et al. 2008]. People with chronic low back pain have been observed to have an altered somatotopic organization of the primary somatosensory cortex [Flor 2003]. Representations for the low back were located more inferior and medial, indicating an expansion toward the cortical representation of the leg. According to Flor [2003], these results suggest that chronic pain leads to expansion of the cortical representation zone related to the nociceptive input. An alternative explanation may be that this change in mapping is related to altered proprioceptive weighting, i.e. reweighting of the proprioceptive signals from the ankles at the expense of the lumbosacral afference [Brumagne et al. 2004a, 2008, 2012; della Volpe et al. 2006). The central processing of proprioceptive signals can be determined indirectly using postural sway characteristics and muscle vibration [Brumagne et al. 2004, Cordo & Gurfinkel 2004, Cordo et al. 2005]. The weighting of the proprioceptive input of the vibrated muscles can be quantified by evaluating the displacement of the center of pressure caused by vibration [Brumagne et al. 2004, 2013]. If the central nervous system is using the signals of the vibrated muscles a larger displacement of the center of pressure in a specific direction is expected. Based on the input (vibration) and the motor output, indirect information of the central processing can be obtained. However, brain imaging techniques are needed to provide a more direct way to study the central processing [Guillot et al. 2009].

Tsao et al. [2008] showed that the motor cortical map of the trunk muscles is located more posterior and lateral in patients with recurrent low back pain compared to healthy controls, using transcranial magnetic stimulation. Moreover, the patient group showed greater symmetrical activation during an anticipatory postural control task compared to healthy controls. These results suggest that healthy persons use uncrossed polysynaptic corticospinal pathways that project via regions in the brainstem (Tsao et al. 2008).

Recently, transcranial magnetic stimulation and neuroimaging techniques such as functional magnetic resonance imaging and functional near-infrared spectroscopy have been used to identify where proprioceptive signals are processed in the brain, and they have provided evidence that the left cerebellum might act as a processor of sensory signals [Hagura et al. 2009]. Neuroimaging techniques can also be used in conjunction with muscle vibration as an alternative paradigm for the evaluation of sensory and motor functions [Montant et al. 2009; Goble et al. 2011].

Brain Structure and Proprioceptive Control

Lately, diffusion-weighted MRI has been increasingly used as a powerful and unique new tool for exploring the white matter microstructure and structural connectivity of the human brain [Jones et al. 2013]. Most diffusion-weighted MRI studies are performed in patients with non-musculoskeletal conditions such as traumatic brain injury and parkinsonism, whereby correlations between postural impairments and reductions in fractional anisotropy in specific brain areas are observed [Caeyenberghs et al. 2010; Wang et al. 2012]. To the authors' knowledge, no studies investigated the association between diffusion-weighted MRI characteristics and postural control in relation with proprioceptive impairments in people with low back pain.

In a preliminary study, we performed both a proprioceptive postural control assessment and a diffusion-weighted MRI, to obtain a quantitative assessment of the white matter microstructure of the brain with emphasis on sensorimotor regions and tracts, in people with and without low back pain. The preliminary results revealed a relation between an increased reliance on ankle proprioception during the stable standing condition and an increased fractional anisotropy in the corticospinal tract. Second, less radial diffusivity was related to more reliance on the ankle muscle proprioception during the stable and unstable standing condition. Despite methodological limitations this study provides evidence on the relation between proprioceptive postural control and diffusion-weighted MRI parameters. These results warrant further investigation.

Future Directions

Future studies are required to identify those aspects of proprioception that are most often altered in low back pain and to determine if such changes have any influence on spinal function, pain or disability. It remains unclear if an altered proprioceptive control strategy, recently identified as a risk factor for low back pain [Claeys et al. 2013], can be modified.

Currently, our research group will determine the effects of a specific proprioceptive therapy on postural control using a randomized controlled longitudinal design, integrating both peripheral and central mechanisms. The proprioceptive training is based on sensing, localizing and discriminating trunk proprioceptive signals during functional activities [Brumagne et al. 2013]. The emphasis is on how enhanced integration of sensory input can optimize the patient's capacity to change the stereotypical posture and movement patterns. A preliminary intervention study has already shown that proprioceptive training has positive effects on postural control and disability in patients with recurrent low back pain [Brumagne et al. 2005]. We hypothesize that patients with recurrent low back pain receiving proprioceptive training (vs. cardiovascular training) will improve in proprioceptive postural control, particularly in the more challenging postural conditions, and that these improvements will still be present one year follow-up. Moreover, we expect that proprioceptive training will induce cortical reorganization, characterized by a reduction of brain (over)activation, enhanced variability, increased asymmetry of brain activation, and changes in resting state connectivity. In addition, proprioceptive training may result in long-lasting structural pathway reorganization, e.g. improved connectivity between parieto-(pre)motor areas (superior longitudinal fasciculus), and pathways carrying afferent input (medial lemniscus, post. thalamic radiation) and efferent output (corticospinal tract).

These combinations of state-of-the-art assessments (e.g. postural control evaluation combined with muscle vibration, brain functional MRI and diffusion-weighted MRI) will enable us to investigate whether both structural and functional brain changes are elicited by the proprioceptive training, perhaps forcing a breakthrough in our current understanding of neuroplasticity of the sensory system in patients with low back pain.

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PLASTICITY IN THE MOTOR SYSTEM

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The capability of the central nervous system to reorganise over time is known as plasticity. It is a continuous process occurring throughout life in response to a variety of stimuli. Plasticity is also associated with injury and disease, which impacts upon normal functioning; it also accompanies recovery.

There is increasing evidence that pain has a significant impact upon both the structural and functional organisation of a number of brain areas. It has been shown, for example, that in subjects with chronic low back pain (LBP), grey matter volume is decreased in brain areas associated with pain processing and there is also functional reorganisation of the primary somatosensory cortex; neurochemical changes have also been reported.

There is emerging evidence of changes within the primary motor cortex associated with LBP. Our studies in which the motor cortex is activated using transcranial magnetic stimulation (TMS) have revealed changes in the excitability of the pathways driving both trunk and leg muscles. In these studies, higher thresholds for both excitatory and inhibitory responses were observed, implying lowered excitability of the corticospinal pathways; these changes correlated with self-rated measures of disability and pain. Additionally, using modified versions of well-established techniques, our data suggest reduced neural drive to back muscles in subjects with LBP. These studies are complimented by those of others showing altered trunk muscle representation in LBP subjects who show altered postural responses, in addition to merging of the motor hotspots in LBP subjects usually observed as discrete cortical networks during normal functioning. Further, motor training has been shown to alter this reorganisation of motor cortical circuits, providing scope for targeted therapies. Longitudinal studies monitoring changes in corticomotor and intracortical inhibitory drive in both treated and untreated LBP populations in the long term may thus be useful in identifying the mechanisms of functional recovery and possible therapeutic targets.

This talk will present the results of a number of recent experiments examining the reliability of TMS measures in trunk and leg muscles in the long term in healthy subjects. It will also detail long term alterations in corticospinal excitability and symmetry of cortically evoked responses in subjects with LBP both with and without neurologic deficit, which reflect motor plasticity. Further, results will be presented showing changes in TMS evoked responses following surgery to improve function and relieve pain.

Conflict of Interest

None

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CORTICAL CHANGES IN CHRONIC LOW BACK PAIN: CURRENT STATE OF THE ART AND IMPLICATIONS FOR CLINICAL PRACTICE

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Abstract
There is increasing evidence that chronic pain problems are characterised by alterations in brain structure and function. Chronic back pain is no exception. There is a growing sentiment, with accompanying theory, that these brain changes contribute to chronic back pain, although empirical support is lacking. This paper reviews the structural and functional changes of the brain that have been observed in people with chronic back pain. We cast light on the clinical implications of these changes and the possibilities for new treatments but we also advise caution against concluding their efficacy in the absence of solid evidence to this effect.

Introduction
Chronic musculoskeletal pain is almost by definition a problem for which previous treatment has been unsuccessful. The clinical stories of patients with problems such as chronic low back pain (CLBP), fibromyalgia, and late whiplash associated disorder are usually ones of confusing and conflicting diagnoses and multiple treatment failures. Diagnosis and treatment has traditionally focused on what Robinson and Apkarian (2009) have called 'end organ dysfunction'. That is, clinicians and researchers have looked to structural and functional abnormalities within the musculoskeletal system for a driver of the clinical condition and treatment has sought to normalise peripheral pathology and mechanics (stretch it, splint it, remove it, anaesthetise or denervate it). In general terms the 'end organ dysfunction' approach might be considered to have proven unsuccessful for these conditions (see for e.g. van Tulder et al., 2006a; van Tulder et al., 2006b). Neuroimaging studies have revealed numerous structural and functional changes within the brains of people with chronic musculoskeletal pain and there is growing opinion that these changes may contribute to the development and maintenance of the chronic pain state (Apkarian et al., 2009; Tracey & Bushnell 2009). In this model of chronic pain the brain is seen as an explicit target for treatment and several treatment strategies have been developed and modified to fit this aim. Although there are data available on a range of chronic painful disorders, we will focus here on the cortical changes observed in patients with CLBP and the possible clinical implications for this population.

Brain Changes in People with Chronic Low Back Pain
Advances in neuroimaging technology have led to rapid increases in our understanding of the human brain in health and disease. Methodologies such as functional magnetic resonance imaging, voxel-based morphometry, magnetic resonance spectroscopy, magnetoencephalography and electroencephalography (EEG) give us insight into multiple dimensions of the brain state. Changes can be broadly categorised as neurochemical, structural or functional.

Neurochemical changes

Several studies have compared the neurochemical profile of healthy controls with those of CLBP patients.

Significant changes (some markers increase, others decrease) in the neurochemical profile in the dorsolateral prefrontal cortex (DLPFC), thalamus and orbitofrontal cortex have been observed in people with CLBP and, by and large, the magnitude of the shift from normative data increases as the duration and intensity of pain increase (Grachev et al., 2000). Further, co-morbid anxiety (Grachev et al., 2001; Grachev et al., 2002) and depression (Grachev et al., 2003) seem to exaggerate the effects. Magnetic spectroscopy data suggest that the magnitude of shifts in neurochemical profile in anterior cingulate cortex, thalamus and prefrontal cortex can differentiate between those with CLBP and healthy controls (Siddall et al., 2006). Similar changes have been reported from studies involving people with neurodegenerative conditions such as Alzheimer's disease and multiple sclerosis, which has led to the proposal of a relationship between chronic pain and neuronal loss and degeneration (Grachev et al., 2000). Notably, although there is clear evidence that brain neurochemistry is awry in people with CLBP, there is no evidence to suggest that neurochemical changes cause CLBP. In fact, there is reasonable argument that CLBP may cause neurochemical changes – certainly the neuroanatomical distribution of the changes is consistent with the established 'pain matrix' and exaggerated and ongoing neural activity can lead to shifts in neurochemistry consistent with those observed. However, the possibility that these changes are at once a result and cause of ongoing pain remains. Clearly, longitudinal data are required.

Structural changes

Brain structure can be compared between people with CLBP and controls via voxel-based morphometry. In short, voxel-based morphometry is a statistical method of comparing the volume of gray and white matter in specific brain areas, that controls to a large extent for the variable shape of human brains by normalising data to anatomical landmarks (Schmidt-Wilcke 2008). Voxel-based morphometry is not without problems – its assumptions are yet to be fully tested – but it has provided fairly compelling evidence of reduced gray matter in the dorsolateral prefrontal cortex (Apkarian et al., 2004b; Schmidt-Wilcke et al., 2006), the right anterior thalamus (Apkarian et al., 2004b), the brainstem, the somatosensory cortex (Schmidt-Wilcke et al., 2006) and the posterior parietal cortex (Buckalew et al., 2008) of people with CLBP. Apkarian et al (2004b) found that a combination of sensory and affective dimensions of pain strongly predicted DLPFC gray matter changes and Schmidt-Wilcke et al. (2006) demonstrated strong correlations between the extent of density changes and pain intensity and unpleasantness. It is worthwhile contemplating what these extraordinary findings actually mean – there seem to be fewer brain cells in these areas, or at least less neuron-matter, in people with CLBP than there is in healthy controls. Because it relates to the matter by which we exist, these discoveries appear remarkable, but are they as catastrophic as they seem? Probably not – gray matter increases with training in the injured brain (Gauthier et al., 2008) and it seems reasonable to suggest that at least the same response might occur in the uninjured brain.

Functional changes

Cortical representation.

In order to understand the notion of 'cortical reorganisation', it is helpful to first understand the notion of cortical representations. A representation can be thought of as a network of neurons that represent something else, for example a word, thought, joint, immune response, or article of knowledge. The physical body is represented in the human brain by neurons in many areas, most famously the primary somatosensory cortex (S1). S1 representation refers to the pattern of activity that is evoked when a particular body part is stimulated and which, when itself stimulated, gives the perception of that particular body part being touched. S1 representation of the back is different in people with CLBP from people without CLBP: Flor et al. (1997a) showed that the representation of the lower back in the primary somatosensory cortex (S1) is shifted medially and expanded, invading the area where the leg is normally represented and that the extent of expansion is closely associated with pain chronicity. Lloyd et al. (2008) demonstrated similar findings in

CLBP patients who were distressed but not in those who were not, which raises the possibility that S1 shifts may not be a feature of CLBP so much as the emotional impact of CLBP.

Cortical activity and responsiveness.

A number of investigations suggest that CLBP is characterised by altered cortical responses to noxious stimulation, although, again, disagreement abounds (Derbyshire et al., 2002; Baliki et al., 2006). Enhanced cortical responses have been noted with noxious subcutaneous stimulation of the back (Flor et al., 1997a) and acute experimental muscle pain (Diers et al., 2007) as well as activation of a more expansive network of pain related brain regions with peripheral noxious input (Giesecke et al., 2004; Giesecke et al., 2006; Kobayashi et al., 2009). In addition, it appears that CLBP patients have significantly lower increases in blood flow in the periaqueductal gray (an important part of the descending antinociception system) than controls when exposed to equally painful stimuli (Giesecke et al., 2006).

Alterations in brain activity do not appear to be isolated to pain processing. Flor et al. (1997a) also noted an enhanced cortical response to non-painful stimulation of the back, and distressed CLBP patients failed to show an increase in DLFPC and anterior cingulate cortex activity in response to non-painful vibratory stimulus in comparison to non-distressed patients (Lloyd et al., 2008), a finding suggestive of a disruption of normal top-down sensory modulation in the distressed group. CLBP patients show a selectively enhanced EEG signal to pain-related words, while no difference is seen for body-related or neutral words which the authors suggest indicates altered implicit pain memories (Flor et al., 1997b). Differences in the ‘resting’ brain have also been reported – medial prefrontal cortex seems to remain active during task performance in people with CLBP whereas it ‘deactivates’ in healthy controls (Baliki et al. 2008). Although preliminary, such a finding raises the possibility that brain activity is different in people with CLBP from those without, even when the brain is not involved in processing noxious input.

Shifts in primary motor cortex representation have also been reported in people with CLBP. Unlike S1 which is organised spatially, M1 is organised according to function (Wolpert et al., 2001). Tsao et al. (2008) found that the motor cortical representation of contraction of the transversus abdominus muscle was shifted and enlarged in patients with recurrent LBP and that both the location and size of the map volume were associated with slower onset of transversus abdominus as part of the postural adjustment associated with rapid arm movement. People with CLBP also exhibit an expanded area of cortical activity in preparation for arm movement and a decrease in specific cortical responses in relation to observed delayed onset of deep abdominal muscles (Jacobs et al., 2010). Furthermore, raised motor thresholds have been reported for the lumbar back muscles of CLBP patients (Strutton et al., 2005), which suggests decreased corticospinal drive to these muscles and motor thresholds for transverses abdominis are lower in recurrent back pain patients than they are in healthy controls (Tsao et al., 2008). Clearly, the picture is expanding, but it is not immediately obvious, how these findings should best be interpreted - whether or not delayed activation of Transversus Abdominis during rapid limb movements contributes to CLBP has not been settled, although a link in the opposite direction seems probable (Moseley & Hodges 2005; Moseley & Hodges 2006; Moseley et al., 2004).

Clinical Implications of Brain Changes

The clinical implications of an altered brain state on the chronic pain experience are far from being fully understood (Apkarian et al., 2009). However, it is already possible to make three observations that are of particular importance to therapists managing patients with CLBP.

<u>Enhanced/increased response to noxious stimuli.</u>

The neurochemical and functional changes that have been observed in people with CLBP should sensitise the neural networks that subserve nociception and pain. That is, brain areas that demonstrate neurodegeneration are known to be involved in antinociception, as are those that demonstrate reduced activation during noxious stimuli and spontaneous pain is associated with abnormalities of cortical connectivity that may cause pronociceptive activation in a kind of self-sustaining mechanisms (see May 2008).

Placebo research suggests that the DLPFC has a key role in expectancy-induced analgesia. In a study of placebo analgesia Wager et al. (2004) found that during the anticipation of pain, DLPFC activity was enhanced in subjects who subsequently reported reduced pain ratings and vice versa. The level of endogenous opioid activity in the DLPFC has been shown to be associated with the size of the analgesic effect that subjects anticipated prior to the administration of a placebo (Zubieta et al., 2005) and using low frequency transcranial magnetic stimulation to temporarily disrupt DLPFC activation, Krummenacher et al. (2009) found that DLPFC inhibition did not affect experimental pain tolerance or thresholds, yet it completely blocked placebo analgesia. These data raise the possibility that decreased efficacy of the DLPFC, which is characteristic of CLBP, might increase pain. Indeed, there are behavioural data that seem consistent with this idea. CLBP patients exhibit lower mechanical pain thresholds than healthy controls over the lumbar spine (Giesbrecht & Battie 2005; Kobayashi et al., 2009), thumb nail (Giesecke et al., 2004) and a combination of sites remote to the lumbar spine (Giesbrecht & Battie 2005); hot noxious stimulation of the hand hurts people with CLBP more than it hurts healthy controls (Kleinbohl et al., 1999); CLBP patients report more intense, more widespread and longer duration of pain after hypertonic saline injection a shoulder muscle (O'Neill et al., 2007). Such changes in sensitivity away from the back implicate cortical rather than peripheral or spinal mechanisms. Hyperalgesia at remote sites has been shown to be positively correlated with self reported pain intensity, physical function and pain duration (Clauw et al., 1999; Jensen et al., 2009) but negatively correlated with degenerative lumbar disc disease or radiculopathy. As such, diffuse tenderness is considered to reflect disturbed nociceptive regulation rather than spinal pathology (Jensen et al., 2009). Curiously, changes in sensitivity in CLBP may not be limited to painful stimuli. Small and Apkarian (2006) noted that CLBP patients rated sour taste stimuli as significantly more intense than normal controls and there is some suggestion that depressed CLBP patients have decreased habituation to repetitive auditory stimulus (Fann et al., 2005), which suggests a widespread dysfunction of normal cortical inhibitory mechanisms.

It is likely that part of the pain experience of CLBP patients is mediated by sensitivity changes within the central nervous system and the demonstrated brain changes are a probable contribution to this. This is important, particularly when one considers that a number of manual therapies are thought to mediate their analgesic effects via descending antinociception (Vicenzino & Wright 2002) – perhaps the failure of manual therapies to significantly influence CLBP (van Tulder et al., 2006a) is due, at least in part, to the breakdown of these antinociceptive systems in people with CLBP.

Psychological and cognitive effects

One might predict that brain dysfunction will have deleterious effects beyond the processing of noxious stimuli. Indeed, there is evidence to this effect: Apakrian et al. (2004a) found CLBP patients to be impaired on a task designed to assess emotional decision making. Performance was negatively related to pain intensity.

Others have noted significant impairments in memory, language skills and mental flexibility (Lourenco Jorge et al., 2009; Weiner et al., 2006) and reduced ability to shift attention away from pictures of physical activities associated with the threat of back injury (Roelofs et al., 2005). Furthermore, whereas distraction increases pain tolerance and threshold in healthy controls, it does little in those with CLBP (Johnson & Petrie 1997).

Whilst the psychological manifestations of CLBP are undoubtedly multifaceted and likely to be influenced by a variety of inputs, brain changes may need to be considered as an additional contributor to psychological dysfunction. Furthermore resultant deficits in cognitive function, changes in decision making and appraisal and possible modification in the relationship between expectation and pain experience may serve as added hurdles to the success of psychologically based treatments.

Altered body perception

One might also predict that disruption of cortical representations of the body will disrupt body perception. Certainly, CLBP patients exhibit deficits in proprioception (Brumagne et al., 2000; Gill & Callaghan 1998; O'Sullivan et al., 2003; Taimela et al., 1999), perform poorly on a task that required subjects to make judgements on the direction of trunk rotation adopted by a model (Bray & Moseley 2009), have poorer tactile acuity (Luomajoki & Moseley 2009; Moseley 2008; Wand et al., 2010), are worse at identifying letters that are traced on their back (Wand et al., 2010) and find it difficult to delineate the outline of their back when asked to complete a drawing of 'how it feels' (Moseley 2008). In some cases patients report that they no longer consider their back as being a part of them and do not feel that the back can be controlled automatically (Osborn & Smith 2006). It is also possible that the varied alterations in trunk muscle recruitment patterns evident in CLBP patients (Hodges & Moseley 2003) may be a manifestation of a disturbance in body perception. While it is beyond the scope of this article to review the extensive literature in this area, it is not unreasonable to consider that movement abnormalities observed in people with CLBP may be a manifestation of a disruption of the working body schema, a proposition supported by the close association between lumbar tactile acuity and performance on motor control tests (Luomajoki & Moseley 2009).

The role of distorted body perception in long standing pain problems has received some attention recently (Lotze & Moseley 2007; McCabe & Blake 2008; Swart et al., 2009). In fact, some have proposed that chronic pain is a result of incongruence between predicted and actual proprioceptive feedback, by virtue of disrupted body maps (Harris 1999; McCabe et al., 2005; McCabe et al., 2007). This is a contentious issue that remains to be supported or refuted (see McCabe et al., 2006; Moseley & Gandevia 2005).

Given our incomplete understanding of cortical function and its inherent complexity it is possible to make a number of predictions to describe how the observed brain changes might cause or perpetuate the CLBP experience that all possess a degree of plausibility. Any such predictions are currently speculative. Most studies of brain function are small and cross sectional and some of the variability between findings and the relationships within the data will be the result of factors such as divergent methodology and simple lack of statistical power. However, what can be concluded with some confidence is that CLBP is characterised by alterations in cortical structure and function and that these alterations demonstrate relationships with the clinical manifestations of the condition. Also the observations we have made here are supported by our current understanding of brain function and each observation has supportive experimental evidence. One could argue then, that the manifestations of cortical changes at least make rehabilitation more difficult, and indeed may prove to contribute to the problem, as well as the failure of common treatment approaches. As such, it seems reasonable to suggest that the brain may be a legitimate target for new therapies.

Training the Brain of People with Chronic Low Back Pain

Treatment approaches that explicitly target brain function have already been tested in other chronic pain problems, such as complex regional pain syndrome (CRPS) and phantom limb pain (PLP), which are also characterised by significant cortical dysfunction. There is growing evidence that graded motor imagery is an effective treatment for CRPS (Moseley 2004; Moseley 2005; Moseley 2006) and PLP (Moseley 2006) and some indication that mirror visual feedback reduces pain in acute CRPS (McCabe et al., 2003) and in PLP patients (Chan et al., 2007; Mercier & Sirigu 2009). Sensory discrimination training programmes have also been shown to improve outcome in patients with PLP (Flor et al., 2001) and CRPS (Moseley et al., 2008; Moseley & Wiech 2009).

Clinicians need to be cautious in generalising these data to the CLBP population. The nature of cortical dysfunction in PLP and CRPS has been more thoroughly investigated and the relationship to clinical status is better understood. Moreover, the management approaches outlined above have focused on patients with unilateral limb pain. The back and limb are obviously functionally distinct, are represented differently in the brain and it is likely that the psychological and social implications of a limb injury are different to those of a low back injury. Significant research still needs to be done before firm recommendations can be made about this type of management approach for patients with CLBP.

We have begun this process by investigating clinical correlates of cortical disruption in the CLBP population (Bray & Moseley 2009; Luomajoki & Moseley 2009; Moseley 2008; Wand et al., 2010) and we are continuing to explore this area. Our group has also started to examine some treatment options. Preliminary data suggest that tactile discrimination training may be helpful, at least for those with reduced tactile acuity. As with CRPS and PLP there are representational changes in S1 and similar deficits in tactile acuity and we are currently investigating the usefulness of a graded tactile discrimination approach for patients with CLBP.

Likewise one possible explanation for the success of graded motor imagery relates to gradual activation of movement related networks without eliciting pain (Moseley 2005). As CLBP is associated with enhanced efficiency of nociceptive networks, it is reasonable to suggest that graded motor imagery may also be helpful in this population, and we have anecdotal data to support this idea. In addition, the data showing disrupted responses to pain-related cues, sensitivity changes to a variety of stimuli and cortical deactivation failure, raises the possibility that widespread disinhibition is a fundamental issue in the problem of CLBP. This suggests that treatment paradigms that elicit intracortical inhibition, such as tone-pitch recognition, may affect the CLBP experience and we have also begun to explore this approach. Crucially, these are embryonic treatments and they are yet to stand the test of experimental interrogation, yet they are evidence of a new line of enquiry and approach to treatment that is being directed toward the brain, not the back, of people with back pain.

Conclusion

High quality evidence suggests that most existing approaches to the management of CLBP have only limited success. CLBP is characterised by a range of structural, functional and neurochemical changes within the brain. In other chronic painful disorders, for example PLP and CRPS, the nature and impact of brain changes are well studied, and treatments that aim to normalise some of these changes have been tested and proven effective at reducing pain and disability. However, for CLBP, this process is in its infancy - we know less about the brain changes themselves and treatments have not been fully developed, nor tested. We are continuing to learn more about the cortical changes apparent in CLBP and the clinical implications of these changes. Our group has begun to focus on developing simple clinical tools for identifying potential cortical disruption in the CLBP population as well as testing cortically orientated treatment approaches for this pernicious problem. We humbly suggest that for those of us interested in better understanding and treating people with CLBP, the challenge is to be both open minded and patient.

Keywords

Low back pain; cortical reorganisation; physical therapy

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PRIMING THE BRAIN WITH NEUROMODULATORY TECHNIQUES

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Therapists have the potential to 'hack' into the human brain using techniques that strengthen or weaken important synaptic connections (i.e. neuroplasticity). Promoting neuroplasticity may enhance clinical outcomes in a range of musculoskeletal and neurological conditions. An exciting and innovative approach is the use of neuromodulatory therapies, such as non-invasive brain stimulation and peripheral electrical stimulation, to 'prime' the human brain. Priming is thought to increase the brain's receptiveness to traditional therapies by elevating neural excitability immediately prior to training. Our research has provided early evidence that this approach improves pain and function in clinical conditions beyond that which can be achieved by traditional therapy alone. This presentation will provide examples of novel neuromodulatory therapies being trialed in lumbopelvic pain and discuss current controversies and future directions in this exciting field.

PLASTICITY IN THE MOTOR SYSTEM AND DRIVING CHANGE WITH MOTOR INTERVENTIONS

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Introduction

A revolution is happening in behavioural and motor control interventions for low back and pelvic pain. Although the mechanisms that underpin the potential for the nervous system to change in pain are only beginning to be understood, this presents a host of new opportunities to understand behaviors in people with pain and new avenues for potentially more effective treatments. Rewiring of the brain and nervous system (neuroplasticity) can underpin both negative and positive changes in motor and sensory aspects of lumbopelvic control in association with the pain experience. Understanding the mechanisms that drive plasticity (both good and bad) opens the possibility for innovative new treatments to change in nervous system and to prepare or "prime" the nervous system for such change. The aim of this paper is to consider the current state of knowledge of motor plasticity as it applies to low back and pelvic pain and the potential this exposes to utilize treatments that target plasticity.

Plasticity of the Motor System in Lumbopelvic Pain

Motor control, which refers to the sum of all process involved in control of motor function from sensory input to information processing and output to the muscle system, is particularly relevant for individuals with low back and pelvic pain who maintain a nociceptive component to their primary pain condition (e.g. maintenance of abnormal load on a tissue(s) as a result of suboptimal features of movement [1]) or any additional problem that are secondary to the modified movement strategy (e.g. knee injury secondary to modified motor control at the trunk [2]). For individuals with low back and pelvic pain for whom motor control is relevant, plastic mechanisms serve an important potential target for treatment. That is treatments that aim to optimize motor behaviours with the intention to optimize load on tissues.

People move differently in pain. This includes a spectrum of presentations from frank avoidance of movement secondary to cognitive/emotional mechanisms [3], to subtle changes in the distribution of activity within and between muscles [4]. Investigation of plastic change in the motor system has been focused on identification of mechanisms to explain changes at the more subtle end of the spectrum, with particular emphasis on the search for mechanisms to explain the redistribution of muscle activation between and within muscles. As a major component of the motor behaviours of the trunk are essentially postural in nature, attention has focused on identification of mechanisms that underpin modified postural behaviours in low back and pelvic pain. This has implications for sites in the nervous system that are probed for plastic change.

Tools available to study neuroplasticity in pain (although not yet extensively used in low back an pelvic pain) include neuroimaging and electrophysiological techniques. Neuroimaging studies primarily use functional magnetic resonance imaging (fMRI) to study blood oxygen level dependent (BOLD) changes and relate to areas of the nervous system that are activated during specific motor tasks [5], or from a sensory perspective, in response to a specific afferent (including nociceptive stimuli) [6]. Electrophysiological work includes investigation of the response of muscles to electrical or magnetic stimuli (transcranial magnetic stimulation: TMS) over different regions of the nervous system including the primary motor and premotor regions of the brain cortex [7], brain stem and spinal cord, or the recording of brain activity (electroencephalography: EEG) associated with a motor task (e.g. corticomuscular coherence between EEG and activation of a muscle [8]; or preparatory processes before predictable challenges to balance [9]) or in response to afferent input (e.g. somatosensory evoked potentials [SEP] [10, 11]).

Research using TMS has focused on changes in the excitability of the motor cortex, specifically, excitability and organization of the primary motor cortex [12, 13]. TMS indirectly activates the cells of the motor cortex as a result of currents induced by the magnetic field generated by application of a brief high intensity current passed through a coil placed over the skull [14]. Unlike electric current, the magnetic field passes easily and painlessly through the skull. The main sensation associated with the stimulation is that of contraction of muscles of the scalp. Two key issues require consideration. First, responses to TMS are not only dependent on the excitability of the cortical cells, but also the excitability of the motoneurons in the spinal cord [14]. Thus, it is not possible to determine whether changes in excitability relate to the cortical cell unless methods are used to measure or control the excitability of spinal motoneurons. This is less important for measures of cortical organization (e.g. area of the cortex over which a response in a muscle can be generated) as the motoneuron excitability can be maintained constant and the size of the muscle response is determined by the size of the descending volley of cortical output that is specific to location of the stimulation. In this way the cortical representation can be estimated. Second, it could be questioned whether investigation of cortical networks is relevant for investigation of postural mechanisms that involve a range of subcortical brain structure. However, it is critical to recognize that although postural responses are not controlled voluntarily, and occur largely without conscious awareness, cortical inputs provide an essential contribution. For instance, stimulation of cells of the motor cortex in animals initiates both a limb movement and the associated postural adjustment [15].

Although the homunculus of the primary motor cortex is commonly considered to represent clearly defined organization that is tightly organized with respect to body part, in reality organization is complex with overlap between body regions and multiple interspersed regions that underpin coordination between body segments [16]. Despite this complexity it is possible to identify regions of cortex with output to specific anatomical regions and specific muscles. A key feature is that the motor cortex networks code for control of both muscles and movements [17], and as such it is relevant to study organization associated with a specific muscle. In low back and pelvic pain, excitability of the corticomotor pathway has reveled increased threshold to evoke a response in paraspinal muscles [13], and greater symmetry in threshold to evoke a response in the deep abdominal muscle, transvesus abominis (TrA) [12]. In response to experimental low back pain, amplitude of the motor evoked potential (MEP) can be modified differentially between muscles; MEPs are larger for obliquus externus abdominis (OE) and but smaller for TrA [18]. This is consistent with the presumed change in coordination between these muscles often observed in clinical populations. As indicated above, that study cannot determine whether the changes involve plastic change at the cortex, or changes in excitability at the spinal cord. One study of pigs showed opposite changes in MEP amplitude of the multifidus muscle after an experimental injury for different sites of electrical stimuli [19]. The response to stimulation between the mastoid processes (which is not influenced by changes in cortical excitability) was reduced, whereas the response to stimulation over the cortex was increased [19]. This implies differential and opposing effects at the spinal cord and cortex. One interpretation is that cortical excitability may be increased in an attempt to counteract a spinal mechanism such as reflex inhibition. Whether these changes constitute a plastic change in the neural networks or a simple transient change in excitability (of either supraspinal or spinal neurons/networks) remains unclear.

More direct evidence of plastic change comes from studies of organization of the motor cortex. These studies show posterolateral shift of the cortical representation of TrA [12], and a change from two to one cortical representation of the paraspinal muscles [20]. Although earlier studies had interpreted the two cortical representations of the paraspinal muscles as separate motor and premotor representations [21], more recent work provide evidence that the separate areas are involved in activation of discrete muscles, with separate areas for deep short muscles (multifidus) and longer, more superifical muscles such as longissimus [20].

Are changes in cortical organization related to functional change? Although causality cannot be inferred, the amplitude of difference in location of the cortical representation of TrA was correlated with the delay in activation of this muscle in an arm movement task [12]. In terms of the change in paraspinal muscle activation it is tempting to speculate that the shift in cortical representation from multiple sites to a single site may relate to the propensity for many with low back pain to not express the differential activation of the deep and superficial muscles [22] that is observed in healthy controls during arm movements [23], externally applied perturbations [24], and with changes in posture [25].

Although not the focus here, it is important to note that SEPs from electrical stimulation of the paraspinal muscles and intra-cutaneous stimulation is increased in people with pain [10], implying changes in somatosensory cortex. Furthermore, the sensory representation of the back (measures with fMRI) is shifted in chronic LBP in a manner that is related to the duration of symptoms [6], and there is evidence of grey matter loss in low back pain in the dorsolateral prefrontal cortex and thalamus [26] which has implications for sensory function.

One limitation of this work is the fact that all existing studies are cross-sectional. As such is it not possible to determine whether the changes in cortical representation represent a “re”organization or whether the organization is simply different in these individuals. Furthermore, it is not possible to determine whether such changes are related to the low back and pelvic pain longitudinally. Current work aims to address this issue.

The plastic adaptation in the nervous system may initially be positive, such as adaptation that aims to protection the body part from further pain and/or injury or the threat of such [27]. Alternatively, the adaptation may be negative initially (e.g. maladaptive adaptation), or despite the initial benefit for the tissue as a result of a protective adaptation, the change in motor function may be problematic in the long term (e.g. increased load on the tissue secondary to augmented muscle activation/co-contraction [28], decreased damping of forces from movement [29], decreased variation [30]) [27]. Thus, there a re numerous reasons to speculate that modification of neural organization is a potential target for treatment.

Opportunities to Target Neuroplastic Mechanisms in Low Back and Pelvic Pain

Evidence of plastic change in motor (and sensory) nervous system, and the potential relationship to function and muscle activation strategies that may be provocative of pain (e.g. augmented recruitment of large, more superficial muscles such as OE; and compromised activation of some of the more deeply situated muscles TrA and MF) provides a potential target for treatment. Plastic change in neural circuits involves a number of processes with variable timescales and these processes may be similar for both an initial adaptation in association with the episode of pain (which as mentioned above may be suboptimal in the short- or long-term), and for the reorganization that is the objective of rehabilitation interventions. One such process involves alteration of synaptic efficacy, such as un-masking of existing connections by modification of inhibitory processes. This process can occur on the timescale of seconds to minutes [31]. These processes can be modified by “top-down” (e.g. motor training [32] and cortical stimulation paradigms [33]) and “bottom-up” processes (e.g. peripheral electrical stimulation [34]). The challenge is to find the optimal methods to drive this change in clinical practice.

There is some evidence that neuroplasticity can be driven by clinical interventions in low back and pelvic pain. One study has shown the potential to shift the motor cortical representation of TrA with a specific motor control training intervention, but not a generic walking program, and this change was related to the change in timing of activation in an arm movement task [32]. Whether the converged motor cortical representation of the paraspinal muscles can be changed with training is a topic of current studies. There is also evidence of reorganisation of cortical networks in other conditions that involve convergence of cortical representations such as focal hand dystonia, albeit convergence of sensory cortex representations [35], by motor rehabilitation [36].

The presence of plastic change in the motor cortex also opens the opportunity to use neuromodulatory interventions such as non-invasive brain stimulation to either change the cortical organization/excitability, or prime the brain to be receptive to motor interventions [33]. This again, is the topic of current work.

Conclusion

Although many questions remain to be answered, there is emerging evidence of plastic change in the motor and sensory regions of the cortex and there is initial evidence that these may be related to motor behavior.

How these changes relate to clinical symptoms, whether the changes can be modified by treatment, and whether such change is associated with robust clinical improvements (and for whom), are all topics of further investigation. Unraveling the role of these changes in low back and pelvic pain and its relationship to clinical improvement presents exciting opportunities that are only beginning to be realized.

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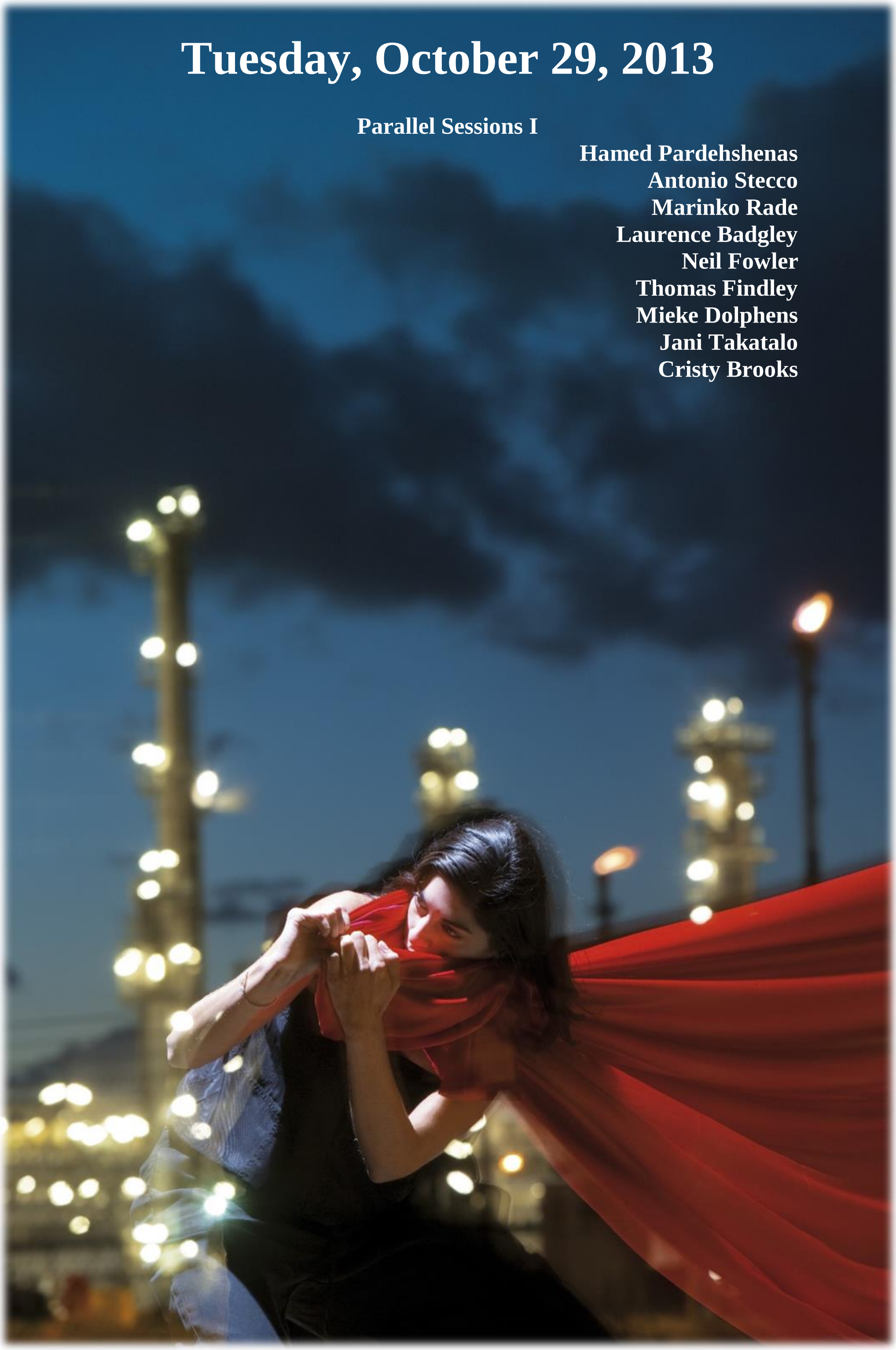

Tuesday, October 29, 2013

Parallel Sessions I

Hamed Pardehshenas
Antonio Stecco
Marinko Rade
Laurence Badgley
Neil Fowler
Thomas Findley
Mieke Dolphens
Jani Takatalo
Cristy Brooks

LUMBOPELVIC MUSCLES ACTIVATION PATTERN IN DIFFERENT LOADING CONDITIONS

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Introduction

According to conventional arch model, sacrum behaves as a keystone of a Roman arch wedged between the iliac bones (Fig. 1). Two imposts are necessary for the stability of an arch and in the absence of one (standing single leg support) the question would be that how stability of sacroiliac joints will be achieved? It is hypothesized that when one stands resting on one leg, upper body weight will be transferred through the supporting sacroiliac joint, but this is in conflict with the concept of an arch. Existence of such conflicts between the arch theory and functional demands of lumbopelvic region for load transfer through the sacroiliac joints shows the necessity of more investigations.

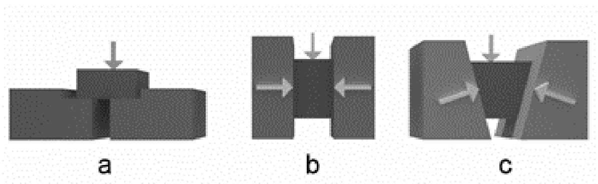

Fig. 1 (a) Form closure: the object remains in place, independent of the exerted load. (b) Force closure: the object can only remain in place when continuous additional transversely oriented forces are applied to resist movement by friction. (c) Combination of form and force closures. Adapted from Snijders et al (1998) J Electromyogr Kinesiol 8:205–214.

Purpose

To evaluate lumbopelvic muscles activation pattern in different loading conditions in order to better understanding of lumbopelvic stability.

Materials and Methods

Thirty healthy male subjects experienced four levels of trunk loading, 0%, 5%, 10% and 15% of body weight, at three conditions, in one-hand holding a bucket at side 1) double support - dominant side loading 2) single support - ipsi lateral side loading 3) single support – contra lateral side loading. During the tasks, EMG signals of four pairs of lumbopelvic muscles; biceps femoris (BF), erector spinae (ES), latissimus dorsi (LD) and internal oblique (IO), were collected. ANOVA with repeated design was performed on normalized EMG's to test the main effect of load and condition, and interaction effect of load by condition.

Findings

Lumbopelvic muscles activation pattern was significantly affected by loading magnitude and supporting condition ($P < 0.05$). In our investigation, changing position from double leg (first condition) to single leg (second condition) support standing did not cause any change in the pattern of all trunk muscles regarding graded loading (see fig. 2). It is hypothesized that when one stands supporting on single leg, shearing load and consequently contraction level of transversely oriented muscles will be diminished on contralateral SI joint and augmented on ipsilateral SI joint. Although we used absolute single leg support position, we observed no unilateral pattern of internal oblique during all trials. By changing the direction of load in the third condition, IO bilaterally co-activated which appears to be a strategy to increase lumbopelvic stability with increasing task demand. Latissimus dorsi and erector spinae showed an antagonistic pattern toward the direction of loading which may suggest these muscles as potential lateral trunk stabilizers.

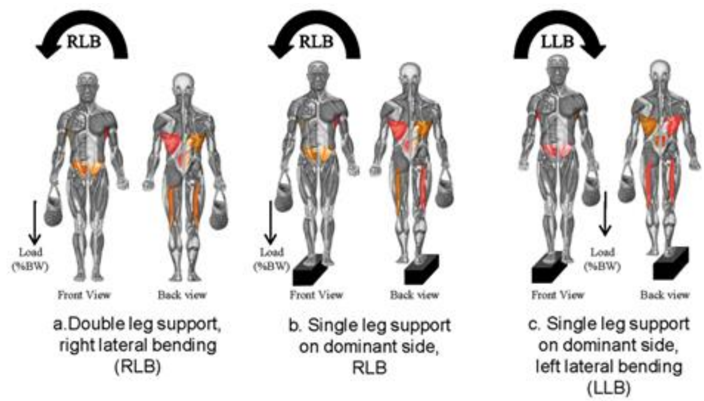

Fig. 2 Panels (a-c) show global lumbopelvic muscle activation pattern during three different loading conditions. Red color shows electrically responding muscles to graded loading in each condition. Panel a and b show external moment in the direction of right lateral bending (RLB) and panel c shows the imposed moment in the direction of left lateral bending (LLB). It indicates antagonistic pattern of latissimus dorsi and erector spinae muscle regarding the direction of applied load. Panel c also shows the co-contraction pattern of internal oblique

Conclusions

Although further investigation is needed, it appears that arch theory may have some merits when one stands double leg support but it is not biomechanically feasible as a model for pelvic stability when one stands supporting on single leg. Bilateral pattern of IO suggest that both sacroiliac joints may have a same role in load transfer through the lumbopelvic region. Our findings are more consistent with suspensory system (wire-spoke wheel model) for pelvic mechanics. If we consider this model, pelvic integrity is more critical for lumbopelvic stability and then efforts to unlock restrictions, muscular correction of positional faults and lumbopelvic or even respiratory exercises following SI joint dysfunctions may help in rehabilitation by establishing optimal pretension state throughout the pelvic ring. Furthermore, co-activation pattern of IO may enhance lumbopelvic stability and reduce the necessity of sophisticated muscle responses which may cause unwanted muscle torques.

As we observed, pattern of response greatly depended on the level of load for each muscle. It means that during graded loading all trunk muscles responded to loading levels differently. In other words, threshold effect of load was different for each muscle. So, in order to better understanding of trunk behavior, characteristics of load (magnitude and direction) must be taken into consideration when planning to design and implement spine rehabilitation programs or researches.

Keywords

Arch theory, Graded loading, Lumbopelvic stability

THE ANATOMICAL AND FUNCTIONAL RELATION BETWEEN GLUTEUS MAXIMUS AND FASCIA LATA

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There is not full agreement regarding the distal insertions of the gluteus maximus muscle (GM), particularly the insertions into the iliotibial band and lateral intermuscular septum. 6 cadavers, 4 males and 2 females, mean age 69 yo, were dissected to evaluate the insertions of the GM into the iliotibial band, fascia lata, lateral intermuscular septum and femur. The iliotibial band is a reinforcement of the fascia lata and cannot be separated from it. Its inner side is in continuity with the lateral intermuscular septum which divides the quadriceps from the hamstring. In all subjects the gluteus maximus presented a major insertion into the fascia lata, so large that the iliotibial tract could be considered a tendon of insertion of the gluteus maximus.
The fascial insertion of the gluteus maximus muscle could explain the transmission of the forces from the thoracolumbar fascia to the knee.

Keywords
Gluteus maximus, myofascial insertion, fascia lata, iliotibial band

IN VIVO MRI MEASUREMENT OF SPINAL CORD DISPLACEMENT IN THE THORACOLUMBAR REGION IN RESPONSE TO UNILATERAL AND BILATERAL STRAIGHT LEG RAISE TESTS

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Introduction

It is generally accepted that the straight leg raise (SLR) test produces some distal movement mainly of L5 and S1 nerve roots, but the magnitude of this displacement is still a matter of debate among researchers.

Aim

To investigate non-invasively in-vivo spinal cord displacement in the vertebral canal during the performance of the passive unilateral and bilateral SLR in asymptomatic subjects, following the basic assumption that the cord follows the L5 and S1 nerve roots displacement by similar magnitude and direction (principle of linear dependence).

Materials and Methods

Sixteen asymptomatic volunteers were scanned with 1.5T magnetic resonance (MR) scanner (Siemens Avanto, Erlangen, Germany) using T2 weighted turbo spin echo fat saturation sequence (TR 3880ms, TE 90ms, 10 slices, slice thickness 3mm, gap 0.3mm, FOV 400mm2, pixel size 1.3mm*0.9mm). Coronal slices were aligned with spinal cord.

The displacement of the medullar cone relative to the vertebral endplate of the adjacent vertebra during the unilateral passive right, left and bilateral SLR was quantified and compared with the position of the conus in the neutral (anatomic) position. Each movement was performed twice for evaluation of reproducibility. The measurements were repeated by two observers. Four practitioners performed the manoeuvres in a random sequence in order to avoid possible series effects. All the metric values were rounded to the next lowest decimal integer (2.55=2.5) to provide more conservative and reliable data.

Results

Compared to the neutral (anatomic) position, the medullar cone displaced caudally in the spinal canal by 2.33±1.2mm (μ±SD) with unilateral ($p \leq 0.001$) and 4.58±1.48mm with bilateral SLR ($p \leq 0.001$).

Spearman correlations proved higher than 0.99 for both intra and inter-observer reliability, as well as results reproducibility for each tested manoeuvre.

Relevance

To the authors' knowledge these are the first data on non-invasive, in vivo, normative measurement of spinal cord displacement with the SLR test. As this study was performed non-invasively, in vivo and in asymptomatic subjects, it provides conclusive and unperturbed evidence that the spinal cord displaces distally with the lumbar nerve roots during both the clinically applied unilateral and bilateral SLR.

Conclusions

The data show that the spinal cord in the thoracolumbar region slides distally in response to the clinically applied SLR test. The high correlation values in this study show that these movements are consistent and reproducible.

Discussion

Due to the neural continuum, the authors speculate that this movement might be directly proportional to the sliding of the L5 and S1 neural roots in response to the execution of unilateral and bilateral SLR, and that these effects are indeed cumulative between ipsilateral and contralateral sides.

This study offers baseline measurements on which further studies in diagnosis and treatment of lumbar disc protrusion and radiculopathy with the SLR may be developed. In particular, relationships between cord and nerve root movement may be a useful tool.

Keywords

SLR, nerve root, spinal cord, sciatica, radiculopathy

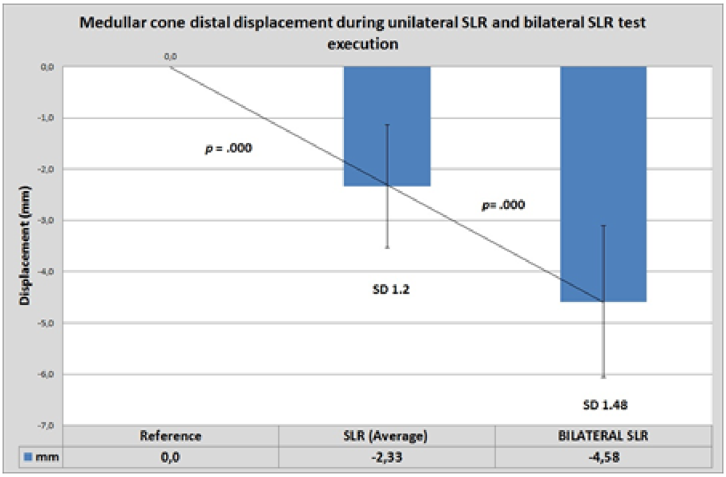

FIGURE 1. Medullar cone distal displacement with unilateral and bilateral SLR. Note that the magnitude of medullar cone displacement almost doubles when the SLR test is performed bilaterally, showing a linearly increasing trend.

Conflict of interest disclosure

The authors have no conflicts of interest to report.

RADIOLOGIC DEMONSTRATION OF SYMPTOMATIC SACROILIAC JOINT HYPERMOBILITY

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Introduction

Sacroiliac joint (SIJ) hypermobility disorder causes pain generation in a significant portion of patients with chronic low back pain. The best attempts to image this disorder have included static images of bone and ligament changes hypothesized to represent changes secondary to chronic tissue trauma.

Purpose/Aim

Creation of a radiographic protocol for identification and measurement of osseous displacement of symptomatic SIJ subluxation.

Materials and Methods

Twenty-three symptomatic patients were selected whose clinical evaluations documented reproducible functional leg length changes ipsilateral to the SIJ disorder. The leg length changes, either the Badgley Book Sign (BBS) or Fulcrum Sign (FS), were each aroused by a novel provocation maneuver previously reported.1 Each subject had several additional prevocation maneuvers positive for SIJ disorder. Subjects underwent cross-table lateral X-rays of their pelvices while sitting upright on the X-ray table with legs horizontal and while provocation maneuvers were imposed. The contralateral hemipelvis/lower extremity was the control. X-ray imaging software enabled precise measurement and comparison of acetabulum shifts evoked by the provocation maneuvers.

Results

Twenty-three subjects and cross-table lateral examinations revealed an average acetabulum shift of 2.17 cm, and each subject's shift was greater than 0.66 cm. This was compared to a less than 0.30 cm shift for each of the controls.

Relevance

Primary care doctors need a reliable method for diagnosing SIJ disorder. The methodology enables collection of objective data to supplement and confirm clinical findings obtained at physical examination.

Conclusions

An effective and accurate X-ray imaging technique to show objective evidence of SIJ hypermobility has been demonstrated.

Discussions

Heretofore, SIJ subluxation has resisted imaging evaluations. The present protocol has novel aspects including an efficient way to replicate and evoke SIJ biomechanical provocation (body weight/gravity) that is uniquely tailored to each patient's body mass, and a force of biomechanical provocation that is constant from one examination to another.

Implications

Physicians now have a reliable clinical tool to objectively document SIJ hypermobility disorder and to thereby authenticate the pathophysiologic generator of severe pain experienced by countless sufferers of chronic low back pain.

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DIURNAL STATURE CHANCE AND PATTERNS OF SPINAL SHRINKAGE AND RECOVERY IN WOMEN WITH AND WITHOUT LOW BACK PAIN

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Introduction

Stature change has been used to indicate the stress associated with specific tasks and as a proxy marker for load on the intervertebral discs. Previous comparisons between those with and without back pain have indicated similar acute responses to loading with regards to the degree of shrinkage but little attention has been paid to stature recovery after loading. Sustained and / or elevated muscle activity is often associated with back pain and may result in a slower recovery of stature in those with back pain. What's more the interpretation of stature change is often related to the diurnal change found in healthy participants which has typically been reported as a stature loss of approximately 1% of standing height across a normal day.
However, it has not been determined whether individuals with chronic Low Back Pain (LBP) experience a similar diurnal pattern or whether the normal loss is indicative of total capacity.

Purpose/Aim

The aims of the present studies were (1) to determine the pattern of stature loss and recovery induced by a moderate dynamic activity task, in women with and without LBP, (2) to describe the relationship between LBP, spinal shrinkage, and recovery in women with and without LBP and (3) to assess the diurnal stature change in individuals with and without CLBP and the impact of applying additional load throughout the day.

Materials and Methods

To assess aims one and two, thirty-one women, divided into control (n=16) and experimental groups (n=15) who had experienced low back pain for at least 12 months. Measurements of stature change were performed using a standing stadiometer. Stature was measured before and immediately after 20 minutes walking task and after a 20 minute lying recovery. Differences between groups were tested using a 2 way ANOVA. For aim three, eight participants with LBP and eight asymptomatic controls participated in the investigation. Twenty-four stature measurements were made across a 24 hour period using the same stadiometer. Measures were taken at 2 hour intervals throughout the day and 20 minute intervals either side of going to bed. Control participants were measured on a second day when they were required to wear a weighted vest with +10% body weight. Differences between groups and load conditions were analysed using two-way ANOVAs (time x group). Correlations between stature change and levels of low-back discomfort were examined using Spearman's rho.

Results

It was observed that the spinal shrinkage induced by the exercise was similar ($p > 0.05$) in both groups (CG = - 3.99 ± 1.13 mm; LBP= - 4.16 ± 1.54 mm). Differences in spinal length were found after a period of 20 minutes in a recovery position ($p < 0.05$). The CG was able to recover stature to a greater extent (111.2 ± 13.6%) than the LBP group ($p < 0.05$), who were not able to regain stature beyond baseline (57.5 ± 25.1%).

A negative correlation was found between regain in stature and low back ($r = -0.52$, $p < 0.05$). When diurnal changes were considered, a sinusoidal variation was found for all conditions, with the trough to peak variation in stature of 17.9 mm (LBP) and 17.6 mm (unloaded control) groups and 21.5mm (loaded control).

All groups experienced their greatest stature change in the 1st hour after rising 31.3% (LBP) and 44.6% (unloaded Control) 50.2% (loaded control) of the total stature change. Towards the end of the day stature in the chronic LBP group reached a plateau while the control groups continued to shrink. A significant correlation was found between low-back discomfort and stature change in the LBP group.

Relevance

These findings demonstrate that although the exercise induced stature loss does not differ between participants with LBP and asymptomatic controls, those with LBP recover significantly less. This delayed recovery will result in increased loading on other spinal structures. Failure to recover stature was strongly correlated with degree of pain. Diurnal data show that although the total stature loss does not differ in participants with LBP, they achieve their nadir earlier in the day, potentially exposing other spinal structures to greater loads. Care needs to be taken when reporting stature loss relative to normal diurnal change as this study demonstrates that in the normal spine, there is considerably greater capacity to shrink than observed in everyday loading.

Conclusions

The present study confirms that participants with LBP are less able to recover the acute stature loss experienced following physical activity and that participants with LBP reach the nadir of their stature loss earlier than control participants. Furthermore the addition of load to control participants results in significantly greater stature loss indicating a greater capacity to shrink if required.

Discussion

No differences were found between those with and without LBP in the amount of shrinkage induced by a walking task, suggesting a similar loading response. The failure of participants with LBP to recover stature following a period of loading is probably explained by greater levels of muscle activity in this group. Stature loss is an interesting proxy marker of load, this study indicates that during the first half of the day patterns of stature loss are similar in patients with LBP and asymptomatic controls. However, in the later hours LBP patients reach a nadir and no longer demonstrate a capacity to shrink. This may indicate greater load bearing on other spinal structures in this period.

Implications

The pattern of stature loss and recovery may prove helpful in explaining the causes of back pain suggesting that there may be a link with elevated muscle activity and prolonged compressive force even during relative recovery. The pattern of stature loss may have implications for the timing of exercise for participants with LBP, suggesting that exercise should be performed prior to the stature nadir.

Keywords

Stature loss, shrinkage, spinal loading, recovery

DISC ABNORMALITIES AFTER MULTIPLE MOTOR VEHICLE ACCIDENTS

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Introduction

Interpretation of MRI findings after a motor vehicle accident relies heavily on the clinical examination as MRI findings are often noted in normal pain free persons. There is very little information on how findings from a first accident may change after a second accident. Sequential prospective studies after trauma report the presence of bulging or herniation across all cervical levels rather than level by level (1, 2). Quantitative measure of lumbar herniations persons with unilateral sciatica showed 20-50% decrease in size at 2 months and another 50% decrease by 12 months (3-5), but again specific level was not mentioned nor was whether complete resolution was achieved. Injury to cervical ligaments has also been documented after whiplash, particularly when head was rotated at the point of impact (6). Disc protrusion at any cervical level has been observed in 33% of 500 persons (age 50 +-15); ten years later this had increased to 81% (7), with 70% of subjects in all age groups 20 and above showing progression. Progression was seen in 50% of C56 levels, 30% of C67 and C45, and only 10% of C34 levels (7). Herniated discs have been observed at L23 in 3.5%, L34 in 6.5 %, L45 in 25% and L5S1 in 35% of normal persons (8) with the primary risk factor for herniations at L34 and L45 being age over 40. 37 of 642 persons seen in the ER with MRI for radicular disorder showed spontaneous regression over an interval of 2-12 months (full in 17 and partial in 20) of MRI findings. 33 of these cases were at lumbar and 3 at cervical levels (9). Spontaneous reduction of massive herniation at L45 and L5S1 of 70% has been seen over a time period of two years (10).

Purpose/Aim

This project is a retrospective chart review of patients seen by a single physician after motor vehicle accidents. For people seen after a second accident, the MRI after the first accident becomes a “baseline” MRI to compare findings from the second.

Materials and Methods

Disc bulging and herniation were recorded by spinal level on MRI reports in notes for approximately 1000 patients seen from 2000 through 2012 from a single clinic and examiner.

Results

A previous accident was noted in 280 patients. 36 were also seen by the first author after both the first and the second accident; 26 had cervical and lumbar MRI, 6 had cervical only, and 4 had lumbar only at both points of time. Time between accidents averaged 2.5 years (range .25 to 9). Reviewing individual cervical disc levels for each subject, there were 23 instances of cervical bulge or herniation which improved or disappeared, 36 were the same and in 36 levels the bulge or herniation was worse than on the previous exam. In the lumbar spine, there were only 7 instances of improvement, 26 remained the same, and 26 showed worsening. 19 (53%) of the patients with dual cervical films showed a bulge or herniation at a level which previously had been normal, and 12 (33%) showed complete disappearance at one disc level. 13 (46%) of the patients with dual lumbar films showed a bulge or herniation at a new level, and only 3 (11%) showed complete resolution at one disc level. Findings were exactly the same as previous MRI at the cervical level in 6 (17%) and the lumbar level in 9 (32%). In the lumbar spine MRI findings are most common at L5S1 and L45; however, at the second accident the prevalence of findings increases at the upper lumbar levels. In the cervical spine MRI findings are most common at C45 and C56; after the second accident increased prevalence is seen both above and below these levels.

	Cases with Herniation or Bulging									
Accident	C23	C34	C45	C56	C67	L12	L23	L34	L45	L5S1
First	1	9	15	21	12	1	1	7	14	16
Second	2	15	19	22	17	4	3	12	18	18
	total cervical N= 32					total lumbar N=30				

Relevance

Half of the cervical and lumbar subjects showed bulging or herniation on MRI at a level which was previously normal. There was complete resolution of some individual disc findings at the cervical level in 33% and lumbar level in 11% of patients. Only a minority of patients showed the same MRI findings on the second examination as on the first.

Conclusions

MRI after a second motor vehicle accident shows different findings than after the first accident in most patients. The overall pattern is extension of injury to neighboring levels which in the cervical spine is both above and below C56, and in the lumbar spine is above L5S1. Individual disc levels show both improvement and worsening, but the overall trend is toward more severe anatomic findings particularly in the lumbar spine.

Discussion

In keeping with findings by Kornstead (1), cervical findings at C56 are almost 1.5x as common as at C67; however, we find a great deal more findings at the higher cervical levels than they did after whiplash. We find herniations at all lumbar levels but particularly at the upper L12 L23 and L34 levels much more frequently than is found in normal individuals (8). Both cervical and lumbar improvement in MRI findings over time have been reported. This study underestimates MRI improvement with the passage of time and treatment, as any improvement which occurred before the second accident would not be seen if there was additional injury at the same level which counteracted the improvement. It is therefore also an underestimate of MRI worsening at the second accident to exactly the same degree, for the same reason. Conclusions from this study are limited by lack of blinded quantitative review of MRI films which was not possible retrospectively.

Implications

Actual biomechanical changes resulting from a motor vehicle accident are probably more frequent than change in MRI from the previous accident would indicate.

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SAGITTAL STANDING ALIGNMENT AT PRE-PEAK HEIGHT VELOCITY AGE: IS THERE A PLACE FOR GENDER DIVERSITY?

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Introduction

The adolescent growth spurt is a critical period for musculoskeletal development. Potential gender-specificity in sagittal standing alignment and biomechanical loading of the spinopelvic complex remains enigmatic in subjects who are on the eve of rapid somatic growth. Gender comparisons may have been hampered by a “wash-out effect” for postural differences when no postural subgroups are created.

Purpose

To analyze gender differences in sagittal standing alignment at pre-peak height velocity age thereby applying a scientifically sound and practically oriented classification scheme for overall standing balance.

Relevance

The results of this study may be valuable for a better understanding of gender-specific biomechanical challenges posed by habitual posture. They may shed new light on several spinopelvic disorders with sex-related prevalence rates.

Materials and Methods

A clinical screening protocol was used to obtain sagittal plane measures of the spine, pelvis and lower limbs in a freestanding position of 557 girls (10.6±0.47 years) and 639 boys (12.6±0.54 years). Values were obtained for gross body segment orientations, specific spinopelvic and knee alignment parameters.

Differences in sagittal plane alignment were analyzed between sexes with each subject classified as one of three postural types: neutral, sway-back, or leaning-forward.

Results

Irrespective of the posture cluster, more thoracic kyphosis was apparent in boys over girls. Within the neutral and sway-back categories, boys compared to girls presented less dorsal inclination of the trunk, less lumbar lordosis and a more retroversed pelvis. Within the leaning-forward category, girls compared to boys displayed more forward trunk lean together with a more forward tilted pelvis. A state of lumbar segmental hyperextension appeared to exist in leaning-forward girls. Within the “neutral” global alignment category, knee hyperextension was more common in girls than in boys whereas the opposite was true for standing with flexed knee positions. Within each of the “non-neutral” postural categories, similar proportions of knee alignment classes were found across genders. As indicated by the body lean angle (i.e., C7 offset from the lateral malleolus line), within the “neutral” global alignment category, the female body as a whole was more dorsally inclined when compared to the male body. Within the “non-neutral” categories, body lean appeared equal in boys and girls.

Conclusions

These results reveal that sagittal standing alignment is different between prepubescent boys and girls when subjects are appropriately subclassified, and conversely represent a "wash-out effect" when pooled.

Discussion

At pre-PHV age, corresponding posture types appear to pose different biomechanical challenges across genders. Gender-specificity in gravity line position is suggested when the classification system is applied.

Implications

The importance of postural subgrouping in clinical research should be stressed. Our study results may be helpful for further research on sex- or posture- related mechanisms of spinal disorder development.

Prospective research examining sagittal balance and clinically relevant outcome measures beyond the period of rapid growth is needed.

Keywords

Sagittal balance, gender differences, posture types, pubertal peak growth, biomechanics

BODY MASS INDEX AND SMOKING PREDICTS LUMBAR DISC DEGENERATION IN YOUNG FINNISH MALES: SUBSAMPLE OF NORTHERN FINLAND BIRTH COHORT STUDY 1986

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Introduction
The role of environmental factors in lumbar intervertebral disc degeneration (DD) in young adults is largely unknown. We have earlier found the association of DD with low back symptoms in young adults.

Purpose
We investigated whether body mass index (BMI), smoking, and physical activity are associated with lumbar DD among young adults.

Materials and Methods
The Oulu Back Study (OBS) is a subpopulation of the 1986 Northern Finland Birth Cohort (NFBC 1986), which originally included 9,479 children. The OBS subjects (N=1,987), living within 100 km from the city of Oulu, were invited to the physical examination and those who participated (N=874) were invited to lumbar MRI study. A total of 558 young adults (325 females and 233 males) underwent MRI (1.5-T) at the mean age of 21. Each lumbar intervertebral disc was graded as normal (0), mildly (1), moderately (2), or severely (3) degenerated. We calculated a sum score of the lumbar DD, and analyzed the associations between environmental risk factors (smoking, physical activity and weight-related factors) and DD using ordinal logistic regression. All analyses were stratified by gender.

Results
Of the 558 subjects, 256 (46%) had no DD, 117 (21%) had sum score of one, 93 (17%) sum score of two, and 92 (16%) sum score of three or higher. In the multivariate ordinal logistic regression model, BMI at 16 years was associated with DD sum score among males (OR 2.35; 95% CI 1.19-4.65) but not among females (OR 1.29; 95% CI 0.72-2.32). Smoking of at least four pack-years tended to be associated with DD among males, but not among females (OR 2.41; 95% CI 0.99-5.86 and 1.59; 95% 0.67-3.76, respectively). Level of physical activity was not associated with DD.

Conclusions
BMI at 16 years predicted lumbar DD at 21 years among young males while no associations were found among females. Smoking of at least four pack-years tended to be associated with DD among males. These results suggest that environmental factors are associated with DD among young males.

Implications
The results of this study encourage health care professionals to focus on lifestyle factors in patient care.

Keywords
Disc degeneration, smoking, body mass index, physical activity, waist circumference, young adult

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN BODY MASS INDEX AND CHRONIC LOW BACK PAIN

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Introduction
Past research has shown evidence of a relationship between body mass index (BMI), a measurement of obesity, and chronic low back pain (cLBP). Exercise is a known beneficial treatment for cLBP. However, it is unclear if exercise-induced changes in pain and disability are related to baseline levels of, or changes in, BMI.

Purpose/Aim
To investigate the relationship between BMI and changes in pain and disability resulting from exercise-based cLBP treatment.

Materials
Stadiometer, digital body weight scales, exercise equipment.

Methods
One hundred and twenty-eight (n=128) men and women with cLBP performed eight weeks of exercise, consisting of three to five exercise sessions (minimum of one supervised) per week. Outcome measures included BMI and self-reported pain and disability. BMI was calculated by weight divided by height squared (kg/m2). Pain was measured using the Visual Analogue Scale (VAS) and disability was measured using the Oswestry Disability Index (ODI). Correlation, regression and likelihood ratios analyses were used to examine the relationship between BMI and self-reported pain and disability changes.

Results
No baseline relationships between BMI and self-reported pain ($r=-0.08$, $p=0.35$) and disability ($r=0.09$, $p=0.31$) were observed. There was no relationship observed between baseline BMI ($p=0.666$, $p=0.835$), or changes in BMI ($p=0.599$, $p=0.806$), with exercise-related changes in pain and disability respectively. BMI was not a predictor of exercise-based pain and disability changes.

Relevance
These findings indicate that BMI shouldn't be relied on as a sole measure of an individual's degree of obesity in cLBP research.

Conclusions
There was no significant relationship between BMI and self-reported pain and disability in cLBP participants.

BMI was not a predictor of exercise-induced changes in pain and disability. The reliance on BMI as a sole measurement of obesity in cLBP research may be unwarranted.

Discussions
BMI alone may not be the most appropriate measure of obesity for cLBP. Other measures of obesity and adiposity in the relationship between obesity and cLBP may require further consideration.

Implications

The reliance on BMI as a measurement of obesity in cLBP research may be unjustified. Further research is needed to investigate the relationship between obesity and cLBP.

Keywords
BMI – cLBP – exercise

Tuesday, October 29, 2013

Parallel Sessions II

David W. Polly
S. Kassis
Zbiggy Brodzynski

OPEN VERSUS PERCUTANEOUS IMAGE-GUIDED LUMBAR PEDICLE SCREW INSERTION: ACCURACY AND REOPERATION RATES

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Introduction
There is widespread use of pedicle screws in the treatment of various lumbar spinal disorders. Percutaneous pedicle screw insertion is increasingly utilized to preserve the paraspinal anatomy. Comparison of image-guided open and percutaneous pedicle screw placement accuracy has not been previously described.

Purpose
The aim of the study was to compare screw revision and reoperation rates between open and percutaneous image-guided screw insertion.

Methods
We identified consecutive patients who underwent either open or percutaneous image-guided lumbar pedicle screw instrumentation from October 2006 to December 2011. Operative notes were reviewed for screw and/or k-wire revision and reoperation rates. We also noted if there were any neurovascular complications secondary to screw malposition.

Results
A total of 988 screws were placed in 199 patients; 601 screws were inserted in 128 patients using the open technique and 387 screws in 71 patients using the percutaneous technique. Overall average age was 58 years (Range: 7 to 87). The screw revision rate for the open technique was 2.7% (16/601) and 2.1% (8/387) for the percutaneous technique. This was not statistically significant ($p=0.55$). When k-wire revision is included, the intervention rate for percutaneous pedicle screw placement is 7.4% (29/387) which is significantly higher compared to the open technique ($p=0.0004$). Reoperation rate was 0% for both techniques. There were no complications from screw malposition with either technique.

Conclusion
Image-guided lumbar pedicle screw insertion, using either open or percutaneous technique, showed low screw revision rates. The ability to perform intra-operative O-arm scans resulted in a 0% reoperation rate for screw malposition.

Discussion
Percutaneous screw insertion has comparable screw revision rate to open technique. It also has the advantage of preserving the paravertebral muscles and potentially preventing supradjacent facet impingement. In spite of a higher K-wire revision rate (compared to screw revision for the open technique), none of the cases requiring K-wire revision had any neurovascular injuries.

Keywords
Accuracy rate, revision rate, percutaneous pedicle screw insertion, open pedicle screw insertion, navigation

INTRA OPERATIVE PEDICLE SCREW STIMULATION (IOPSS) COMPARED TO INTRA OPERATIVE 3D FLUOROSCOPY IN PREDICTING THE ACCURACY OF PEDICLE SCREW POSITIONING - A PROSPECTIVE COMPARATIVE STUDY

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Background

The free hand technique with or without fluoroscopy is widely used for pedicle screw insertion in the thoraco-lumbar spine, However, it has a relatively high rate of malpositioned screws with, although rare but possible neurological complications.

Intra operative pedicle screw stimulation IOPSS and intra operative 3D fluoroscopy are used to verify the accuracy of pedicle screw positioning before wound closure. However no studies compare these two methods.

The aim of our study is to find out whether pedicle screw stimulation has comparative predictive accuracy to 3D fluoroscopy and whether it is worth using them together to increase the overall predictive value. The study includes also a comparison between conventional fluoroscopy and the spinal navigation regarding the rate of malposition.

Study design

A comparative prospective study

Methods

Since 24/4/2012, all patients having thoracolumbar spinal pedicle screw fixation in our institution were included, the patients randomly underwent the fixation using conventional fluoroscopy or O-Arm spinal navigation, intra operative 3D fluoroscopy verification and screw stimulation was performed in all the cases, malpositioned screws were repositioned.

Results

During the procedure, any discrepancy between the operative 3D reconstructed images and IOPSS results were recorded.

To date, 33 patients were involved in the study, 13 had spinal navigation (90 screws), and 20 had the fixation with conventional fluoroscopy (106 screws). All patients had intra operative 3D fluoroscopy verification (In total 196 pedicle screws were inserted. 11 screws needed repositioning (5.6 %). O-Arm navigation accuracy was 96.7 %. Conventional fluoroscopy 92.4 %.

For 190 screws (97%) stimulation results corresponded to the intra operative 3D fluoroscopy findings (including 4 malpositioned screws). In 1 medially placed and 5 laterally placed screw stimulation gave a false negative result while 3D fluoroscopy was showing a malpositioned screw. However the medial breach was not exceeding 2 mm of the pedicle wall.

Conclusion

Our preliminary results show IOPSS has high sensitivity (97 %) compared to intra operative 3D fluoroscopy in detecting a malpositioned screw. It is a valuable tool for detecting a medial wall breach and avoids neurological injury; we recommend its use alone or as compliment to the intra operative 3D fluoroscopy or spinal navigation.

FAR LATERAL SPONDYLODESIS OPTION FOR LBP DUE TO DDD AND "DE NOVO" DEGENERATIVE SCOLIOSIS

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Nowadays the lateral transpsoas approach to the lumbar spine, also known as extreme lateral interbody fusion (XLIF) or direct lateral interbody fusion (DLIF), has become an increasingly common method to achieve fusion as far lateral spondylodesis option for LBP due to DDD and "de novo" degenerative scoliosis.
Several recent large series describe several advantages to this approach, including less tissue dissection, smaller incisions, decreased operative time, blood loss, shorter hospital stay, reduced postoperative pain, enhanced fusion rates, and the ability to place instrumentation through the same incision. Indications for this approach have expanded and now include degenerative disease/DDD, tumor, deformity, and infection.

Methods

A lateral X-ray confirms that the patient is in a truly lateral position. Next, a series of tubes and dilators are used, along with fluoroscopy, to identify the mid-position of the disk to be incised. After continued dilation, the optimal site to enter the disk space is the midpoint of the disk, or a position slightly anterior to the midpoint of the disk. XLIF typically allows for a larger implant to be inserted compared to TLIF or PLIF, and, if necessary, instrumentation can be inserted percutaneously, which would allow for an overall minimally invasive procedure.

Results

Fixation techniques appear to be equal between XLIF and more traditional approaches. Some caution should be exercised because common fusion levels of the lumbar spine, including L4-5 and L4-S1, are often inaccessible. In addition, XLIF has a unique set of complications, including neural injuries, psoas weakness, and thigh numbness.

Conclusion

Additional studies are required to further evaluate and monitor the short and long-term safety, efficacy, outcomes, and complications of XLIF procedures.

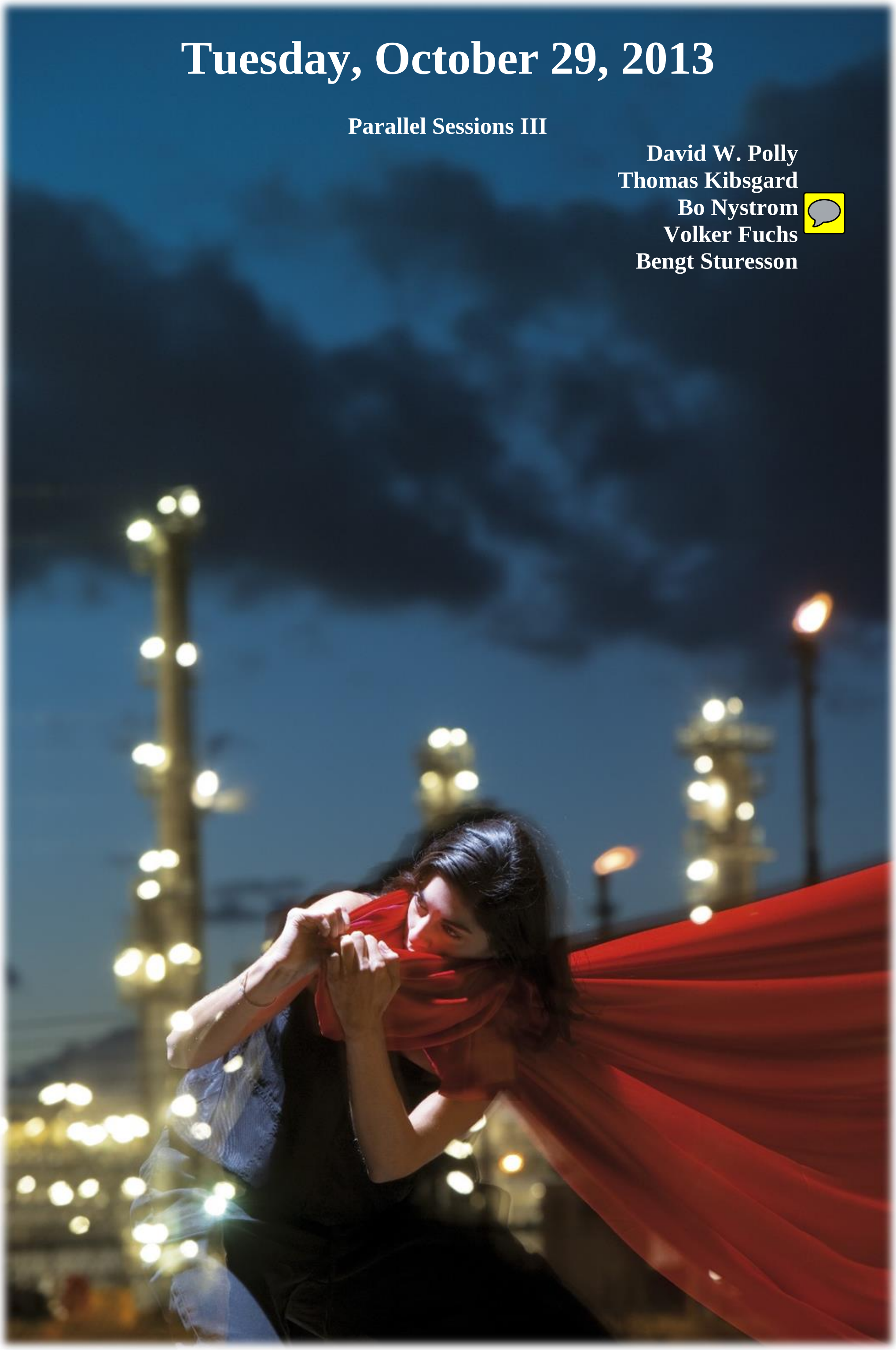
Keywords

Lateral transpsoas approach, extreme lateral interbody fusion, direct lateral interbody fusion, lumbar spine, lumbosacral plexus, surgical technique, DDD, "De Novo" Scoliosis, Intra-Op EMG

Tuesday, October 29, 2013

Parallel Sessions III

David W. Polly
Thomas Kibsgard
Bo Nystrom
Volker Fuchs
Bengt Sturesson



MINIMALLY INVASIVE VERSUS OPEN SACROILIAC JOINT FUSION: A COMPARISON OF PROCESS MEASURES

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Introduction

The Sacroiliac joint (SIJ) has been implicated as a source of chronic low back pain in 15 to 30% of patients. The mainstay of therapy for disorders of the sacroiliac joint has been nonoperative treatment, including activity modification, no steroidal anti-inflammatory agents, and physical therapy. When these modalities fail, sacroiliac joint fusion may be recommended. Open anterior approach to the SIJ fusion using plates and screws is a common technique. Recently, with advances in intraoperative image guidance, minimally invasive (MIS) techniques using ingrowth coated fusion rods have been utilized with increasing frequency potentially due to its observed advantages of decrease morbidity, shorter hospital stay and shorter surgical time. The purpose of this study is to compare the operative process measures associated with both techniques.

Materials and Methods

This is a retrospective chart review of patients who underwent SIJ fusion. Specifically, operative process measures were compared between MIS and the open anterior approach technique of SIJ fusion. All patients had sacroilitis confirmed by physical exam and SIJ injection and have failed non-operative treatment. Student's t-test was used to compare the mean estimated blood loss (EBL), length of hospital stay and length of surgery.

Results

27 MIS and 26 open SI joint fusions were included for comparison. Mean age, mean BMI and gender distribution did not differ significantly between the two groups ($p>0.05$). There were statistically significant differences in EBL, length of hospital stay and length of surgery between MIS and open anterior SI joint fusion (Table 1).

Table 1. MIS vs Open SI joint fusion operative process measures

	MIS N=27	**Open N=26**	***p* value (2tailed t-test)**
M:F	18:9	18:8	
Age	47.93	53.19	0.113
BMI	31.81	30.36	0.396
EBL (ml)	46.0 ±32.9	659.6 ±455.6	<0.001
Hospital days	1.8 ±1.4	3.5 ±1.4	<0.001
Length of surgery (min)	74.26 ±27.5	210.0 ±83.6	<0.001

Conclusion

A statistical and clinical significant decrease in EBL, length of hospital days and length of surgery was observed for minimally invasive SIJ fusion compared to the open technique. Comparative effectiveness of patient and physician reported outcomes are not yet available. If the outcomes show comparable efficacy then the less morbid procedure may be the preferred technique.

COMPARISON OF THE COST OF NON-OPERATIVE CARE TO MINIMALLY INVASIVE SURGERY FOR SACROILIAC JOINT DISRUPTION AND DEGENERATIVE SACROILIITIS IN A MEDICARE POPULATION: POTENTIAL ECONOMIC IMPLICATIONS OF A NEW MINIMALLY INVASIVE TECHNOLOGY

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Introduction

Low back pain is highly prevalent and expensive. The sacroiliac (SI) joint is a recognized generator of low back pain. Non-operative medical management has been a common treatment. With new, effective minimally invasive surgery (MIS) options available, comparing the costs of MIS to non-operative treatment may inform policy makers about options for cost savings to the Medicare program in the United States (U.S.).

Purpose/Aim

The objective of this study was to compare the costs, including resource use and Medicare reimbursement, of MIS treatment for degenerative sacroiliitis/SI joint disruption to non-operative care in a Medicare population.

Materials and Methods

A retrospective study evaluating the costs of non-operative care was conducted using claim-level data from the Medicare 5% Standard Analytic Files (SAF) for years 2005–2010. Patients with a primary International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code for degenerative sacroiliitis/SI joint disruption (ICD-9-CM diagnosis codes 720.2, 724.6, 739.4, 846.9, or 847.3) were included.

Claims attributable to degenerative sacroiliitis/SI joint disruption were identified using ICD-9-CM diagnosis codes (claims with a primary or secondary ICD-9-CM diagnosis code of 71x.xx, 72x.xx, 73x.xx, or 84x.xx), and the five-year medical resource use and direct medical costs (reported in 2012 U.S. dollars) were tabulated across practice settings. An economic model was developed to compare the costs of non-operative care from the Medicare SAF analysis to the estimated costs of a hypothetical cohort of patients managed with MIS fusion in the hospital inpatient setting, which was then extrapolated to a lifetime cost impact to the Medicare program (reported in 2012 U.S. dollars). The cost of the MIS fusion hospitalization was based on Diagnosis Related Group (DRG) payments of $46,700 (DRG 459 with major complication) and $27,800 (DRG 460 without major complication), weighted using the percentage of patients (3.8% of 5,319) with clinical, device-related, or procedure-related events (Miller 2013). The professional fee for MIS fusion was determined from the 2012 Medicare payment for Current Procedural Terminology (CPT) code 27280.

The MIS fusion success rate was specified at 82% (Rudolf 2012) and the MIS revision rate at 1.8% (Miller 2013). Three surgeons with experience treating over 360 patients with MIS fusion determined medical resource use for MIS SI joint fusion follow-up care; associated costs were based on Medicare reimbursements. Sensitivity analyses were performed to determine the consequences of making alternative assumptions about the durability of the MIS treatment success rate and the inclusion of ICD-9-CM code 721.3 (lumbosacral spondylosis). Costs were extrapolated to a lifetime cost impact to the Medicare program using a 3% discount rate.

Results

Among Medicare patients managed using non-operative care (N=14,552 based on the Medicare 5% SAF), the five-year direct medical costs attributable to degenerative sacroiliitis/SI joint disruption were $18,527 (SD $28,285) per patient. When patients diagnosed with ICD-9-CM code 721.3 were included, the five-year direct medical costs attributable to degenerative sacroiliitis/SI joint disruption managed with non-operative care (N=35,464 based on the Medicare 5% SAF) increased to $23,149 (SD $31,739) per patient. The economic model assumed that approximately two-thirds of non-operative care patients experience chronic pain and dysfunction despite medical intervention and are eligible for MIS fusion. Based on the economic model, the extrapolated lifetime cost of treating Medicare patients with MIS fusion in the hospital inpatient setting was $48,185/patient compared to $51,543/patient for non-operative care, resulting in a $660 million savings to the Medicare program (196,452 beneficiaries at $3,358 in savings/patient) due to reductions in spine-related health care costs over Medicare patients' lifetimes. When ICD-9-CM code 721.3 (lumbosacral spondylosis) was included in the analysis, the potential lifetime cost savings to the Medicare program by treating this population with MIS increases to $4.2 billion (478,764 beneficiaries at $8,692 in savings/patient). This study demonstrates that MIS becomes cost saving compared to non-operative care at a 1-year MIS treatment success rate of 78.7% (Figure).

Relevance

This analysis can inform policy makers as they explore options for cost savings to the Medicare program for patients who suffer from low back pain due to SI joint disruption and degenerative sacroiliitis.

Conclusion

The economic burden of non-operative care for SI joint disruption and degenerative sacroiliitis among Medicare beneficiaries is substantial.

Discussion

The economic model suggests that MIS SI joint fusion performed in the hospital inpatient setting could result in a potential cost savings to the Medicare program of $660 million to $4.2 billion over Medicare patients' lifetimes.

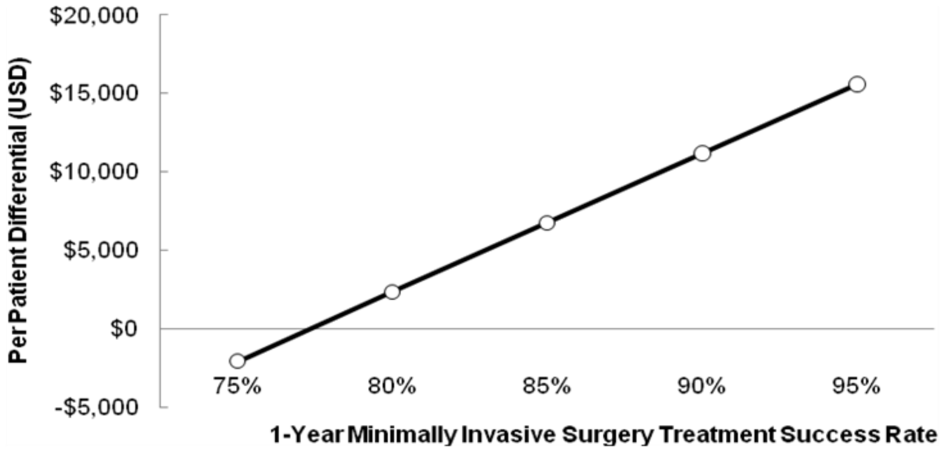

Figure. Lifetime Cost Differentials by Minimally Invasive Surgery Treatment Success Rate (in 2012 U.S. Dollars) Lifetime cost differentials were calculated as per patient differential = cost of non-operative care – cost of MIS (2012 USD). For the overall population, MIS becomes cost saving compared to non-operative care at a 1-year MIS treatment success rate of 78.7%. Abbreviations: MIS, minimally invasive surgery.

Potential Conflicts of Interest

This study was sponsored by SI-BONE, Inc. SJA, TK, and KS are consultants to SI-BONE through their employment at Covance. DWP receives research support from the Department of Defense, Orthopaedic Research and Education Foundation, Minnesota Medical Foundation, and Chest Wall and Spine Deformity Foundation. TAH is a teaching consultant for SI-BONE, Inc. JTC is a teaching consultant for SI-BONE, Inc. and receives a royalty from NuVasive, Inc.

WHAT IS THE FREQUENCY OF MINIMALLY INVASIVE SACROILIAC JOINT FUSION ANNUALLY IN THE UNITED STATES?

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Introduction

Sacroiliac (SI) joint pain is a frequent occurrence. In the past, the diagnosis has not been aggressively pursued by allopathic practitioners. More recently it has gained a greater appreciation as a source of back pain. The SI joint has been reported as the pain generator in 15%–22% of patients with low back pain (Sembrano et al. and Bernard et al.). SI joint pain treatment options include either non-operative care, such as pain management through injections, physical therapy, and radiofrequency ablation, or SI joint fusion surgery. When non-operative treatment fails, patients are either left to suffer or may be offered SI joint fusion. Traditionally, open SI joint arthrodesis was the only SI joint fusion surgery option, but recently SI joint fusion has been performed with a minimally invasive surgical technique. The frequency of this procedure in the United States (US) has not been well studied.

Purpose/Aim

This study looks at the current prevalence of SI joint fusion and the frequency with which it is being performed using a minimally invasive surgery (MIS) technique in the US.

Materials and Methods

Current Procedural Terminology (CPT) code 27280 (arthrodesis, sacroiliac joint) utilization values were provided by the AMA/Specialty Society Relative Value Scale Update Committee (RUC) database from 2001 to 2011. The payer mix was estimated for CPT 27280 associated with degenerative sacroiliitis and SI joint disruption using International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM) codes (720.2, 721.3, 724.6, 739.4, 846.9, or 847.3) across practice settings. Specifically, using nationally representative US healthcare system encounters from 2009, the payer mix was derived using 1) the National Hospital Discharge Survey (NHDS; for inpatient hospital discharges), 2) the National Ambulatory Care Survey (NAMCS; for physician office visits), and 3) the National Hospital Ambulatory Care Survey (NHAMCS; for emergency room and hospital outpatient department visits). The number of Medicare SI joint fusion procedures was divided by the Medicare portion of the payer mix (45.39%) to estimate the total utilization of CPT 27280 across all payers. A sigmoidal growth curve was derived using data from 2001 through 2011, which was then applied to estimate 2012 Medicare RUC and All Payer utilization during 2012.

MIS procedures, as a percent of total SI joint fusion procedures, were calculated using MIS data provided by 1 of the 4 SI joint fusion device manufacturers of an FDA-approved SI joint fusion device (SI-BONE, San Jose, CA) on year-to-date sales through September of 2012 and an average of 400 cases per month for the remainder of 2012.

Results

Medicare represented approximately 45% of the payer mix for CPT 27280. The total number of estimated SI joint fusion procedures (all payers) increased from 189 in 2001 to 3,900 in 2012

(Figure 1). MIS SI joint fusions accounted for an increasing percentage of the total, ranging from 0% in 2008 to 76% in 2011, with an estimate of 85% for 2012 (Table 1).

Figure 1. Sacroiliac Joint Fusion Procedures From 2001–2012

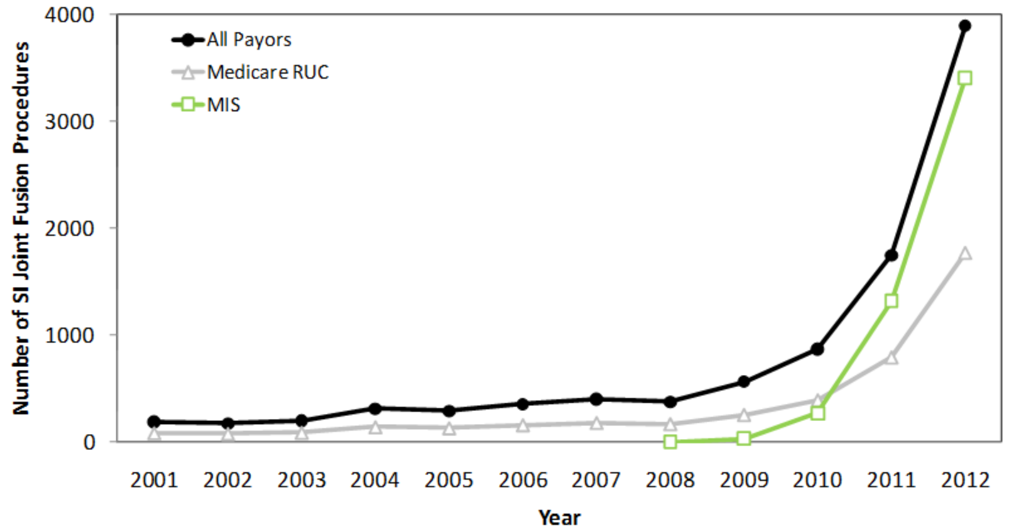

Table 1. Known Minimally Invasive Surgery (MIS) Procedures as a Percent of Total SI Joint Fusion Procedures

Year	2008	2009	2010	2011	2012*
% MIS	0%	6%	31%	76%	85%

*The 2012 minimally invasive procedure estimate is based on data provided by 1 of the 4 manufacturers (SI-BONE, San Jose, CA) of an FDA-approved SI joint fusion device on year-to-date sales through September of 2012 and an average of 400 cases per month for the remainder of 2012.

Relevance

The increasing proportion of MIS SI joint fusion suggests that MIS techniques have become a reasonable treatment alternative in the continuum of care between continued non-operative care and invasive SI joint fusion surgery, which may further inform payer coverage and reimbursement decisions.

Conclusions

Use of SI joint fusion has been increasing substantially over the last few years. Presumably, this is due to improvement in diagnosis, as well as improvement of the risk-benefit ratio with the use of MIS.

Discussion Robust outcomes data are only now beginning to emerge, and the cost-effectiveness of surgical versus non-surgical treatment needs to be established. MIS SI joint fusion has been broadly adopted in the US and is a viable treatment alternative for patients who have failed non-operative treatment.

Potential Conflicts of Interest

This study was sponsored by SI-BONE, Inc. SJA, TK, and EK are consultants to SI-BONE through their employment at Covance. DWP receives research support from the Department of Defense, Orthopaedic Research and Education Foundation, Minnesota Medical Foundation, and Chest Wall and Spine Deformity Foundation. SY is an employee of SI-BONE, Inc.

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RADIOSTERIOMETRIC ANALYIS OF MOVEMENT IN THE SACROILIAC JOINT DURING THE ACTIVE STRAIGHT LEG RAISE

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Introduction

The Active Straight Leg Raise (ASLR) test is commonly used in diagnosing and severity assessment of pelvic girdle pain (PGP). It has been shown that patients with a pelvic belt easier can perform the ASLR, hence an instability of the sacroiliac joint (SIJ) is thought to be related to the PGP syndrome. Attempts have been made to measure the SIJ movement indirectly using the Chamberlain projections, but the movement in the SIJ, during the ASLR, have never been examined.

Purpose/Aim

The aim was to measure the movement of the SIJ's during the ASLR.

Materials and Methods

Twelve patients with severe PGP that were assigned to SIJ fusion, had tantalum markers inserted in the sacrum and both ilia before planned SIJ fusion. We measured the 3D movement of these marker segments with radiosteriometric analysis (RSA with a precision down to 0.5° degree rotation and 0.5 mm translation). The UmRSA Biomedical software was used to calculate SIJ movement in both rotation and translation in a x,z,y coordinate system during the ASLR (Fig 1). Movements around a helical axis (true axis of rotation) were also calculated.

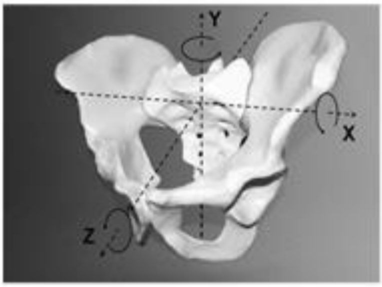

Figure 1. Coordinate system

Results

Eleven women and one man were examined. They had a mean age of 39 years (range 29-47) with a duration of SIJ pain for 8 years (range 1.5-20). Four patients had unilateral SIJ pain and 8 had bilateral pain. Severity, as measured by ASLR showed a mean score of 5.8 (range: 4-8) (0=no problem lifting the leg, 5= impossible to lift the leg, maximum score is 10 when the two sides were added). The patients had a high level of disability (Oswestry disability index of mean 56; range 26-76) and pain (mean VAS in the evening: 75; range 53-91).

Overall there were only small movements detected in the SIJ, as only 27 % of the measurements were above the precision of the method. Most movement were rotations, predominantly around the x-axis. There were a small rotation in both SIJ, with a 0.7 degrees rotation in SIJ of the lifted leg and 1.0 degree in the SIJ of the non-lifted leg's (p=0.066). In the SIJ of the lifted leg the movements varied around zero without any predominant direction (table 1). In the rested leg's SIJ there were a 0.8 degree backward rotation of the innominate bone (rotation around the x-axis) and a 0.3 degree rotation around the z-axis (table 1).

		Movement in the lifted leg's SIJ (right leg)					Movement in the rested leg's SIJ (left leg)				
		N	Mean (SD)	*p-value*	Min	Max	N	Mean (SD)	*p-value*	Min	Max
Rotation	X	12	**0.0** (0.4)	0.688	-1.1	1.0	12	**-0.8** (0.3)	0.000	-1.5	-0.3
	Y	12	**-0.3** (0.4)	0.058	-1.4	0.4	12	**-0.2** (0.3)	0.078	-0.9	0.5
	Z	12	**0.0** (0.2)	0.962	-0.5	0.5	12	**0.3** (0.2)	0.001	-0.3	0.8
Translation	X	12	**0.0** (0.2)	0.314	-0.5	0.6	12	**-0.1** (0.2)	0.221	-0.4	0.3
	Y	12	**0.2** (0.1)	0.001	-0.1	0.6	12	**0.1** (0.2)	0.042	-0.2	0.4
	Z	12	**0.0** (0.2)	0.695	-0.6	1.0	12	**-0.2** (0.3)	0.075	-0.6	1.1
Helical axis											
Rotation		12	**0.7** (0.4)	0.000	0.2	1.4	12	**1.0** (0.3)	0.000	0.3	1.6
Translation		12	**0.0** (0.1)	0.750	-0.6	0.4	12	**0.0** (0.1)	0.712	-0.3	0.2

Table 1. Movements in the SIJ during ASLR. All measures were converted so the lifted leg represents the right leg and the rested leg represents a left leg. Movements was according to the x,y,z coordinate system (Fig 1).

Relevance

The movement in the SIJ, during ASLR, seems to be close to zero and based on our results severe PGP cannot be explained by hyper-mobility of the SIJ.

Conclusions

During the ASLR only small movements in the SIJ were detected. There were movements in both joint, predominantly in the rested leg, where a small backward rotation of the innominate was seen.

Discussion

Based on these preliminary results it seems that SIJ movements, during the ASLR, are small. These findings are consistent with previous knowledge.

Implications

Our findings might be a piece of the puzzle to understand PGP and the ASLR.

Keywords

Active straight leg raise, sacrolilac joint, movement, radiosteriometric analysis

TREATING PATIENTS WITH CHRONIC PELVIC PAIN: POSTERIOR SACRO-ILIAC JOINT ARTHRODESIS OR CONSERVATIVE TREATMENT - A RANDOMIZED STUDY

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Introduction

Controversy remains concerning whether chronic pelvic pain with possible origin in the sacro-iliac (SI) joints or their ligamentous structures can be relieved by surgery.

Purpose/aim

In a prospective randomized study analyse possible differences in outcome between patients treated by posterior arthrodesis of the SI joints and a rehabilitation program and those treated solely with the same rehabilitation program.

Material and Methods

We investigated 19 patients, all women, with a clinical history suggesting possible pain from the SI joints. Mean age was 43 years (range 35-68). All patients underwent thorough neurological investigation, plain X-ray and MRI of the spine and plain X-ray of the SI joints, with no findings of specific abnormalities. They were examined using clinical tests aimed at indicating possible pain from the SI joints and injection tests at the posterior aspects of these joints, not intra-articular. The patients completed the generic questionnaire SF-36 and the disease specific Balanced Inventory for Spinal disorders (BIS) before randomization, and at follow-up at one year, and they assessed their level of pelvic and leg pain (VAS, 0-100). Randomization was performed by a statistician who delivered closed envelopes with the message, “Operate” or “Do not operate”.
The operations were performed by a posterior approach using microsurgical technique. Bone was transplanted between sacrum and ilium and the arthrodesis secured by a fixation device. Both groups underwent the same rehabilitation program.

Results

Duration of pain was 9.8 years (mean) in the surgical (S) group (9 patients) and 8.6 years in the rehabilitation (R) group (10 patients). At randomization pelvic pain (VAS) was 69 (median) in the S group and 76 in the R group. At follow-up the figures were 8 and 74, respectively. Bodily pain reported in SF-36 was 23 in the S group and 22 in the R group at randomization, and 69 and 29, respectively, at follow-up. For the global assessment concerning a change in their condition (BIS) at follow-up, the results in terms of number of patients in the S and R groups, respectively, were: Completely pain-free 2-0, Much better 6-1, Somewhat better 0-2, Unchanged 0-3 and Somewhat worse 1-4.

Relevance

We consider our study to be highly relevant for this group of patients since, to our knowledge, no previous randomized study has been presented concerning surgical treatment of SI joint pain.

Conclusions

In the selected group of patients posterior arthrodesis of the SI joints showed very good results.

Discussion

Our results clearly demonstrate that severe pain can arise from the SI joints or their ligamentous structures and that pain persisting for 8-10 years can be relieved by posterior arthrodesis involving resection of the posterior ligaments and bony union: which one being most important remains unclear.

Implications
Severe pain can arise from the SI joints or their ligamentous structures.

Keywords
Pelvic pain, surgery, randomized study, rehabilitation, sacro-iliac joints

DIANA® – NEW SOLUTION FOR AN OLD PROBLEM – THE DISTRACTION ARTHRODESIS OF THE SI-JOINT

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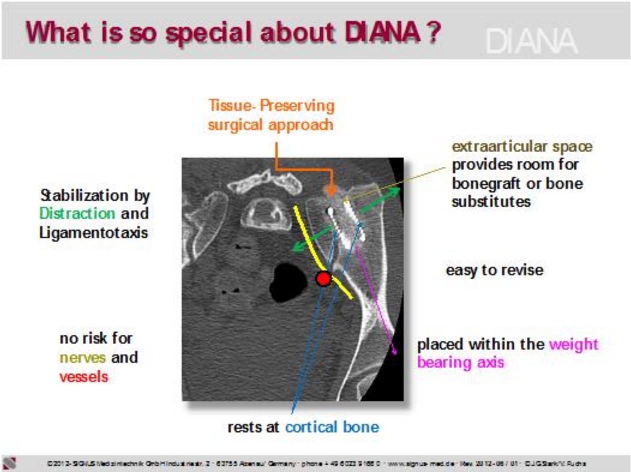
Introduction

The incidence of the SI-Joint as percentage of lower back pain is indicated up to 30% in the literature. Its vulnerability to injury and disease related processes can lead to painful, irreversible degenerative changes.

Surgical arthrodesis is sometimes required when pain is severe and resistant to standard non-operative methods such as manual therapy, injection or denervation. Since 1936 many surgical methods have been described for fusing the SI-Joint, but none of these had the strength to establish itself in the long run.

Purpose

Our goal is to present a new SI-joint fusion technique called DIANA and measure the surgical and functional outcomes of this method in a prospective multicenter study.

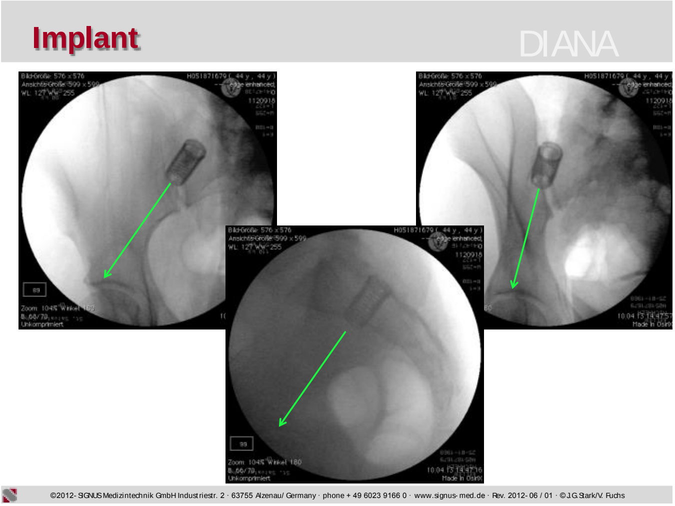


Materials and Methods

From January 2011 to June 2012 in 22 hospitals almost 200 patients were fused due to severe SI-Joint problems. Postoperative patients were followed prospective receiving questionnaires at 6 weeks, 3 months, 6 months, 12 months and 24 months. In our patient group we collected data for the Oswestry-Disability-Index (ODI), the million visual analog scale (MVAS), the McGill pain questionnaire (MPQ) and the overall satisfaction of the patients, as well as the implant positioning and fusion oft the SI-joint based on CT-scans after 6 months.

Results

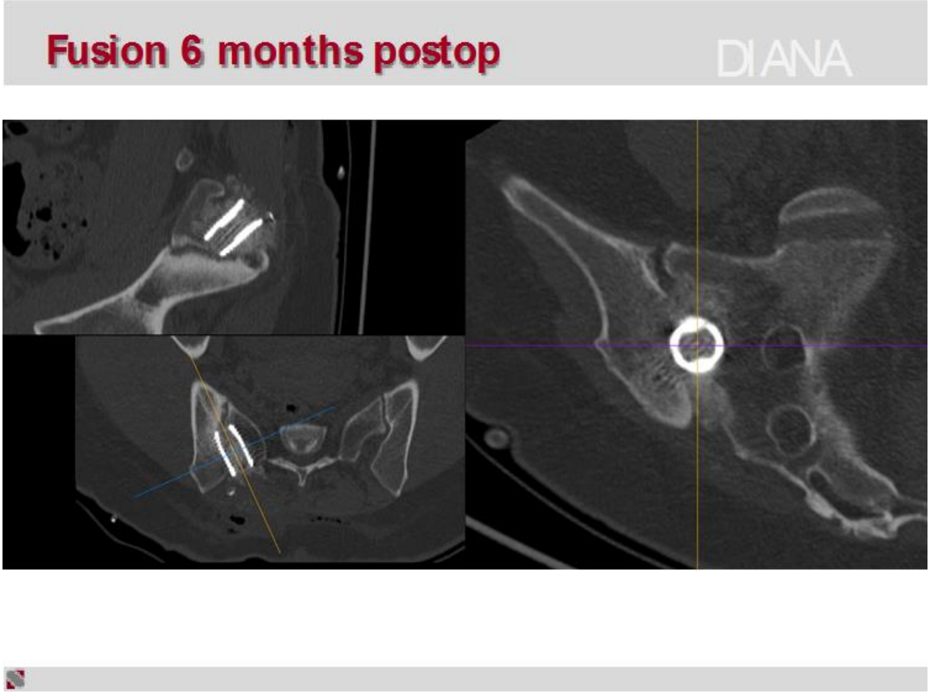
The first results up to 12 months follow-up are available. The ODI improved from 53% preoperative to 38% after 12 months, the MVAS improved from 64 points preooperative to 43 points after 12 months. The MPQ showed good improvement too, from 110 points preoperative to 79 points at 12 months after surgery. The improvement of back pain at 12 months postoperative was 54%, the relief of leg pain at the same time was with 58% even higher. The overall satisfaction with this surgery was high: 12 months after surgery 60% of the patients said that they feel excellent or good, 72% would undergo this procedure again.



Conclusion

The DIANA-method is a safe procedure fusing the SI-Joint and can be performed minimally invasive. In comparison to many other fusion techniques this method respects bony structures as well as neurovascular structures and is easy to reproduce. Due to the great bony surface area oft he recess the fusion rate is high.

The first results are very promising.



Disclosure of Interest

F. Hassel and V. Fuchs are consultants for Signus Medizintechnik, Germany.

A NOVEL MINIMALLY INVASIVE TECHNIQUE FOR SACROILIAC FUSION - REPORT FROM 33 OPERATIONS ON 24 PATIENTS WITH A 12 MONTH FOLLOW UP

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Introduction

Pain arising from the sacroiliac joints is a challenging subject. The diagnostic procedures have been developed into an evidence-based algorithm, but the surgical technique has been demanding for the surgeon and complicated for the patient with concomitant morbidity. Previously, we have performed sacroiliac fusions with the Smith-Peterson technique either with an external frame fixation or internal iliosacral screw fixation. Since January 2011, we have adopted a minimally invasive surgical technique using porous coated, triangular titanium rods for fixation and fusion (iFuse, SI-BONE, USA).

Patients and Methods

24 patients, 5 male and 19 females with longstanding disabling pain from the sacroiliac joints were operated with iFuse during 2012. 7 patients had persistent pain after pregnancy, 4 had a history of trauma, 3 had sacroiliitis of unknown origin, and 7 had degenerative disease. Two were operated because of pseudarthrosis and one because of extrofi of the bladder and symphysis. 15 patients were operated unilaterally and 9 bilaterally. The bilateral procedures were performed with a 2 to 3 months interval between the surgeries. All patients were preoperatively analysed with specific diagnostic tests, sacroiliac blocks and except those with previous lumbar screw fixation also an internal test fixation. The operative time was approximately 30 to 45 minutes, and the perioperative bleeding was negligible. The patients were allowed partial weight-bearing with half of their bodyweight immediately and full loading and walking after 6 weeks. Lifting and excessive load was restricted for 5 months. The outcome was measured with ODI, EQ-5D and SF-36 as well as global assessment.

Results

The patients had a high level of disability. Preoperative mean VAS was 63 range 45-87, ODI 52, range 30-74 and EQ-5D 10, range 7-13.

All patients improved regarding to pain, painkiller consumption, ability to walk, sit and the sleeping disturbances was reduced. 12 months data will be presented. There were no surgical complications or postoperative infections.

Relevance

Surgical treatment can be an option in the treatment algorithm in severe PGP.

Conclusions

This minimally invasive surgical technique has dramatically reduced the postoperative pain and morbidity of traditional sacroiliac joint fusions. The implant’s construction provides immediate stability to the sacroiliac joint.

Discussion

The surgical procedure is safe and complications are rare. Patients who underwent surgery had in all cases a long history of pain and severe disability.

Implications

The results of this pilot study suggest that the technique can be recommended for further trials. Scientific protocols including either registry data or RCT are recommended.

Keywords
Sacroiliac joint, sacroiliac fusion, minimal invasive surgery, PGP

Disclosures
No grants were received for this study.

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LOW BACK STABILITY AND HAPTIC PERCEPTION: FROM CELL TO MUSCULOSKELETAL SYSTEM

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Recently, a classical form of architectural design, called tensegrity (tensional integrity), is being used as a model for biological structures, such as the cell (Ingber, 2003). Tensegrity is a stable, self-balanced system that contains a discontinuous set of components in compression inside a network of components in tension (Motro, 1992). The cell has been shown to have an intricate internal framework, which provides a behavior similar to that of a tensegrity structure. This complex cell architectural organization allows the emergence of a biological process called mechanosensation (Ingber, 2002). Our premise is that the musculoskeletal system, including the human spine, behaves as a tensegrity-like structure as a natural means for achieving mechanical stability (Levin, 2002). Pre-stress and tensional continuity are fundamental properties of tensegrity structures (Snelson, 1996). Prestress is a self-sustained tensile state in elastic components, which provides intrinsic stability. Tensional continuity is characterized by topological distribution of tension in interconnected elastic components, which creates mechanical interdependence among parts of a system. In the musculoskeletal system, (a) prestress would be held passively in soft tissues and (b) a resultant tensional continuity would cause remote joints to be intrinsically interdependent (Turvey & Fonseca, 2009).

We tested the first hypothesis by contrasting predictions of a prestressed two-spring model with changes in the passive behavior of the ankle due to modifications in knee position. The passive moment of the ankle behaved as predicted, revealing that the elastic tissues of the musculoskeletal system are pre-tensioned.

Further, we tested the second hypothesis by investigating if modifications in position and muscle activity of the latissimus dorsi muscle change the passive moment of the contralateral hip by means of the thorocalumbar fascia. Hip passive behavior changed according to the predicted existence of tensional continuity between these structures. These findings support a tensegrity model for the architectural organization of the musculoskeletal system. Due to its tensegrity-like architecture, the spine distributes stresses among its components to establish a force balance and stabilize itself omnidirectionally against environmental perturbations. As the cell, this organization also supports the emergence of perceptual processes analogous to mechanosensation. Thus, tensegrity is a general and principled (lawful) structural organization that allows mechanical stability and functional adaptability of the cell and musculoskeletal system to different contexts.

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SUPERFICIAL AND DEEP LAYERS OF THORACOLUMBAR FASCIAE AND THEIR POTENTIAL ROLES IN FORCE TRANSMISSION AND PROPRIOCEPTION

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The fascial architecture of the back is complicate, we need to distinguish different layers and to consider the connections with the head, limbs, thorax and abdomen. In the trunk we can recognize three deep muscular-fascial layers:

1. the superficial layer
2. the intermediate layer
3. the deep layer

Among these fascial layers, some "lines of fusion" could be recognized. They are well defined points were the muscles and fasciae of one layer merge with the muscles and fasciae of an adjacent layer. These lines of fusion guarantee the coordination among the various muscular groups.

The superficial layer of the deep fascia invests the trapezius, the latissimus dorsi, the gluteus maximus and includes the posterior layer of the thoracolumbar fascia (TLF). Over these muscles, the superficial layer of the deep fascia of the back is a thin fibrous layer strongly adherent to the underlying muscles by many intramuscular septa. There is a definite coupling between the gluteus maximus and the contralateral latissimus dorsi muscle by way of the posterior layer of the thoracolumbar fascia. Both of these muscles conduct the forces contra laterally during gait and tense the TLF. In so doing they are important in rotation of the trunk and stabilization of the lower lumbar spine and sacroiliac joints. Due to the different fiber directions of the latissimus dorsi and gluteus maximus, the posterior layer of the TLF has a cross-hatched appearance.

Therefore, we can consider the posterior layer of the thoracolumbar fascia as a big retinaculum that connect the two halves of the body with the upper and lower limbs. This structure allows proper balance and distribution of forces that act in the lumbosacral region during movements, notably the pendulum-like actions of the contralateral arms and legs during walking and running.

The intermediate layer of the deep fascia is formed by thin and weak muscles: the rhomboid and the serratus posterior muscles with their fascia. For thoracic surgeons this continuity is very important and they refer to it as the "serrati-rhomboid complex". Distally this complex fuses with the inner aspect of the posterior layer of the thoracolumbar fascia. Proximally, it continues with the fascia of the splenius of the neck and levator scapulae muscles (middle layer of the deep fasciae of the neck). Laterally, it reaches out to the angle of the ribs and continues with the serratus anterior fascia and then with the clavipectoral fascia and the obliquus internus muscle. In the middle layer could be included also the supraspinatus and infraspinatus fasciae.

The deep layer of the deep fascia of the back surrounds the erector spinae muscles. In this group the multifidus and the interspinales muscles have their own individual fascial layers. Besides, also the anterior layer of the thoracolumbar fascia could be included in this layer. The anterior layer gives insertion to the internal oblique and transverse muscles of the abdomen. In this way it collaborates to the core stability of the trunk.

FASCIA RESEARCH 100 YEARS AFTER A.T. STILL: WHAT IS NEW AND RELEVANT FOR UNDERSTANDING BACK PAIN

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Fascia is connective tissue that surrounds and connects every muscle and organ, forming continuity throughout the body. It is considered to be any dense irregular connective tissue sheets in the human body, including aponeuroses, joint capsules, or muscular envelops such as the endo-, peri- and epimysium. (Langevin & Huijing, 2009) The intramuscular extracellular matrix is composed of the endomysium, perimysium, and epimysium. The epimysium surrounds each muscle and is continuous with tendons that attach muscles to bones. The perimysium divides the muscle into fascicles or muscle fibre bundles. The endomysium is a continuous network of connective tissue that covers individual muscle fibers. (P. Purslow, 2009; P. P. Purslow, 2002; Peter P. Purslow, 2010) (Yucesoy, 2009) Small fascial fibers extend to connect to the cell membrane itself. (Passerieux et al., 2006)

Dissections and physiological studies have shown there are fascial connections resulting in myofascial force transmission between adjacent and even antagonistic muscles. (Bojsen-Moller et al., 2010; Huijing, 1999, 2007; Kreulen, 2009; H. Maas & Sandercock, 2008; Huub Maas & Sandercock, 2010; Smeulders & Kreulen, 2007; Yu et al., 2007; Yucesoy & Huijing, 2007) The superficial fascia is a layer of areolar connective tissue or adipose tissue located directly beneath the skin. Fascial limb dissections show the extensive network of fascia throughout the limbs. (A. Stecco et al., 2009; C. Stecco, 2009)

Deep fascia is tougher and contains denser connective tissue, containing and separating groups of muscles into well-defined compartments. Fascia plays an ectoskeletal role, creating a functional organization of muscles. Fascia also permeates through compartments, transmitting loads between them. (Benjamin, 2009) The deep fascia in multiple specimens showed similar structural organization, with ability to adapt to volume variations of muscles during contraction, and to resist high pressure without damage. (A. Stecco et al., 2009)

This paper will outline fascial concepts presented in keynote addresses and in the program materials at the international fascia research congresses in 2007, 2009, and 2012, and is adapted from an analysis of fascial principles described more than 100 years ago by AT Still MD, the founder of osteopathic medicine (Findley 2013). Many of these observations have been made in muscle and fascia of the extremities, but they represent general principles which can also be observed in the trunk, and particularly the low back.

Fascia as a Covering

The connective tissue that surrounds muscle is not an isolated and independent entity; rather it is a continuous substance throughout the body. The broad definition of fascia allows fascial tissues to be seen as an interconnected tensional network that adapts its fiber arrangement, length, and density according to local tensional demands. Fascia forms linkages between muscular and non-muscular tissues at several locations in addition to tendon origins and insertions. (Yucesoy & Huijing, 2007) For example, studies of the Achilles tendon in the foot have shown that the tendon not only attaches to the calcaneus, it is continuous with the plantar aponeurosis over the heel and the fibrous septa of the heel fat pad. (Benjamin, 2009) Simply pulling or pushing one muscle leads to movement of its neighboring muscle, showing that muscles are unquestionably linked. (Kreulen, 2009)

Fascia is traditionally named according to the discrete anatomic structure that it surrounds which obscures its four distinct layers. (Willard, 2007) Fascia in different regions are named according to their regional anatomy, such as the fascia lata and iliotibial tract, the clavipectoral, axillary, brachial, and thoracolumbar fascia. It is considered to be “part of” organs or structures instead of a connective tissue continuum throughout the body, which unites and integrates different regions. The naming and studying of fascia in isolation is believed by some to be “barrier to understanding the bigger picture of facial function.” (Benjamin, 2009)

Dissection methods often start by “clearing” or “cleaning” structures from their connective tissue covering. Van Der Wal studied the interrelationships of muscle and other structures in the forelimb, using a fascia sparing dissection technique. He showed that muscular and joint connective tissues are continuous, not separate entities. He found that there are specialized connective tissue structures that are found between muscles and the bone of origin or insertion. This connection called the “dynament can adapt to changes in distance between bones as joints open and close, unlike fixed length ligaments, which can only be of optimal length and one joint angle. The continuity of fascia throughout the body can be attributed to its embryologic origin in the mesoderm. (J. C. van der Wal, 2009a; J. C. van der Wal, 2009b) Connective tissue is developed around structures of the body, continuously adapting and transmitting mechanical and chemical signals to differentiate tissue and providing a structural framework for growth. (D. E. Ingber, 2003) Dr. Guimberteau observed the structure of subcutaneous tissue both during surgery and in anatomical specimens, finding a highly repetitive and organized multifibrillar and microvacuolar architecture that allows tissue motion while maintaining connection. (J.C. Guimberteau, 2009; J. C. Guimberteau et al., 2010)

The continuum of fascia throughout the body allows it to serve as a body-wide mechanosensitive signaling system. (Langevin, 2006) Cells in living tissue are anchored to the extracellular matrix through focal adhesions. At these sites, there are clusters of transmembrane receptors, known as integrins, that bind to ECM molecules on the outside of cells to anchor them in place. These integrins provide a path for mechanical stress to transfer across the cell surface and mediate signals within the cell to modulate growth, remodeling, and viability (apoptosis). Studies have confirmed that mechanical forces on cell surface receptors can immediately alter the organization and composition of molecules in the cytoplasm and nucleus of cells (Chen & Ingber, 1999; D. E. Ingber, 2007; Donald E. Ingber, 2010) Furthermore, the mechanical environment within the embryo is critical to its proper development. (Mammoto & Ingber, 2010)

The amount and composition of the Extracellular Matrix (ECM) is constantly changing based on the demands on the tissue and mechanical environment. (Peter P. Purslow, 2010). Fibroblasts in culture and in vivo respond to mechanical loads with measureable effects, such as extracellular calcium influx (through stretch-activated membrane channels), calcium-induced release of intracellular calcium stores, and the release of ATP. These studies indicate that tissue contraction and relaxation may result in a dynamic, body-wide pattern of cellular activity. (Langevin et al., 2011; Langevin et al., 2010) Furthermore the morphology of the embedded fibroblast changes from lamellar to dendritic , depending on the tensional status of the fascial network. (Grinnell, 2000, 2007, 2008)

The Gliding Function of Fascia

All living cells also express some inherent contractility by generating tension within their internal cytoskeleton. (Chen & Ingber, 1999) Fascia plays a dynamic role in transmitting mechanical tension, and may be able to contract in a smooth muscle like manner. In vitro studies of human lumbar fascia show that fascia can autonomously contract, hypothesized to be due to the presence of contractile cells within fascia. Fascia contains fibroblasts, which can transform into myofibroblasts which express a gene for alpha-smooth muscle actin (ASMA) and display contractile behavior. (Schleip et al., 2005)

The force generated by skeletal muscle fibers has been shown to spread throughout connective tissue, outside of the skeletal muscle and tendons. (Benjamin, 2009; Huijing, 1999, 2007; Huub Maas & Sandercock, 2010) These are known as epimuscular myofascial pathways. Proof of these pathways has been shown by force measurements at the origin and insertion of muscle, as well as the demonstration that length changes in one muscle can affect forces in neighboring muscles kept at a constant length. These findings suggest that morphologically defined muscle is not the functional unit, as muscle length-force characteristics are variable depending on the conditions of other entities and cannot be considered a fixed property of the muscle. Furthermore, the sarcomere length within a given muscle may not be uniform along its entire length, resulting in the necessity for micro sliding at and within the muscle fiber level. (Yucesoy, 2009)

Fascia aids in muscle contraction by several mechanisms. It links muscles together and to non-muscular structures via the myofascial pathways described above, and the direct attachment of muscles into the connective tissue structure around the joint. For example, none of the muscle fibers of the supinator muscle insert directly onto the humeral epicondyle, but go instead to a connective tissue apparatus. (J. C. van der Wal, 2009a; J. C. van der Wal, 2009b)

Over 200 vivo hand dissections show the complex network of connective tissue that facilitate sliding adaptation and mobility of structures within the body. Direct and of mechanically adaptable multimicrovascular and fibrillar tissue connections between the tendon and the tendon sheath provide vascular access to the tendon. This tissue allows sliding of structures without any dynamic influence on surrounding tissues and can be found everywhere in the body, not just in tendon sheaths. (J.C. Guimberteau, 2009; J. C. Guimberteau et al., 2010)

Furthermore, even within a single muscle individual fibers must be able to slide next to each other as the muscle changes shape as it changes length. However, muscle fibers can act in unison by shear force transmission across the very small distance of the endomysium. (P. Purslow, 2009)

Loose connective tissue present between the deep fascia and underlying muscles permits sliding of muscles. (C. Stecco, 2012) This has also been demonstrated by dynamic ultrasound imaging of layers of the thoracolumbar fascia. (Langevin, 2009) There is also a layer of lubricating hyaluronic acid between the deep fascia and the muscle, about 100 microns thick (McCombe et al., 2001) which is just at the limit of resolution of newer musculoskeletal ultrasound equipment. Collagen sheets that form layers of connective tissue promote skin sliding and stretching, and allow the skin to maintain its original shape. (Benjamin, 2009) Fascia plays an important role in separating and organizing muscle groups into compartments. The groups of synergistic muscles are believed to increase the efficiency of muscle contraction, as it has been shown that a small elevation in pressure within each compartment can increase the contractile efficiency of all of the members within the group. (P. P. Purslow, 2002)

Innervation of Fascia

Fascia is richly innervated. (J. C. van der Wal, 2009a; J. C. van der Wal, 2009b) Nerves have a three-fascial layer structure. Endoneurium covers individual axons, perinurium covers bundles of axons, and the epineurium is a thicker layer that covers the perinurium. All layers of the nerve are innervated, and have a plexus of nociceptors. (Bove, 2007, 2008) Fascia contains abundant free and encapsulated nerve endings, and they have been described in the thoracolumbar fascia, the bicipital aponeurosis, and various retinacula. (Benjamin, 2009) Nerve fibers are found in deep fascia. (Bhattacharya et al., 2010) The thoracolumbar fascia (TLF) is densely innervated with different nerve ending distributions in different facial layers (Tesarz et al 2011). Free sensory nerve endings supply nociceptors. sensory thoracolumbar fascia fibers give input to lumbar dorsal horn neurons, indicating that this may be a source of lower back pain. (S. Mense, 2007; J Tesarz, 2009; J. Tesarz et al., 2011)

Fascia plays an important role in proprioception. Muscle spindles are not located uniformly within muscle, but concentrate in areas of force transmission to the fascia surrounding the muscle. (J. C. van der Wal, 2009a; J. C. van der Wal, 2009b) A specific pattern of proprioceptor activation occurs when there is fascial tension, and it is directly associated with the deep fascia's relationship to muscle. (Benjamin, 2009)

Fascia contains several terminal endings of nociceptors, responsible for muscle pain. Nociceptors detect stimuli that are capable of damaging tissue such as mechanical overloading and trauma, and inflammatory mediators such as bradykinin, serotonin, and prostaglandin E2. (S. Mense, 2007; Siegfried Mense, 2008) Muscle nociceptors, imaged by light and electron microscopy, were found to be present in all types of tissues within muscle: connective tissue, extrafusal and intrafusal muscle fibers, adventitia of arterioles and venuoles, fat cells, and tendons. (Bhattacharya et al., 2010) These nerve endings directly transduce noxious mechanical stimuli. The in vivo response of individual mechano-nociceptors is dependent on their physical connection to the ECM. (Khalsa, 2004, 2007)

Fascia is also capable of transmitting electrical signals throughout the body. One of the main components of fascia is collagen. Collagen has been shown to have semiconductive, piezoelectric and photoconductive properties in vitro. Electric currents can flow over much greater distances than ionically derived potentials. These electronic currents within connective tissue can be altered by external influences, and cause a physiologic response in neighboring structures. (Langevin, 2006) However, exploration of the change in bone structures in response to stress (Wolffs law) suggests that fluid flow within tissue is more important than piezoelectric effects. (Ahn & Grodzinsky, 2009) .

Fascia and Fluid Flow

Loose connective tissue harbors the vast majority of the 15 liters of interstitial fluid. (Reed et al., 2010; Reed & Rubin, 2010) This flows through an extracellular matrix which contains cells such as fibroblasts, tumor cells, immune cells, and adipocytes. Interstitial fluid flow can have important effects on tissue morphogenesis, function, cell migration, differentiation, and remodeling, and fibroblast cells embedded in the extracellular matrix align themselves perpendicular to the direction of fluid flow. Variations of content of water, ions and other substances can alter the biomechanical properties of loose connective tissue. The slightest change in fluid flow can alter the shear stress on a cell surface and alter the biochemical environment of the cell. Interstitial flow regulates nutrient transport to metabolically active cells and plays a crucial role in maintaining healthy tissue. It can also give directional clues to cells by guiding lymphocytes and tumor cells to lymph nodes or towards lymphatic capillaries. (Rutkowski & Swartz, 2007)

Blood flow to skeletal muscle is tightly regulated by its metabolic demands. When muscles contract, the local arterioles rapidly dilate by a mechanism which is not regulated by the skeletal or autonomic nervous system but rather by a direct mechanical connection. Tensile forces from contracting skeletal muscle alter the conformation of fibronectin fibrils running from the muscle to the nearby arteriole. This pulls open the nitric oxide receptor and causes local vasodilation. (Hocking et al., 2008)

Fluid volume is regulated by interstitial hydrostatic and colloid osmotic pressures, which are constantly readjusting due to alterations in capillary filtration and the lymphatics. Connective tissues can alter transcapillary fluid flux by altering cell tension on dermal fibers which surround the hydrophilic ground substance and prevent its osmotic pressure from drawing fluid out of the capillary. When these fibers relax, this allows glycosaminoglycan ground substance to expand and take up fluid, resulting in edema formation. (Reed et al., 2010; Reed & Rubin, 2010)

Summary

Manual therapy techniques treat the fascial layers by altering density, tonus, viscosity, and the arrangement of fascia. (Crane et al., 2012; Pohl, 2010; Simmonds et al., 2012) The manual stimulation of sensory nerve endings may lead to tonus changes in muscle. The fascial system is now being recognized as an etiology of pain and proprioception. Myofascial trigger points are local thickenings of individual muscle fibers that are caused by contractions of a small group of sarcomeres. (Mense, 2008) Fascia research can help understand aspects of musculoskeletal problems such as myofascial trigger points, low back pain, and fibromyalgia. Connective tissue is also intimately associated with other tissues and organs, so it may influence the normal or pathological processes in a wide variety of organ systems. As specific applications to manual therapies are being developed, guidelines for treatment of low back pain will become available.

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INFLUENCE OF EXERCISE ON COLLAGEN SYNTHESIS AND ON OTHER ASPECTS OF MATRIX REMODELING

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Human tendon and intramuscular connective tissue demonstrate a moderate collagen synthesis and degradation in the state of normal bodily activity, and mechanical loading of human tendon results in an up-regulation of collagen synthesis. The exercise stimulated increase in collagen formation remains elevated for about 3 days after exercise, and is associated with a stimulation of collagen degradation. Insulin-like growth factor I, transforming growth factor beta, interleukin 6 and estrogen can each be shown in humans to have a stimulating effect upon collagen synthesis. However, the basic core structure of tendon matrix remains unchanged in normal tendon in the adult life time, and much adaptation occurs during childhood and adolescence. In vitro experiments upon human tendon cells indicate that mechanical loading is crucial for an optimal stimulation of collagen synthesis. Anti-inflammatory medication is shown to limit the exercise related responses in collagen synthesis. It is suggested that the development of tendon overuse injury (tendinopathy) is related to a mismatch between anabolic and catabolic signaling upon collagen turnover.

Signaling for collagen synthesis and degradation is upregulated with tendinopathy, whereas only controlled loading (strength training) results in any manifest rise in collagen synthesis and a normalization of tendon fibril structure.

ELECTRICAL IMPEDANCE COMBINED WITH SONOELASTOGRAPHY AS A TOOL FOR THE EXAMINATION OF LUMBAR FASCIA

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Introduction
Electrical impedance is a parameter which can be used to determine the amount of water within human tissue. Measuring impedance using various frequencies and considering the physical aspects of impedance, it is also possible to differentiate between intracellular and extracellular water. Ultrasound elasticity imaging has recently attracted attention as a technique which directly reveals the physical property of fascial tissues and makes it possible to quantify changes in, for example, tissue hardness due to pathology. As manual myofascial treatments often claim to change the properties of tissue, this device can also be used to assess changes in thickness as well as stiffness before and after fascial manipulation.

Purpose/Aim
In order to characterize tissue properties, we utilized ultrasound and impedance measurements before and after a short manual treatment of the lumbar region using Rolfing® techniques.

Materials and Methods
The erector spinae region between the 2nd and 4th lumbar vertebra of 59 subjects was manually treated for 3 to 5 minutes until the practitioner felt the tissue becoming softer. Measurements were taken before and after the tissue manipulation (TM) in order to compare parameters of electrical impedance, such as resistance, reactance and phase-angle, and a histogram was generated via sonoelastography. Subjects were asked beforehand about their sex, age, body mass index, level of activity and history of pain.

Results
All parameters of the impedance measurements resulted in a significant rise during the TM (impedance at rest: 73 ± 18; during TM: 76 ± 19 Ohm)(Fig.1). After the TM the extracellular parameters, i.e. impedance and resistance, remained high, whereas reactance and phase-angle, which represent intracellular water content, returned to pre-TM levels dirctly after the TM. Divided into subgroups, women (n = 30) showed about 20% higher levels in median impedance and resistance compared to men (n = 28), but smaller reactance and phase-angle (Fig. 2). At rest, the participants over 60 years of age showed the highest impedance (81 ± 23 Ohm) compared to the probands between 40 and 59 years (74 ± 12 Ohm) and under 40 years (65 ± 23 Ohm). This age-dependence was observed at all times of the measurement. Furthermore, reactance and phase-angle decreased with age, hinting towards decreased intracellular water content in comparatively older individuals.
The evaluation of sonoelastography resulted in a histogram median of 76 ± 34 at rest and 84 ± 30 after the TM. Here, the TM-induced changes were highly variable, however the female participants had a significant increase from 76 ± 35 to 85 ± 30, whereas the male participants expressed a reduction from 77 ± 32 to 73 ± 30 units.

Conclusions and Discussion

Both measurement methods used in combination yield significant information about the tissue changes during and after manual treatment (Fig. 3). Sonoelastography makes it possible to visualize softening in the lumbar fascia and delineates the location where this softening takes place. The tissue reacts differently depending on the sex, age, weight, pain history and activity level of the person. Since there is no data about the normal impedance of different kinds of human tissue, more detailed research is necessary to estimate individual variations.

Implications

Manual therapists often claim to feel the tissue become softer in a so-called "release". This effect could be quantified via impedance and sonoelastography measurements, providing a tool for evaluating the therapeutic effect of tissue manipulation. Both methods also point to some individual risk factors for lumbar restrictions and back pain and are very compliant to the person receiving a treatment.

Another aspect is the visualization and quantification of the TM for the therapist himself, giving a sincere feedback of his manual work.

Keywords

Lumbar fascia, impedance, sonoelastography, manual treatment

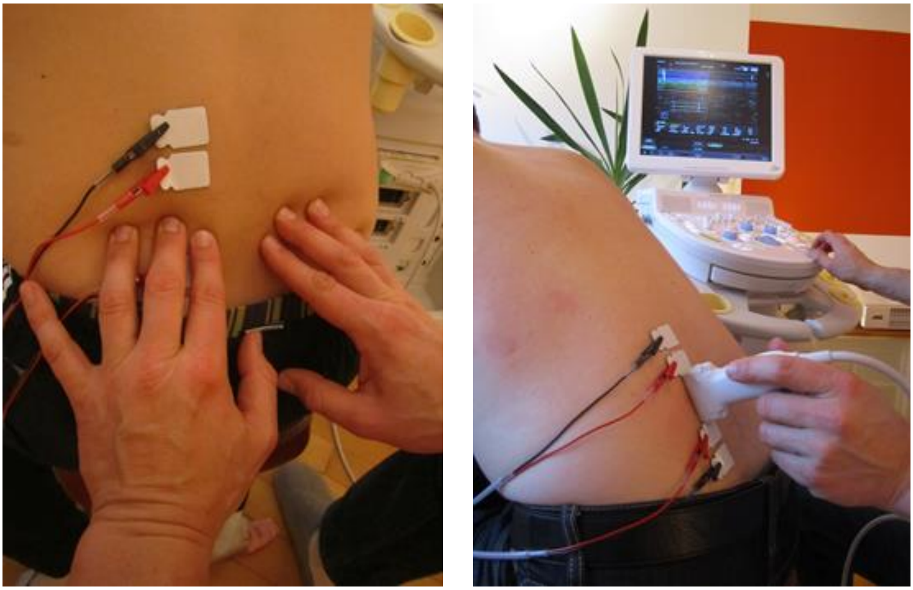

Fig. 1: The experiment started with the subject in a seated position, making it easy to carry out the measurements without the need for position change. Electrodes were then attached to the skin with a spacing of approximately 6 cm; this was just enough space to fit the ultrasound device between the sensors. The tissue-manipulation was done only at this part of the back due to the fact that we only wanted to assess local effects.

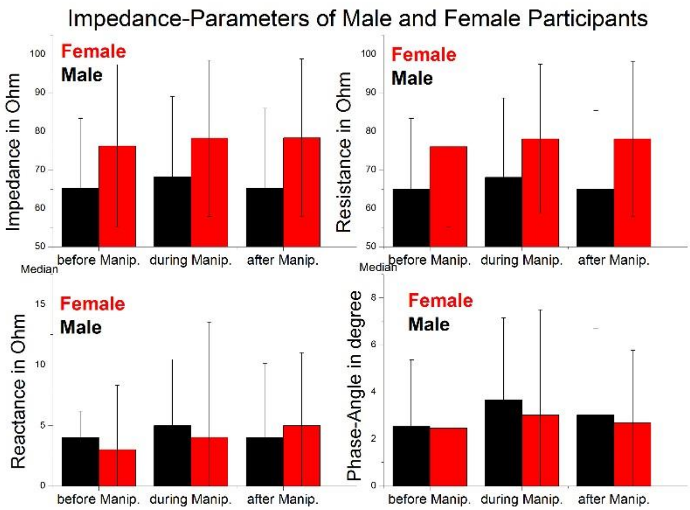

Fig. 2: Median ± SD impedance-parameters before, during and after tissue-manipulation. Male and female participants show gender specific differences in impedance and resistance. These parameters are linked to the extracellular water content and pointing towards a lower interstitial hydration in women. The so-called intracellular parameters, reactance and phase angle do not show statistically significant gender effects. Manual treatment resulted in a tendency towards higher resistance and phase angle parameters, only reaching the level for significance in female probands.

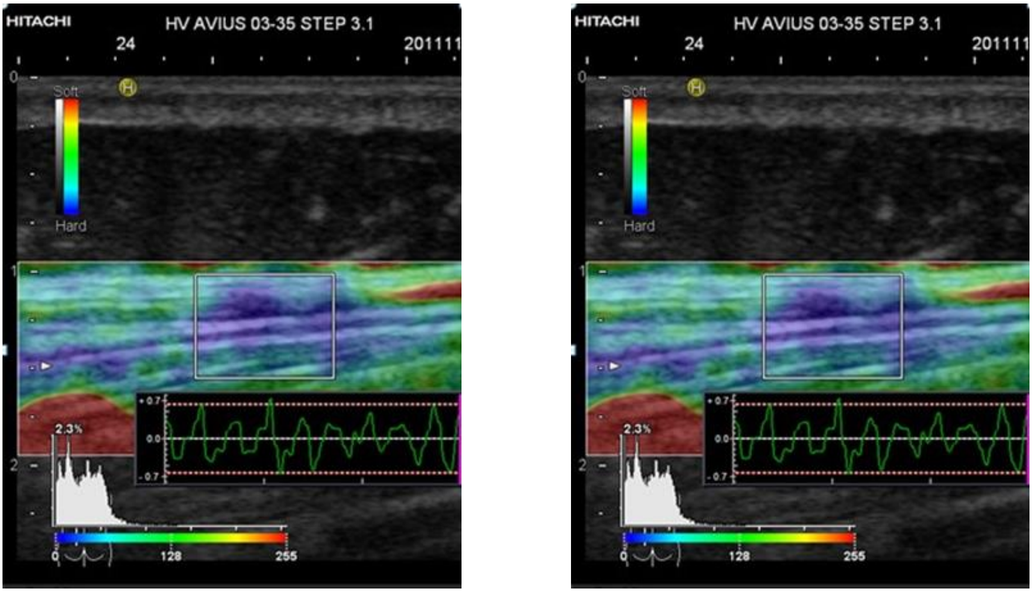

Fig. 3: Sonoelastographic images of the lumbar fascia before and after the treatment show a change in colours from blue (hard tissue) to green (middle) along the histogram at the bottom left. This figure shows original sonoelastography images from the lumbar region taken before, during and after manual treatment of a 24 years old male proband. A) At rest the lumbodorsal fascia region is characterized by a low histogram median and a blue color code resembling a rather hard tissue structure. After manual treatment (B) the tissue becomes softer, which is quantified by increasing histogram median and green color in the region of interest.

POSSIBILITIES AND LIMITATIONS OF FASCIA ORIENTED CONCEPTS IN RESEARCH AND TREATMENT OF LOW BACK AND PELVIC PAIN

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Fascia: from the Cinderella of Orthopedic Science towards a New Miracle Tissue?

During many decades fascial tissues were mostly regarded as inert packing organs within the field of musculoskeletal medicine. Their description hardly took on more than a few paragraphs in classical anatomy textbooks, compared with the detailed attention given to muscular tissues and the skeleton. While precise measurement of bones and muscles had been possible for a long time (via X-ray, EMG), the ubiquitous fascial net was hard to grasp in terms of a reliable quantitative assessment.

Enhanced by the first Fascia Research Congress in 2007 plus a subsequent coverage in 'Science' (Grimm 2007) a drastic shift of attention could be observed during recent years. The number of research papers on fascia in peer-reviewed journals has shown a rapid rise (Findley 2012). Similar to the rapidly growing field of glia research in neurology, there is now a global recognition that this underestimated contextual tissue plays a much more important role in health and pathology than was estimated during previous decades.

Among the many surprising fascial properties, which are now being discovered and investigated, are the following:

- The bodywide fascial web as an interconnected tensional force transmission network (Turina et al. 2013)
- The elastic storage capacity of fascial tissues in sports (Kawakami et al 2002)
- Adaptive tonicity changes in fascial tissues, driven by cellular dynamics (Schleip et al. 2006)
- Fascia as sensory organ for proprioception (Stecco et al. 2007, Schleip 2012)
- Nociceptive properties of fascial tissues (Tesarz et al. 2011).

This general trend has also affected the field of low back pain research. Recent studies suggest a potential role of the lumbar fasciae in the force transmission between lumbopelvic trunk and legs (Willard et al. 2102) as well as between arms and lower back, see Fig. 1 (Carvalhais et al. 2013). Changes in the morphology of the lumbar fascia have been observed between chronic low back pain patients compared to normal controls (Langevin et al. 2011). In addition the presence of nociceptive nerve endings has been documented in the lumbar fascia of both rats and humans (Tesarz et al. 2011).

Based on these inspiring developments some authors and practitioners now suggest that fascia oriented treatments may provide ultimate solutions to a vast majority of back related questions and pathologies. The question therefore merits exploration: What are the limits and possibilities of a fascial oriented focus in the investigation of low back and pelvic pain as well as in the related clinical treatment?

New Research Possibilities

While fascial tissues such as the lumbar fasciae or the iliotibial tract can sustain substantial tensional forces, their thickness is very small; ranging usually between 0.3 and 1.7 mm. In the past most imaging methods were not able to recognize small but significant changes in these planes (e.g. a thickness increase of 20%).

In addition, the stiffness and elasticity of these sheet-like tissues were commonly assessed by manual palpation only, however without clear objective parameters.

Due to technological advances several new assessment tools are now available which make a more reliable investigation of fascial tissues and fascial properties possible. Among these are modern sonographic technologies, which allow for a resolution of 0.1 mm and less, if applied to tissues like the superficial layer of the lumbar fascia. Furthermore, sonographic elastography has advanced to a degree where it promises to replace the refinement of at least some manual tissue palpations, in terms of measuring tissue stiffness (Sconfienza et al. 2013). Similarly, mechanographic myometry tools, like the newly available and portable MyotonPro, allow for measuring the viscoelastic parameters, such as the elastic storage capacity, in fascial tissues situated close to the surface (Aird et al. 2012).

Advances in histology - including the use of biopsies and of microdialysis - also offer promising aspects for this field, in addition to the rapid improvements in the field of matrix biology.

Current Research Limitations

Nevertheless, many pathological fascial adhesions, such as in peripheral nerve disorders are still not recognizable in many cases, no matter how agonizing they may be for the patient. Often they are only visible during subsequent surgery in that area (Brüggemann et al. 2010). Measurement of deeper layers would require magnetic resonance imaging, which is usually associated with financial restrictions as well as limitations in terms of client positioning (Xie et al. 2013).

Many recent investigations on fascial properties have been performed on rodent animals. Extrapolation of the related findings may be questionable, particularly in relation to the lumbopelvic area in humans, which serves a different function in us bipeds than in quadruped animals.

When it comes to clinical research an increasing difficulty is posed by severe differences in language and mentality that are frequently found between fascia oriented clinicians and academic researchers (Grimm 2007).

Treatment Possibilities

Several manual therapies claim to be able to improve myofascial pain conditions via massage-like manipulation of related fascial tissues. These include the Rolfing method of Structural Integration (Fig. 2), osteopathy, chiropractic, connective tissue massage, various brands of myofascial release, and others.

Anecdotal reports are usually positively overwhelming, including successful treatment cases which would otherwise been headed for low back surgery. Randomized controlled trials exist for osteopathic as well as chiropractic treatments, indicating that at least in some circumstances these manual treatments are effective treatments for acute back pain (Liccardione et al. 2005, Rubinstein et al. 2013).

A recent study suggests that application of 10 minutes of daily yoga-like static trunk extension seems to exert analgesic effects in previously inflamed lumbar fascial tissues of rats (Corey et al. 2012). It remains to be seen whether a related therapeutic application with humans may induce similar beneficial improvements.

Besides manual therapies, multiple forms of tool-assisted therapies exist, which claim to improve low back and/or pelvic pain conditions via stimulation of fascial tissues. These include metal needles, such as in acupuncture or dry needling, as well as various rubbing and vibratory devices. For acupuncture as well as Gua Sha randomized trials tend to suggest clinical improvements in acute back pain in at least some cases.
A diminished lateral shear motion of the superficial layer of the lumbar fascia during passive lumbar flexion has been observed in low back patients (Langevin et al. 2011). It is possible that this feature is a result of pain induced immobility rather than the cause of it. However, a surprising richness of proprioceptive nerve endings has subsequently been found in the sliding zone between this fascial layer and the overlying subcutaneous connective tissue (Tesarz et al. 2011). While a lowered lumbopelvic proprioceptive acuity has been described as a contributing factor in back pain (Lee et al. 2010), it seems possible that an inhibited sliding motion between lumbar superficial fascial layers may be part of these dynamics. Based on that background the recent rat study by Bove & Chapelle (2012) deserves particular attention, which showed that post-surgical adhesions could be lysed with a gentle myofascial mobilization.

Treatment Limitations

While the above described release of fresh fascial adhesions is impressive, it is questionable whether the force and time parameters of manual treatments are sufficient to alter the biomechanical properties of more dense tissues, such as are found in long term fibrotic adhesions, at least when viewed as an immediate effect of the mobilization (Chaudhry et al. 2008).
The missionary attitude of many fascia related complementary medicine practitioners could play an influential factor in the important psychosocial dynamics of low back pain. While being helpful in many aspects of the treatment, the same mentality could go along with a partial blindness of the related practitioner towards factors that contradict her/his optimistic treatment expectations. Bias control is a difficult feature in manual therapies and related studies. Mehling et al. (2005) suggested several methodological modifications for related clinical studies, which promise significant improvements in estimating the magnitude of the involved psychosocial expectation factors. Unfortunately very few fascia related clinical studies have attempted to incorporate these methodological suggestions.
Finally, fascia oriented treatments will find their limitations in all those cases, in which low back or pelvic pain is clearly caused by non fascial causes, such as in a sequestered intervertebral disc herniation with accompanying cauda equine syndrome, or in endometriosis related pelvic pain.

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Photo credits: Fig. 1 WikiMedia Commons Repository/Anatomist90. Fig. 2 European Rolfing Association e.V.

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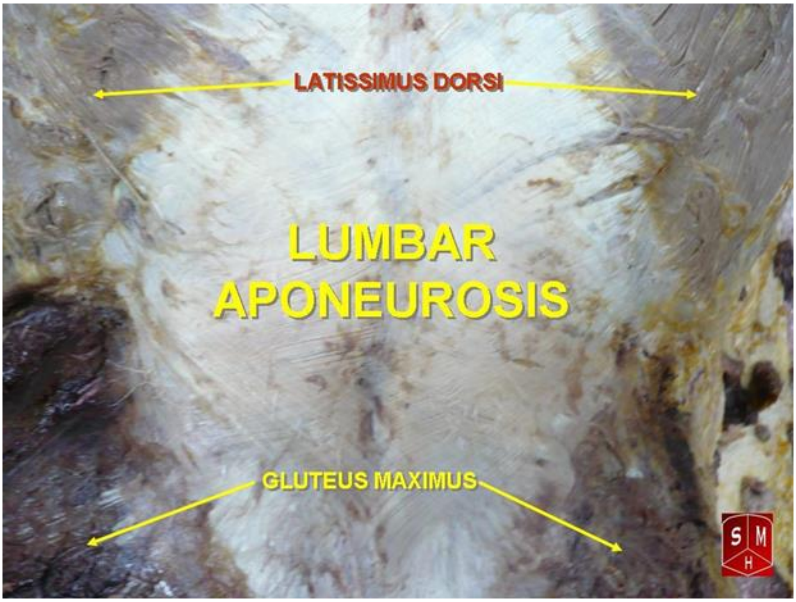

Fig. 1: The lumbar aponeurosis of healthy persons tends to express a lattice-like fiber orientation. This arrangement allows for a strain transmission between arms and lumbar fascia (via the latissimus dorsi) as well as between the upper legs and the lumbopelvic region (via the gluteaus maximus).

Fig. 2: In the Rolfing method of Structural Integration the lumbar fasciae are treated with slow but strong manual pressure and shear application (up to 100N per hand) with the aim of increasing proprioceptive refinement and loosing fascial adhesions in this area. During the maneuver demonstrated here the patient is instructed to perform a smooth lumbar flexion in slow motion while gently breathing into the hands of the practitioner at her back. The practitioner tries to hold the tissues medial (preventing them to slide laterally apart) and also moves them slowly in a caudal direction during the client's forward bending motion.

COST-EFFECTIVENESS OF INTERVENTIONS FOR LOW BACK PAIN IN PRIMARY CARE

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Most people with low back pain are treated in primary care and only a small proportion of those are referred to secondary care. Eleven studies investigated the cost-effectiveness of usual GP care. Adding advice, education and exercise, or exercise and behavioural counselling, to usual GP care was more cost-effective than usual GP care alone. Clinical rehabilitation and/or occupational intervention, and acupuncture were more cost-effective than usual GP care. In conclusion, GP care alone did not appear to be the most cost-effective treatment option for low back pain. GPs can improve the cost-effectiveness of their treatment by referring their patients for additional services, such as advice, education and exercise.

Twenty-six studies investigated the cost-effectiveness of guideline-endorsed treatments. There is evidence supporting the cost-effectiveness of multidisciplinary rehabilitation, exercise, acupuncture, spinal manipulation and cognitive-behavioural therapy for sub-acute or chronic LBP. There is little or inconsistent evidence for other treatments endorsed in the guideline.

Although there is an increase in the number of economic evaluations published, still most randomized trials only evaluate effectiveness and not cost-effectiveness. More economic evaluations on primary care interventions for LBP are direly needed.

Introduction

Low back pain (LBP) is a common health condition which affects up to 80% of adults at some point during their life [1]. The source of symptoms cannot be identified in most patients. Consequently, most patients are labelled having non-specific LBP, and are treated in primary care [2]. Patients with back pain associated with radiculopathy or spinal stenosis [3] and the rare patients whose LBP can be attributed to a disease or condition such as fracture, tumour or infection are managed in secondary care [4].

In Europe LBP is the disease with highest burden to patients and society [5 Vos et al.] The costs of LBP are tremendous, especially due to high costs of productivity losses [6]. Direct and indirect costs of LBP in the UK in 1998 were estimated at £1,632 million and £3,440 million, respectively [7]. In the US, healthcare costs among people with LBP increased by 65% from 1997 to 2005, and accounted for 9% of the total healthcare costs in 2005 [8]. In the Netherlands, the total costs of back pain decreased from € 4.3 billion in 2002 to € 3.5 billion in 2007, which equalled about 0.9% of the gross national product in 2002 and 0.6% in 2007 [9]. The high costs associated with LBP illustrate the need to efficiently use available healthcare budgets when managing LBP.

An economic evaluation evaluates the costs and effects of two or more alternatives [10]. It does not necessarily answer the question of what the cheapest intervention is. If an intervention is more effective than another intervention but associated with higher costs, the intervention may still be cost-effective if the ratio of costs and effects is acceptable to policy makers. Hence, economic evaluations are designed to inform policy makers, but they may be useful to clinicians and consumers as well.

Many health care professionals are involved in primary care for LBP, such as general practitioners (GPs), physiotherapists, manual therapists, chiropractors, osteopaths, psychologists/psychotherapists and occupational physicians and therapists. The relative contribution of each of these professionals may vary across countries. In this article, based on two systematic reviews [11,12], we describe the costs-effectiveness of LBP interventions in primary care.

Cost-Effectiveness of GP Care

Eleven studies reported on cost-effectiveness of GP care [13-24]; one study reported one- and two-year results in two separate articles [19,20]. The number of participants ranged from 104 to 1334. Most studies included participants with sub-acute to chronic LBP. Of the 11 included studies, nine studies were conducted in Europe and one in the US [18] and one in Canada [20].

Most studies evaluated “usual GP care”. That is, they did not specify whether the treatments followed a protocol or guideline but provided care that included advice, exercises, rest and prescription of medications with or without referrals to other services [13,15,16,18,24] A number of studies did not describe details of the GP care, except that it was the normal or usual care provided by a GP [17,21-23] which may include referrals to other services [19,20,21]. The UK BEAM Trial provided training to GPs to deliver care according to the UK guideline for the management of LBP [14].

GP care alone versus another treatment

Eight studies investigated the cost-effectiveness of usual GP care alone versus another treatment. The costs of usual GP care alone were lower than other treatment if only costs to the healthcare sector were considered [15,16,21,23,24]. However, usual GP care alone was generally associated with higher costs than other treatment if a societal perspective was used and costs associated with loss of productivity were included [16,17,21,22]. There were no statistically significant between-group differences for most comparisons. The Alexander technique [21] and clinical rehabilitation and/or occupational intervention [17] appeared cost-effective compared to usual GP care alone. Massage was more costly and less effective than usual GP care alone, and therefore in this study GP care alone was the dominant treatment [21]. Ratcliffe et al found, when costs were considered from the societal perspective and using intention-to-treat analysis, that acupuncture was dominant compared with usual GP care alone [24].

GP care plus other treatment versus other treatment

Only one study was included in this comparison [21]. This study compared usual GP care plus exercise and behavioural counselling with massage or the Alexander technique plus exercise and behavioural counselling from the healthcare perspective. The incremental cost-effectiveness ratio’s (ICERs) for Alexander technique and massage compared with GP care were low, suggesting that these treatments were cost-effective compared to usual GP care (ICER for massage plus exercise and behavioural counselling = 5,304 per QALY gained, for the Alexander technique plus exercise and behavioural counselling = 5,332 per QALY gained, in 2005 GBP).

GP care alone versus GP care plus additional treatment

Four studies compared usual GP care alone versus usual GP care plus additional treatment [13,15,19-21]. The costs of usual GP care alone were lower than usual GP care plus additional treatment if only costs to the healthcare sector were considered [15,21]. However, in studies that included the costs associated with loss of productivity, the total costs were lower when additional treatment was added to usual GP care [13,19-21]. Adding exercise and behavioural counselling to usual GP care improved pain-free days (mean between-group difference = 11 days, 95% CI 1 to 23) and appeared relatively cost-effective from the healthcare sector’s perspective [21]. Adding advice, education and exercise with or without worksite visit to usual GP care improved some outcomes (e.g. pain bothersomeness) and appeared cost-effective [19,20]. One study found that adding neuroreflexology to GP care improved pain and disability, but not quality of life, outcomes [13]. However, there was no incremental cost-effectiveness analysis reported, and an ICER could not be estimated based on the data provided.

One study investigated the cost-effectiveness of guideline-based GP care, and found similar results to studies that investigated usual GP care [14]. From the healthcare sector’s perspective, guideline-based GP care alone incurred lower costs compared to guideline-based GP care plus exercise and/or spinal manipulation. Adding spinal manipulation to guideline-based GP care was effective in managing sub-acute to chronic LBP (mean between-group difference = 0.04 QALYs),

and the ICER was low (£4,800 in 2000 to 2001 GBP per QALY gained from the healthcare sector's perspective). In contrast, adding both spinal manipulation and exercise to guideline-based GP care did not statistically significant increase the number of QALYs gained compared to guideline-based GP care alone, but would only cost £3,800 per QALY gained.
This shows that the most effective treatment may not be the most cost-effective treatment, as cost-effectiveness analysis considers costs relative to effects.

Cost-Effectiveness of Guideline Endorsed Treatment

A total of 26 studies were identified [25-53]. Results of two separate studies [25,26] were reported in one paper [27]. One- and two-year follow-up results of two studies were published separately [28-31]. Most studies recruited participants with sub-acute or chronic LBP. One study recruited participants sick listed for less than two weeks due to LBP [38]. Most studies were conducted in the UK [39-47] or other European countries [28-31,33-36,38,48-52]; three studies were conducted in the US [27,37] and two in Canada [32,53].

Advice (evidence-based information)

A total of nine studies were included. Six studies compared advice to another treatment [27-29,34,45,53], and three compared adding another treatment to advice with advice alone [30,31,33,43]. Regardless of the comparison and the economic perspective adopted, results regarding the cost-effectiveness of advice were inconsistent across the studies. Four studies suggested that advice may be more cost-effective than treatments received in primary care [28,29,34] or a book on back pain care [27], but other studies reported a cost-effectiveness ratio or cost-benefit outcome which favoured adding naturopathic care [53], graded activity [33],or manipulation and stabilizing exercises [30,31] over advice alone, or physiotherapy over advice [45]. In a study comparing adding manipulation and exercises to advice alone [30,31], it is unclear why the reported cost-effectiveness ratio was positive for pain and but negative for disability, given that costs were identical and the direction of benefits was the same for both outcomes.

Addition of spinal manipulation for acute LBP

Only one study investigated the cost-effectiveness of spinal manipulation in people with acute LBP [38]. Results of this cost-minimization study showed that the differences in costs over one year compared to GP care or exercise were small. However, there was no formal statistical comparison and this study did not include all relevant costs.
Multidisciplinary rehabilitation, exercise, acupuncture, massage, spinal manipulation, yoga, cognitive-behavioural therapy or relaxation for sub-acute or chronic LBP
Fifteen studies investigated the cost-effectiveness of multidisciplinary rehabilitation, exercise, spinal manipulation or cognitive-behavioural therapy. These interventions were compared to conventional physiotherapy [36,39,40,50], GP care [32,35,37,42], spinal surgery [36] or walking [46], or as an additional treatment to advice [30,31,33], GP care [41,43,47] or inpatient rehabilitation [51]. Regardless of the comparisons and the perspectives adopted, all but two studies [37,39] found that these interventions were cost-effective compared to the treatment alternatives.

Discussion

In this article, we presented results of two systematic reviews of economic evaluations of primary care treatments for LBP. Most studies examined the cost-effectiveness of treatments for patients with sub-acute or chronic LBP.
The economic evaluations of GP care showed that the perspective chosen may influence the final results and conclusions. From the healthcare sector's perspective, GP care was associated with lower costs than other treatment alternatives, and this finding was consistent across healthcare systems. However, from a societal perspective, if the costs associated with loss of earnings or changes in productivity were included, GP care generally incurred higher costs than other treatments. Most treatments appeared relatively cost-effective compared to GP care. This

suggests that GP care alone may not be the most cost-effective treatment for LBP, yet currently GP guidelines recommend a wait-and-see policy instead of referral to another healthcare service. The economic evaluations of guideline-endorsed treatments showed that multidisciplinary rehabilitation, exercise, acupuncture, spinal manipulation and cognitive-behavioural therapy were relatively cost-effective for people with sub-acute or chronic LBP.

Because both the incremental costs and the effects are taken into account in an economic evaluation, a treatment may be relatively cost-effective compared to an alternative treatment even if the difference in clinical effectiveness is small. Hence, future studies should consider including an economic evaluation in order to provide comprehensive information on both effectiveness and efficiency of treatments in managing LBP.

There were some methodological issues that limit the interpretation of our findings. These include the incomplete identification and measurement of costs in some studies, which reduces the rigor of the results. Some studies had follow-up periods that are likely to be too short for measuring all relevant economic consequences. Generalizability of economic evaluations is a challenge. Whilst it seems reasonable to assume that individuals or groups are likely to react in the same way to a particular intervention, no matter where they live, comparing economic data across different settings or countries is not as straightforward due to differences in the structure and organization of healthcare systems. For example, in some countries patients may have direct access to medical specialists or other healthcare providers while in other countries patients need a referral from a primary care physician. Access to some care providers may be limited in some countries where this care is not provided by a public healthcare system or is not reimbursed by an insurance scheme. Cost data may also be sensitive to the funding and reimbursement arrangements in a particular healthcare system.

Although we identified an increasing number of economic evaluations being published in the last decade, most randomized controlled trials do not consider cost-effectiveness. We would strongly recommend adding an economic evaluation to future trials, so that policy makers, care providers and consumers can not only take information on effectiveness into account when considering treatment options, but also information on cost-effectiveness.

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Treatment-based subgroups of low back pain: A guide to appraisal of research studies and a summary of current evidence

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There has been a recent increase in research evaluating treatmentbased subgroups of non-specific low back pain. The aim of these sub-classification schemes is to identify subgroups of patients who will respond preferentially to one treatment as opposed to another. Our article provides accessible guidance on to how to interpret this research and determine its implications for clinical practice. We propose that studies evaluating treatment-based subgroups can be interpreted in the context of a three-stage process: (1) hypothesis generation–proposal of clinical features to define subgroups; (2) hypothesis testing–a randomised controlled trial (RCT) to test that subgroup membership modifies the effect of a treatment; and (3) replication–another RCT to confirm the results of stage 2 and ensure that findings hold beyond the specific original conditions. At this point, the bulk of research evidence in defining subgroups of patients with low back pain is in the hypothesis generation stage; no classification system is supported by sufficient evidence to recommend implementation into clinical practice.

For about 3 decades, the position adopted in evidence-based treatment guidelines has been that the source of pain cannot be determined for most patients (up to 90%) presenting to primary care with low back pain (LBP). Most guidelines recommend that such patients be assigned to the classification ‘non-specific LBP’ [1–3] and be provided with generic treatment. Recently, there has been some reconsideration of this position and it has been suggested that it may be better to divide patients with non-specific LBP into treatment-based subgroups that inform the choice of specific treatment for that individual [4]. Importantly, this is also the position adopted by many clinicians who use a subgroup approach to direct treatment [5].

Some subgroups are based to some extent on putative pathoanatomy [6], while others are based on clinical findings such as psychosocial characteristics (or yellow flags) [7] or characteristic patterns of signs and symptoms [8]. What unifies most schemes is an underlying belief that the effect of treatment will be greater when patients receive the specific treatment that matches their subgroup. Proponents of treatment-based subgroups argue that this approach offers the possibility of much larger treatment effects than are typically observed after applying generic treatments to all patients with non-specific LBP. The argument is that mean group treatment effects may be diluted by the inclusion of subgroups of LBP subjects for whom the treatment is not effective [9]. If treatment-based subgroups could be reliably identified, it would represent an important advance in LBP treatment, and the pursuit of this goal has been identified as a priority for LBP researchers [10].

The aim of this article is to illustrate the key methodological issues in this area, provide clinicians with a better understanding of the literature in LBP and thus present implications for clinical practice and future research.We begin by defining some key concepts and then describe the process to identify and test the existence of LBP subgroups which respond differently to a treatment. We conclude with a brief summary of the state of evidence so far in relation to subgroups of subjects with LBP.

Key concepts

Treatment effect modification

The effect of treatment is the difference in outcome between the treatment and control groups. A system for treatment-based subgroups needs to reliably identify patients where the effect of treatment is consistently greater than it would be for the whole group. A characteristic that defines the subgroup, for example, gender or high pain intensity, is described as a treatment effect modifier. Subgroups may be defined by the presence of one or several effect modifiers.
The potential for treatment-based subgroups is often justified by reference to the variability of patient outcomes observed in clinical practice and also within the treatment arm of clinical trials. However, variability in treatment outcomes can arise for reasons other than treatment effect modification. For example, variability in outcomes can be due to patients having variable prognoses (regardless of treatment) or because of random variation in a patient's response to treatment. Variability in outcome due to either of these reasons would not contribute to defining a subgroup of patients for which the effect of treatment is consistently greater. What is required is treatment effect modification where subgroups of patients reliably exhibit greater effects of treatment.

Distinguishing treatment effect modifiers and prognostic factors

It is important to distinguish between factors predictive of patient outcomes (prognostic factors) and those that predict treatment effects (treatment effect modifiers). Prognostic factors relate to the susceptibility of a patient's condition to time, while treatment effect modifiers relate to the suscetibility of their condition to a specific treatment. An important point is that single-arm studies cannot quantify treatment effects (difference in outcomes between experimental and control groups) and so cannot identify treatment effect modifiers. Clinically, there may be value in identifying patients with good prognoses; this information may be used to reassure patients and can limit the implementation of unnecessary interventions. However, recognition of the difference between the two concepts is crucial.

Illustrative example: A single-arm study incorrectly interpreted as providing evidence of effect modification. Predicting response of patients with neck pain to cervical manipulation. Tseng and colleagues conducted a prospective cohort study on 100 patients with neck pain, all of whom received cervical manipulation [11]. Outcome was assessed with subjective global improvement or changes in pain rating and patients were classified as 'responders' or 'non-responders' based on these variables. The authors used regression analyses to identify baseline demographic and clinical characteristics associated with outcome. They reported that the following factors predicted the outcome: low disability score, bilateral symptoms, not performing sedentary work, feeling better while moving, not feeling worse when extending the neck and diagnosis of spondylosis without radiculopathy. Their conclusion, however, that these variables predict response to treatment (cervical manipulation) is not supported.
While this study does enable us to identify factors associated with a favourable prognosis, we do not know that it is the effect of manipulation that drives the improved outcome for patients with these characteristics. While prognostic factors and treatment effect modifiers may overlap in some instances [12], in other cases they do not [13]. More importantly there are examples where the same factor predicts a favourable response to treatment although an unfavourable response to time. For example, in Stewart's study of whiplash [14], high baseline pain predicted a greater response to exercise treatment (when compared with advice) but, by itself, high pain is an adverse prognostic factor for spinal pain [15,16]. Accordingly, the use of single-arm studies to generate information on treatment effect modification is unwise [17].

Study design considerations

While there has been a sharp rise in the amount of research evaluating treatment-based subgroups, unfortunately, not all of it is methodologically sound. To establish that subgroup membership influences the effect of treatment, we need a design whereby patients are classified in one subgroup or another, and they receive the treatment or the control, represented by the four cells of a 2x2 table (Fig. 1a). A well-known study that used this design is the Childs et al. [12] trial, which reported that the effect of spinal manipulation was greater in those who were positive on a clinical prediction rule than in those who were negative. As shown in Fig. 1b, the subjects in the trial could be divided into the four cells based upon the treatment they received and their rule status. A modified version of this approach compares the outcomes of patients who were randomised to receive treatment matched to their classification (subgroup) with patients who received treatment not matched to their classification. An example of this is the study of Long et al. [18] where subjects with a directional preference were allocated to exercise in the matched direction, the opposite direction, or all directions. In this case the design can be represented in a 3x3 table (Fig. 1c); this more complex design is discussed further in a later section.

Unfortunately, many researchers have used flawed designs to estimate if subgroups influence treatment effects. One mistake is to give all subjects the same treatment and to compare outcomes in those in the subgroup and those not. As there is no control group, this design cannot estimate the effect of treatment and so cannot establish if subgroup membership influences the effect of treatment. The study of Tseng and colleagues mentioned above is an example of this design (Fig. 1d). The second mistake is to only enroll subjects who fit the subgroup and then allocate subjects to receive or not receive the treatment. While this design can estimate the effect of treatment, it cannot establish if the effect is greater in those within the subgroup than in those not in the subgroup. An example of this is the O'Sullivan et al. [19] randomised controlled trial (RCT) of stabilisation exercise (Fig. 1e). This trial is frequently misrepresented as providing evidence that stabilisation exercise works best in the subgroup of patients with instability but, as all subjects enrolled in the O'Sullivan trial had instability, this conclusion is erroneous.

Process of developing treatment-based subgroups

The process of developing treatment-based subgroups can be divided into three stages (Fig. 2): (1) hypothesis generation; proposal of factors/variables that may be treatment effect modifiers; (2) hypothesis testing; establishing preliminary evidence that subgroups respond differently to one treatment as opposed to another; and (3) replication; testing whether preliminary observations are generalisable when tested outside the bounds of the original RCT.

a

	Treatment	Control
Subgroup 1	A	B
Subgroup 2	C	D

b

	Treatment	Control
Rule +ve	Manipulation	Exercise
Rule -ve	Manipulation	Exercise

c

	Matched	Unmatched	Non-specific
Extension (n=191)	Extension exercises	Flexion exercises	Non-specific exercises
Flexion (n=16)	Flexion exercises	Extension exercises	Non-specific exercises
Lateral (n=23)	Lateral exercises (direction a)	Lateral exercises (direction b)	Non-specific exercises

d

	Treatment
Subgroup 1	Manipulation
Subgroup 2	Manipulation

e

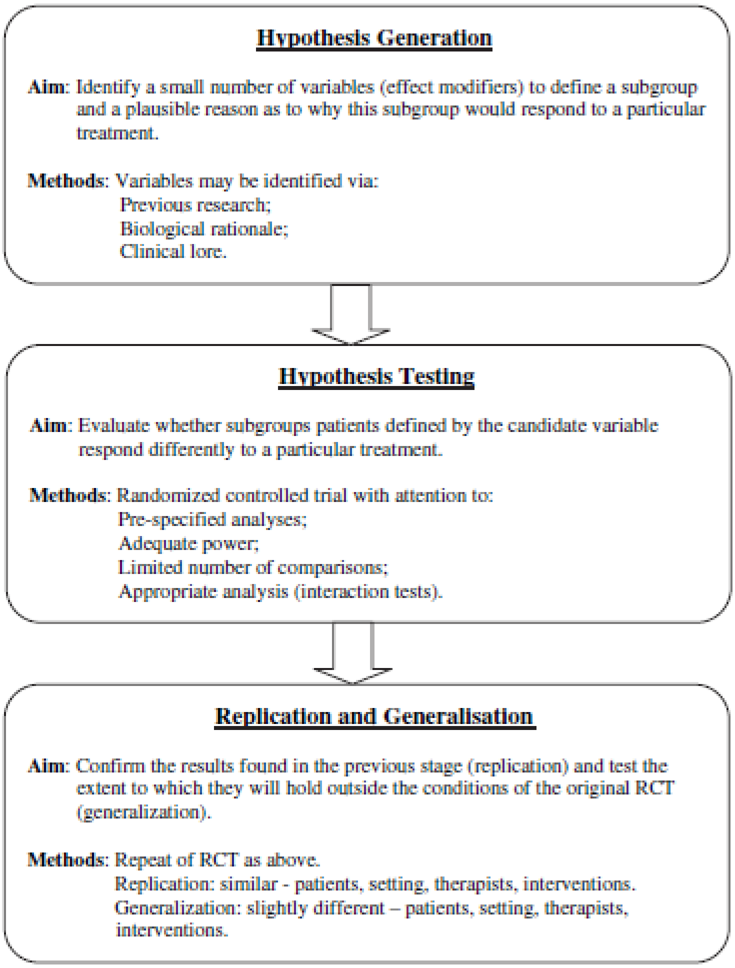
	Treatment	Control
Subgroup 1	Stabilization exercises	Usual care

Fig. 1. a. Design to evaluate treatment subgroups. b. Design used in the Childs et al. trial. c. Design used in the Long et al. trial. d. Inadequate design to evaluate treatment subgroups. This design provides information on prognosis not treatment effects so it cannot provide information on treatment effect modification, e.g. Tseng et al. study. e. Inadequate design to evaluate treatment subgroups. This design provides information on treatment effect but not treatment effect modification, e.g. O'Sullivan et al. study.

1. Hypothesis generation–proposal of potential effect modifiers

The aim of the hypothesis generation step is to obtain a list of plausible characteristics that are worth investigating as potential treatment effect modifiers. Candidate variables may be identified via generalisation, theoretical/biological rationale or clinical lore.

- Generalisation: It is possible that prognostic factors may also be treatment effect modifiers or that effect modifiers for related treatments may generalise; so, candidate effect modifiers may be sourced from previous research; for example, Tseng et al. [11] (example above) found that bilateral symptoms predict better outcome in patients receiving manipulation – this finding may be worth investigating as a potential effect modifier in an RCT.
- Biological rationale: Where there is a strong physiological, anatomical or psychological theory as to why some patients should respond to a particular treatment, for example, non-steroidal antiinflammatory drugs being more effective in patients with inflammatory pain [20].
- Clinical lore: the experience of respected clinicians or established texts may be used to propose candidate variables, for example, centralisation as a clinical feature that predicts the effect of the McKenzie treatment [6].



Guidelines for testing treatment effect modification emphasise the need to constrain testing to a limited number of plausible effect modifiers [21,22]. Limiting the number of candidate variables reduces the likelihood of chance findings due to multiple comparisons (Type 1 error).

Illustrative example: A large number of variables tested in a small sample. Predicting response to lumbopelvic manipulation in subjects with patellofemoral pain.

Iverson and colleagues [23] recruited a sample of 50 subjects with patellofemoral pain. Over 30 demographic and clinical variables were collected before subjects received a manipulative

treatment followed by assessment of outcome. Regression analyses were used to develop a clinical prediction rule comprising five variables; subjects positive on at least three items were found to have significantly more favourable outcome than those with two or less. In this study the large number of candidate predictors tested raises the likelihood that some associations will be found merely by chance (type 1 Error); that is, the findings are an artefact of the data and peculiar to that study. As outlined previously, the fact that this was a single-arm study also means that the authors' conclusion that status on the rule predicts response to treatment is not supported.
In preparation for the hypothesis testing stage, researchers should review the theoretical rationale for each potential effect modifier; in particular, the case for why the variable should logically be associated with the effect of a specific intervention. For example, researchers may posit that patients with high levels of fear of pain will see greater improvements in pain and disability outcomes with a graded exposure programme than patients with low levels of fear [24]. At this point it is useful to distinguish between variables which are themselves targets for intervention (in the earlier example: fear as the target of a graded exposure intervention) and those which potentially modify other treatments (e.g., fear may nullify the effect of advice to exercise).
A practical goal of the hypothesis-generating stage is to limit the number of candidate variables tested in the second stage (hypothesis testing) of the process.

2. Hypothesis testing – testing of the potential effect modifiers

The second stage involves performing an RCT with sufficient power to detect an interaction between each of the potential effect modifiers and treatment allocation. The optimal design for testing effect modifiers is a high-quality and large RCT with subjects randomised to the index treatment or a control. The appropriate statistical test is an interaction term between the potential effect modifier and treatment either within a single RCT or as part of a meta-analysis. Ideally, the analysis plan for testing treatment interaction is pre-specified and recorded in the published trial protocol and registry [25]. These last two steps allow a reader to check whether selective reporting of results from a larger set of analyses is a possibility. However, subgroup analyses will often be published as a post-hoc/secondary analysis of the original trial [26]; these reports provide a less convincing form of evidence, and validation in a new sample is particularly important.

Illustrative example: A post-hoc analysis of data from an RCT testing for effect modifiers. Possible effect modifiers for a workplace-graded activity programme in patients with occupational LBP.

Steenstra and colleagues conducted a secondary analysis, to investigate effect modifiers, of data from an RCT that tested a workplace-graded activity programme versus usual care in patients off work with LBP [27]. The authors chose the following six potential effect modifiers based on the literature on prognosis and rationale: age, gender, pain, functional status, heavy work and sick leave in the past 12 months. They used suitable statistical methods (interaction tests), the number of variables (six) was appropriate given the sample size (n=196) and there is reason to believe at least some of the variables (e.g., heavy work and functional status) would be amenable to the intervention. They found that the intervention was more effective in older subjects and those who reported sick leave in the past 12 months. In recognition of the post hoc nature of the study, the authors correctly concluded that their findings are exploratory and still require formal testing.
To lessen the potential for spurious findings, it is advised to limit testing to the primary outcomes and a small number of pre-defined, plausible treatment effect modifiers. Where it is not clear that this has occurred, readers should view positive findings with caution. Negative results from hypothesis testing are also not straightforward. This is because RCTs will have less power to test for treatment effect modification than to test for the main effects of treatment. As a rule of thumb, the sample size needed to test for an interaction is approximately 4 times that required for a test of the main effect [28]. Ideally, the analyses should obtain a sufficiently precise estimate of the interaction between treatment and subgroup. This is best judged by inspecting the 95% confidence interval (CI) for the interaction effect. A common result is that the observed p value for the interaction test is greater than the critical value (e.g., 0.05) but the CI includes clinically

important effect modification. In such a case, it would be premature to rule out the possibility of treatment-effect modification.

If the treatment effect modification analyses are robust, it is important to then consider the methodological quality of the RCTs. Methodological quality is important in the light of evidence that low-quality trials may report exaggerated effect sizes [29]. It is essential to note that any treatment subgroup identified in this stage may only be specific to the treatment contrast used in the study. For example, having identified a subgroup that recovers more quickly following an exercise intervention than following ultrasound, it does not necessarily follow that the same subgroup will recover more quickly with exercise than with joint mobilisation. Lastly, when interpreting subgroup analyses, it is important to acknowledge that confounding is possible as most factors that define a subgroup are nonrandomised comparisons. For example, treatment subgroups formed on the basis of level of fear avoidance may differ on other clinical (e.g., pain intensity) or psychological (e.g., self-efficacy) characteristics and it could be these other characteristics that moderate the effect of treatment.

Treatment effect modification observed in a large well-conducted RCT provides preliminary evidence that subgroups of patients may respond differently to the same treatment. Completion of this stage, however, is not sufficient to recommend application of the results to clinical practice. Replication is necessary to verify and substantiate the findings.

Illustrative example: Appropriate methods for testing a hypothesis within an RCT. Predicting response to lumbar manipulation in subjects with LBP.

Childs and colleagues [12] set out to validate the rule developed previously by the same group [30]. The rule was designed to predict response to manipulative treatment among subjects with LBP. The hypothesis was generated based on a previous single-arm trial by Flynn et al. [30], who found that subjects with certain characteristics (rule positive) had a better prognosis after receiving Spinal Manipulative Therapy (SMT). The authors evaluate the rule as an effect modifier within a methodologically sound RCT. The likelihood of spurious findings was reduced by limiting the number of potential effect modifiers tested to one (i.e., positive or negative on the rule), pre-planned analysis of the interaction term and power analysis to guide sample size requirement. The study found a significant interaction between status on the rule and the effect of manipulation.

RCTs where subjects are assigned to a treatment regimen ‘matched’ or ‘unmatched’ to their classification offer an alternate approach to subgroup identification. In these studies, subjects are categorised based on their clinical presentation according to a particular classification system. Two systems that have been investigated in this way are the McKenzie method [18] and the system described by Brennan, Fritz and colleagues [31,32]. The aim of this design is to test the effectiveness of the classification system as a whole, as opposed to the effect of a treatment in one subgroup compared with another. These studies therefore address a related, but slightly different, research question.While this approach provides some information about the classification system, there are important limitations that prevent such studies from elucidating the specific effects of a particular intervention on patients belonging to a subgroup. To understand the interaction between a subgroup of patients and an intervention,we need a large enough number of themembers of each subgroup to be randomised to either a treatment or a control. In studies of this design, however, the numbers of subjects within any one subgroup may be small and those randomised to control may receive any of several interventions. Results are presented as a mean difference in the effect of receiving a matched treatment and receiving an unmatched treatment for the whole cohort.

Illustrative example: Testing the effectiveness of a complete classification system. Predicting response to a McKenzie programme in LBP patients.

Long and colleagues [18] conducted a study to test the McKenzie protocol. Subjects were placed in one of three directional preference (DP) categories during the baseline assessment and they were then randomised to receive a treatment which was matched or unmatched to their DP. Analysis compared outcomes in those receiving treatment matched to their classification with those receiving one of three unmatched (control) treatments and found better outcomes in the former group. While the design of this study involves randomisation, sufficient data are not provided to enable readers to assess the interaction between subgroups (e.g., extension DP) and a specific treatment contrast (e.g., extension exercises versus non-specific exercises). For example, we do not know whether and by how much a patient classified with extension DP will do better with extension exercises than with non-specific exercises. Presentation of results for subjects allocated to each treatment regimen (extension, flexion, lateral flexion and evidence based) divided according subgroups (extension, flexion and lateral flexion) would enable readers to assess this interaction. It is likely, given the small proportion of the sample in two of the subgroups (see Fig. 1c) that the study would not have sufficient statistical power to detect such an interaction were it to exist.

3. Replication – assessing generalisability

Replication of initial findings involves re-testing the interaction between the effect modifier(s) and treatment inanindependentRCT. All the same issues regarding a priori specificationof analyses,powerand methodological quality outlined above are relevant at this stage too. Replication is necessary to confirm that initial results are not chance findings and also to test the extent to which the findings generalise [21].

Given the variability in effect sizes reported in RCTs testing the same intervention [33], we might similarly expect that there is variability in treatment interaction effect sizes. As with the main effects of treatment, some of this variability from study to study will be due to chance and some may be due to study-level factors because true replication of an RCT is difficult to accomplish. Further, studies in which models are derived commonly report greater predictive ability than those in which the models are validated [34]. This expectation reinforces the view that replication of results is a critical step in confirming the usefulness of the subgroups as first identified. Replication may be achieved through conduct of new trial or meta-analysis of existing trials if suitable trials are available. On a similar theme, collaboration between research groups offers the opportunity to increase the power of analyses by combining individual patient data from multiple studies.

Illustrative example: Combining data sets to improve power. Predicting response to conservative treatment in subjects with tennis elbow.

Although not specifically related to back pain, this study provides a worthwhile example of how data from multiple studies can be combined for the purpose of identifying subgroups. Bisset and colleagues [35] pooled individual patient data from two RCTs evaluating physiotherapy, corticosteroids and wait list for patients with lateral epicondylalgia (tennis elbow). This technique increases the statistical power of the analyses, improving the capacity to identify relevant interaction effects. The authors formed subgroups based on four baseline variables and performed pre-planned analyses assessing the interactions between the subgroups and treatment allocation. While they found statistically significant effects in two of their analyses, the authors were cautious in attributing relevance to them given the small effect sizes and likelihood of type 1 error due to multiple comparisons.

Generalisation is different and involves testing effect modification in different scenarios, for example, different clinics, different therapists and different treatment doses. Some authors refer to replication and generalisation as narrow and broad validation studies. Narrow validation refers to replication in an RCT as similar as possible to the original in terms of setting, patient group, therapists and interventions. Broad validation is intended to test the extent to which the findings will hold as these factors are modified, for example, the Childs (2004) [12] and Hancock (2008) studies [36].

Illustrative example: Broad validation of a hypothesis. Predicting response to mobilisation in subjects with LBP.

Hancock et al [36]. performed a pre-planned analysis on data from an RCT to test the generalisability of the Flynn/Childs prediction rule. The aim was to determine whether the findings held in a typical primary care setting, with the choice of manipulative technique left to the clinician. The study failed to show a significant interaction between rule status and allocation to manipulative treatment. This study can be considered a broad validation test of the above rule. At present, the rule to define subgroups of LBP patients that respond preferentially to manipulative treatment has not been shown to genralise beyond the conditions of the original RCT; this may be due to differences in the subject sample or the intervention used.

Current evidence

Considerable research efforts have gone into attempting to identify subgroups within the population of patients with non-specific LBP. The vast majority of research to date however falls into the hypothesis generation stage of investigation. The classification system that has undergone the most thorough investigation thus far is the rule designed to predict response to manipulation (Childs and colleagues [12,30,36]), this being part of a more extensive classification system described by Fritz and colleagues [8,32,37]. While results have been encouraging, there is at present insufficient evidence to recommend that either the rule or the wider classification system be adopted in clinical practice.

Psychosocial risk factors (yellow flags) have been identified as prognostic factors in studies on patients with LBP [38] and some treatment guidelines recommend screening for these factors early in the course of the condition [39]. This being the case, it is believed that specific interventions designed to modify these factors might improve outcome in those patients with a suitable clinical profile. However, findings from studies that apply targeted treatment to patients with psychological dysfunction have so far been equivocal [24,40–42]. In general, evidence remains far from conclusive and no classification systems have passed through the three-stage process.

At this point, research has failed to demonstrate the utility of any classification system with sufficient certainty to recommend incorporation into clinical practice. There are some promising lines of research but all require further refinement and testing.

Summary

In brief, although guidelines place the vast majority of patients with back pain in one homogeneous category, many believe that it is possible to divide patients into smaller subgroups. The aim of some classification schemes is to match subgroups of patients with particular treatments in the belief that they will experience better outcomes than with a generic management course. To define subgroups, it is necessary to identify factors that differentiate between those in a particular subgroup and those not. The factors that define a subgroup based on response to a treatment are called 'effect modifiers' and their identification requires a particular empirical approach.We provide some background to the issue of defining subgroups and present a three-stage process by which effect modifiers can be identified and tested. The stages are: hypothesis generation, hypothesis testing and replication. Hypothesis generation involves the proposal of a limited number of candidate effect modifiers: this may be conducted through any number of study designs but the proposed factors should be linked by a plausible rationale as to why they should interact with a particular treatment. Hypothesis testing requires an RCT to test for the interaction between candidate effect modifiers and the selected treatment. The final stage requires replication of the RCT testing the effect modifiers necessary to confirm the results and ensure that the findings hold outside the confines of the original trial. The process presented here is intended as a guide to design of new research in the area and to assist in interpretation of published studies.

What does this mean for clinical practice?

The evidence for treatment-based subgroups is not compelling and this is unlikely to change in the near future. At present, the best estimate of the likely effect of treatment for an individual is the group effect from a large high-quality trial or systematic review. In clinical scenarios where there are multiple effective treatments available, treatment selection can be based upon consideration of factors such as patient preferences, treatment availability, likely cost and inconvenience of competing treatments and the likely risk of side effects. With complex interventions such as cognitive behavioural treatment or motor control exercise, the expertise of the clinician should also be borne in mind. Health-care professionals should continue to rely on their clinical judgement when making management decisions for patients with LBP.

Research agenda

- Research should concentrate on prospective evaluation of existing hypotheses regarding candidate effect modifiers. This would involve pre-planned analyses of appropriately powered RCTs.

Conflicts of interest statement

The authors have no conflicts of interest to declare.

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The roland-morris disability questionnaire is not a unidimensional measure. A summary of main findings from rasch analyses of four different versions of the roland-morris disability questionnaire

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Background

The Roland-Morris Disability Questionnaire (RDQ) is one of the most frequently used and recommended outcome measures for patients with low back pain. An increasing number of studies report problems in the RDQ when using Item Response Theory and Rasch analysis in order to investigate the construct validity.

Objective

The main objective is to provide a brief summary of the main findings in a study that investigated the fit of data from four different versions of the RDQ to a Rasch model in a Norwegian sample of patients with chronic low back pain. The main findings were compared with previous published studies in which a Rasch analysis on the RDQ was carried out.

Method

Patients with chronic low back pain and degenerative lumbar osteoarthritis completed the RDQ prior to treatment in a secondary health care clinic. Data were analysed using a dichotomous Rasch model.

Results

A total of 243 patients with mean age 48.5 years completed all 24 items of the RDQ. None of the four RDQ versions – the original 24-item, the 18-item of Williams and Stratford, and the 11-item of Stroud – were a unidimensional measure of disability due to low back pain. Items 3 and 23 were redundant and items 13 and 18 did not fit the Rasch model. Several items showed differential item functioning, indicating that the items performed differently in subgroups of the sample. When comparing the results from the Norwegian study with four other studies with data from Australia, Turkey, UK and USA, none of the four versions of the RDQ were unidimensional according to the Rasch model. The number of misfitting items varied between 3 and 13. There was considerable variation in misfitting and redundant items across the five studies with the exception for item 18 (sleep), 15 (appetite) and 19 (need of personal assistance).

Conclusion

In the absence of consistent findings across studies that have evaluated the RDQ by Rasch analysis, caution should be exercised in the development and application of alternate versions of the RDQ.

Background and Purpose

Several questionnaires have been developed to evaluate disability in people with low back pain (LBP) (1;2). The Roland-Morris Disability Questionnaire (RDQ) is one of the most frequently used back-specific measures and it has been translated into several languages. Many versions have been evaluated (1) and it has been recommended as a core outcome measure for this patient group (3). The RDQ assesses disability in daily living among patients with LBP with 24 items in the original version (4), 18 items in two different versions (5;6), and 11 items in a fourth version (7). In addition, there exists a modified 23-item version developed for sciatica patients (8), with briefer sciatica versions comprising 11 (9) and 12 items (10).

The traditional metric properties such as validity, reliability and responsiveness of the RDQ have been extensively described in the literature, which are generally acceptable (1;2;11;12). However, construct validity has mostly been examined by using classic test theory. Item Response Theory and Rasch analysis have been increasingly applied in the field of patient-reported outcomes and is considered a more appropriate method when assessing construct validity as it provides specific analyses of the unidimensionality (the extent to which items measure a single construct, e.g. disability due to LBP), item difficulty (the relative difficulty of the items when compared to one another), and person separation (the extent to which items distinguish between distinct levels of disability) (13). The few studies that have assessed the RDQ using Item Response Theory and Rasch analysis found that there are misfitting items in the original 24-item version (7;14-16). However, the misfitting items were not similar across the different studies, for example Garratt AM (14) found that item 1, 2, 15 and 19 did not fit a unidimensional construct, whereas a recent study of Davidson M (16) found that item 9 and 17 did not fit the Rasch model. The lack of consistent findings might be due to the fact that the studies have been carried out in different countries including Australia, Canada, Turkey and United Kingdom. If so, then this has important implications for cross-national comparisons and generalisability of RDQ scores. Therefore, it was important to further evaluate existing RDQ versions by using similar and appropriate methods such as Rasch analysis. Hence, the aim of the original paper was to examine the fit of data from four different RDQ versions to a Rasch model when used in a Norwegian sample with chronic LBP and degenerative lumbar osteoarthritis; the original 24-item version (4), the two 18-item versions (5;6), and the 11-item version of the RDQ (7).

The aim of the present brief paper is to provide a brief summary of the main results from the Norwegian study (17) and to compare the main findings with the previous published studies in which a Rasch analysis on the RDQ was carried out.

Material and Methods

The RDQ measurement

The RDQ was developed in the UK in the early 1980s (4) and the items cover a range of aspects of daily livingwith a yes/no response format. The items are summed scores range from 0 (no disability) to 24 (severe disability). The Norwegian version of the original RDQ has been cross-culturally adapted for patients in primary and secondary health care and tested for measurement properties, including reliability, validity and responsiveness (18;19). Each of the RDQ versions evaluated in this study was based on patient responses to the full 24-item version. The items in the four RDQ versions are presented in Table 1.

Data collection

250 patients aged between 25 and 75 years with non-specific chronic LBP taking part in a double-blinded randomized, placebo-controlled trial comparing glucosamine sulphate with placebo were asked to complete the RDQ prior to treatment (20). Inclusion requirements were primary complaint of LBP longer than 6 months, more LBP than leg pain, no influential comorbidity, an RDQ score of 3 or more at baseline, no previous spinal fracture or surgery, no symptomatic disc herniation or spinal stenosis. They were recruited from general practitioners, chiropractors, physiotherapists and a newspaper advertisement. Patients were given the self-completed questionnaire that included the RDQ after giving informed consent to take part in the trial. They were asked to complete it at home and return it in a reply paid envelope. The study was approved

by the Regional Ethical Committee for Medical Research (Regional komite for medisinsk forskningsetikk, reference number 53-06028 1.2006.40) in Norway.

Statistical analysis

A Rasch analysis including a series of fit statistics was performed in RUMM2020, which were used to indicate if the data from the Norwegian material met model expectations (21;22). Fit to the Rasch model was examined for the original 24-item version (4), the two 18-item versions (5;6), and the 11-item version of the RDQ (7). Details of the analyses can be found in the published paper (17) . In the current paper only the main results along with the interpretation of the Rasch findings are provided.

Summary of Main Results

A total of 243 patients completed all 24 items of the RDQ. Their mean age was 48.5 years (SD 11.2) and 48.4% were women. Most of the patients (74.4%) were working. The mean total score of the 24 item RDQ was 9.5 (SD 4.2) and the median score was 9 (interquartile range 6) on the 0-24 scale.

Item 2 of the RDQ "I change positions frequently to try and get my back comfortable", had the highest endorsement of 90.8%, whereas item 24 "I stay in bed most of the time because of my back", had the lowest endorsement of 1.2%. Figure I displays the person-item distributions for the four RDQ versions, showing person ability (upper part of the graph) mapped towards the item difficulty (lower part of the graph). When comparing the person-item distributions, only the original RDQ version has items covering the whole person distribution. The individual person and item fit values of the 24-item version indicated a lower ability level of the persons (-0.83, SD 1.13) than difficulty level of the RDQ (0.00, SD 1.90).

The individual person fit and item fit were assessed by inspecting the mean and standard deviation (sd) of the fit residuals. A mean value of approximately 0 and sd of 1 were expected. Misfitting items were identified by fit residuals of greater than plus or minus 2.5 or a significant Chi-square probability value. In the present study 4 items had fit statistics outside the acceptable level of ±2.5 in the original 24-item version and in the two 18-item versions. Item 3 "I walk more slowly than usual because of my back" and item 23 "Because of my back, I go upstairs more slowly than usual" were redundant, whereas item 13 "My back is painful almost all of the time" and item 18 "I sleep less well because of my back" did not fit the model. In the 11-item Stroud version item 23 was also redundant and item 10 "I only stand up for short periods of time because of my back" did not fit the model. The overall fit statistics showed that all the RDQ versions had probability values under 0.001, which confirm that none of the versions reflected a unidimensional instrument of disability.

The Person Separation Index is equivalent to Cronbach's Alpha and provides an indication of how many groups of ability the test can discriminate amongst. Values of 0.8 and 0.9 indicate that the scale can statistically discriminate between at least two and three groups, respectively. The Person Separation Reliability Index varied from 0.77 to 0.73, indicating an acceptable ability to discriminate amongst respondents with two different levels of disability.

To assess potential bias across groups of respondents, differential item functioning (DIF) was assessed in relation to gender, age, work status (in work or not), and use of pain medication (yes/no). A uniform DIF occurs when there is a difference between the subgroups across all the class intervals, for example one subgroup is displaying a consistently greater ability to confirm an item than the other subgroup. A non-uniform DIF indicates that the ability differences are inconsistent across the subgroups. The present DIF analyses showed that several of the items performed differently across these groups, and that the pattern was similar across the original RDQ, the Willams and Stratford versions (Table II).

Current Findings Compared with Previous Studies

Table II provides an overview of sample characteristics and results across five different studies using Rasch analysis for the Roland-Morris Disability Questionnaire (7;12;14;15;17). Regarding the results from item fit statistics they can be summarised as follows:

- Item 18 was misfitting in four of five studies
- Item 15 and 19 were misfitting in three of five studies
- Item 1, 2 and 13 were misfitting in two of five studies
- Item 3, 4, 6, 7, 8, 9, 10, 14, 17, 20, 22, 23 and 24 were misfitting in one of five studies
- Item 5, 11, 12, 16 and 21 showed no problems in fit statistics in any of the five studies

In other words, none of the items were consistently misfitting across all the five studies using Rasch analysis. Item 15, 18 and 19 were the most consistently misfitting item. According to the ICF classification (23), the item 13 (pain), item 15 (appetite) and 18 (sleep) all represent "impairments" whereas the other items represent aspects of activity limitations. Item 19 represents a typical activity, but with the focus on need for personal assistance in this task. Hence, the misfit of these items suits well in an ICF perspective, and support that these items represent other constructs than activity limitation items.

The lack of consistency in most of the misfitting items reflecting activity limitations (1, 2, 3, 4, 6, 7, 8, 9, 10, 14, 17, 20, 22, 23 and 24) might be explained by differences in culture, sample characteristics and sample sizes across the five published studies. The studies mostly involved back pain populations from Australia, Norway, Turkey, USA and the UK. The study from USA (7), however, included patients with chronic pain in different body areas, of which low back pain was reported by 36% of the total sample. The mixed population might explain why many items were misfitting in this study, which limits the comparison of this study with the others in Table II. A total of 13 items did not fit into the Rasch model in the USA study, whereas the number of misfitting items varied between 3 and 5 items in the other studies. On the other hand, none of the other four studies (12;14;15;17) excluded the misfitting items and reported a final version of the Rasch analysis. A final version of these samples might have resulted in more excluded items, which were identified to have problems in the first Rasch step.

Furthermore, cultural differences might explain why patients in Turkey scored much higher on the original RDQ (mean of 15) than patients from Norway and the UK (mean of 9). In order to address the issue of cross-cultural equivalence, one could explore DIF by country on merged data sets from several countries (21;24).

Although there was little overlap in misfitting items when compared with previous studies, the difficulty level of the items was very similar (14-16). The items 15, 19, 20, and 24, which were excluded in all the adapted versions (5-7), were all "easy" items reflecting increasing disability in the present study. Also the excluded item 2 was a "hard" item reflecting little disability in the current study. In the current and comparable studies (14-16) the RDQ items tended to cluster around the middle of the scale of difficulty, with relatively few items at the extremes. Hence, it is ill advised to remove items at the extreme ends of the scale hierarchy where few of the 24 items contribute in terms of describing the disability of patients. However, this is exactly what all the shortened versions of the RDQ have done. In particular, the exclusion of item 2 reflecting low disability seems inappropriate and as shown by both the current and previous studies (14-16), item 2 has high endorsement and hence is important for determining patients with very low levels of disability. Only the original 24-item version had items that covered the very low difficulty level. Figure I indicates that there is poor targeting of the items in both the lower and upper end of the scale in all the RDQ versions. This finding is very similar to what Davidson et al (16) found, and suggests that more items are needed in order to assess lower and higher levels of disability more appropriately than what is possible with todays RDQ versions.

With respect to DIF analyses only three of the five studies reported results for gender and age group (7; 12;17). There was little consistency in the findings across the studies except for a DIF for age group in two of the studies (12;17). The Australian and Norwegian studies both found DIF for age in item 5 ("Because of my back, I use a handrail to get upstairs"), which showed that older persons were more likely to affirm this item than younger persons (16). Both the Turkish (15) and the Norwegian study (17) found a DIF for gender, but these were in different items (item 5 and 7 in Turkish study and item 9 and 14 in the Norwegian study. Again, these findings might be explained by differences in culture and back pain populations.

The weaknesses of the RDQ have been reported in a number of studies (1;14). It has been argued that patients should contribute to item selection for instruments designed to assess health and quality of life in back pain (25). In contrast to a large number of specific instruments that are now available for different health problems, the content of the RDQ was not developed following input from patients including interviews or focus groups. Hence, the RDQ may lack content validity as a patient-reported outcome since it may not adequately reflect the concerns of patients. The RDQ assesses disability but other aspects of health and quality of life are important to patients with back pain (26). Moreover, the aspects of disability assessed by the RDQ may not concord with those of back pain patients, the content of the RDQ being based on the generic Sickness Impact Profile. Other criticisms levelled at the RDQ include the use of dichotomous items which generally have lower levels of data quality and reliability than categorical rating scales with more response alternatives (14). They may also be less responsive to change (27;28).

The lack of consistent findings across studies means that caution should be exercised in developing new versions of the RDQ. If researchers want to continue to use the RDQ despite the reported weaknesses it is more appropriate to use the 24-item version so that scores can be compared across studies. Furthermore, it is important that researchers and clinicians are aware that the RDQ cannot be considered a unidimensional measure of disability due to LBP. The application of Rasch analysis to merged data from different countries might further our understanding of the performance of the RDQ.

In conclusion, none of the four versions of the RDQ were found to be unidimensional according to the Rasch model. Five published studies with data from Australia, Norway, Turkey, UK and USA have used modern psychometric methods when analysing the construct validity of the RDQ, and all five studies have identified problems with the instrument. The number of misfitting items varies between 3 to 13. There is, however, considerable variation in misfitting and redundant items across the five studies (with the exception for item 18, 15 and 19). In the absence of consistent findings across studies, caution should be exercised in the development and application of alternate versions of the RDQ.

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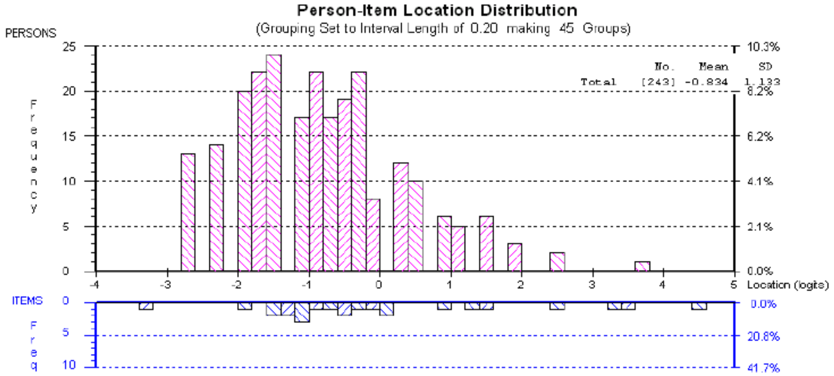
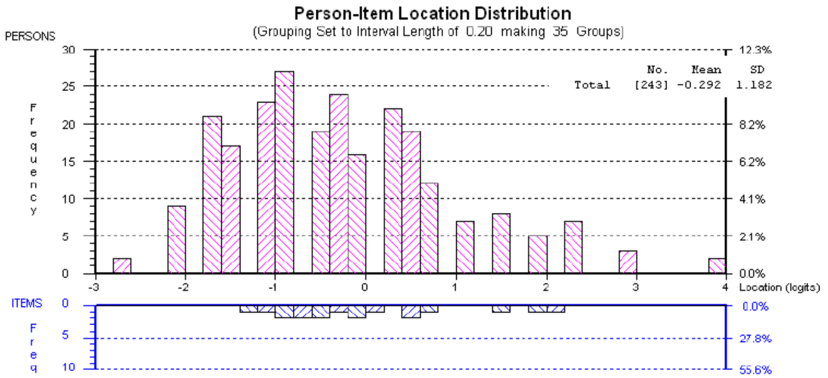
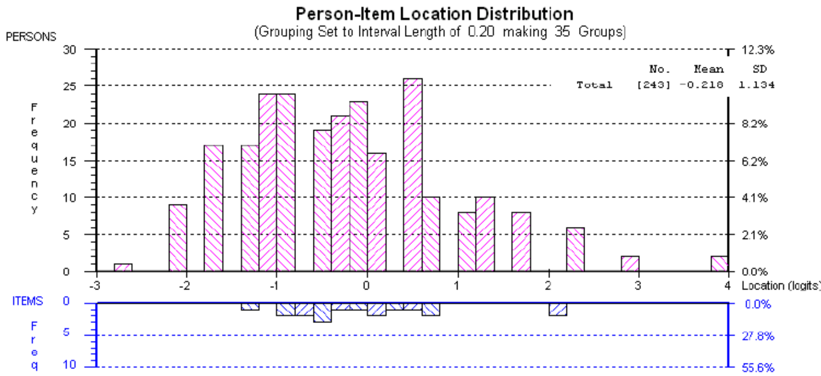


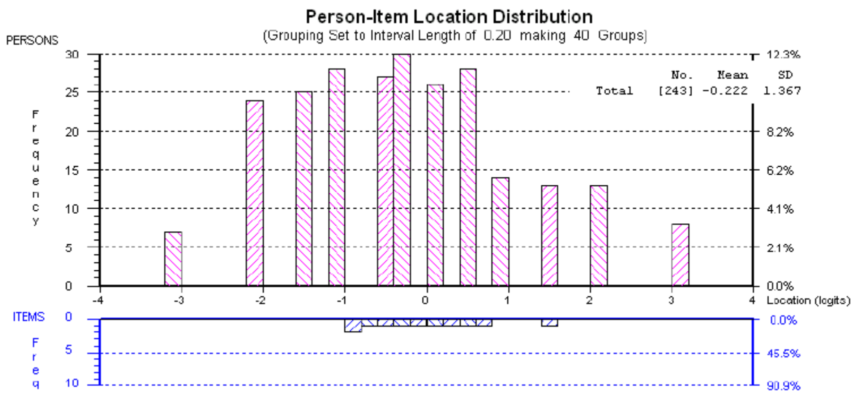
24-item version of the Roland-Morris Disability Questionnaire



18-item William version



18-item Stratford version



11-item Stroud version

Harder items
More able persons

Easier items
Less able persons

Fig. I. Person-item location distributions for the four versions of the Roland-2 Morris Disability 3 Questionnaire; 24-item original version at the top, 18-item William and Stratford in the middle, 4 and 11-item Stroud at the bottom.

Table I. Items in the four versions of the Roland-Morris Disability 1 questionnaire

Item no	Description	Original 24 item	Williams 18 item	Stratford 18 item	Stroud 11 item
1	I stay at home most of the time because of my back	X	X	X	-
2	I change positions frequently to try and get my back comfortable	X	-	-	-
3	I walk more slowly than usual because of my back	X	X	X	X
4	Because of my back, I am not doing any of the jobs that I usually do around the house	X	X	X	-
5	Because of my back, I use a handrail to get upstairs.	X	X	X	X
6	Because of my back, I lie down to rest more often	X	X	X	-
7	Because of my back, I have to hold on to something to get out of my easy chair	X	X	X	X
8	Because of my back, I try to get other people to do things for me	X	X	X	-
9	I get dressed more slowly than usual because of my back	X	X	X	X
10	I only stand up for short periods of time because of my back	X	X	X	X
11	Because of my back, I try nto to bend or kneel down	X	X	X	X
12	I find it difficult to turn over in bed because of my back pain	X	X	X	X
13	My back is painful almost all of the time	X	X	X	-
14	I find it difficult to turn over in bed because of my back pain	X	X	X	-
15	My appetite is not very good because of my back pain	X	-	-	-
16	I have trouble putting on my socks because of the pain in my back	X	X	X	X
17	I only walk short distances because of my back pain	X	X	-	X
18	I sleep less well because of my back	X	X	X	-
19	Because of my back pain, I get dressed with help from someone else	X	-	-	-
20	I sit down for most of the day because of my back	X	-	-	-
21	I avoid heavy jobs around the house because of my back	X	X	X	X
22	Because of my back, I am more irritable and bad tempered with people than usual	X	-	X	-
23	Because of my back, I go upstairs more slowly than usual	X	X	X	X
24	I stay in bed most of the time because of my back	X	-	-	-

Table II. Comparing sample characteristics and results across five different studies using Rasch analysis for the Roland-Morris Disability Questionnaire

	Garratt et al (2003)	Kucukdeveci et al (2003)	Stroud et al (2004)	Davidson et al (2009)	Grotle et al (2013
RDQ version(s) tested	Original 24-item	Original 24-item	Original 24-item Stratford 18-item Stroud 11-item	Original 24-item Williams 18-item Stratford 18-item Stroud 11-item	Original 24-item Williams 18-item Stratford 18-item Stroud 11-item
Type of back pain sample and clinical setting	Subacute and chronic LBP recruited from primary care to a randomised, controlled trial - UK	LBP in an outpatient clinic - Ankara, Turkey	Chronic pain, screened for admission to a multidisciplinary pain management program - Washington, USA	Subacute and chronic LBP, physiotherapy clinics – Melbourne, Australia	Chronic LBP and degenerative lumbar osteoarthritis recruited from primary care to a randomised, controlled trial - Norway
Sample size	1008	81	993	140	250
Mean age years (SD)	42.9 (SD not reported)	37.0 (10.6)	43.5 (SD 12.6)	51 (SD 17.0)	48.5 (SD 11.2)
Gender (% female)	55%	63%	57%	66%	48%
Duration LBP	All > 4 weeks	All > 4 months with average duration of 4.6 years (SD 3.7)	36.2% of the patients had chronic LBP (average duration of 6.5 years(SD 8.3))	43% < 6 weeks	All > 6 months
Work status (full or part time employed)	Not reported	Not reported	41%	41%	73%
Mean sum score (SD), and/or median when available	9.0 (4.1)	Median 15.0 (interquartile range 8)	Not reported	Not reported	9.5 (4.2) Median 9 (interquartile range 6)
Fit statistics*					
Original 24-item version	0.8 and 1.2**	1.28 and 1.76**	Not reported	p=0.025*	p<0.001*
Williams 18-item version	-		-	p=0.016*	p<0.001*
Stratfords 18-item version	-		Not reported	p=0.031*	p<0.001*
Strouds 11-item version	-		Not reported	p=0.027*	p<0.001*
Separation index/ Cronbach Alpha					
Original 24-item version	Not reported	0.85-0.89	0.90	0.87	0.77
Williams 18-item version	-		-	0.88	0.76
Stratfords 18-item version	-		0.89	0.85	0.75
Strouds 11-item version	-		0.88	0.87	0.73
Item fit					
1	Poor outfit	X	Poor fit	X	X
2	Misfit to construct	X	Poor fit	X	X
3	X	X	X	X	Poor fit, redundant

4	X	X	Poor fit	X	X
5	X	X	X	X	X
6	X	X	Poor fit	X	X
7	X	Poor outfit	X	X	X
8	X	X	Poor fit	X	X
9	X	X	X	Poor fit, redundant	X
10	X	Poor outfit	X	X	X
11	X	X	X	X	X
12	X	X	X	X	X
13	X	X	Poor fit	X	Poor fit to construct
14	X	X	Poor fit	X	X
15	Poor outfit	Poor outfit	Poor fit	X	X
16	X	X	X	X	X
17	X	X	X	Poor fit, redundant	X
18	X	Poor outfit	Poor fit	Poor fit to construct	Poor fit to construct
19	Poor outfit	Poor outfit	Poor fit	X	X
20	X	X	Poor fit	X	X
21	X	X	X	X	X
22	X	X	Poor fit	X	X
23	X	X	X	X	Poor fit, redundant
24	X	X	Poor fit	X	X
Total number of misfitting items	4	5	13	3	4
Uniform DIF for gender	Not reported	Item 5 and 7	Not reported	None	Item 9 and 14
Uniform DIF for age	Not reported	None	Not reported	Item 5	Item 5, 22 and 23
Uniform DIF for work	Not reported	Not reported	Not reported	Not reported	Item 1 and 18
Uniform DIF for pain medication	Not reported	Not reported	Not reported	Not reported	Item 1 and 11
Uniform DIF for pain duration	Not reported	None	Not reported	Not reported	Not reported
Uniform DIF for pain severity	Not reported	None	Not reported	Not reported	-

X-items meeting 1 Rasch criteria
* Fit statics in the RUMM program is provided by Total item Chi-Square Item-Trait Interaction statistic and Total Chi-Square probability (which should be non3
significant when the items fit the Rasch model). Here the Total Chi-Square probability is provided.
**The Rasch analysis were carried out using the WINSTEPS program, which operate with other concepts than the RUMM programme. In the WINSTEPS program the fit statistics is provided in terms of Infit and Outfit statistic, which assess the extent to which unpredicted responses to an item are given by patients whose position in the hierarchy, as determined by their physical disability resulting from back pain, is either close to the item's position (Infit statistic) or far from the item's position (Outfit statistic) in the hierarchy of items. For the data to fit the model adequately, it generally is recommended that the two fit statistics range from 0.7 to 1.3.Fit statistics higher than 1.3 and below 0.7, respectively, indicate too much and too little variation in response patterns. The two fit statistics range from 0.7 to 1.3.

OPTIMAL CARE FOR LOW BACK PAIN: MEETING PATIENT'S EXPECTATIONS?

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Background

Patient's expectations have shown to be associated with outcomes of treatment in many different disorders. In low back pain Smeets et al1 found that treatment expectations regarding rehabilitation treatment were significantly associated with disability and satisfaction. Mannion et al2 found that fulfilled expectations were the most important predictor of general perceived effect in spinal surgery. Iles et al3 conducted a systematic review and meta-analysis assessing the predictive value of patients' expectations and found a small but consistent association between expectations and return to work.

This body of literature suggests that patients' expectations may be important in identifying patients at risk of poor outcomes, such as: chronicity, relapse, delayed recovery and delayed return to work. Bialosky et al4 extend this idea and suggest that expectations can be altered or optimized in order to improve treatment outcomes.

Challenges

The above indicates that patients' expectations are a promising and important for the low back pain field. However, if we want to study patients' expectations or want to use patients' expectations in daily practice it is necessary to have a thorough understanding of what expectations are, how to measure them, what their determinants are, via which pathways expectations influence outcomes and which type of expectation is associated with which specific outcome. In sum, there are a number of challenging issues which need to be addressed in order to move the field forward.

1) How to define expectations

There is debate in the literature as to how best define patient expectations. Existing theoretical models on expectations lack empirical support and many definitions and taxonomies have been proposed. For example there are important distinctions between outcome expectations (beliefs that treatment will lead to a certain result) and self-efficacy expectations (beliefs in one's own ability to perform a certain treatment regimen)5. Researchers have also suggested that expectations have both calculative/cognitive components as well as emotional ones6. On the basis of these considerations, Kravitz7 proposed a distinction between value expectations (i.e. idealized expectations expressed as hopes, wishes, desires, needs or wants) and probability expectations (i.e. predictive expectations, expressed as probabilities, likelihoods or certainties). In a qualitative study we investigated how low back pain patients conceptualize their expectations before treatment8. We found that patients' have many expectations which we could categorize in two broad categories: 1) expectations about treatment process; 2) expectations about treatment outcome. Within both categories some patients expressed their expectations in a predictive way, whilst others expressed them in a idealized way. Moreover, expectations can be activity or situation specific (e.g. I will likely be able to get in and out of my bathtub after treatment) or more general (e.g. there is a 80% chance that I will be fully recovered after treatment).

2) How to measure expectations

Measuring expectations is challenging. No standardized measurement instrument exist, and measurement is highly dependent on the definition of expectations used and the disorder or treatment studies. Van Hartingsveld et al9 identified 24 measurement instruments used to measure expectations in patients with musculoskeletal disorders, though none of the instruments was superior to the others in terms of clinimetric properties. For the low back pain population several validated instruments were identified and can be found in Van Hartingsveld's review.

3) What are the determinants of expectations?

Determinants of patients' expectations are largely unknown. It is interesting to study these determinants because they may be useful targets for altering expectations. In our qualitative study8 among low back pain patients we asked patients about what they thought had influenced their expectations. It seemed that having a previous experience with a particular treatment was the strongest influencing factor. Patients with past experience expected to get the same results as before irrespective of whether the experience was positive or negative. Other determinants were others' experiences, knowledge, beliefs/assumptions and the treatment setting (eg. being treated friendly by the receptionist). It may be that the latter three factors are useful targets for changing expectations. Quantitative studies have identified some other factors to be associated with expectations, for example disease severity, depression and optimism.

4) Can we influence expectations?

So far, interventions aimed at altering or improving expectations are scarce. Recently though a protocol of a study10 aiming to alter expectations of low back pain patients with low recovery expectations was published. This intervention consists of health coaching which concentrates on goal setting and action planning in order to increase self-efficacy and outcome expectations. In cardiovascular surgery a similar interventions has been developed, though no results are yet available11. In total hip/total knee arthroplasty an Mancuso et al12 designed an intervention to create more realistic expectations through patient education in a randomized controlled trial. They found that expectations changed in both groups, but there was no between group difference.

Recommendations for Clinicians regarding their Patients' Expectations

All the above implies that there is much work to do in this area. For now it is important for clinicians to be aware that their patients may have different types of expectations. These maybe related to the process of care, or the type of treatment they expect, or they may be related towards the outcome. Therefore it is important that expectations are discussed with the patient in a specific way specifically focusing on the type of expectations the therapist want to know about. Taking these expectations into account also may assist in guiding therapy choices made in the clinical setting and may improve the outcome. It should however be understood that the evidence for these recommendations is to date speculative.

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EPIDURAL CORTICOSTEROID INJECTIONS IN THE MANAGEMENT OF SCIATICA: SYSTEMATIC REVIEW AND META-ANALYSIS

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Introduction

Existing guidelines and systematic reviews provide inconsistent recommendations on epidural corticosteroid injections for sciatica. Key limitations of existing reviews are the inclusion of trials with active controls of unknown efficacy and failure to provide an estimate of the size of the treatment effect.

Purpose/Aim

To determine the efficacy of epidural corticosteroid injections for sciatica compared with placebo.

Material and Methods

A sensitive search of 7 electronic databases (International Pharmaceutical Abstracts, PsycINFO, MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, and CINAHL) was conducted. Randomized, placebo-controlled trials assessing the efficacy of epidural corticosteroid injections in participants with sciatica were included. Two independent reviewers extracted data and assessed risk of bias. Leg pain, back pain, and disability were converted to common scales from 0 (no pain or disability) to 100 (worst possible pain or disability). Thresholds for clinically important change in the range of 10 to 30 have been proposed for these outcomes. Effects were calculated for short-term (>2 weeks but ≤3 months) and long-term (≥12 months) follow-up. Meta-analyses were conducted using a random-effects model, and the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach was used in summary conclusions.

Results

Twenty-five published reports (23 trials) were included. The pooled results showed a significant, although small, effect of epidural corticosteroid injections compared with placebo for leg pain in the short term (mean difference, -6.2 [95% CI, -9.4 to -3.0]) and also for disability in the short term (mean difference, -3.1 [CI,-5.0 to -1.2]). The long-term pooled effects were smaller and not statistically significant. The overall quality of evidence according to the GRADE classification was rated as high.

Conclusion

The available evidence suggests that epidural corticosteroid injections offer only short-term relief of leg pain and disability for patients with sciatica. The small size of the treatment effects, however, raises questions about the clinical utility of this procedure in the target population.

Implications

Findings from this review should assist patients and clinicians when discussing evidence-based treatment options for this condition.

Keywords
Epidural injections, corticosteroids, sciatica

ELECTRONIC CONSULTATIONS FOR SPINE SPECIALTY CARE: A COMPARISON OF TWO CARE MODELS IN A LARGE MULTIDISCIPLINARY ACADEMIC CENTER

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Introduction

Rising medical care costs are driving new care model exploration including electronic consultations (eConsults). EConsults offer several advantages: patient convenience (avoids work loss, travel and parking); significant cost reduction compared to traditional face-to-face consultation; and improved access to specialty care opinions. EConsults are recommendations made based on electronic medical record review (clinical notes, imaging studies, and laboratory data) without a personal interview or physical examination. Referring care providers have found eConsults to be cost effective, efficient and high quality medical care. Spine specialty eConsults have also been shown to be high quality.

Purpose

To compare the cost effectiveness, efficiency and appropriateness of eConsults for spine specialty care compared to traditional face-to-face consultation in a large academic institution.

Methods

All Spine Center eConsults from 6/1/2010 to 3/15/2012 were reviewed. EConsults were available to all care providers within the institution and ordered through the electronic medical record. Referring department staff verified availability of the clinical question and imaging electronically. Designated specialty providers were then notified of the eConsult request. Total institutional eConsult volume, reason for consultation, referring provider specialty, clinical diagnoses, and time to completion were collected for both traditional and eConsults. Cost data were similarly collected. Surveys ranking Spine Center eConsult process satisfaction were sent to all referring providers.

Results

Over the study period, 10,561 eConsults were completed institution wide. Top eConsult requested departments were: Internal Medicine (2650), Family Medicine (1593), Infectious disease (867), Neurology (843), and Hematology (766).

Seventy-eight Spine eConsult requests were made (0.74% of total) and were 15th in total volume of requests out of 37 departments/divisions. Spine eConsults were completed in 2 days in 92% of cases versus 17.9 days for face-to-face spine consults. Spine eConsults costs were $50 (US). Face-to-face spine consultation averaged $750 each. Twenty of 78 (25.6%) eConsults eventually required face-to-face Spine Center consultation. Thus, cost savings were $40,600 over the 33 month study period.

Spine eConsult requests included: medical management options; appropriateness of specific spine procedures, and the need for further work-up. Further analysis reflected referring provider's appeals for receiving management assistance with radiculopathy and chronic back pain; candidacy for corticosteroid injection, vertebroplasty or spinal surgery; and further work-up for acute on chronic spine pain, "bulging discs" or limb paresthesias. Over 90% of referring providers responded in 'agreement' or 'strong agreement' that Spine Center eConsults were prompt, added value, and met patient's needs.

Conclusions

Spine specialty eConsult care model provided a beneficial service to referring providers. This model was underutilized given overall volumes of eConsults institutionally. Proven efficient, low cost, and high satisfaction care significantly reduced the need for face-to-face spine specialty consultation. This care model should be considered for spine patient specialty care when appropriate.

Keywords
Back pain, care model

Wednesday, October 30, 2013

Parallel Session IV

Annelie Gutke
Hilde Stendal Robinson
Helen Elden
Elisabeth Bjelland
Monika Fagevik Olson
Anne Lindgren
Bruce Mitchell
Leanne Sawle
Ursula Wesselmann

WOMEN WITH PELVIC GIRDLE PAIN DURING PREGNANCY DO NOT DEVELOP WIDESPREAD PAIN IN LONG TERM

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Introduction

During pregnancy over 50% of women report pain in the lumbopelvic area. Consequences from lumbopelvic pain are reported in all daily activities including work. Severe impact is reported by 25% in pregnancy and by 5-20% after. Widespread pain has shown prognostic value for long-term lumbopelvic pain and is more common among women but the knowledge on mechanism related to pregnancy is limited.

Aim

The aim of the present study was to explore whether women with lumbopelvic pain during pregnancy develop widespread pain later. A second aim was to explore its influence on the pain system.

Materials and Methods

Out of eligible pregnant women in one community in 2001-2003, 82 % (313/384) participated in a cohort study and 272/313 (87 %) in a postpartum follow-up. A long-term follow-up was undertaken 2011.

Questionnaires in the three cross-sectional studies included questions of background, function (Oswestry Disability Index) and pain (prevalence, location, intensity, frequency, duration). Sensory and pain threshold measures (Pain matcher) were added in the long-term follow-up. From pain drawings, the number of pain locations (i.e. cervical, thoracic, lumbar) were divided into 0-1 and >1 respectively.

Results

Out of 154 returned questionnaires (response rate 51%), 75 women (49%) reported lumbopelvic pain. Among women with no pain in early pregnancy, 33 women (75%) still reported no pain after 8-10 years. There was no difference (p=0.113) in proportions of 0-1 and >1 pain locations respectively longitudinally over the three measurement points. Having >1 pain locations in pregnancy, the risk estimates to still have it long-term was 4.2 (CI 1.7-10.6). There was no difference among subgroups i.e. pelvic girdle pain and lumbar pain. The result suggests that women with longstanding lumbopelvic pain have low pain threshold.

Relevance

First experience of lumbopelvic pain is reported in pregnancy by 59% of women. Pregnancy might be seen as a risk period for lumbopelvic pain during life. It might be possible to implement preventive strategies if more knowledge of predictors is developed.

Conclusions

The pain drawings of a cohort of previous pregnant women show a stable pattern from pregnancy over a ten-year period. Pregnancy-related lumbopelvic pain including pelvic girdle pain, can be considered localized and specific pain syndromes, in most women they do not develop into widespread pain, although in some women they are longstanding.

Discussion

Our result does not support the suggestion that lumbopelvic pain is a syndrome with generalization of pain, at least not when debut in relation to pregnancy.

Implications

Since our results suggest it is possible to identify women with risk of long term pain and widespread pain already in early pregnancy, pregnant women with >1 pain locations should be targeted for preventive strategies.

Keywords

Pelvic girdle pain, widespread pain, pregnancy, long term

PELVIC GIRDLE PAIN ONE YEAR POSTPARTUM - HIGH PREVALENCE BUT LOW DEGREE OF AFFLICTION

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Introduction

High prevalence of pelvic girdle pain (PGP) has been reported during and shortly after pregnancy,1-5 but the long-term affliction is less studied. PGP affects activities of daily living,6 but large variations in severity are reported.1;2;7 It is of interest to study both the PGP prevalence and the degree of affliction one year postpartum.

Purpose

To explore the self-reported PGP prevalence and the affliction from PGP in terms of physical functioning and pain one year postpartum.

Materials and Methods

The study is part of a cohort study, following women through pregnancy and the postpartum period. One year postpartum the presence of self-reported PGP was examined by a single question, “Do you have pain in the pelvic girdle?” (yes, no). Physical functioning (PF) and bodily pain (BP) from the Short Form-36, Norwegian version 1.1, (0-100; 0 is worst) were used as affliction measures.8;9 For comparison we calculated expected age-adjusted mean scores,10 using Norwegian population norms. 8

Results

215 of the 326 in the cohort answered the questionnaires at one year postpartum and constituted the study sample. Mean age (SD) was 31 (4) years and 56% were nulliparous, and comparable with the total cohort. The self-reported PGP prevalence was 30% one year postpartum. The median (first and third quartiles) of PF and BP were 100 (95, 100) and 84 (72, 100) and the mean scores in the study sample were slightly higher than the expected age-adjusted mean scores. The mean scores (SD) for Norwegian women between 30-39 years are 92 (13) and 77 (25) for PF and BP respectively. Six and 16% of the women in the cohort scored below the lower SD of PF and BP respectively.

Relevance

The high prevalence of PGP indicates a need to explore the affliction from PGP. The use of PF and BP from SF-36 allows comparison with population norms and seems relevant for evaluating affliction from PGP postpartum.

Conclusion

The results indicate that most women had recovered in terms of PF and BP one year postpartum, although 30% reported to have PGP.

Discussion

The PGP prevalence was surprisingly high, but the PF and BP scores were slightly higher than population norms at one year postpartum. On explanation for this apparent disparity could be that PGP is no longer experienced as bothersome, but more like a complaint that is reported when asked. The slightly higher PF and BP scores in our cohort could be due to a response shift.11

However, the differences between observed and estimated means were small. The validity of a single question to assess PGP can also be questioned.

Implications

The results underscore the importance of evaluating affliction in women with PGP. Furthermore, the results show that even if many women experience PGP during and after pregnancy, most of them recover in terms of PF and BP one year postpartum.

Keywords

Pelvic girdle pain, postpartum, affliction

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BACK PAIN IN RELATION TO PREGNANCY: A LONGITUDINAL 10-YEAR FOLLOW-UP OF 369 WOMEN DIAGNOSED WITH PELVIC GIRDLE PAIN DURING PREGNANCY

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Introduction

To describe the long-term development of back pain in women with well-defined PGP during pregnancy and, to identify potential predictors for persistent PGP and/or LBP in a long time perspective PGP have been associated with muscular dysfunction, maternal factors, and pre-pregnancy low back pain, LBP, and/or pelvic girdle pain, PGP. It has also been stated that the pain and functional disturbances in relation to PGP must be reproducible by specific clinical tests. However, physical examinations have not been performed in long-time follow-ups of women with well-defined PGP during pregnancy and knowledge of potential predictors for long-standing LBP/PGP in these women is limited.

Aim

To describe the long-term development of back pain in women with well-defined PGP during pregnancy and, to identify potential predictors for persistent PGP and/or LBP in a long time perspective.

Materials and Methods

Women with well-defined PGP according to mechanical assessment of the, lumbar spine, pelvic pain provocation tests, standard history, pain drawings and European Guidelines who completed one of three treatment studies in 2000-2002, 2006-2007 or 2009-2011 answered a questionnaire. Women reporting pain from the pelvic girdle and/or lower back were physically examined.

Results

Of 525 eligible women, 369 (70%) answered the questionnaire. Twenty-five women were excluded from analysis due to pregnancy (n=16) or systemic disease (n=9). Forty-nine women/344 (14%) had verified back pain. Of these women, 12/344 (5%) had LBP; 17/344 (5%) had PGP and 20/344 (6%) had combined back- and pelvic girdle pain. During pregnancy, predictors for persisting back pain were: Having a back pain history before pregnancy (p=0.0194), high pain intensity in the morning (Visual Analogue Scale, p=0.0097), impaired function (Oswestry Disability Index p=0.0127), low health related quality of life (Euro-qol, p=0.0097), use of an elastic pelvic belt (p=0.031), difficulty to turn over in bed (p=0.001) and early debut of PGP in pregnancy (p=0.029). Relevance of the number of positive pain provocation tests during pregnancy and at follow-up will also be presented.

Relevance

PGP can be physically compromising during pregnancy and cause anxiousness concerning childcare after delivery and later return to work and future work planning. It is therefore important to present a reliable prognosis to these women as early as possible, preferably during pregnancy.

Discussion

Considering the long follow up (up to 10 years), the dropout-ratio in this study was acceptable and the results presented were in line with earlier publications about persistent LBP and PGP in a shorter perspective. Furthermore, the women were physically examined by skilled physiotherapists to confirm the diagnoses PGP and LBP in accordance with the European Guidelines. This increases the reliability of our findings, and we therefore believe that general conclusions can be drawn. A well founded prognosis for the later development of PGP and LBP found during pregnancy thus can be presented to the pregnant women covering the time from delivery up to a decade later.

Conclusion

Most women (88%) with well-defined PGP during pregnancy recovered. The long time results confirm earlier short time findings that a back pain history before pregnancy, server PGP during pregnancy and early debut of PGP in pregnancy are risk factors for persisting pain several years postpartum.

Implications

Identification of women at risk for longstanding back pain seems possible in early pregnancy using physical examination and self-reports.

Keywords

Pregnancy-related, pelvic girdle pain, low back pain, course, predictors, recovery, persistent

MODE OF DELIVERY AND PERSISTENCE OF PELVIC GIRDLE SYNDROME 6 MONTHS POSTPARTUM

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Introduction

Cesarean section rates are increasing, and this trend has partially been explained by maternal requests for planned cesarean section without medical or obstetrical indication. Pelvic girdle pain has been associated with increased planned cesarean section rates. Whether the mode of delivery affects the prognosis of pelvic girdle pain has, however, insufficiently been studied.

Purpose/Aim

To study the association between mode of delivery and persistence of pelvic girdle syndrome (PGS; pain in anterior and bilateral posterior pelvis) 6 months postpartum.

Materials and Methods

We followed up 10.400 women with singleton deliveries in the Norwegian Mother and Child Cohort Study who reported PGS in pregnancy week 30. Data were obtained by three self-administered questionnaires and linked to the Medical Birth Registry of Norway. The outcome six months postpartum was PGS, and pain intensity was categorized as mild or severe. The risk of persistence of PGS postpartum was estimated as adjusted odds ratios (aOR) with 95% confidence intervals (CI).

Results

Planned cesarean section was associated with the presence of severe PGS 6 months postpartum (aOR 2.3; 95% CI: 1.4-3.9). In women who used crutches during pregnancy, emergency (aOR 2.0; 95% CI: 1.0-4.0) and planned cesarean section (aOR 3.3; 95% CI: 1.9-5.9) were each associated with severe PGS.

Relevance

An association between pelvic girdle pain and maternal preference for cesarean section has been reported. Because a cesarean section may have unfavourable short-term and/or long-term consequences, knowledge about how the mode of delivery influences the prognosis of pelvic girdle pain is warranted.

Conclusions

The present follow-up study of women with PGS during pregnancy demonstrates a two- to threefold increased risk of severe PGS 6 months postpartum in women who had planned or emergency cesarean section compared with unassisted vaginal delivery.

Discussion

Performing a surgical procedure may cause chronic pain. Women, who initially suffer from other pain conditions or report high pain intensity after giving birth, reportedly have increased risk of chronic pain after cesarean section. Therefore, in women with severe pelvic girdle pain, additional pain in connection with cesarean section may influence the recovery-process after delivery.

Implications

When deciding the mode of delivery, obstetricians should be aware of the increased risk of non-recovery after cesarean section among women presenting with severe pelvic girdle pain. If there are no medical or obstetrical indications for a cesarean section, the results suggest that vaginal delivery is the preferred delivery mode for women with severe pelvic girdle pain.

Keywords

Cesarean section; Delivery mode; Pelvic girdle pain; Postpartum; Prognostic factors

LUMBOPELVIC PAIN IN PREGNANCY, ASSOCIATION BETWEEN SICK-LEAVE, PAIN AND DISABILITY IN NORWAY AND SWEDEN

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Introduction

Lumbopelvic pain (LPP) represents a combination of low back and pelvic girdle pain during pregnancy. Prevalence above 50% is reported,1;2 which is about twice the prevalence of LBP in the non-pregnant female population at comparable age.3 LPP affects weight-bearing activities,4 and an increasing sick-leave rate has been reported.5 Norway and Sweden are comparable countries in socio-economical aspects, and it is of interest to compare prevalence of sick leave due to LPP in pregnancy.

Purpose

To explore and compare the prevalence of sick leave due to LPP among pregnant women in Norway and Sweden, and to examine factors associated with sick-leave due to LPP.

Materials and methods

898 pregnant women from one Norwegian cohort (272 women) and two Swedish cohorts (308 and 311 women, respectively) participated.6-8 Questionnaires were administrated between gestation week (GW) 10-24, and between GW28-38. Pain was recorded by visual analogue scales (VAS) and disability by Disability Rating Index (DRI) or Oswestry Disability Index (ODI). Logistic regression analyses were used to examine factors associated with sick leave due to LPP. To get comparable units on disability, we recalculated the DRI scores using data from a previous study (n=80) with both ODI and DRI scores available.

Results

GW10-24: The prevalence of sick leave due to LPP was similar in Norway and Sweden (4% in both countries, $p \geq 0.48$) even though the prevalence of LPP differed ($p<0.001$). Disability, pain intensity and cohort were significantly associated with sick leave.

GW28-38: The prevalence of sick leave due to LPP was similar in Norway and Sweden (26 and 27%, $p=0.95$). Disability, pain intensity and occupational classification were significantly associated with sick leave. Women on sick leave reported highest disability ($p<0.001$).

Relevance

The questions of sick leave in pregnancy in general, and for pregnancy-related LPP in special, are of high interest at present in Norway and Sweden. It is thus of interest to explore factors associated with sick leave due to LPP.

Conclusion

Disability and pain intensity were associated to sick leave due to LPP at both times. Furthermore, cohort and occupational classification were associated to sick leave in GW10-24 and GW28-38 respectively.

Discussion

The person's reduced working capacity should be the basis for sick leave. Hence, disability seems to be an important factor when sick leave is to be considered. The accuracy of sick leave due to LPP is supported by the fact that women on sick leave reported the highest disability. Furthermore, the occupational classification was also associated with sick leave.

Implications

Due to the focus on reducing sick leave in general and also in pregnancy, the results indicate that assessing self-reported disability with an instrument like DRI or ODI together with occupational classification could be of importance when considering sick leave.

Keywords

Pregnancy, lumbopelvic pain, sick leave, disability

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A CLINICAL EVALUATION OF SELF-ADMINISTERED TESTS FOR PELVIC GIRDLE PAIN IN PREGNANCY

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Introduction

Lumbopelvic pain is one of the most common complications of pregnancy. Clinically, in large surveys as well as in longitudinal and follow-up studies it could be an advantage to have a practical and cheap way to screen for pelvic girdle pain. Tests, possible to perform without an examiner, have been developed based on traditional test recommended by the European guidelines. A first study distinguished the most sensitive and specific self-administered tests but these tests needed to be evaluated also in a natural setting.

Purpose

The purpose of this study was to investigate agreement between self-administrated tests performed at home following written instructions and informative photos and tests performed by an examiner to classify pelvic girdle pain (PGP) in pregnant women.

Methods

A series of pregnant women referred to a specialist clinic for PGP participated in the study. The evening before the appointment all women performed self-administered tests to screen for posterior and anterior PGP. During the appointment a specialized physiotherapist performed the tests. Results of self-administered tests and those performed by the examiner were compared.

Results

A total of 123 women participated in the study. Percentage of agreement and sensitivity between the self-administered tests and the tests performed by an examiner for posterior PGP was >63% and >74%. Positive predicted value was >56% and negative predicted >37%. Corresponding figures for anterior PGP were >53%, >78%, >40% and ≥88%. A significantly higher number of positive P4 and bridging tests were recorded by the examiner compared to the self-administered tests ($P=0.036$ and 0.001 respectively). Also a significantly higher number of positive modified Trendelenburg tests recorded when self-administered ($p<0.05$). Agreement between diagnoses set by the examiner and the results of the self-administered tests together with questionnaires was 87%.

Relevance

It is important to have relevant screening tools to not over- or underestimate the need for treatment for women with PGP.

Conclusions

Our results indicate that it is possible to screen for PGP by evaluating results from a questionnaire and self-administered tests.

Implications

Self-administered tests together with specific questions can classify PGP in pregnant women. The concept is sensitive enough to be used in larger surveys or within maternity care as a ground for referral to physical therapy.

Key Words
Low back pain, pelvic girdle pain, pregnancy, provocation tests

FINGER JOINT MOBILITY AND PREVIOUS PREGNANCIES AS ANTENATAL MARKERS OF PREGNANCY INDUCED BACK PAIN

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Introduction

Back pain induced in pregnancy is a common complaint described by women all over the world. Several studies indicate that pregnancy affects ligaments and bone in the pelvic region. Hormonal influence on fragile connective tissue could be an important factor in the development of Pregnancy related Low Back Pain (PLBP). Joint hypermobility is a common finding in conditions of known connective tissue abnormalities and is considered a reliable marker for altered connective tissue.

Purpose/Aim

To identify predictors, in early the pregnancy, for PLBP persisting after pregnancy.

Materials and Methods

A cohort of 200 pregnant women was assessed by questionnaire and clinical examination, including measurement of passive abduction of the left fourth finger (figure 1), at gestational weeks 11, 24, 36 and at 13 weeks post partum.

Results

Women with PLBP persistent three months post partum had a significantly larger mean passive abduction angle of the left fourth finger of 4.4°, twice as many previous pregnancies and deliveries and more than twice as frequent back pain in a previous pregnancy, compared with women with no such pain. A similar pattern was displayed in late pregnancy. Women with more than 40° passive abduction of the left fourth finger had a larger risk of PLBP. In a multiple regression analysis, the passive abduction angle of the left fourth finger in early pregnancy and the number of previous pregnancies, were significantly and independently correlated to the incidence of PLBP in late pregnancy and postpartum (figure 2).

Relevance

It is important to identify women who have increased risk for PLBP to prevent disability during and after pregnancy. Women with increased finger joint laxity abduction of the fourth finger might have advantage of adequate available prevention.

Conclusions

Joint mobility as a reflection of constitutional weakness of connective tissue and its influence from previous pregnancies are suggested to be important factors in the development of back pain induced in pregnancy and persisting after childbirth. These factors may provide a foundation for development of targeted prevention strategies for many women at risk of disabling back pain after childbirth.

Discussion

The effect of a previous pregnancy on PLBP development was prominent in women with increased joint mobility, which could be used in future preventive care. The association between specific and general joint laxity is largely explained by genetic factors. The use of the specific joint is justified by high correlations between laxity of the metacarpo-phalangeal joint and general joint measures. One possible explanation for the demonstrated effects could be a successively increased general mobility with each additional pregnancy in particularly constitutionally weak connective tissue.

Implications

The result leads to a possibility to detect women at risk of PLBP persisting after childbirth, already in early pregnancy.

Keywords

Joint mobility, pregnancy, post-partum, low back pain, pelvic pain.

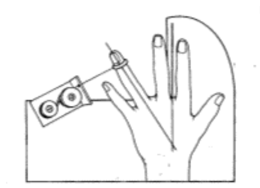

Figure 1. Measurement of passive abduction of the left fourth finger.

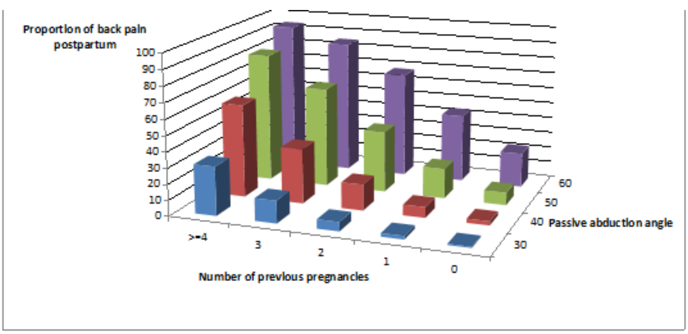

Figure 2. Estimated proportion of back pain reported 3 months post partum with onset during pregnancy, by passive abduction angle of the left fourth finger and number of previous pregnancies.

DIAGNOSTIC SACROILIAC JOINT INJECTIONS: IS A CONTROL BLOCK NECESSARY?

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Introduction
Sacroiliac joint (SIJ) pain presents as a deep, somatic pain, with pain patterns presenting predominantly in the buttock but also referring down the leg sometimes as far as the foot. Given that the features of SIJ pain are non-specific and that this referred pain is similar to lumbar facet joint and lumbar disc pain, diagnostic SIJ and deep interosseous ligament (DIL) local anaesthetic injections, called diagnostic blocks, are used to identify the source of pain. Despite its wide use, little is known about the false positive rate of a single diagnostic sacroiliac (SI) block and the requirement for a control block.

Purpose/Aim
The study set out to determine whether a control SI block is necessary and to monitor the false positive and negative rate for a single injection.

Materials and Methods
Under fluoroscopic guidance, 1408 patients presenting with prominent deep somatic pain over the SIJ region were sterilely injected with a contrast fluid to clearly outline and to ensure accurate non-vascular needle placement in the SIJ and DIL. Anaesthetic was then injected into the SIJ and/or into the deep interosseous ligament. Pain was measured on the 11 point visual analogue scale (VAS) pre-injection and incrementally over the following 1- 2 weeks. Decreases in pain scores (>80%) following the injections were indicative of SIJ pain and recorded as a positive SIJ block.

Results
A prospective observational study with data collected over 3.5 years revealed that a single diagnostic SIJ injection has diagnostic accuracy of 87%, with high sensitivity (98.3%) when compared to a second control diagnostic block.

Relevance
SIJ injection is a commonly used technique for diagnosing SIJ pain. The analgesic response to one or more blocks is the criterion-standard to assess whether or not the patient's pain emanates from the SIJ.

Conclusions
The findings of this study suggest that an initial SIJ/DIL injection performed under fluoroscopic guidance with the use of contrast has a sensitivity of 98.3% and a low false positive rate (12.5%), therefore indicating a reliable method of SIJ pain diagnosis. Furthermore, a second control block may be unnecessary in the diagnosis of SIJ pain in chronic pain sufferers.

Discussions
A diagnosis of SIJ pain can be useful as it may lead to some target specific interventional treatment including radiofrequency neurotomy, prolotherapy and surgery. Successful treatment will confirm the predictive validity of diagnostic SIJ blocks. It is probably reasonable to perform the first two less invasive treatments on a cohort of patients in whom the diagnosis is incorrect in 12.5% of cases, as it means that there would have been far less diagnostic procedures. However, for surgical interventions, control blocks are necessary.

Implications
A diagnosis of SIJ pain can be useful as it may lead to some target specific interventional treatment including radiofrequency neurotomy, prolotherapy and surgery.

Keywords
Sacroiliac joint injection, sacroiliac joint pain, diagnostic injections, control block

PROLOTHERAPY FOR SACROILIAC JOINT PAIN

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Introduction

Prolotherapy is a non-surgical treatment for chronic musculoskeletal pain in damaged ligaments or tendons. Prolotherapy involves injecting a soluble solution such as dextrose into the ligament and tendon sites, inducing a localized inflammatory response, stimulating the growth of collagen fibres and connective tissue. This process is thought to thicken, tighten and strengthen weakened tissue. A previous study of 25 sacroiliac joint (SIJ) pain patients reported a functional improvement of 76% following prolotherapy1. This study set out to investigate the efficacy of prolotherapy in treating SIJ instability.

Purpose/Aim

This study set out to investigate the efficacy of prolotherapy in treating SIJ instability.

Materials and Methods

Over a 2.5-year period, we assessed 102 patients who underwent prolotherapy treatment around the SIJ. This process involved outlining the deep interosseous ligament with contrast material under direct fluoroscopy, which was then injected with 1.5ml Narapin 0.75% and 10ml 50% glucose over multiple sites. This procedure was repeated on average three times, at 6-week intervals. Outcome measures included pain relief, back/hip/pelvic strength, Oswestry disability index (ODI), patient satisfaction and analgesic use.

Results

Half the patients reported improved stability of 69.7 ± 23.0%. Similarly, more than half of patients described pain relief of 74.8 ± 19.2%. Pain relief is dependent on improved stability $r = 0.617$; ($p \leq 0.0001$). Whilst no patients reported pain relief without improved stability, 13/102 patients reported improved stability without pain relief. Where patients reported an improvement in both pain relief and strength, percentage of improvements directly correlated with one another $r = 0.875$; ($p \leq 0.0001$). In turn, improvement in pain relief and strength directly correlated with the number of prolotherapy injections in a series $r = 0.422$; ($p \leq 0.01$) and $r = 0.265$; ($p \leq 0.05$) respectively. Pain relief was also found to be directly correlated with the number of injected sites during each treatment (e.g., unilateral, bilateral etc.) $r = 0.289$; ($p \leq 0.05$). A trend depicting a reduction in ODI was observed with patients reporting pain relief also scoring lower on their post-prolotherapy ODI questionnaire.

Relevance

A significant number of patients around the world are diagnosed with SIJ instability, which is one of the causes of low back pain. If left untreated this can lead to significant reduction in quality of life and reduced functionality.

Conclusions

These findings suggest that prolotherapy can be an effective treatment for increasing stability and strength and decreasing pain in patients with SIJ pain.

Discussions

Prolotherapy is an interventional method of dealing with SIJ instability and provides pain relief and functional improvement in most patients. The results of the study show that prolotherapy improves patients' outcomes via strengthening of the sacroiliac joint.

Implications
Prolotherapy can be used as a safe and effective method for treating SIJ instability and pain.

Keywords
sacroiliac joint, prolotherapy, low back pain

Reference

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DEVELOPING A DYNAMIC ELASTOMERIC FABRIC ORTHOSIS (DEFO) TO AID IN THE MANAGEMENT OF ATHLETIC PELVIC PAIN

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Introduction

Athletic pelvic pain has been acknowledged as being a common problem in many sports; a problem that has been discussed in terms of deficits in strength and neuromuscular control(1). Transverse pelvic belts have been shown to improve pain and function in athletes with adduction-related pain(2); but other belt configurations (diagonal) may also warrant investigation.
Dynamic elastomeric fabric orthoses (DEFOs) are a recent advance in orthotic management, and are increasingly being used in the treatment of a range of musculoskeletal and neurological conditions. These dynamic orthoses may provide an opportunity for transferring the application of pelvic belts into a practical and bespoke format.

Purpose

To explore the effect of different pelvic belt configurations upon athletic pelvic pain, and, to use these results to inform the design of a DEFO (as shorts).

Materials and Method

A repeated measures design was employed, powered for 20 athletes, confirmed through clinical screening as presenting with pain affecting the pelvic girdle. Five conditions were examined: No belt, ASIS belt, and three diagonal belt configurations (a belt traversing across the pelvis towards the site of pain, a belt travelling across the pelvis and away from the site of pain, and, both these belts in conjunction). Belts applied 50 Newtons of force. Outcome measures were: force produced on bilateral resisted hip adduction (squeeze test), and self-scored pain (using a numerical rating scale 0-10) at rest, on completing an active straight leg raise (ASLR) and a broad jump.

Results

The results of repeated measures ANOVAs found the ASIS, and, diagonal belt traversing towards the site of pain, both significantly increased force output on the squeeze test ($p=<0.05$). Pain on ipsilateral ASLR was significantly reduced ($p=<0.05$) with a belt travelling towards the site of pain, and, the diagonal belts in combination.

Relevance

Using these results to develop a DEFO may result in a useful tool for managing athletic pelvic pain.

Conclusions

Whilst the role of an ASIS belt was confirmed, the benefits of diagonal belts were also highlighted.
The results were used to inform the design of a DEFO aimed at supporting the management of athletic pelvic pain.

Discussions

The effects observed with pelvic belts may be associated with addressing loss of force closure, and/or improving proprioceptive awareness at the pelvic literature(3). Both mechanisms have been linked with lumbopelvic pain.

Future work will investigate whether a DEFO can replicate the effects on pain and function seen with belts, and, to investigate these proposed mechanisms.

Implications

This DEFO will be evaluated in athletes with pelvic pain, to assess its potential as a management tool.

Keywords

Athletes, pelvic pain, pelvic belts

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RESEARCH INSIGHTS INTO THE PATHOPHYSIOLOGY OF PELVIC PAIN – IMPLICATIONS FOR DIAGNOSIS AND TREATMENT

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Introduction

Chronic gynecological pain is a common and debilitating problem. The clinical presentation is often considered to be a diagnostic dilemma, since many urological, gastrointestinal and gynecological disorders appear to cause or are associated with chronic pelvic pain. Chronic pelvic pain affects up to 20% of reproductive age women (1) and results in significant personal and societal costs (2).

Purpose/Aim

This lecture will highlight recent basic science and clinical studies that will lead to new insights into the pathophysiological mechanisms of chronic gynecological pain and to improved treatment avenues.

Methods

Studies in a rat model of inflammatory uterine pain will be reported (3). These studies serve as a model to identify spinal cord pathways that are involved in pain from the reproductive organs. Epidemiological (4) and psychophysical studies in healthy volunteers and women suffering from pelvic and urogenital pain syndromes will be considered to assess alterations in pain modulatory mechanisms.

Results

(1) Results of the animal studies demonstrate that a noxious stimulus to one area of the reproductive tract influences the reactivity to subsequent stimulation of another area of the reproductive tract, whose sensory innervation projects to adjacent spinal cord segments.
(2) Results of the epidemiological and psychophysical studies in women with chronic pelvic pain demonstrate distinct alterations in sensory processing.

Conclusions

These basic science and clinical studies suggest that there are specific alterations in pain modulatory mechanisms in women suffering from chronic pelvic pain. The viscero-visceral and viscero-somatic interactions documented in these studies highlight the pathophysiological mechanisms, which account for the overlap of pelvic pain and low back pain observed in clinical practice. The results of these studies elucidate the pathophysiological mechanisms accounting for the co-morbidities observed in a subgroup of these patients.

Acknowledgement

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Wednesday, October 30, 2013

Parallel Session V

Yildiz Erdoganoglu
Yves Henchoz
Rob Laird
Einas Al-Eisa
Lotte Janssens
Sanaz Davarian
David MacDonald
Shwu-Fen Wang
Karsten Kaping
Benedicte van Damme
Seyed Javad Mousavi
Jeremy Houser
Roberto Meroni
D. Klyne

A RANDOMIZED CONTROLLED TRIAL: THE INVESTIGATION OF THE EFFECTIVENESS OF TRANSVERSUS ABDOMINUS AND MULTIFIDUS MUSCLE TRAINING ON FEMALE PATIENTS WITH LOW BACK PAIN IN PHYSICAL TREATMENT AND REHABILITATION

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Introduction

This study was to investigate the difference between traditional exercise approaches and segmental stabilization exercise activities in people with low back pain.

Purpose/Aim

This study was conducted with the aim of investigating the activity of training Transversus abdominus (TRA) and the lumbar multifidus (LM) in physical therapy and rehabilitation applications on female patients with low back pain.

Materials and Methods

The subjects were 66 women with age range of 18-60 years, diagnosed as low back pain. The subjects were allocated randomly into 3 groups which were identified as segmental stabilization group (Group 1, n=23), Williams flexion exercise group (Group 2, n=23) and control group which was included patients following with home exercise (Group 3, n=23). Subjects in group 1 and 2 also was treated with 15 sessions hotpack and ultrasound before exercise. Subjects were assessed at the beginning of the treatment and at the end of the treatment which was eighth week for pain (Short Form McGill), physical performance, isometric muscle strength of lumbar area (Biodex System Pro 3 Isokinetic System), (Figure 1), thickness of TrA and LM muscles (Rehabilitative Ultrasound Imaging) (Figure 2, Figure 3).

Results

Comparing the data before and after the training in each 3 groups, statistically significant ($p < 0.05$) improvement was detected in pain and physical performance. In group 1, statistically significant increase ($p < 0.05$) was detected in the findings of peak torque and peak torque/ body weight, while in groups 2 and 3 there was not a significant increase in muscle strength ($p > 0.05$). In each 3 groups no significant difference ($p > 0.05$) was found in TRA and the rate of change in the LM muscle thickness. Comparing the groups regarding pain, TrA and LM muscle thickness change have not shown any significant difference ($p>0.05$). There were significant statistical differences between group 1 and group 2 regarding physical performance, trunk muscle strength between group 1 and group 3, trunk muscle strength between group 2 and group 3 ($p<0.05$).

Relevance

As a result of our study, while segmental stabilization exercises raises the general muscle body force and physical performance, it didn’t create any change in TrA and LM muscle thickness.

Conclusions

As a result of this study, while trunk muscle strength increased significantly in segmental stabilization exercise applied group, a similar effect was not observed in Williams flexion exercises and home exercise program. Following segmental stabilization exercise and Williams flexion exercise applications, no difference was observed in thickness change in TrA and LM muscle contraction which is primarily responsible for segmental stabilization. Each of three applied approaches increased physical performance in patients with low back pain, decrease in pain levels was achieved.

Discussion

As a result of this study, while segmental stabilization exercises improved overall trunk muscle strength and physical performance, it did not change TrA and LM muscle thickness.

Implications

We believe that patients with back pain should not only be observed with muscle thickness but also with diverse approach and that segmental stabilization exercises are effective in the control of long term repetitive attacks and protection from new lumbar area injuries.

Keywords

Low back pain, Transversus Abdominus, Multifidus, Ultasonography`

Figure 1. Assessment of Muscle Strength with 'Biodex System 3 PRO'

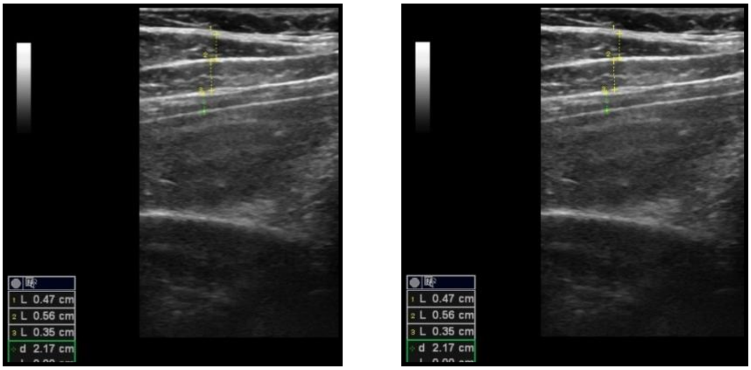

Figure 2 . Image of the TrA at rest and contraction.

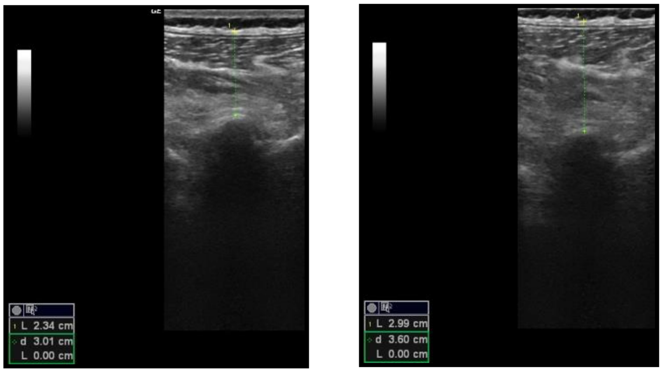

Figure 2. LM image at rest and contraction.

EFFECTS OF PAIN EXPECTATIONS ON NEUROMUSCULAR CONTROL OF THE SPINE DURING NOXIOUS STIMULATIONS

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Introduction

The mechanisms underlying the transition from acute to chronic low back pain (cLBP) are poorly understood. Physiological and psychological factors are believed to be involved. Although significant associations have been found between lumbar spine neuromuscular control and the fear of pain level, it is still unknown whether acute exposure to fear of pain alters trunk sensorimotor control.

Purpose/Aim

The objective of this study was to determine if experimentally induced pain expectations modulate trunk neuromuscular responses differently in participants with and without cLBP.

Relevance

Understanding changes in the neuromuscular control of the spine associated to pain anticipation should provide relevant insight into the pathophysiology and clinical evolution of cLBP.

Materials and Methods

This cross-sectional study included 22 patients with cLBP and 22 healthy participants. They performed 6 trunk flexion-extension trials under three experimental conditions: innocuous heat, and noxious stimulation with low or high pain expectations. Noxious stimulation was generated by thermal cutaneous heat stimulations in the lumbar region (L4-L5), whereas low or high pain expectations were generated by verbal and visual instructions (see Fig. 1). After each task, experimental pain was evaluated using a numerical rating scale (NRS). Surface electromyography (sEMG) of erector spinae at L2-L3 and L4-L5 as well as lumbopelvic kinematic variables were collected during each trial.

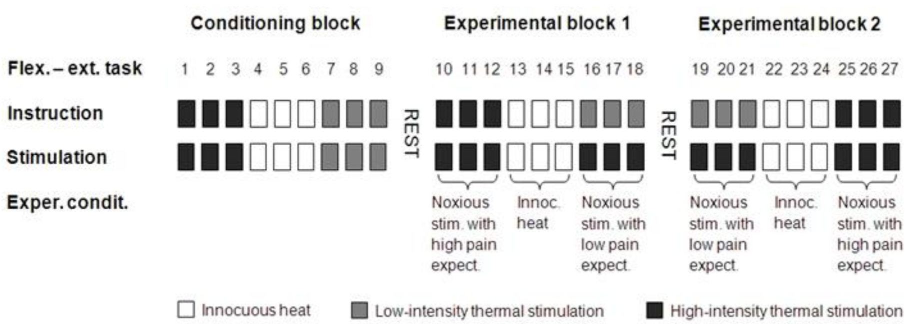

Fig. 1 Study design

Results

Pain ratings were significantly different between high and low pain expectations conditions ($P<0.001$; $\eta p2 = 0.88$) but these changes were comparable between patients with cLBP and control participants (15.2±13.4 vs 13.3±10.2, respectively; $P=0.364$; $\eta p2 = 0.02$). Two-way mixed ANOVA yielded a significant "group x condition" interaction for sEMG in Full flexion at L4-L5 ($P=0.045$; $\eta p2 = 0.08$). Planned comparisons revealed a stronger effect of pain expectation in healthy participants than in patients with cLBP ($P=0.032$). In patients with cLBP, the increase in sEMG activity in full flexion caused by expectation was related to higher pain catastrophizing, but not to disability, anxiety and fear-avoidance beliefs. Lumbopelvic kinematic variables were similarly affected by pain expectation between both groups (all Ps>0.05).

Discussions

Expectations of high pain resulted in neuromuscular adaptations that were lower in patients with cLBP than in control participants. This result may be explained by motor control adaptations developed in response to cLBP, consistent with the decreased motor variability associated with chronic pain.

Implications

Repeated exposure to pain appears to generate rigid and less variable patterns of muscle activation in patients with cLBP, which attenuate their response to pain expectations.

Conclusions

Expectations were successfully manipulated and produced similar pain expectations between groups. However, expectations resulted in neuromechanical adaptations that were less pronounced in patients with cLBP, suggesting that patients may have decreased motor variability.

Keywords

Fear avoidance model, flexion-relaxation, electromyography, lumbopelvic kinematics.

CHANGING MOVEMENT/MOTOR CONTROL PATTERNS USING BIOFEEDBACK WITH MOTION SENSOR TECHNOLOGY IN PEOPLE WITH BACK PAIN – A PILOT TRIAL

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Introduction

Observation of movement and posture is a common component of physical examination of people with low back pain (LBP). However there is conflicting evidence about the relationship between movement and LBP. Despite this, clinicians design and implement interventions aimed at minimizing pain, based on observed relationships between movement dysfunction and pain. It may be that for such interventions to show clinically meaningful effects, modification of movement needs to be based on individualised patterns of dysfunction. Motion sensor technology can assist clinicians to detect and measure movement characteristics that have previously been difficult to measure in a typical clinical setting.

Purpose/Aim

This aim of this pilot trial was to test the hypothesis that modifying patterns of painful lumbo-pelvic movement in people with back pain would lead to reduced pain and activity limitation when compared to standard care and placebo.

Materials and Methods

A multicentre, cluster randomized, placebo-controlled pilot trial compared two groups of people with back pain (n=96). Group one received modification of movement patterns augmented by motion-sensor movement biofeedback (ViMove, dorsaVi). Group two received standard medical care and a placebo (wearing the motion-sensor device without feedback). Primary outcomes were pain intensity (QVAS 0-100 scale) and activity limitation (RMDQ, PSFS). Secondary outcomes included analgesic use, change in fear avoidance beliefs (FABQ), recurrence and movement limitation. Both groups received 6-8 treatment sessions. Outcomes were measured on a weekly basis during treatment and at 12, 26 and 52 weeks follow-up.

Results

An interim analysis, with 48 participants having completed the 6 month follow-up and 30 participants the 12 month follow-up, showed significant between-group differences favouring the biofeedback group for pain [linear mixed model coefficient (95% CI): -8.00 (-12.78, -3.21)] and activity limitation [RMDQ: -1.64 (-2.90, -0.37), PSFS: 0.73 (0.01, 1.46)].

Relevance

Modification of movement patterns is a common intervention for people with back pain but there is conflicting evidence of its utility. This pilot trial demonstrated improvement during and after a novel intervention aimed at individualised modification of patterns of painful lumbo-pelvic movement.

Conclusions

These preliminary results indicate that modification of painful lumbo-pelvic movement may produce superior reduction of pain, and improvement to activity limitation, in people with back pain when compared to standard care.

Discussion

Motion-sensor technology presents new opportunities for increased accuracy and detail when assessing movement, as well as the addition of therapeutic biofeedback to change movement-provoked pain. Enhanced clinical diagnostics and treatment possibilities are supported by the promising preliminary findings of this pilot trial, but now require more complete investigation. An important finding is that improvement continued to occur even after the intervention was completed, suggesting that self-managed movement modification can produce ongoing benefit.

Implications

A fully powered trial is now planned

Keywords

Motor control, clinical trial

ASSOCIATION BETWEEN CORE MUSCLE ENDURANCE, STRESS URINARY INCONTINENCE, AND LOW BACK PAIN: A CASE-CONTROL STUDY

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Background

Recent studies suggest an association between low back pain (LBP) and stress urinary incontinence (SUI), and therapists commonly note that treating one component often impacts the other. The high prevalence of both conditions among women warrants special attention. It is hypothesized that core muscles must be functioning optimally for an individual to be free of LBP, and to be continent during activities which increase the intra-abdominal pressure. Physiological evidence supports that the core muscles are involved in the maintenance of trunk control as well as continence. Yet, clinical evidence remains scarce.

Purpose

To determine the clinical association between LBP, SUI and core muscle endurance.

Methods

A total of 303 women aged 18-45 years were included in this case control study. Cases with LBP were recruited through outpatient physical therapy departments, targeting patients referred with LBP of 6 months duration or longer. Healthy controls were recruited through poster advertisement in the university newsletter and website. Outcome measures included the Oswestry Disability Index (ODI) to assess LBP, and the International Consultation on Incontinence Questionnaire (ICIQ) to assess SUI. Core muscle endurance was assessed using the clinical prone plank test. Correlational analysis and Chi-square test were used to test for associations and differences respectively.

Results

There were no statistically significant differences in the demographics between the control group (n=160), and cases with LBP (n=143). Over 60% of cases with LBP had SUI compared to 20% incidence of SUI in the control group. SUI was significantly greater in the LBP cases compared to the control group ($p<0.05$). Prone plank holding times were significantly shorter among the cases with LBP ($p<0.05$). Core muscle endurance moderately correlated with the ODI ($r=-0.54$). Core muscle endurance and SUI were moderately correlated in the control group ($r=-0.6$), and highly correlated in the cases with LBP ($r=-0.75$).

Discussion & Conclusions

Women with LBP have a higher risk of developing SUI especially if the core muscles are not functioning optimally. The weaker the endurance of the core muscles, the higher the perceived level of LBP disability, and the stronger the severity of UI and it's impact on quality of life. The current study suggests that the correlation may be associated with an alteration of the optimal function of the muscles surrounding the whole abdominal cavity, supporting the view that LBP can be managed with an integrated approach including exercises targeting the diaphragm, deep abdominals and pelvic floor muscles.

Relevance

This study highlights the importance of utilizing the core muscles in their entirety in the assessment and treatment of both conditions. The findings have implications for clinicians designing prevention and treatment programs for this subgroup of women.

Keywords
Low back pain, incontinence, core muscles, abdominals, pelvic floor

INSPIRATORY MUSCLE TRAINING IMPROVES PROPRIOCEPTIVE POSTURAL CONTROL IN INDIVIDUALS WITH RECURRENT NONSPECIFIC LOW BACK PAIN

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Introduction

Individuals with recurrent non-specific low back pain (LBP) show a suboptimal, more ankle-steered, proprioceptive postural control (PPC) strategy. Moreover, LBP is strongly related to respiratory disorders, and PPC seems to be impaired in individuals with compromised inspiratory muscle function. Loading of the inspiratory muscles impairs postural control by decreasing lumbar proprioceptive sensitivity. Individuals with LBP are known to have a greater diaphragm fatigability compared to healthy controls. It remains unclear whether unloading of the inspiratory muscles might improve PPC in individuals with LBP.

Aim

The aim was to investigate the effect of inspiratory muscle training (IMT) on PPC, inspiratory muscle strength, severity of LBP and disability in individuals with LBP.

Methods

Twenty-four individuals with LBP were randomly assigned into an intervention (IMT) and control group (c-IMT). The participants were instructed to breathe (30 times, twice daily, 8 weeks) through an inspiratory resistance of 60% of their maximal inspiratory pressure (PImax) (IMT) or 10% of PImax (c-IMT). Outcomes were evaluated at baseline and after 8 weeks of (c-)IMT. Center of pressure (CoP) displacement was determined during upright standing on stable and unstable support surface, and muscles vibration (ankle, back, ankle-back) was used to evaluate PPC. A Relative Proprioceptive Weighting ratio (RPW) was calculated using the equation: RPW= (Abs ankle)/(Abs ankle + Abs back). ‘Abs ankle’ is the absolute value of the mean CoP displacement during ankle muscle vibration and ‘Abs back’ during back muscle vibration. A RPW score equal to one corresponds to 100% reliance on ankle muscle input (‘ankle-steered strategy’), whereas a score equal to zero corresponds to 100% reliance on back muscle input (‘multi-segmental strategy’). Inspiratory muscle strength was evaluated by measuring PImax. Severity of LBP and disability were assessed using the Numeric Rating Scale (NRS) and Oswestry Disability Index (ODI-2), respectively.

Results

Inspiratory muscle strength After the intervention, inspiratory muscle strength was significantly different between both groups ($p= 0.001$). After IMT, inspiratory muscle strength significantly increased as shown by higher PImax values (136±35 cmH_2O) compared to pre IMT (94±31 cmH_2O) (Δ 42 cm cmH_2O; $p= 0.001$). After c-IMT, individuals did not show an increase in PImax (94±26 cmH_2O) compared to pre c-IMT (92±27 cmH_2O) (Δ 2 cm cmH_2O; $p= 0.984$).
Proprioceptive postural control When comparing the relative use of ankle versus back muscle proprioceptive input (RPW 0–1), no difference between both groups was observed after the intervention ($p= 0.160$ (RPW stable); $p= 0.150$ (RPW unstable)). Though, in the IMT group, the decreased RPW values after IMT showed a more multi-segmental postural control strategy compared to pre IMT when standing on stable support surface (Δ 0.18; $p= 0.005$). This could not be confirmed in the c-IMT group when comparing the RPW before and after the c-IMT intervention (Δ 0.09; $p= 0.328$). When standing on unstable support surface, the IMT group showed a similar switch to a multi-segmental postural control strategy, as shown by the decreased

RPW values after IMT compared baseline (Δ 0.22; p= 0.005). Individuals who underwent c-IMT did not exhibit a difference in proprioceptive strategy before and after c-IMT (Δ 0.10; p= 0.340) when standing on unstable support surface. No significant correlation was found between the change in RPW on stable support surface and the change in PImax after (c-)IMT (r= -0.29; p= 0.174), although on unstable support surface a significant negative correlation could be observed (r= -0.43; p= 0.041), suggesting higher PImax values to be correlated to a more multi-segmental postural control strategy.

Severity of LBP & LBP-related disability After the intervention, there was a trend for LBP to be lower in the IMT group compared to the c-IMT group (p= 0.064). More specifically, severity of LBP (NRS score 1–10) decreased significantly in the individuals with LBP following IMT (3±2) compared to pre IMT (5±2) (Δ 2; p= 0.004), whereas this was not seen in the individuals with LBP following c-IMT as no difference in LBP score was found before (5±2) and after (5±2) the training in this latter group ((Δ 0; p= 0.665). Disability associated with LBP did not differ between both groups after the intervention (p= 0.791), and was not significant different before (17±8 %) and after IMT (13±10 %) ((Δ 4 %; p= 0.454), nor before (20±8 %) and after c-IMT (17±7 %) ((Δ 3 %; p= 0.681).

Relevance

The decreased RPW ratios in the IMT-group suggest a decreased reliance on ankle proprioceptive signals and increased reliance on back proprioceptive signals.

Conclusions

After eight weeks of IMT, individuals with recurrent non-specific LBP adopt a more multi-segmental postural control strategy, show an increase in inspiratory muscle strength, and report a decrease in LBP severity. These findings could not be confirmed following c-IMT.

Discussion

Proprioceptive postural control might be improved following IMT by addressing the trunk stabilizing function of the diaphragm, by attenuating the vasoconstrictor influence of the metaboreflex, or by increasing body awareness. This may enable individuals to reweight proprioceptive signals and to shift to a more optimal proprioceptive strategy.

Implications

The results of this study provide evidence of inspiratory muscle loading as one potential underlying mechanism of altered proprioceptive postural control and LBP, which can be reversed by IMT. Nevertheless, a randomized controlled trial with a larger sample size and long term follow-up must reveal whether IMT can be valuable in the rehabilitation of individuals with recurrent non-specific LBP.

Keywords

Inspiratory muscle training, Low back pain, Postural control, Proprioception

ANTICIPATORY POSTURAL ACTIVITY IN CHRONIC LOW BACK PAIN PATIENTS AFTER TRUNK MUSCLE FATIGUE

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Introduction

Previous studies have demonstrated sooner anticipatory activity of postural muscles during an internal perturbation in healthy subjects. Altered motor control in chronic low back pain (CLBP) patients compared to healthy subjects has been shown in many studies. However, whether the central nervous system in these patients may use different anticipatory strategies under fatigue condition is not clear.

Purpose

The aim of this study was to evaluate the influence of fatigue on anticipatory postural adjustments in CLBP patients.

Materials and Methods

18 CLBP patients (13 women and 5 men) and 18 matched healthy subjects participated in this study. 10 trials of rapid arm flexion were recorded before and after the trunk extensors fatiguing exertion. The onset latency and anticipatory activity of the bilateral Transversus Abdominis/Obliquus Internus (TA/OI), Superficial Lumbar Multifidus (SLM) and Lumbar Erector Spinae (LES) were collected.

Results

The results showed a significant group effect for the onset latency of the right TA/OI, SLM and LES ($P<0.05$) and a significant fatigue effect for the onset latency of the right TA/OI ($P<0.05$). There was a significant group effect for the anticipatory activity of the right TA/OI, SLM and LES ($P<0.05$) and a significant fatigue effect for the anticipatory activity of the bilateral SLM and LES ($P<0.05$). There was no significant interaction effect for either of the variables for any of the muscles ($P>0.05$).

Conclusions

It seems that CLBP patients may use anticipatory co-activation strategy during rapid arm flexion compared to healthy subjects in pre-fatigue condition. Lower anticipatory activity of posterior trunk muscles after fatiguing exertion may support the peripheral mechanism of fatigue. In addition, sooner activity of the right TA/OI after fatiguing trunk extensor muscles can support that fatigue is a centrally-mediated event.

Keywords

Anticipatory Postural Adjustments, Low Back Pain, Fatigue, Motor Control

THE INFLUENCE OF CENTER OF PRESSURE ON TRUNK AND HIP EXTENSOR MUSCLE ACTIVITY DURING LIFTING

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Introduction

Lifting is frequently performed in vocational and sporting contexts. Maintenance of center of pressure (CoP) at the hindfoot is a commonly used strategy thought to improve lifting performance by influencing trunk and hip extensor muscle activity. However, whether CoP differences influence trunk and hip extensor muscle activity during a lifting task remained to be investigated.

Purpose/Aim

This study aimed to investigate the influence of changes in CoP on trunk and hip extensor muscle activity during the performance of a lifting task.

Materials and Methods

Fifteen experienced lifters performed a barbell deadlift under two conditions (1) with CoP at the forefoot (CPF) and (2) the hindfoot (CPH). Surface electromyographic activity (EMG) of the trunk (thoracic and lumbar erector spinae) and hip extensor muscles (gluteus maximus, semimembranosus, and biceps femoris) was recorded while a force plate provided visual feedback of CoP. The ascent phase of the lift was divided into four epochs of equal duration. Normalised root mean square (RMS) EMG amplitude of each muscle was compared between epochs and conditions. Rate of perceived exertion (RPE) was also monitored and compared between lifting conditions.

Results

Trunk and hip extensor muscle activity during the CPF condition was not significantly different to CPH ($p = 0.44$). RPE during the CPF condition was significantly greater than during the CPH condition ($p = 0.02$).

Relevance

This is the first study to investigate whether differences in CoP influence trunk and hip extensor muscle activity during a lifting task. This study is an important first step in understanding the contribution of commonly used lifting instructions to lifting performance.

Conclusions

Although participants perceived greater effort when lifting with CoP maintained at the forefoot, differences in CoP were not associated with differences in trunk and hip extensor muscle activity. This suggests that changes in trunk and hip extensor muscle activity do not underlie the reported improvements in lifting performance.

Discussions

Despite popular belief, trunk and hip extensor muscle activity was not influenced by differences in CoP and appear independent of RPE differences and reported improvements in lifting performance while lifting with the CoP through the hindfoot. However, this does not exclude the possibility that differences in CoP are associated with some other aspect of lifting that could influence performance and rate of perceived exertion.

Implications

In the long term, the findings of this study may be used to inform lifting education with potential for improved performance and a reduction in injury rates and their associated disability. Further research in this area could improve coaching practices by illuminating the key principles of improving lifting performance.

Keywords

Electromyography, deadlift, trunk extensor muscles, hip extensor muscles, center of pressure

MORPHOLOGICAL CHANGE OF TRANSVERSE ABOMINIS AND MULTIFIDUS IN PATIENT WITH RECURRENT LOW BACK PAIN

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Introduction

The deep layer of trunk muscle such as transverse abdominis (TrA) and deep multifidus (dMF) is considered important in maintaining tonic contraction and trunk stability. Motor control impairment of the deep muscles is discovered in patients with low back pain (LBP). We have developed a comprehensive examination of the TrA in the anterior and posterior parts and its muscle-fascia junction1,2. Furthermore, a non-invasive method to evaluate the morphology of the dMF1 has been established in our laboratory.

Purposes

This study is to compare the contraction pattern of the dMF, morphological change of TrA at the anterior and posterior junctions between asymptomatic participants and patients with recurrent low back pain.

Materials and Methods

Two ultrasonographic instruments are used to capture the morphologic changes of the dMF and TrA. The changes of thickness and sliding between static and contracted status of dMF and TrA are measured in 76 asymptomatic and 75 patients with recurrent low back pain. The tasks performed included: abdominal draw-in maneuver (ADIM), lifting the ipsilateral and contralateral leg of the observing side of multifidus in prone position, and combined task of lifting leg while performing ADIM. Independent t-test was used to compare the difference between groups.

Results

For the task of ADIM, patients with recurrent LBP performed with significant less sliding of muscle fascia junction of TrA at anterior side ($p<0.05$, figure 1). While at the posterior muscle-fascia junction of TrA, less thickness change ($p<0.05$, figure 2) and less sliding ($p<0.05$, figure 1) were demonstrated in patients with recurrent LBP. However, during the task of lifting ipsilateral leg in prone position, the patients demonstrated more thickness change of TrA ($p<0.05$) than asymptomatic participants. During the tasks combined ADIM and lifting leg, the patients demonstrated greater thickness of TrA after ADIM before leg lifting ($p<0.05$) compared to asymptomatic participants. However, sliding of the muscle-junction is not significant change in patients ($p>0.05$). Deep multifidus measured in patients demonstrated great thickness measured in rest ($p<0.05$) and during contraction ($p<0.05$) than that of asymptomatic participants. However, the change of thickness of multifidus in patients is not significantly different from that in the asymptomatic participants ($p>0.05$).

Relevance

The identification of the morphological changes in deep muscles of patients with recurrent LBP could reveal the functional role of the deep muscles in the mechanism of development of low back pain.

Conclusions

Patients with recurrent LBP showed less change of thickness of TrA at the posterior side and less sliding of muscle fascia junction at both anterior and posterior sides.

Discussion

Patients with recurrent LBP adapted an activation pattern of TrA and dMF during static and dynamic tasks. Whether this adaptation related to the over-usage of superficial muscles and/or disuse of the deep muscles, which causing a viscous cycle in impairment of sensory-motor control of the low back, need further investigation.

Implications

The treatment effect of deep muscle activation as well increase the sliding of muscle-fascia junction in patients with recurrent LBP required further investigation.

Keywords

Lumbar multifidus, Transverse abdominis, Ultrasonography, Low back pain

Acknowledgement

NHRI-EX101-10042E1

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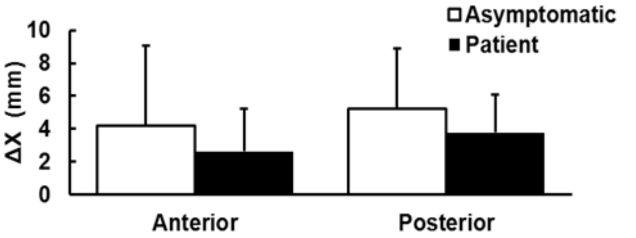

Figure 1 Sliding of muscle-fascia junction of transverse abdominis measured at anterior and posterior sides in patients with recurrent low back pain and asymptomatic participants during ADIM.

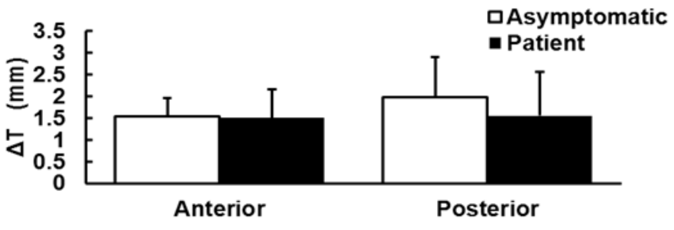

Figure 2 Change of thickness of transverse abdominis measured at anterior and posterior sides in patients with recurrent low back pain and asymptomatic participants during ADIM..

VALIDATION AND RELIABILITY OF THE ABDOMINAL DRAWING-IN MANEUVER IN SUBJECTS WITH LOW-BACK PAIN

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Introduction

In order to evaluate voluntary activation of the lateral abdominal muscles the abdominal drawing in maneuver (ADIM) has been proposed. ADIM is used as a therapeutic tool to instruct and assess how subjects activate the lateral abdominals and especially the Transversus Abdominus muscle(TrA). In order to quantify the activation of the deep abdominals, ultrasound imaging (USI) have been validated in measuring activation and muscle thickness.

Purpose/Aim

The aim of current study was to investigate the concurrent validity, the discriminative validity and the reliability of manually assessed ADIM in healthy and subjects with LBP.

Materials and Method

Fifty three subjects,(18-64 years) were included in the study; 38 with LBP and 15 healthy. All subjects' underwent manual and USI examination of the ADIM. 24 subjects were examined by two observers for inter-rater reliability. All observers were manual therapist with high experience in teaching ADIM. The ADIM was scored as pass/fail. USI was recorded by Prosonix 600 DCPD, motions was collected with a linear-array transducer (5-10 MHz). Mean values of the measurements from three ADIM contractions and three resting positions were calculated for the TrA and oblique muscles. Mean values for each muscle going from rested to contract state resulted in three different ratios. Spearman´s rank correlation coefficient (r) was used to calculate associations between the result from manual and USI investigation of ADIM. Kappa was used to describe inter-reliability.

Results

Associations between the manual examination and the USI calculated ratios of a pass/fail ADIM ranged between r=0.4-0.13. Associations between manual examination and the subjects' state (healthy/LBP) (r= -0.15) and the USI and subjects state (Healthy/LBP) (r= -0.22) was low. Association between the TrA contraction and preferential activation ratio was r= -0.53. The inter-rater reliability was κ=0.71 (n=24).

Relevance

Physical therapist world wide use ADIM in clinical practise to assess activation of the lateral abdominals. Clinical tests need to be investigated for validity and reliability even if empirically considered useful.

Conclusion

Our results show that no association was shown between the manual assessment of ADIM and the calculated ratios from the USI measurements. In addition, no association were obtained between healthy or subjects with LPB with the manual or the USI assessment of ADIM. The manual test seems to be reliably.

Discussion

The obtained values from USI were in accordance with other authors. One contribution to the difference is that current study investigated both healthy and subjects with LBP though earlier reports included mostly healthy. The anatomical position with the lateral abdominal muscles overlaying each other may possible contribute to the problems in palpating a correct ADIM.

Implications

Even if our study doesn't confirm validity of manual examination of activation of the TrA, the maneuver may still be a useful tool in clinical practise in training the lateral abdominals.

Keywords

Low-back pain, ultrasound, transversus abdominis, ADIM

TRUNK MUSCLE RECRUITMENT PATTERNS DURING NEUROMOTOR CONTROL EXERCISES

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Introduction

A lot of studies suggest that trunk muscle recruitment patterns are important in the prevention and rehabilitation of low back pain (LBP). Neuromotor control exercises are widely used to optimize trunk muscle recruitment. But there is a lack of objective data to assess trunk muscle recruitment patterns in patients with LBP and to evaluate the effect of neuromotor control exercise therapy on these patterns.

Aim

To investigate trunk muscle activation patterns of deep stabilizing and superficial torque producing muscles during different neuromotor control exercises in healthy subjects.

Materials and Methods

99 healthy subjects of Belgian Defense (51 men and 48 women), aged between 20 and 65, voluntary participated in this study. Muscle activity of the internal obliques (IO), the external obliques (EO), the multifidus and the iliocostalis pars thoracis was registered using surface EMG. Ratios of deep stabilizing to superficial torque producing muscle activity were calculated to examine trunk muscle recruitment patterns during 6 different neuromotor control exercises. The subjects were asked to maintain a neutral position of the back while different movements of the arms, legs and trunk were performed. Differences in gender and age were analyzed.

Results

Ratios of deep stabilizing to superficial torque producing muscles during the different neuromotor control exercises varied between 0.33 and 2.19, implicating different recruitment strategies for each exercise. In some of these exercises, deep stabilizing muscles dominated; while in other exercises the torque producing muscles were dominantly recruited. In some of the exercises, gender and age related significant differences were present. But one of the main findings was the observation of a very wide variation of the EMG data among the different subjects.

Relevance

Optimizing the objective assessment of neuromotor control exercises and providing a starting point for individual exercise therapy.

Discussion

There is no preferential recruitment pattern among the investigated neuromotor control exercises indicating that trunk muscle recruitment patterns are very task dependent.

The high variation in the activation levels in healthy subjects could complicate comparison with patients. This questions the potential value of a normative database indicating that further research on this issue is required.

Conclusion

In low load neuromotor control exercises, trunk muscle recruitment patterns (deep stabilizing to superficial torque producing muscle activity) appear to vary highly between healthy subjects.

Implications

Task dependency of muscle recruitment strategies stresses the importance of combinations of exercises in the assessment and rehabilitation of muscle activity in the lower back.

Keywords

Neuromotor control exercises, surface EMG, recruitment patterns, low back pain

TRUNK MOTOR CONTROL DURING MULTIDIRECTIONAL TRACKING TASKS

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Introduction

Despite the popularity of continuous motor performances (tracking tasks) in motor control studies, little attention has been paid to this kind of research in spine motor control studies. The findings of more recent tracking studies have shown the potential ability of this method to substantially challenge trunk neuromuscular system both in asymptomatic participants and patients with chronic low back pain (LBP).

Purpose

To investigate trunk motor control (trunk accuracy) during multidirectional tracking tasks in asymptomatic participants and patients with chronic LBP.

Materials and Methods

Twelve patients with chronic LBP and 12 asymptomatic controls participated in this study. A novel isometric torque tracking system was used to quantify trunk motor control in 12 angles consisting 4 uniaxial (pure) and 8 biaxial (combined) exertions. The tracking system included a moving target object, which moved in a straight path from the center of the screen corresponded to (0,0) in the torque space to the end point that set to be equal to the intended exertion level of 80% of the individual maximum voluntary exertion (MVE) at each angle. The target moved with the rate of 6% MVE/s. The target object was a circle with a variable radius; i.e., bigger in the higher magnitudes of exertion than lower magnitudes to accommodate the higher absolute amount of deviation at higher torque magnitudes. A small red circle represented the real-time visual feedback of the applied isometric torque against a 3D dynamometer was presented on a computer monitor in front of the participant. The 2D location of the circle on the screen indicated the measured torque in the sagittal and transverse planes. The participants were asked to exert isometric contraction as accurately as possible to position the red cursor on the center of the target and then follow its movement. Trunk motor control was quantified by computing constant error and variable error during each trial.

Results

The results showed that constant and variable errors were larger in patients group than in healthy controls. Repeated measures ANOVA indicated that subject group, direction and magnitude of exertions had a significant effect on the mean of control errors ($P < 0.001$).

Relevance

Our results suggested that the tracking accuracy of both groups decreased substantially during rotational and combined directions as well as during higher magnitudes of exertion. The findings also showed higher errors (lower accuracy) of patients during tracking tasks especially in rotational and combined exertions compared to asymptomatic controls.

Conclusions

This study demonstrated poor accuracy of patients with LBP compared to asymptomatic subjects during a novel continuous performance task. Poor accuracy has been observed in rotational and biaxial directions as well as higher magnitudes of isometric exertion. These findings can be explained by the presence of signal dependent noise in muscle force generation.

Implications

The results showed that combined exertions and more strenuous efforts may impair trunk neuromuscular control and eventually increase the risk of low back injury. The results suggested that continuous motor performance tasks (tracking tasks) can be a useful research tool to measure and quantify trunk motor control. The tracking system may also have a potential ability to identify subgroups of patients or high-risk individuals based on their neuromuscular control.

Keywords

Low Back Pain, Motor Control, Tracking Task

COMPARING EMG IN WOMEN WITH CHRONIC LOW BACK PAIN TO HEALTHY CONTROLS DURING SELECTED FUNCTIONAL ACTIVITIES

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Introduction

It is well established that chronic low back pain (LBP) continues to be a prevalent concern and an economic burden in health care globally. Consequently, to improve outcomes of treatment interventions and decrease health care costs, a better understanding of the underlying mechanisms regarding muscle activation in those with chronic LBP is warranted. Through a comparison of muscle activation during functional activities of those with LBP and healthy controls, we aimed to provide clinically relevant information that can improve examination, treatment, and intervention strategies. The long-term objective of this line of research is to determine if objective measurements of muscle activity and balance can consistently differentiate subjects with varying types of low back pain. If such measurements can result in a sub-classification system, then these objective measures can be used to evaluate various interventions and their comparative effectiveness.

Purpose/Aims

As a portion of the larger study, the purpose of this cross-sectional study was to investigate whether the magnitude and/or symmetry of muscle activity would differ between women with chronic low back pain (LBP) and healthy controls (CTL). The first specific aim was to investigate whether any disparities exist in the magnitudes of normalized muscle activation between the groups for each of the functional activities: squat, forward trunk flexion, and step-up-and-over. The second aim was to investigate if any consistent variations in the symmetry of activation levels exist between muscles of the left and right sides between the groups for each of the three functional activities.

Methods

During the recruitment process numerous inclusion criteria for inclusion in LBP were used, but not limited to the following: age range (18-50yrs), BMI (≤30kg/m2), chronic, persistent condition (≥3months, ≥5days/wk), average pain level ≥4 out of 10, non-pregnant for six months, and free from numerous musculoskeletal conditions/surgeries. Control subjects (N=28) were age- and BMI-matched to the LBP subjects (N=28). Various questions were used to determine whether their self-assessed symptoms indicated possible inclusion in either group. After providing consent, subjects completed a set of questionnaires (medical history, Oswestry Low Back Pain Disability Scale, and PROMIS-29 Profile). The subjects practiced the functional activities: a squat, a forward trunk flexion, and a step-up-and-over activity. The subjects then underwent a standardized physical examination, which was used in conjunction with the medical history to appropriately determine group placement. The researchers conducting the following methodologies were blind to group placement. The subjects were instrumented with surface electromyography (EMG) electrodes on the following muscles bilaterally: iliocostalis, longissimus, multifidus, gluteus maximus, gluteus medius, biceps femoris, and transversus abdominis. Electrogoniometers were placed across the lateral surface of both knees to provide events used to split each functional activity into phases. Data were measured using a Noraxon TelemyoTM system (1000Hz). Prior to functional activity protocols, the subjects were instructed to hold several standardization limb and torso postures for 5 seconds to provide for submaximal normalization of muscle activity. Each subject randomly completed 3 trials of each of the 3 functional activities on a NeuroCom® Balance Master System. During the squat, subjects paused at 40, 80 and 120 degrees of knee flexion during the descent phase. The forward flexion activity was performed with a 1 second flexion, a 5 second hold at maximum flexion, and a 1 second extension. Due to the alternating limb use of the step-up-and-over activity, it was performed with each limb leading separately so as to make appropriate comparisons, totaling 6 trials. The step-up-and-over activity was divided into four phases; the first phase was lifting the lead limb to step on the 40cm box, the second phase was the ascent to be atop the box, the third phase was the descent to place the trailing limb on the platform on the opposite side of the box, and the fourth phase was lowering the leading limb to regain a bipedal stance. Muscle activity was bandpass filtered (30-1000Hz), RMS processed (50ms window), and normalized to the standardized submaximal activity. For selected phases of the squat and forward flexion activities, muscle activity magnitudes were calculated as the average of the left and right sides. For the step-up-and-over activities, the muscle ipsilateral to the lead limb was averaged for left and right step-overs and repeated for the muscles ipsilateral to the trail limb.

Average muscle activity magnitudes and the absolute difference between left and right muscle activities were compared between the groups using Wilcoxon-Mann-Whitney tests (α=.10).

Results

There were numerous variations in the magnitudes of muscle activation and symmetries in LBP subjects when compared to CTL. During the squat, the biceps femoris (p=.05) and the multifidus (p=.01) were more active during the start of the descent in the LBP group. At mid-squat, the gluteus medius (p=.06) and the multifidus (p=.04) were more active in the LBP group. In late descent of the squat, the gluteus medius (p=.03) was more active in the LBP group. Regarding symmetry of muscle activation during the squat, the gluteus maximus was more asymmetrical in the LBP group during mid-squat (p=.07) and late descent (p=.1).

During forward trunk flexion, the biceps femoris (p=.008) had greater activation for the LBP group while descending. Similarly, the biceps femoris (p=.1) and gluteus medius (p=.01) muscle of the LBP group were more active while maximally flexed. The transversus abdominis muscles of the CTL group were greater during the extension phase of the forward flexion (p=.08). Regarding symmetry during forward flexion, the gluteus maximus was more asymmetrical in the LBP group during flexion (p=.05) and extension (p=.05), while the transversus abdominis was more asymmetrical in the LBP group (p=.09) at maximum flexion. For the step-up-and-over, the biceps femoris muscle of the lead limb was more active in the LBP group during the ascent (p=.05) and descent (p=.04) phases. No significant differences in activation were found for the trail limb musculature during any phase. Regarding symmetry relative to the lead limb; the gluteus medius was more asymmetrical in the LBP group while lifting the lead limb during phase one (p=.01), the iliocostalis muscle was more asymmetrical in the LBP group while ascending during phase two (p=.03), and the longissimus muscle was more asymmetrical in the LBP group during the final phase (p=.1). Regarding symmetry relative to the trailing limb, the only significant difference was greater asymmetry in the LBP group gluteus maximus musculature during the ascent phase (p=.06).

Conclusions

Based on the results of this study, muscle activation is different in women with chronic low back pain compared with healthy controls during selected functional activities. Muscles affecting the pelvis at the hip joint seemed to differentiate the groups better than erector spinae muscles. In the LBP group, 1) gluteal and biceps femoris muscles showed more activation and asymmetry, 2) the biceps femoris was particularly more active during eccentric motion of each activity, and 3) the gluteus maximum showed asymmetry during all three activities. Each of these weight-bearing activities required significant hip muscle activation to transfer forces between the lower limb and the pelvis. The sole instance of significantly higher muscle activity in CTL subjects was the transversus abdominis during extension of the forward flexion activity, perhaps indicating greater overall core stability. Thus, the clinical application suggests examination and intervention strategies for women with low back pain should be directed towards activation of muscles controlling the torso and the pelvic regions.

Keywords
Muscle activity, Squat, Forward flexion, Step-up-and-over

TACTILE ACUITY OF THE TRUNK IN CHRONIC LOW BACK PAIN

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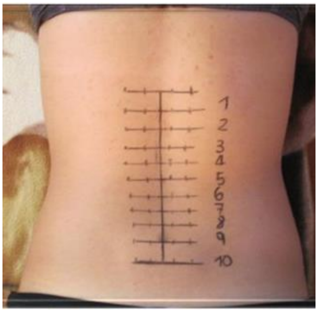
Introduction

Chronic non-specific low back pain is a common problem with high costs. Many factors can contribute to motor dysfunction after an initial episode of pain and many people are not aware that they are moving differently. The loss of proprioceptive acuity is an element that can contribute to motor dysfunction. Recent literature suggests that two point discrimination (TPD) threshold at the back is greater in patients with back pain than in healthy controls, and greater TPD threshold at the back relates to decreased voluntary lumbopelvic control. These findings raise the possibility that decreased tactile acuity may contribute to poor motor control, which has implications for back pain rehabilitation in particular and for movement retraining in general.

Purpose/Aim

to study TPD threshold in a sample of CLBP patients, to verify if a 6 week sensory discrimination training improved TDP threshold, low back pain, function, movement patterns

Materials and Methods



A blinded randomized clinical study involving a sample of 77 patients with chronic non-specific low back pain. Subjects aged between 18 and 65 years, with low back pain more than 12 months, for at least 90 days within the past year were enrolled in the study. While patients with red flags or yellow flags, structural pathologies, spine surgery, pain below the knee were excluded. Patients underwent an interview and physical assessment with a physiotherapist and completed a body chart, the Baecke scale, the SF 36 questionnaire, the Oswestry disability index, the Roland–Morris Disability questionnaire and two 100-mm VAS to describe both back pain at the moment of evaluation and average back pain. The TPD was assessed bilaterally in the back.

Figure 1 TPD assessment grid on the subject's back, a plastic caliper was used to test the TPD threshold in the different areas.

The movement impairment evaluation was based on Sahrmann examination. The sample was divided into two groups (experimental and control group) by randomization: 40 patients were submitted to the sensory discrimination training, while 37 patients took part in the control group. The treatment group underwent 3 session per week lasting 6 weeks (grand total of 18 sessions). All the enrolled subjects were evaluated at baseline (t0), at 6 weeks (t1) and after another 6 weeks follow up (t2).

Figure 2 TPD treatment grid example on subject's back (subject with unilateral pain). The subjects, while looking at a picture of their back with the points represented, were asked to recognize which point the therapist was touching and which kind of pointer was used (thin or thick).

Results

Treated patients and controls were homogeneous showing no differences in sex, age, weight, height, body mass index, pain, Baecke scale, SF 36 questionnaire, Oswestry disability index and Roland–Morris Disability questionnaire and TDP threshold. Also the movement impairment evaluation was similar between patients and controls. Movement impairment evaluation at t1 demonstrated an improvement in treated subjects on rotation signs, extension signs and total symptoms. Patients had a significant improvement of pain intensity (VAS mean t0= 4,8mm and VAS mean t1=2,9mm, p=0,015). Also the Oswestry disability index and the Roland–Morris Disability questionnaire disability scales showed a significant decrease after the period of training. Improvement at t1 were kept at t2.

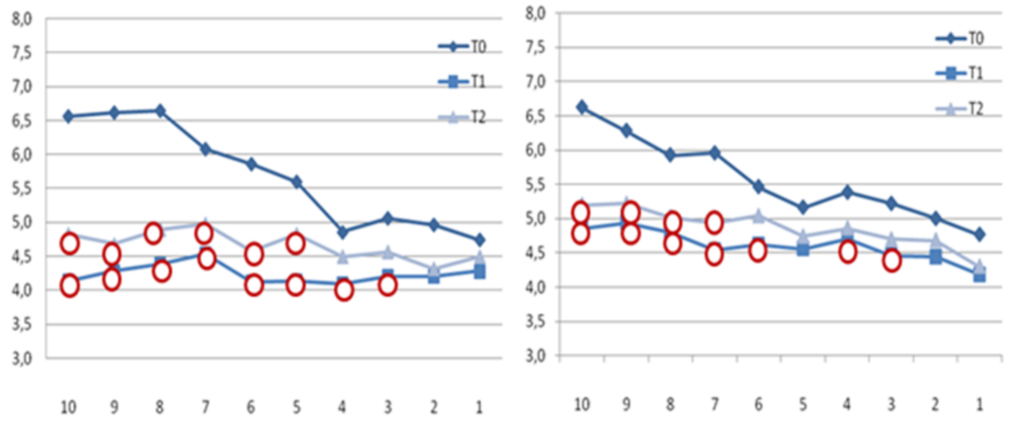


Figure 3 TPD changes (cm) over time, levels are reported on the horizontal axis with 10 representing the most caudal level (Fig.1). Red circles represent significant changes ($p<0,05$)

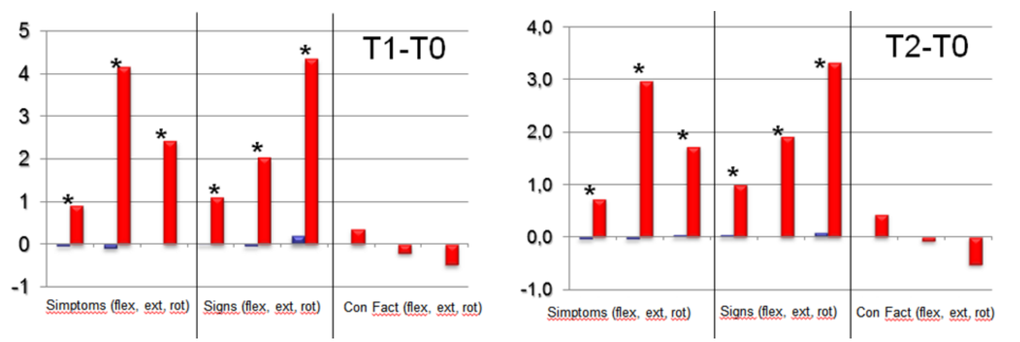


Figure 4 Movement System Impairment assessment changes (item counts), the graphs represent changes at T1-T0 and T2-T0. Note that while movement-related symptoms and dysfunctional signs decreased no significant changes have been found in the contributing factors (e.g. muscle excessive length or tissue rigidity etc..)

Relevance

Understanding strategies to improve pain and motor control is a key factor for low back pain treatment

Conclusions

Our data suggests that tactile training might play a role in improving symptoms and movement pattern in subjects with LBP.

Implications
Tactile training might be a useful tool for the treatment of people with LBP.

Keywords
Low back pain, two point discrimination, treatment

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OPEN- AND CLOSED-LOOP CONTROL OF THE TRUNK ARE DIFFERENTIALLY AFFECTED IN ACUTE LOW BACK PAIN

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Introduction

Postural control is compromised in low back pain (LBP). The mechanisms remain unclear, but suboptimal trunk control may contribute. Although simple balance measures provide some information, they do not enable separate consideration of closed- (with feedback) and open-loop (without feedback) control mechanisms. Measures of short- (DS) and long-term (DL) diffusion coefficients may yield insight into the performance of both systems. Evaluation of these measures during a seated postural task enables focus on trunk control with less contribution from lower limbs.

Aim

To investigate open- and closed-loop mechanisms of dynamic trunk control in sitting in patients with and without acute low back pain (LBP) with eyes open (EO) and closed (EC).

Materials and Methods

Eleven people in an episode of acute LBP (<3 weeks since onset) and eight age-matched controls sat with EO and EC on a seat with a curved base placed on a force plate to record the centre of pressure (CoP). Participants maintained balance during six 30-s trials. Mean amplitude of CoP (root mean square - RMS), CoP trajectory length travelled per second (PATH), DS and DL of CoP in the anteroposterior (AP) and mediolateral (ML) directions, and CoP area (CoParea) were calculated. Ten trials were performed with balance perturbed by release, at an unexpected time, of a weight (3% body weight) attached behind the trunk. Participants regained balance as fast as possible. A decay function was fitted to the positive peaks of AP CoP velocity following the perturbation to estimate the rate of balance recovery.

Results

AP RMS and CoParea were greater with EC than EO without difference between groups. AP CoP PATH was greater in LBP than controls, and with EC than EO for both groups. DS was higher in LBP than controls with EC. In the ML direction, the CoP PATH and DS were greater with EC than EO, but without difference between groups. DL was higher with EC than EO in both directions. Balance recovery after perturbation was slower in LBP than controls, but did not differ between conditions, and correlated negatively with DS in LBP with EC.

Relevance

Postural control was compromised in acute LBP, particularly over short time intervals reflecting suboptimal open-loop mechanisms.

Discussion & Implications

Although visual information affected simple CoP displacement measures, this did not differ between people with and without LBP. Compared to controls, DS was higher in LBP patients, without change in DL. This suggests greater short-term stochastic sway (open-loop) and risk of earlier loss of balance in challenging postural tasks. This is consistent with poor balance recovery after perturbation in LBP. Poor trunk control in acute LBP may be particularly affected by suboptimal open-loop control (e.g. muscle co-contraction).

Keywords
Postural control; Open-loop control; Closed-loop control

Thursday, October 31, 2013

Parallel Session VI

Prawit Janwantanak
Lolwah Al Rashed
Kieran O’Sullivan
Trish Wisbey-Roth
James Steele
Nathalie Roussel
Mirco Branchini
Josephine Key
Simon Spencer
Paul Marshall
Alexander Chan
Rita Fernandes
Teresa Cheung
Gunilla Limback Svensson

EFFECT OF EXERCISE PROGRAM TO PREVENT LOW BACK PAIN IN OFFICE WORKERS: A 1-YEAR CLUSTER-RANDOMIZED CONTROLLED TRIAL

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Introduction

Low back pain (LBP) is a significant health problem in office workers. The 1-year prevalence rate of LBP in office workers is approximately 34%–51% while the 1-year incidence rate is 23%. Apart from personal suffering and impaired quality of life in general, LBP in office workers can lead to sickness absence and reduced work effectiveness, which can be a great socio-economic burden on patients and society. Thus, prevention of LBP is desirable.

Purpose

To evaluate the effects of an exercise program focusing on muscle stretching and endurance training on the 12-month incidence of LBP in office workers.

Materials and Methods

This study was a prospective cluster-randomized controlled trial with healthy office workers recruited from 12 large-scale enterprises. Subjects were included if they were aged 18-55 years, worked full-time, had at least 1 year of experience in the current position, and had poor back extension flexibility or trunk muscle endurance. Subjects were excluded if they had reported musculoskeletal symptoms in the spine in the previous 6 months, reported pregnancy or had planned to become pregnant in the next 12 months, had a history of trauma or accidents in the spinal region, or had a history of spinal, intra-abdominal and femoral surgery in the previous 12 months. Subjects who had performed regular exercise or had been diagnosed with congenital anomaly of the spine, rheumatoid arthritis, infection of the spine and discs, ankylosing spondylitis, spondylolisthesis, spondylosis, tumor, systemic lupus erythymatosus, or osteoporosis were also excluded from the study.

Subjects were randomly assigned at the cluster level into either intervention (n=282) or control (n=281) groups. Participants in the intervention group received an exercise program that included daily stretching exercise and twice-a-week muscle endurance training. Muscle that was stretched was iliopsoas muscle. Muscle that received an endurance training included: erector spinae, quadratus lumborum, lumbar multifidus and transversus abdominis muscles. Those in the control group received no intervention.

The 12-month incidence of LBP was the primary outcome. Secondary outcome were pain intensity, disability level, and quality of life and health status. The Cox proportional hazards model was used to calculate hazard ratios for the intervention with respect to incident cases for LBP. The covariates of age, gender and psychological scores were forced into all models to reduce confounding due to these factors. The other 45 possible covariates were each examined in multivariate models. If a tested covariate changed the hazard ratio of the intervention variable by 0.05 or more, it was included in the final, adjusted model.

Difference in health outcomes (i.e. pain intensity, disability, quality of life and health status) between those reporting incidence of LBP in the intervention and control groups were analyzed using independent t-tests. All statistical analyses were performed using SPSS statistical software, version 17.0 (SPSS Inc, Chicago, IL, USA). Statistical significance was set at the 5% level.

Results

Over the 12-month follow up, 8.8% of participants in the intervention group and 19.7% in the control group developed incidence of LBP. Hazard rate ratios showed a protective effect of the exercise program for LBP (HR = 0.37, 95% CI 0.22-0.64) after adjusting for biopsychosocial factors. There was no significant difference in pain intensity, disability, and quality of life and health status between those who reported incidence of LBP in the intervention and control groups.

Conclusion

An exercise program consisting of muscle stretching and endurance training is an effective intervention to prevent LBP among office workers with poor back extension flexibility or trunk muscle endurance.

EFFECTIVENESS OF NON-PAIN CONTINGENT SPINE REHABILITATION IN FEMALES WITH CHRONICH LOW BACK PAIN: A RANDOMIZED CONTROLLED TRIAL

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Introduction

Evidence suggests that intensive multidisciplinary rehabilitation programs (>100 hours) reduce pain and functional disability in chronic low back pain (CLBP) patients. However, less intensive, effective interventions are needed. A non-pain contingent rehabilitation incorporating lifting training has been suggested, but its efficacy remains questionable.

Purpose

To evaluate the effectiveness of non-pain contingent spine rehabilitation in decreasing pain and functional disability, and in improving physical performance in females with chronic low back pain (CLBP).

Materials and Methods

This was a parallel group design, prospective, randomized controlled trial. Fifty-four females with CLBP were randomized to receive either a spine rehabilitation program (n=28) or conventional physiotherapy (n=26). Both groups received treatment twice a week for 6 weeks. Primary outcome measures were the visual analogue scale, and the Oswestry Disability Index. Secondary outcomes included range of motion for trunk flexion, extension and straight leg raising; Ito and Shirado tests; and progressive isoinertial lifting evaluation. All outcomes were assessed at baseline, week 4, and at discharge.

Results

Both groups significantly improved in pain, functional disability, and all physical measures, but clinically relevant improvement was achieved only in the spine rehabilitation group. The spine rehabilitation group also showed significantly greater improvement in trunk muscle endurance and lifting capacity. Four weeks post-treatment, maximal attainment of pain reduction was observed in the spine rehabilitation group, while the greatest improvement in flexibility scores was found in the conventional physiotherapy group.

Relevance

We advise physiotherapists to extend their recommendations beyond pain-free exercises, and encourage patients to remain active during the course of treatment.

Conclusion

Patterns of improvement suggest that the spine rehabilitation approach is more effective than conventional physiotherapy in this subgroup of patients. Implementing well-designed physiotherapy biopsychosocial programs for CLBP that incorporate lifting training is recommended.

Discussion

Both treatment programs were effective. However, only patients who completed the spine rehabilitation program attained clinically relevant improvements of pain and functional disability, faster pain recovery time, and greater improvement in almost all of the physical capacity measures; suggesting that the spine rehabilitation program is more effective, at short-term, than the conventional physiotherapy in treating females with CLBP. Our physiotherapists addressed patients' fear-avoidance behavior and pain beliefs during the spine rehabilitation program, especially during lifting training. They also encouraged patients to work within their pain limits and to return to normal activities that they have avoided because of LBP. Such motivational factors may have added value to the spine rehabilitation approach over the conventional physiotherapy.

Implications

Currently, it is challenging for clinicians and patients to choose among the numerous treatment options for CLBP. Such findings may help clinicians select the best approach for each patient and, hence, to minimize the expense and time of treatment.

Key words

Low back pain, exercise, functional disability, rehabilitation, lifting training, conventional physiotherapy

THE EFFECTIVENESS OF A NOVEL MULTIDIMENSIONAL BEHAVIOURAL-BASED INTERVENTION ON PEOPLE WITH NON-SPECIFIC CHRONIC LOW BACK PAIN: A CASE SERIES

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Introduction

Most conservative interventions for non-specific chronic low back pain (NSCLBP) display small effect sizes. Cognitive Functional Therapy (CFT) is an individualised behavioural intervention which aims to address multiple dimensions across the biopsychosocial spectrum in the management of NSCLBP[1]. CFT combines a behavioural approach of retraining provocative postures and movements with cognitive reconceptualisation of the NSCLBP problem, while also targeting psychosocial barriers to recovery. In a recent randomised clinical trial (RCT), CFT was significantly more effective than a combination of manual therapy and exercise for NSCLBP[2]. However, the disability of the NSCLBP population in that study was only mild-moderate.

Purpose/Aim

To examine the effectiveness of CFT among people with more disabling NSCLBP awaiting specialist medical consultant review.

Materials and Methods

A multiple case-series (n=26) design study, consisting of 3 phases (A1-B-A2). Measurement phase A1 was a baseline phase during which pain and functional disability were collected on three occasions over two months for all participants. During phase B, participants entered a CFT intervention program, involving approximately eight treatments over an average of 12 weeks. Finally, phase A2 was a no-treatment follow-up period lasting three months. A general linear model repeated measures ANOVA (post-hoc Bonferroni) compared functional disability and pain across the five time intervals – three baselines, immediately post-intervention, and three months later.

Results

Statistically significant improvements in both functional disability ($p<0.001$) and pain ($p<0.001$) were observed immediately post-intervention, and three months later compared to baseline measurements. The effect sizes were large, and reached clinical significance for both disability and pain. Several secondary outcomes were significantly ($p<0.01$) improved after the intervention, including depression, back beliefs, fear of physical activity, catastrophising and self-efficacy.

Relevance

These promising results add further support to the hypothesis that CFT is an effective intervention for NSCLBP.

Conclusions

An intervention which targets contributing factors across multiple domains, and which is individualised to each person with NSCLBP, significantly reduced both functional disability and pain at three-month follow-up.

Discussions

This case-series adds to recent data2 that CFT can reduce NSCLBP to a statistically and clinically significant degree. This case-series examined the potential of CFT in a more disabled NSCLBP population than the earlier RCT, as a precursor to a blinded RCT among a highly disabled NSCLBP population.

Implications

CFT should now be compared to another evidence-based intervention for the management of disabling NSCLBP in a large RCT.

Keywords

Low back pain; rehabilitation; behaviour; physiotherapy

References

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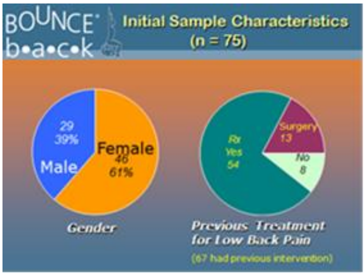
2 YEAR FOLLOW UP OF A SPINAL STABILISATION EXERCISE REGIME IN SUBJECTS WITH CHRONIC NON-SPECIFIC LOW BACK PAIN – A CASE SERIES STUDY

Wisbey-Roth T.

Australian Catholic University

Introduction

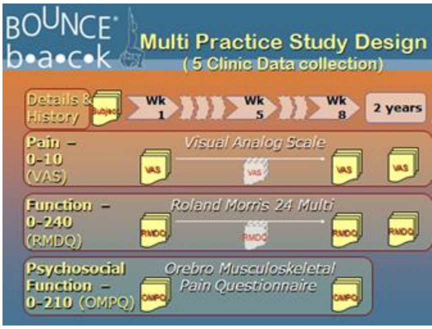


The proprietary Bounce back clinical system of progressed functional exercises has been used by over 100 individually trained instructors over the last 10 years. Five different structured programs offer clinicians a way of providing clear, consistent and cost effective exercise programs to their clients, with a focus on retraining effective motor control in typical patterns used in daily activity.

Purpose/Aim

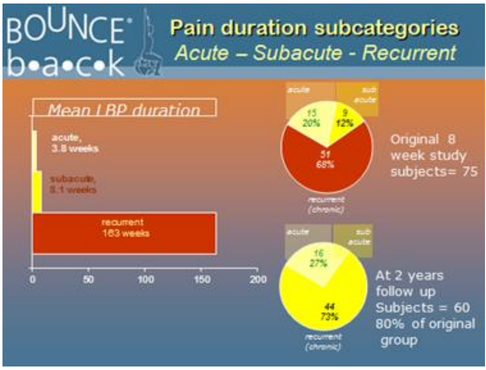
The aim of this study was to investigate short and long term outcomes of a specific 8 week small group spinal stabilisation exercise regime (Introduction Level) in subjects with non-specific LBP.

Materials and Methods



Trained instructors in five different physiotherapy clinics participated in this study. Data was collected prospectively from 75 participants with non-specific LBP. Outcome assessments for pain intensity (11-point Pain Numerical Rating Scale) and function (24-point Roland Morris Disability Questionnaire) was collected at baseline, after 8 weeks of intervention and at 2 years follow up. A detailed exercise handout was provided at each one hour group session and participants were encouraged to perform the home program independently 2-3 times weekly.

Results



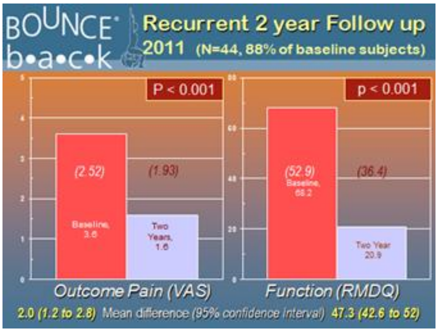
At two years follow up, 44 of the original 51 Chronic subjects (>12weeks) responded giving an 88% follow up rating. Overall 60 of original 75 subjects responded giving an overall 80% follow up rating

Bounce back classes improved pain intensity and function in the chronic population in both short term and at long term follow up. Immediately after the 8 week group intervention pain intensity mean effect was 1.5 points (95%CI, 0.9 to 2.0, $p<0.001$). At 2 years post intervention the mean effect of the group exercise intervention compared to week 1 on pain intensity was 2.0 (95%CI, 1.2 to 2.8, $p<0.001$).

After 8 week exercise intervention, the mean effect on function in the chronic population was 31.3 points (95%CI, 27.7 to 41.0 $p<0.001$). At 2 years post intervention the mean effect on function was 47.3 points (95%CI, 42.6 to 52.0 $p<0.001$). We found preliminary evidence of effectiveness of Bounce Back classes in pain intensity and function in non specific LBP patients in the short and long term.

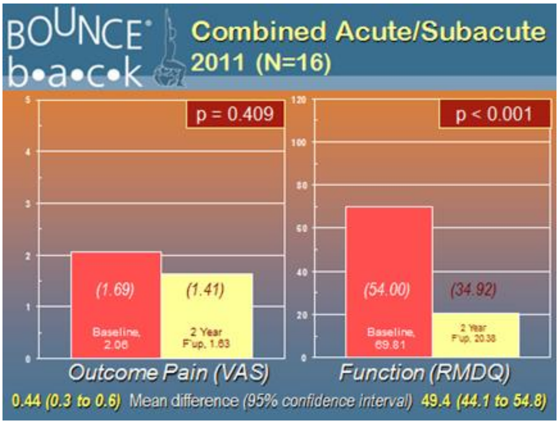
Discussion and Implications

This study has important implications for the management of chronic LBP and the identification of effective, standardised and reproducible exercise programs for spinal stabilisation.
Further integration of the outcome reporting system in clinical practice is expected to lead to continued refinement to LBP exercise intervention and help identify factors affecting outcomes outside the predicted outcomes.



Relevance and Conclusions

Adoption of formal quality system principals in regards to continual improvement, training and quality support material is continuing to show promising and reproducible results across over 40 clinics in Australia and NZ utilising the Bounce back active rehab program.



Keywords

Exercise, rehabilitation, chronic back pain, functional

ISOLATED LUMBAR EXTENSION RESISTANCE EXERCISE REDUCES LUMBAR KINEMATIC VARIABILITY DURING GAIT IN CHRONIC LOW BACK PAIN PARTICIPANTS

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Introduction

Research shows chronic low back pain (CLBP) is a multifactorial condition with a variety of associations and symptoms; one of these being gait variability. The lumbar spine and extensor musculature are considered important in controlling gait, and in CLBP the lumbar extensors are often deconditioned. Isolated exercise for the lumbar extensors (ILEX) addresses this deconditioning, and improves pain and disability in CLBP, but, its effects on gait variability are unknown.

Purpose/Aim

The purpose of this study was to examine the effect of ILEX upon lumbar kinematic variability during gait, pain, disability and ILEX strength in CLBP.

Materials and Methods

Twenty four participants were assessed for lumbar kinematics during gait using 3D Vicon motion capture system, ILEX strength using the MedX Lumbar Extension Machine, pain using visual analogue scale, and disability using revised Oswestry questionnaire, before being randomised to one of three intervention groups. Two groups performed a 12 week ILEX intervention (full range of motion or limited range of motion), another group were non-training controls. Kinematic variability was examined using waveform pattern analysis. Wilcoxon Signed Ranks Exact tests were performed applying bonferonni adjustments for multiple comparisons. Pearson's correlations were also examined between significantly different kinematic variables and ILEX strength, pain and disability.

Results

Sagittal plane lumbar kinematic variability was significantly reduced in the full range of motion group (-20.32+22.69%, p=0.014). Pearson's correlation showed significant associations between change in sagittal plane lumbar kinematic variability with ILEX strength (r=-.697 to -.714; p=0.031 to 0.037). ILEX strength, pain and disability all improved significantly in both ILEX groups.

Relevance

The findings of this study have relevance in that they demonstrate a variety of positive multifactorial outcomes from a single intervention approach.

Conclusions

Novel to this study, ILEX significantly reduces lumbar kinematic variability during gait in CLBP in addition to improving ILEX strength, pain and disability.

Discussion

The effect of ILEX upon gait variability in this study, and the lumbar extensors role in gait control, offers information regarding lumbar extensor deconditioning's role in CLBP. As CLBP is a multifactorial condition there is the possibility that other symptoms, such as gait variability, may be a consequence of deconditioning. Thus addressing such deconditioning, as has been done here using ILEX, may also improve other symptoms. In the case of this study, gait variability was reduced and this change was correlated with change in ILEX strength.

Implications

These findings show that ILEX reduces gait variability in CLBP alongside improving ILEX strength, pain and disability. This range of multifactorial benefits indicates the value of a single intervention approach using ILEX for improving a range of factors in CLBP potentially indicating potential for reduced costs through avoiding multiple interventions.

Keywords

MedX; Rehabilitation; Strength Training

EXERCISE PROGRAM TARGETING AEROBIC ENDURANCE, MUSCLE STRENGTH & MOTOR CONTROL IN DANCERS: A RANDOMIZED CONTROLLED TRIAL

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Introduction

Although dancing is a heavy physical exertion, dancers pay little attention to their physical condition. Reduced physical fitness and altered motor control have been suggested as contributing factor for the development of musculoskeletal injuries.

Purpose

To examine whether an additional active intervention to regular dance lessons influences physical condition of pre-professional dancers. In addition, the musculoskeletal injury incidence rate will be compared between groups.

Materials and Methods

A randomized controlled trial study was conducted among students enrolled in a full time Bachelor degree in Dance at the Royal Conservatoire in Belgium. Forty-four pre-professional dancers were randomly allocated to either an active or passive intervention group. Duration and frequency of the intervention sessions were equal for both groups. The active intervention comprised of fitness training in addition to local strength and motor control training. The passive intervention comprised of practical and theoretical educational sessions regarding stretching, nutrition, massage and injury information, without active exercises. Outcome assessment was conducted prior to and following the 4 months intervention period by blinded assessors. A maximal exercise test with continuous physiological monitoring was the primary outcome measure. Secondary outcomes included explosive strength, musculoskeletal injury incidence and several self-reported measures.

Results

Both groups showed a significant increase in maximal load, exercise duration, mechanical efficiency and peak respiratory exchange ratio following either intervention ($p<0.05$). Except for bodily pain, no significant interactions between groups were observed, meaning that the evolution between the groups is not different ($p>0.05$). Twenty-six dancers developed musculoskeletal injuries requiring temporally interruption of dancing. The proportion in injured dancers was identical in both groups.

Relevance

Despite positive results provided from uncontrolled studies, further research is required to examine how additional training can be organized to increase physical condition and prevent musculoskeletal injuries in dancers.

Conclusions

The combination of dance training with additional exercises does not lead to a significant increase in physical fitness of pre-professional dancers compared to a group receiving an alternative intervention without active exercising. Neither interventions influence musculoskeletal injury incidence. However, an additional active intervention leads to less bodily pain.

Discussion

Several researchers suggested that burn out may occur in dancers. The end of the intervention coincided with an exhaustive period for our dancers. Further research should explore the intensity of performances and the possibility of burn out in dancers, and determine whether an additional intervention program is of clinical importance in dancers. The intensive nature of performances should be held in mind.

Implications

The combination of dance training with additional exercises does not lead to a significant increase in physical fitness of pre-professional dancers, but leads to less bodily pain.

Keywords

Dancing, physical fitness, training, injury, exercise, stretching

FASCIAL MANIPULATION FOR CHRONIC LOW BACK PAIN – A RANDOMIZED CONTROLLED TRIAL

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Introduction

Chronic non specific low back pain (LBP) is one of the most common afflictions in modern society. Only 5% of subjects with LBP develop chronicity [1] but these subjects are responsible for 80% of total medical costs for LBP, including clinical examinations and treatment [2]. LBP disables subjects, limiting their work capacity and adversely influencing quality of life. Numerous international guidelines contain strong recommendations for a physiotherapy interventions for LBP. [3,4]

Many cochrane reviews show that there aren't strong indication towards a specific technique to get the best results, probably due to the difficult definition of the etiopathogenesis of chronic LBP. Many studies are focusing their attention on the correlation between LBP and the alteration in thickness and consistence of fascial tissue [6,7,8]

In this study we compared a physiotherapy intervention, based on the best practice (BP) that we have deduced from the national and international guidelines, with a specific manual therapy named Fascial Manipulation® (FM). FM is a manual intervention directed to deep muscular fascia, with the intention to restore natural fascia elasticity, the tissue involved in muscular coordination[9,10,11].

Recent studies about extra cellular matrix of connective tissue seem to confirm the utility to treat fascia because of its tixotropic properties[12]

atherials and Methods

We designed a monocentric, randomised, controlled and single blinded trial, that was approved by the Ethics Committee of S.Orsola-Malpighi Hospital, Bologna, Italy.

We enrolled 36 outpatients with chronic LBP, visited by a physiatrist or an orthopaedist of S.Orsola University Hospital. The doctors selected inclusion and exclusion criteria, then obtained informed consent from the patients. Afterwards they sent the patients to the head of the study for the assessment (T-0) of the outcome scores. We identified outcome score. For pain: Visual Analogic Scale (VAS); Brief Pain Inventory (BPI). For disability: Roland and Morris Disability Questionnaire (RMDQ). For health status: Health Survey, Short Form (SF-36).

Patients were randomized, following a random number sequence, in two groups. Both of these groups carried out 8 treatment sessions, two times a week. While patients in control group were treated with BP in each session, patients in study group were treated with one session of FM and one session of BP each week. Each patient was treated by the same physiotherapist. The physiotherapist who treated patients in study group was trained in FM. All physiotherapists involved in the study were students about to graduate, with the same educational background and clinical experience. VAS was also recorded before and after every treatment session in both group.

At the end of the 8th treatment (T-1), all patients were re-assessed by the head of the study with the same outcome. Same assessment was carried out in the 30 and 90 days follow up session (T-2 e T-3). The head of the study didn't know about the treatment group of the patients. Data was analyzed with Wilcoxon-Mann Whitney test for non-parametric variables

Results

Only 24 subjects completed the study; 10 didn't begin the treatment because of organizational problems; 2 interrupted treatment for traumatic (n.1) and pulmonary (n.1) disease.

2 patients who completed all treatments were lost at both follow up.

Results are presented for the 22 subjects who completed all the study sessions. 12 subjects were included in control group, 10 in study group. The pre-test analysis shows that groups didn't have significant difference about age and every outcome score, except for VAS score (see tab.1)

Outcome	Control (n.12) Mean (±S.D.)	Study (n.10) Mean (±S.D.)	Score
Age	49.4 [±11.05]	45.25 [±7.6]	p = 0.31
VAS	5.90 [±1.96]	2.83 [±1.81]	z = 0.003
BPI	9.26 [±3.67]	6.83 [±3.35]	z = 0.19
RMDQ	6.50 [±3.37]	7.17 [±3.92]	z = 0.55
SF-36	59.23 [±13.70]	50.61 [±17.50]	z = 1

Tab. 1: analisi pre-test

OUTCOME	Wilcoxon-Mann Whytney [ranksum-test]		
	Pre/Post	Pre/fu30	Pre/fu90
VAS	0.0009	0.0004	0.0008
RMDQ	0.022 (%Riduzione)	0.018 (%Riduzione)	0.11 (%Riduzione)
BPI	0.007	0.005	0.015
SF36	0.009	0.07	0.21

Tab. 2: analysis pre-post and at 30 and 90 days f.u.

Score recorded in T-1 shows a significant statistic difference of the study group compared to the control group, for every outcome.

Same relevant difference is maintained at T-2 and T-3 for VAS and BPI (in both intensity and interference score).

RMDQ maintain its significant difference at T-2, and SF-36 score is different at T-2 and T-3, but not statistically (see tab 2).

Pre-post treatment VAS analysis (particularly of the first four sessions) details that the mean difference between subjects was almost steady for control group, and different in study group, with higher values in FM session. Particularly, the first session has a significant statistic difference ($z < 0,03$) between groups (see tab. 3).

We calculated also the Minimal Clinical Important Difference (MCID) [13], representing for all patients in both groups very important clinical results for the outcome we had a clinical reference: VAS, BPI and RMDQ.

Study group got results really higher in every outcome (see tab. 4).

Discussion and Conclusions

Despite limited number of subjects (22), this study indicates that integrating Fascial Manipulation treatments with physiotherapy treatment sessions based on international guidelines could represent a valid modality for improving outcomes in subjects with LBP in the short e medium period.

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VAS	MEAN		Ranksum test
Pre-post	Control group	Study group	|z|
1st treatment	0,96	2,92	0,02
2nd treatment	1,38	0,47	0,14
3rd treatment	1,21	1,68	0,97
4th treatment	1,25	1,19	0,89

Tab.3: VAS analysis pre-post first four treatment

Out Come	VAS		RMDQ		BPI Intensity		BPI Interference		BPI Total	
MCID	1.5 (=> 4)		30% less		1.5		1		1.5	
group	Contr.	Study	Contr.	Study	Contr.	Study	Contr.	Study	Contr.	Study
pre - post	**1.73**	**5.55**	**41.99**	**77.33**	**1.17**	**3.98**	**1.77**	**3.60**	**2.94**	**3.79**
pre-f.u.30	**0.67**	**5.30**	**39.89**	**80.01**	**1.19**	**4.08**	**1.75**	**3.93**	**2.94**	**4.00**
pre - f.u.90	**0.88**	**4.80**	**43.35**	**85.46**	**1.25**	**3.75**	**2.02**	**3.71**	**3.27**	**3.73**
Subject /total	**39%**	**100%**	**64%**	**100%**	**31%**	**90%**	**67%**	**80%**	**67%**	**90%**

Tab.4: MCID value for VAS, RMDQ, and BPI in both groups

SIFTING THE EVIDENCE AND 'SEEING' THE PATIENT IN FRONT OF YOU: EXAMINING THE 'FUNDAMENTAL PATTERNS' OF SPINO-PELVIC CONTROL IN HEALTH AND IN DYSFUNCTION

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Introduction
The challenge for the busy clinician is to both distil and appropriately integrate the increasingly robust evidence base while also further developing the artful skills required for effective clinical practice.

Purpose
This presentation aims to assist the clinician to simply identify the observable physical changes and movement related problems which are commonly apparent in populations with spino-pelvic pain disorders.

Methods
This presentation will integrate the contemporary evidence base and clinical practice and focus upon the relationship between spino-pelvic pain syndromes and axial posturo-movement disorders and the co-related dysfunction in the neuro-myofascial- articular systems.

It will encompass:

- The important role of the internal pressure change mechanisms and 'deep system' control for postural support and movement control of the spine and pelvis.
- The 'Fundamental Patterns' of healthy axio-pelvic control – the important 'key', inter-dependent, basic functional mechanisms which underlie all movement: breathing; axio-pelvic posturo-movement control; intrapelvic control, and control of the pelvis on the legs
- The common physical problem encountered in spino-pelvic pain populations is essentially one of imbalanced activity in the myofascial envelope:
    - Deficient 'deep system control' which interferes with the quality of the 'Fundamental Patterns' of control.
    - The apparent, necessary, compensatory (over)activity of the more superficial myofascial system has further deleterious consequences on pain sensitive structures in the neuromuscular and articular systems over time.
- The evident clinical patterns will be presented. While compromised control of the 'Fundamental Patterns' is common, there are differing patterns of response to the usual, everyday environmental demands. Essentially, two basic subgroups are apparent
- Exploration of the distinctive physical features that each subgroup display, helps the practitioner to 'see' the patient in front of him and aids a deeper understanding of the mechanisms driving many lumbo-pelvic pain disorders
- Appreciating the predictable link between altered 'Fundamental Patterns' of control and the development and maintenance of many spino-pelvic pain disorders provides important implications for the direction of treatment – manual, therapeutic exercise and patient education

Relevance
The purpose of this presentation is to present an approach which helps to integrate and practically apply the contemporary evidence base towards a more specific approach to the treatment of lumbo-pelvic pain.

Conclusion

This presentation aims to assist the practitioner to read the body for the clinically useful clues to help facilitate the assessment, functional diagnosis and more effective management of many spino-pelvic pain disorders.

Key words

Pelvic girdle pain; spinal pain, Motor control and therapeutic exercise, Treatment techniques, Sports medicine, Prevention and education

ESTABLISHING A SPINAL TRAINING CLASSIFICATION SYSTEM FOR USE IN ELITE SPORT REHABILITATION, INJURY PREVENTION AND PERFORMANCE DEVELOPMENT

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Introduction

The use of exercise as part of a multifaceted approach to spinal rehabilitation, injury prevention and sports performance is widely accepted. Exercise selection has historically been influenced by misinformed opinion, failure to consolidate research evidence and uni-dimensional paradigms of exercise delivery at the expense of practitioner reasoning.

Clinical and performance reasoning in exercise prescription requires a clear understanding of the spinal abilities which underpin optimal function during skilled athletic performance; and is defined by the ability to delineate the desired training intention (objective) and physical outcome to address identified dysfunctions within the context of any diagnosed pathology. Only when all options for exercise prescription are clearly defined is the practitioner able to reason their inclusion or exclusion within the proposed training/rehabilitation plan.

The aim of the project was to define the modifiable spinal abilities which underpin optimal function during skilled athletic performance in order to establish a system of classifying spinal training exercises by intent and physical outcome.

Method

The spinal training classification system was developed through collaboration between members of the physiotherapy and strength and conditioning teams across the national English Institute of Sport (EIS) network.

Results

<u>Spinal Exercise Classification</u>

Exercise Sub-Classifications:

Exercises were sub-classified by their functional characteristics (e.g. body position, movement complexity, proprioceptive yield) as either non-functional (NF) or functional (F); and spinal displacement as either static or dynamic. All exercises were subsequently described by plane of motion or direction of muscular torque.

Physical Outcomes:

Physical outcomes were classified as mobility, motor control, work capacity, strength and rate of force production.

Training Objectives:

1. Mobility - Mobility Development
2. Motor Control - Spinal Dissociation (NF)
3. Motor Control - Spinal Dissociation (F)
4. Motor Control - Segmental Movement Control (NF)
5. Motor Control - Whole Body Co-ordination (F)
6. Work Capacity - Pillar Conditioning (NF)
7. Work Capacity - Pillar Conditioning (F)
8. Work Capacity - Segmental Conditioning (NF)
9. Work Capacity - Segmental Conditioning (F)
10. Strength - Pillar Strength Development (NF)
11. Strength - Pillar Strength Development (F)

12. Strength - Segmental Strength Development (NF)
13. Strength - Segmental Strength Development (F)
14. Rate of Force Production - Static Rate of Force / Stiffness Development (F)
15. Rate of Force Production - Dynamic Rate of Force / Power Development (F)

Discussion

During sporting activity, optimal spinal function is defined by the ability to create, absorb and transfer force and motion to the terminal appendicular segment. The efficiency of the system relies on accurate neuromuscular control with prerequisite strength and mobility. A comprehensive approach to understanding the spinal abilities which underpin optimal function during skilled athletic performance provides a basis for rehabilitation, injury prevention and performance enhancement within the sporting environment.

Conclusion

The spinal training classification system developed at the EIS supports reasoned exercise prescription through a systematic description of spinal training objectives (intent) and determines the exercise specificity required to produce the desired physical outcome. In addition, the system establishes commonality of language within and between medical and sport science practitioners. The classification system has subsequently been used to establish an internal, on-line exercise database with over 500 exercises. The results provide a platform for further research and innovation within applied sports medicine. The ability to systematically identify functional and performance deficits for use in conjunction with the training classification provides focus for future development.

Keywords

Spine, Exercise Prescription, Training Classification, Injury Prevention, Rehabilitation, Performance Development, Sport

CLINICAL OUTCOMES AND MECHANISMS OF ACTION FOLLOWING PILATES EXERCISE OR STATIONARY CYCLING FOR PATIENTS WITH CHRONIC NON-SPECIFIC LOW BACK PAIN

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Introduction

It is thought that an exercise program for patients with chronic non-specific low back pain (LBP) must be targeted towards biological deficits. This has led to the design of specific trunk exercise programs to target deficient strength, endurance, and motor control in LBP patients. Alternatively, many reason that owing to the importance of psychological factors such as pain catastrophizing and fear-avoidance beliefs (FAB), any form of moderate-to-vigorous physical activity is likely to be effective for patients with LBP. No clinical trial has compared outcomes, or examined the key mechanisms of action, between a program specific targeted to the trunk muscles (e.g. Pilates exercise) and an exercise program that has no specific trunk focus (e.g stationary cycling).

Purpose

To examine changes in pain and disability following 8-weeks of Pilates or stationary cycling, and to investigate whether motor control or psychological adaptation explains any similar, or differential outcomes.

Methods

This was a single-blinded randomized controlled trial of 8-weeks group-based, supervised Pilates or stationary cycling with a 6-month follow-up. 64 patients with chronic non-specific LBP volunteered to participate. Primary clinical outcomes were pain (VAS scale) and disability (Oswestry disability index). Catastrophizing and FAB were examined using self-report questionnaires. The motor control mechanism examined was the onset of trunk muscles during a rapid limb movement using surface electromyography. Intention-to-treat principles were followed in the analyses. Effect sizes and confidence intervals were calculated for all results. Per-protocol analysis was conducted on adherent participants (2/3 attendance). Clinically meaningful improvements (CMI) were based on greater than 30% reductions in VAS or Oswestry scores.

Results

Greater reductions in pain and disability were observed at 8-weeks following Pilates ($p<0.05$). FAB were reduced following Pilates ($p<0.05$), but were not different from cycling. Similar reductions in catastrophizing were observed for both groups ($p<0.01$). Per-protocol analysis revealed numbers of participants in the training groups reporting a CMI were the same. No between-group differences were observed for self-report measures at 6-months. Trunk muscle onsets were only analyzed for adherent participants. Similar between-group changes were observed at 8-weeks.

Relevance

These results should be considered within the context of a clinician recommending a type of exercise for a LBP patient.

Conclusions

Inferential statistics suggest greater improvements in pain and disability at 8-weeks following Pilates, although patient biases may have exaggerated the magnitude of change. If a minimum level of adherence is achieved, it is likely that similar numbers of patients will experience clinically meaningful improvements.

Similar between-group changes in catastrophizing and trunk muscle onsets would suggest these are the likely 'active ingredients' that explain similar clinical outcomes.

Implications

If a LBP patient adheres to the exercise program, it is likely that either Pilates or stationary cycling will achieve similar clinical improvements. This study did not address issues of patient sub-grouping or individual responsiveness.

Keywords

Exercise, Pilates, stationary cycling, pain, disability, fear-avoidance, catastrophizing, feedforward activation, electromyography, motor control

12 MONTH RESULTS OF A RANDOMISED CONTROLLED TRIAL COMPARING SPECIFIC PHYSIOTHERAPY VERSUS ADVICE FOR PEOPLE WITH NON-REDUCIBLE DISCOGENIC PAIN

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Introduction
Non-reducible discogenic pain (NRDP) has been proposed as a clinically important subgroup of low back disorders (LBD). It has been proposed that NRDP may benefit from specific physiotherapy functional restoration treatment that accounts for pathoanatomical factors, despite advice being recommended for acute-subacute LBD in multiple guidelines. However, the evidence is limited, possibly due to the clinical heterogeneity in randomised controlled trials that may reduce the likelihood of demonstrating treatment effects.

Purpose/Aim
The aim of the Specific Treatment of Problems of the Spine (STOPS) trials was to evaluate the effectiveness of specific physiotherapy functional restoration compared to physiotherapy advice in a subgroup of people with NRDP.

Materials and Methods
Participants with NRDP presenting with low back pain (≥ 6 weeks, ≤ 6 months) with/without referred leg pain were randomly allocated to receive either physiotherapy advice or specific physiotherapy functional restoration over 10 weeks. Primary outcomes were the Oswestry Disability Index as well as back and leg pain intensity as measured on a numerical rating scale. Data were analysed using linear mixed models for continuous outcomes.

Results
Linear mixed model analyses of primary outcomes showed significant ($p < .05$) between-group differences for Oswestry favouring specific physiotherapy treatment over advice at 10-weeks (6.3; 95% CI: 1.4 to 11.4) and 26-weeks (5.7; 95% CI: 0.7 to 10.8). Back and leg pain were also significantly lower in the physiotherapy group relative to the advice group at 10-weeks (back: 1.1; 95% CI: 0.2 to 2.1, leg: 1.1; 95% CI: 0.2 to 2.0). There were no significant between-group differences for primary outcomes at one-year follow-up.

Relevance
These results suggest that people with NRDP who underwent specific physiotherapy functional restoration had a significantly greater short term improvement in pain and short to intermediate term improvement in function compared to those who had advice.

Conclusions
Statistically significant and clinically meaningful short-term effects were demonstrated for specific physiotherapy functional restoration compared to physiotherapy advice for people with NRDP. At intermediate follow-up, those allocated to specific physiotherapy functional restoration maintained significantly better functional improvements.

Discussion
The development of the STOPS classification system and application of specific treatment for the LBP subgroup of NRDP will be reviewed.

Implications

For people with NRDP, specific functional restoration may be more effective than guideline recommended advice in the short and medium term.

Keywords

Low back pain, treatment, classification, lumbar intervertebral disc

PREDICTORS OF SHORT-TERM OUTCOME IN PATIENTS WITH NON-SPECIFIC CHRONIC LOW BACK PAIN UNDERGOING AN EDUCATION AND EXERCISE REHABILITATION PROGRAMME

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Introduction

Physiotherapy is a common treatment option for patients with non-specific chronic low back pain (NSCLBP), and the best evidence suggests that treatments involving education and exercise are more effective than other conservative approaches. However, the relative contribution of individual prognostic factors to successful response to treatment remains unclear.

Purpose/ aim

The aim of this study was to describe the clinical course of a sample of patients with NSCLBP undergoing a rehabilitation programme covered, education and exercise, and to identify prognostic factors for recovery.

Material and Methods

A prospective single arm cohort study design, with an inception cohort of 64 NSCLBP patients, initiating a 6-week rehabilitation physiotherapy treatment. Participants were considered eligible if they had pain in the back for at least 3 months, with or without leg pain, and were aged between 18 and 65 years.

Patients were assessed at the baseline and immediately after 6 weeks. Socio-demographic, clinical and psychosocial factors were included as potential predictors of outcome. Based on a previous study, treatment recovery was defined as the Quebec Back Pain Disability Scale (QBPDS, 0-100) score improving ≥ 7 (minimal clinically important difference-MCID) and the Visual Analogue Scale (VAS, 0-10) score improving ≥ 2 (MCID). Uni and multivariate logistic regression analyses were used to evaluate factors associated with treatment recovery.

Results

Of the 70 patients enrolled in the programme, 62 completed the follow-up (mean age of 50.6±10.2). Differences between baseline and follow-up results showed a significant reduction in pain intensity (6.5± 2.35 to 3.2± 2.12, p=0.001) and disability (40.76 ± 15.14 to 29.74 ± 14.64 p=0.001). For the outcome "disability", 39 participants (62.9%) were categorized as treatment recovery and 23 as treatment failure (37.1%). After using a logistic regression analysis the likelihood of a successful recovery was statistically associated with disability (OR 1.1, CI 95% 1.04-1.16), and pain intensity (OR 0.66, CI 95% 0.46-0.97), at baseline. The logistic regression model was statistically significant ($\chi2(6) = 25.195$, $p < 0.0001$) and explained 46,4% (Nagelkerke R2) of the variance in the improvement of the disability above the MCID. The model correctly classified 80,3% of the patients (sensitivity, 87,2%; specificity, 68,2%). For the "pain" outcome, pain reduction was significantly associated with pain intensity at the baseline (OR 1.66, CI 95% 1.2-2.4). The model correctly classified 73,8% of the patients with an explained variance of 39.4% (sensitivity, 89.1%; specificity, 26.7%).

Conclusions

These results suggest that disability recovery was related with high levels of disability and low levels of pain intensity at the baseline. In contrast, pain recovery, was related with high levels of pain intensity.

Keywords

Non-Specific Chronic Low Back Pain; Physiotherapy; Outcome Predictors

EVALUATION OF A COMPREHENSIVE EMPOWERING PRE-OPERATIVE AND POST-OPERATIVE PHYSIOTHERAPY MANAGEMENT PROGRAM FOR BACK PAIN PATIENTS

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Introduction

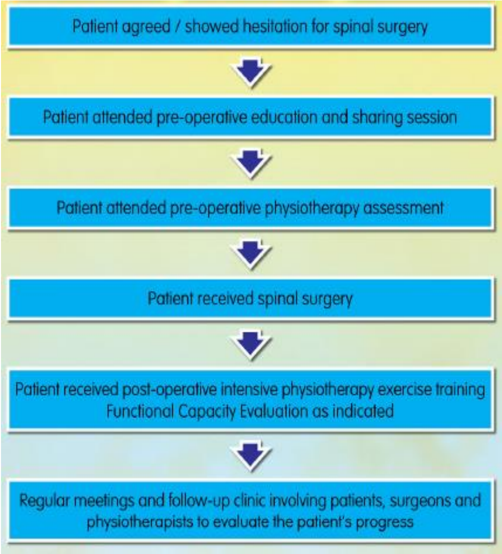
A comprehensive empowering pre-operative and post-operative physiotherapy management program was established for patients with lumbar spine pathologies to provide pre-operative psychological screening with reassurance to patients to facilitate post-operative planning and surgery outcomes. Intensive post-operative exercise program was also provided for effective pain reduction and functional status improvement.

Purpose/Aim

To evaluate the effectiveness of a comprehensive empowering pre-operative and post-operative physiotherapy management program for patients with lumbar spine pathologies.

Materials and Methods

Patients who agreed for lumbar spine surgery (excluding those with spinal cord injury) were recruited. A pre-operative education and sharing session with assessment and post-operative physiotherapy exercise training were scheduled pre-operatively and given. Outcome measures were: (1) Numerical Global Rating of Change Scale (NGRCS) as subjective reported improvement; (2) Numerical Pain Rating Scale (NPRS) as pain intensity; (3) Roland Morris Disability Questionnaire (RMDQ) as functional disability; (4) Fear-Avoidance Beliefs Questionnaire (FABQ) as fear-avoidance belief; (5) Hospital Anxiety and Depression Scale (HADS) as anxiety and depressive mood, which were collected pre-operatively, at the first post-operative session and final physiotherapy session. SPSS software version 11 was used to analyse the data.

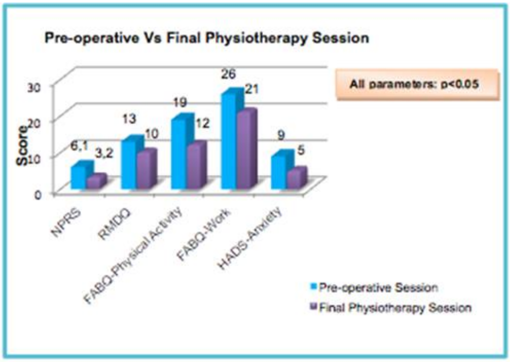


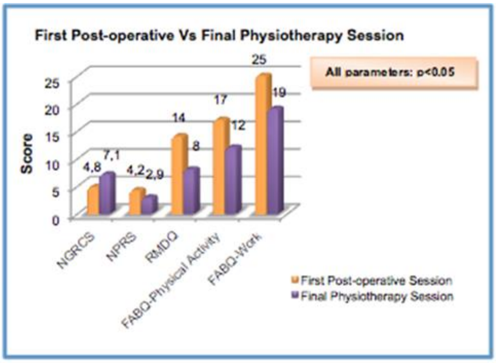
Results / Discussion

From July 2008 to Dec 2012, 254 patients (149 male and 105 female; mean age of 54.1 ± 11.8 years old; 33.4% of them were working population) with lumbar spine operation completed the program.

Mean number of physiotherapy session was 20 ± 14 with average duration of post-operative physiotherapy intervention of 124 ± 71 days. NPRS (6.1 to 3.2), RMDQ (13 to 10), FABQ-

Physical Activity (19 to 12), FABQ-Work (26 to 21) and HADS-Anxiety (9 to 5) were significantly improved (p <0.05) from pre-operative to final physiotherapy session. NPRS (4.2 to 2.9), RMDQ (14 to 8), FABQ-Physical Activity (17 to 12) and FABQ-Work (25 to 19) were significantly improved (p < 0.05) from first post-operative to final physiotherapy session. The work status was significantly improved. 21.2% of the patients were working pre-operatively and 48.2% of them were working upon discharge. Subjective improvement as measured by NGRCS was significantly increased (p < 0.05) from 4.8 ± 2.4 to 7.1 ± 2.2 from first post-operative to final physiotherapy session.





Conclusions / Relevance / Implication

A comprehensive empowering pre-operative and post-operative physiotherapy management program was found to be effective in improving back pain, restoring functional activities, resuming work duties, alleviating the psychological factors in anxiety and fear avoidance beliefs for those patients received lumbar spine operation.

Keywords

Back pain, spine surgery, patient empowerment program, pre-operation, post operation, physiotherapy management program

A STRUCTURED PHYSIOTHERAPY TREATMENT MODEL CAN GIVE RAPID RELIEF TO PATIENTS WHO QUALIFY FOR LUMBAR DISC SURGERY

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Introduction

The spontaneous resolution of symptoms from lumbar disc herniation is regarded as common, which makes it difficult to evaluate the effects of treatment. Surgery for lumbar disc herniation has been investigated in numerous studies and often compared with non-surgical treatments. However the non-surgical treatments have only been vaguely described and variations of treatments have been used.

Aim

Of this study was therefore to evaluate a structured physiotherapy treatment model in patients who qualified for lumbar disc surgery.

Material and Methods

Orthopedic surgeons determined if the patients qualified for lumbar disc surgery after MRI and physical examination. Forty-one patients were included. All the patients followed a structured physiotherapy treatment model including McKenzie therapy combined with graded trunk stabilisation training. Study outcome measures; the Oswestry Disability Index, the Visual Analogue Scale for leg and back pain, the Tampa Scale for Kinesiophobia, the European Quality of Life in 5 Dimensions Questionnaires, the Zung Self-Rating Depression Scale, the Self-Efficacy Scale, work status and patient satisfaction with treatment. The questionnaires were distributed before treatment, and at the three-, 12- and 24-month follow-ups.

Results

The patients had already improved significantly three months after the structured physiotherapy treatment model in all assessments: disability, pain, kinesiophobia, health related quality of life, depression, and self-efficacy. The improvement could still be seen at the two-year follow-up.

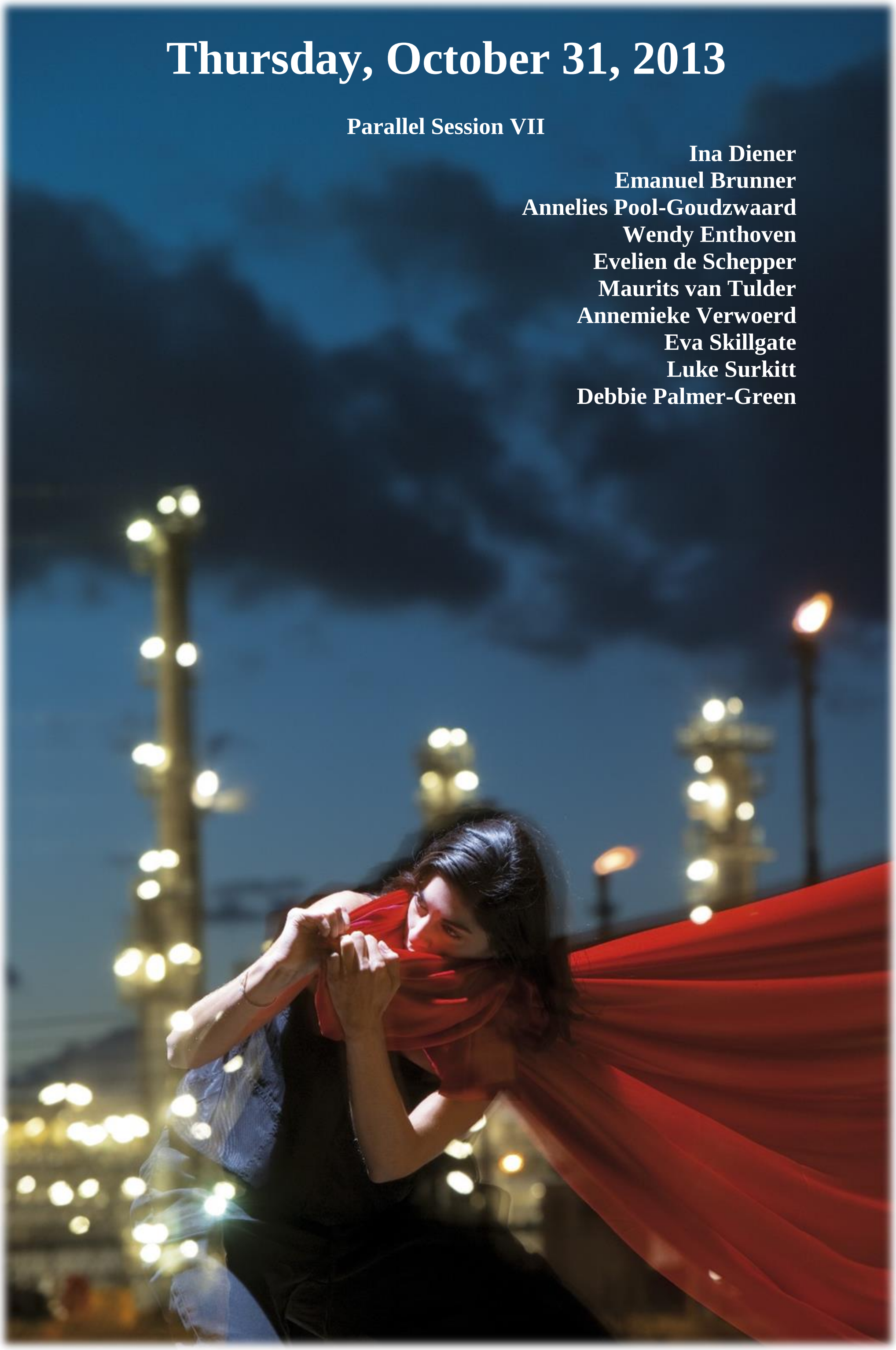
Conclusions

This study shows that patients eligible for lumbar disc surgery improved significantly after treatment with the structured physiotherapy model, as early as three months after treatment, and the results could still be seen at the 24-month follow-up. Consequently, these patients did not qualify for lumbar disc surgery three months after the physiotherapy treatment started. Moreover, the majority of patients had had symptoms for more than three months at the start of treatment and for this reason most of the spontaneous healing ought to have occurred before this study started.

Implications

This study recommends adopting the structured physiotherapy treatment model before considering surgery, when patients report symptoms such as pain and disability due to lumbar disc herniation.

Keywords
Disc Displacement, Rehabilitation, Physical Therapy Modalities



Thursday, October 31, 2013

Parallel Session VII

Ina Diener
Emanuel Brunner
Annelies Pool-Goudzwaard
Wendy Enthoven
Evelien de Schepper
Maurits van Tulder
Annemieke Verwoerd
Eva Skillgate
Luke Surkitt
Debbie Palmer-Green

DEVELOPMENT OF A PREOPERATIVE NEUROSCIENCE EDUCATION PROGRAM FOR LUMBAR RADICULOPATHY

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Introduction

Pain is a powerful motivating force that guides treatment-seeking behaviours, and a common postoperative issue that many lumbar spine surgery (LSS) patients are left to face. Nearly 40% of patients have persistent pain and disability following lumbar surgery.

Purpose/Aim

In preparation for a randomised controlled trial (RCT) on the outcome of preoperative therapeutic neuroscience education (TNE) for LSS patients, an education program was developed and tested.

Materials and Methods

Preoperative education in LSS is dominated by studies comparing structured, preoperative educational interventions with the usual care that patients receive. Firstly, “usual care” was explored in a survey among spinal surgeons in the USA. Furthermore two systematic literature reviews (SLR) were conducted: One on preoperative education, addressing postoperative pain in total joint arthroplasty, and one on the effect of TNE on pain, disability, anxiety, and stress in chronic musculoskeletal pain. The findings of these 3 studies guided the contents and delivery methods of the intervention. The developed program was tested in a pilot study, a single-case fMRI study, followed by an RCT, which is currently collecting six month post-operative data.

Results

The US spine surgeon survey showed that surgeons believe preoperative education is important and they utilize mainly a biomedical model of explaining surgery and pain to LSS patients. This is what the control group of the RCT received. The SLR on preoperative education in orthopaedics also yielded a biomedical and procedural education approach, resulting in making almost no difference on experienced postoperative pain. The SLR on utilizing TNE resulted in compelling evidence to improve pain, physical movement, catastrophization and disability in chronic musculoskeletal pain. The newly designed preoperative TNE program, aiming to educate LSS patients about the neurophysiology of pain, has shown immediate changes in pain, various psychometric measures, physical movements, beliefs and expectations regarding lumbar surgery, as well as decreased nerve sensitization and brain activation. These results were demonstrated in a pilot study, a single-case fMRI study, and in the final study, a RCT, both three and six month post-operatively.

Relevance

A bio-psychosocial approach is needed to address pain in lumbar surgery. Patients want to know more about pain and how treatment, including surgery, will impact on their pain. TNE should be added to preoperative care to advance the results of LS.

Conclusions

A newly designed TNE program teaches LSS patients more about pain before their surgery, resulting in various positive post-surgical outcomes, including pain, disability, movement, fear and catastrophization, healthcare utilization and surgical experience.

Discussion

TNE aims to help patients develop a greater understanding of their pain, the biology behind their pain and how pain is processed. The designed preoperative TNE program by physical therapists, have shown immediate post-education improvements in psychometric measures, beliefs and expectations for surgery and physical movements, and also significant reduction of brain activity associated with painful tasks in patients scheduled for lumbar surgery. Preoperative TNE also resulted in superior outcomes following surgery compared to patients receiving traditional surgeon-led education in regards to back pain, leg pain, fear, catastrophization, function and postoperative healthcare utilization. The short and long term results of the RCT will be available at the time of the congress in 2013.

Keywords

Pain; disability; lumbar surgery; preoperative neuroscience education

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CAN COGNITIVE BEHAVIOURAL THERAPY BASED STRATEGIES BE INTEGRATED INTO PHYSIOTHERAPY FOR THE PREVENTION OF CHRONIC LOW BACK PAIN? A SYSTEMATIC REVIEW

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Introduction

Psychosocial factors play a crucial role in the development of chronic disability in patients with non-specific low back pain (NSLBP). However, physiotherapists are challenged to address these factors in their standard pain management. Cognitive behavioural therapy (CBT) has been identified as a promising approach for such psychosocial interventions, but it is unclear whether or how physiotherapists can integrate these strategies into their outpatient management.

Purpose

The primary purpose was to identify randomized controlled trials which investigated CBT- based strategies in acute/sub-acute NSLBP. The secondary purpose was to analyse the methodological properties, and to identify theory-based treatment strategies that are applicable in outpatient physiotherapy settings.

Methods

A literature search on four databases was conducted and updated in September 2011. Included studies were assessed based on their risk of bias and their methodological properties were summarized. Additionally, content and treatment theory of detected CBT-based strategies were systematically analysed and classified into three distinctive concepts of CBT: operant, cognitive and respondent treatment. Finally, applicability of these treatment strategies in physiotherapy practice were discussed.

Results

Eight studies were included in the systematic review. Half of the studies suffered from high risk of bias, and study characteristics varied in all domains of methodology. Analysis of the treatment content and theory detected one programme with explicitly described theoretical justification. This graded activity programme, based on the concept of operant conditioning, consisted of endurance and strengthening exercises. Exercise intensity was gradually increased towards a pre-defined goal, regardless of the level of pain. The theoretical justification of detected cognitive and respondent treatment approaches could not be identified.

Discussion

The concept of operant conditioning explains how pain behaviours are controlled by learning processes. Positive reinforcement of exercise behaviour therefore, may lead to a decrease of pain behaviour. Operant learning theories are applicable for physiotherapists, because of their expertise in therapeutic exercises and functional training. The content and theoretical justification of cognitive and respondent treatment approaches was not explicitly reported and it is unclear how these strategies address psychosocial obstacles to recovery.

Conclusion

Physiotherapists can integrate CBT- based strategies into their outpatient pain management programmes. The operant treatment approach is promising for the promotion of healthy behaviour, whilst delivering active coping strategies to patients with NSLBP. Future randomized controlled trials should explicitly report the treatment content and treatment theory for better understanding treatment processes and mechanisms.

Implication

Graded activity, based on operant conditioning, is a promising approach for the prevention of chronic NSLBP. Not only clinical psychologists, but health care providers, should integrate CBT-based strategies in their outpatient treatments.

Keywords

Biopsychosocial model, psychosocial intervention, low back pain, cognitive behavioural therapy, physiotherapy

PROGNOSIS AND COURSE OF PAIN AND DISABILITY IN PATIENTS WITH CHRONIC NON-SPECIFIC LOW BACK PAIN: A 5 AND 12 MONTHS FOLLOW-UP COHORT STUDY

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Introduction

To what extent patients recover from chronic non-specific low back pain (CNLBP) is not clear.

Purpose

To describe the course and to identify clinically important prognostic factors by chronic non-specific low back pain in patients receiving multidisciplinary therapy, on the outcome back pain intensity and low-back-pain-specific disability at 5 and 12 months follow-up.

Materials and Methods

A prospective study was conducted among 1760 chronic non-specific low back pain patients (mean age; 40.1 years, SD 10.6) in Rotterdam, Netherlands. These patients were evaluated after a 2 months program of multidisciplinary therapy and measured at 5 and 12 months follow-up. Recovery was defined as: 'relative recovery (30% improvement in VAS pain compared to baseline or 30% improvement in low-back-pain-specific disability at follow-up compared to baseline)' and 'absolute recovery' (VAS pain ≤ 20 mm or the Quebec Back Pain Disability Scale (QBPDS) scored lower than 20 points at follow-up). Twenty-three eligible baseline characteristics were included in the multivariable backward stepwise logistic regression analysis.

Results

Outcome back pain intensity: Patients' reported decreased back pain intensity from 55.5 (23.0) at baseline to 37.0 (23.8), 35.3 (26.1) and 32.3 (26.9), at 2, 5 and 12 months follow-up respectively. Younger age, back pain intensity at baseline, no psychological / physical dysfunction (psycho-neuroticism) measured with the SCL-90 (item 9) and higher scores on the physical (PSC) and mental part (MSC) of quality of life (SF-36) at baseline were associated with recovery at 5 and 12 months. At the 5 months follow-up the two definitions of recovery (improvement 30% and VAS ≤ 20mm) also reported higher work participation at baseline as a prognostic factor for recovery.

Outcome low-back-pain-specific disability: Patients' reported disability during the 12 months process at 2, 5 and 12 months follow-up, from 51.7 (SD 15.6) at baseline to 31.7 (SD 15.2), 31.1 (SD 18.2), 29.1 (SD 20.0) on the QBPDS respectively. The prognostic factors identified for recovery at 5 and 12 months: younger age, high scores on disability, on the physical and mental quality of life (SF-36) at baseline. At 5 months follow-up shorter duration of complaints is a positive predictor and having no co-morbidity and less pain at baseline (VAS) at 12 months follow-up.

Relevance

The course and prognostic factors could be clinical relevant in optimizing rehabilitation for patients with chronic non-specific low back pain.

Conclusion

Overall the results from this current study provided information that some bio psychosocial factors could be important for the clinician in predicting recovery in over a year, in chronic non-specific low back pain patients.

Discussion

There was little to no difference in identified prognostic factors in the sensitivity analyses.

Implication

For daily practice this provides preliminary evidence for clinics to estimate the prognoses regarding pain and disability over a year with chronic non-specific low back pain patients in tertiary care, based on easily to obtain data at baseline.

Keywords

Chronic non-specific low back pain; course; prognosis; outcome assessment; cohort study; logistic regression

BACK COMPLAINTS IN THE ELDERS (BACE): PREVALENCE OF NEUROPATHIC PAIN AND ITS CHARACTERISTICS

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Introduction
Neuropathic symptoms are reported in 16-55.6% of patients with low back pain. The range is broad because studies were performed in various populations, however, none focused on elders.

Aim
To assess prevalence of neuropathic pain in elders who consulted their general practitioner with a new episode of back complaints.

Materials and Methods
Prevalence of neuropathic pain, measured with the Dolour Neuropathic 4 questionnaire (DN4), was assessed. Patients (>55 years) consulting their general practitioner with a new episode of back complaints were included. Two DN4-versions were used; one based on interview plus physical examination, the other based on interview alone. In the interview plus physical examination version, patients' and complaint characteristics were compared between groups with different scores (0,1,2,3, and ≥4). The DN4 interview-version compared patients with negative and positive scores.

Results
Of the 261 included patients available for analysis were 250 patients (95.8%) with the DN4 interview plus physical examination, and 259 patients (99.2%) with the DN4 interview.

DN4 interview plus physical examination (n=250): 5 patients (2%) scored positive (score ≥4). Higher score was associated with pain radiating below the knee (p<0.001) and use of paracetamol (p=0.02).

DN4 interview (n=259): 29 (11.2%) patients scored positive (score ≥3). Positive score was associated with higher body mass index (p=0.01), pain radiating below the knee (p=0.01) and use of paracetamol (p=0.02).

Relevance
Our study provides the prevalence of neuropathic pain in elders, which might be important because these patients need different management for their back pain.

Conclusions
In elders with back pain presenting in primary care prevalence of neuropathic pain is 2% on DN4 interview plus physical examination and 11% on DN4 interview alone. It seems to be associated with pain radiating below the knee, use of paracetamol and higher body mass index.

Discussions

Due to a low number of patients scoring positive on the DN4, it is difficult to make statements about the differences between patients with and without neuropathic pain. It is thought that neuropathic pain is not just positive or negative, but can be more or less neuropathic. Therefore we analyzed all scores separately and pooled patients scoring 4 or 5 on the DN4 interview plus physical examination.

Implications

Patients with neuropathic pain may need different pain management. Future research will assess the clinical impact of neuropathic pain in elders in general practice.

Keywords

Back pain, neuropathic pain, primary care, DN4

DISC DEGENERATION OF THE UPPER LUMBAR DISCS IS ASSOCIATED WITH HIP PAIN

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Introduction

The differential diagnosis of hip pain is broad and includes intra-articular pathology, extra-articular pathology and other causes like radiating pain from the lumbar spine. The differentiation of signs and symptoms suggestive of hip disorders versus spine disorders is important in giving patients the most beneficial treatment, especially if the treatment includes a major reconstructive surgery, such as hip replacement.

Preoperative identification of factors associated with hip pain arising from the lumbar spine would aid the physician by identifying the subgroup of patients who might not experience full relief of pain with a hip arthroplasty. One of the first steps to identify possible factors is to look at the association between hip pain and osteoarthritis of the lumbar spine.

Purpose/Aim

The purpose of this study was to explore the association of self-reported hip pain with the different individual radiographic features (IRF) of spinal osteoarthritis by vertebral level, including osteophytes and disc space narrowing.

Materials and Methods

In an open population based study of people 55 years and older (Rotterdam study), 2819 lumbar radiographs were scored for the presence and severity of individual radiographic features of disc degeneration. Hip osteoarthritis was scored on anteroposterior pelvic radiographs, and questionnaires including self-reported hip pain were taken. Logistic regression adjusted for possible confounders was used to determine the association between self-reported hip pain and the individual radiographic features of lumbar disc degeneration.

Results

The presence of disc space narrowing grade ≥ 1 at level L1/L2 was significantly associated with hip pain in the last month (men OR = 2.0; 95% CI: 1.1 to 3.8 and women OR = 1.7; 95% CI: 1.1 to 2.5). The presence of disc space narrowing grade ≥ 1 at level L2/L3 was only significantly associated with hip pain in women. The strength of the associations increased for self-reported chronic hip pain, especially in men (L1/L2 OR = 2.5; 95% CI: 1.3 to 5.0). The presence of disc space narrowing at the lower levels (L3/L4/L5/S1) was not significantly associated with hip pain.

Conclusion

Our data provide evidence for an association between hip pain and disc space narrowing at disc level L1/L2 and L2/L3.

Discussion

However, there are several limitations in our explorative study that need to be considered when interpreting the results. Well-designed studies are needed to verify this hypothesis.

Implications

In case of uncertainty of the cause of hip pain, evaluation of lumbar radiographs may help to identify those hip pain patients who might have pain arising from the lumbar spine. Perhaps hip infiltration in patients without higher lumbar disc degeneration is even unnecessary.

Keywords

Hip pain, back pain, lumbar disc degeneration

REHABILITATION AFTER LUMBAR DISC SURGERY (REVIEW)

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Introduction
Several rehabilitation programmes are available for individuals after lumbar disc surgery.

Purpose/Aim
To evaluate the effects of active rehabilitation for adults after first-time lumbar disc surgery.

Materials and Methods
CENTRAL, MEDLINE, EMBASE, CINAHL, PsycINFO and PEDro were searched to June 2012. Only randomised controlled trials (RCTs) were included. Pairs of review authors independently assessed studies for eligibility and risk of bias. A meta-analysis was performed with clinically homogeneous studies. The GRADE approach was used to determine the quality of evidence. The final search update was conducted in May 2013 and the results of this updated search will be presented in October 2013.

Results
Twenty-one studies were included, 10 of which had a low risk of bias. Most programmes were only assessed in one study. Statistical pooling was only completed for three comparisons in which exercises were started four to six weeks post-surgery: exercise programmes versus no treatment, high versus low intensity exercise programmes, and supervised versus home exercises. There is very low quality evidence (five RCTs, N = 272) that exercises are more effective than no treatment for pain at short-term follow-up (SMD -0.94; 95% CI -1.49 to -0.40), low quality evidence (four RCTs, N = 252) that they are more effective for functional status on short-term follow-up (SMD -0.70; 95% CI-1.09 to -0.32) and low quality evidence that there is no difference in functional status on long-term follow-up (three RCTs, N=226; SMD 0.02; 95% CI -0.35 to 0.40). None of these studies reported that exercises increased the re-operation rate. There is very low quality evidence (two RCTs, N =103) that high intensity exercise programs are more effective than low intensity exercise programs for pain in the short term (WMD -10.67; 95% CI -17.04 to -4.30) and low quality evidence (two RCTs, N = 103) that they are more effective for functional status in the short term (SMD -0.77; 95% CI -1.17 to -0.36).
There is very low quality evidence (four RCTs, N = 154) that there were no significant differences between supervised and home exercises for short-term pain relief (SMD -0.76; 95% CI -2.04 to 0.53) or functional status (four RCTs, N = 154; SMD -0.36; 95% CI -0.88 to 0.15).

Conclusions
Exercise programs starting 4-6 weeks post-surgery seem to lead to a faster decrease in pain and disability than no treatment, with small to medium effect sizes, and high intensity exercise programs seem to lead to a slightly faster decrease in pain and disability than low intensity

programs, but the overall quality of the evidence was only low to very low. There were no significant differences between supervised and home exercises for pain relief or disability.

Keywords
Rehabilitation, lumbar disc surgery, postoperative

DIAGNOSTIC ACCURACY OF HISTORY TAKING TO ASSESS LUMBOSACRAL NERVE ROOT COMPRESSION OR DISC HERNIATION

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Introduction
The diagnosis of sciatica is primarily based on history and physical examination. Most physical tests used in isolation show poor diagnostic accuracy. Little is known about the diagnostic accuracy of history items.

Purpose/Aim
To assess the diagnostic accuracy of history taking for the presence of lumbosacral nerve root compression or disc herniation on MRI in patients with sciatica.

Materials and Methods
A total of 395 adult patients with severe disabling radicular leg pain of 6-12 weeks duration were included in a diagnostic study. Data were prospectively collected in 9 hospitals. History was taken according to a standardized protocol. Lumbosacral nerve root compression and disc herniation on MRI were independently assessed by two neuroradiologists and one neurosurgeon blinded to any clinical information.

Results
310 patients (80%) had lumbosacral nerve root compression and 331 patients (85%) had a disc herniation on MRI. Exploring the diagnostic value of history items used in isolation, we assessed the diagnostic odds ratio of 20 items. 'Male sex', 'pain worse in the leg than in back' and 'a non-sudden onset' revealed a significant contribution in diagnosing nerve root compression. A significant contribution to the diagnosis of a herniated disc was found for 'BMI <30', 'a non-sudden onset', and 'sensory loss'. Multivariate logistic regression analysis of 6 history items pre-selected from the literature (age, gender, pain worse in leg than in back, sensory loss, muscle weakness and more pain on coughing/sneezing/straining) showed an AUC of 0.65 (95% CI 0.58-0.71) for the model diagnosing nerve root compression and an AUC of 0.66 (95% CI 0.58-0.74) for the model diagnosing disc herniation (after bootstrapping to correct for overoptimism an AUC of 0.62 and 0.63 respectively).

Relevance
Knowledge on the diagnostic accuracy of history items is necessary to establish which history items matter in daily clinical practice for diagnosing patients.

Conclusions

A few history items used in isolation had significant diagnostic value and the diagnostic accuracy of a model with 6 pre-selected items was poor.

Discussion

A limitation of our study is the highly selected population of patients who are likely to be surgical candidates. Therefore generalizability to primary care is problematic. Secondly, inclusion of physical examination in the diagnostic models was not possible because physical tests were carried out after patients had undergone MRI and therefore blinding for the results of MRI was not warranted.

Implications

The diagnostic accuracy of history taking in assessing lumbosacral nerve root compression and disc herniation on MRI might be more limited than previously assumed. This may cause difficulty in distinguishing between patients with specific and non-specific low back pain. The evidence on which to base an optimal diagnostic trajectory of history taking and physical examination in patients with sciatica remains limited and warrants further study.

Keywords

Sciatica, Diagnosis, Medical History Taking, Sensitivity, Specificity

THE AGE- AND SEX-SPECIFIC OCCURRENCE OF BOTHERSOME LOW BACK PAIN IN THE GENERAL POPULATION

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Introduction
Low back pain (LBP) is very common, but the knowledge about the sex and age differences in bothersome LBP in the general population is insufficient.

Purpose/Aim
To report on the sex- and age- specific one-year prevalence, incidence and recovery rate of bothersome LBP in the general population.

Materials and Methods
A population-based cohort study in Stockholm County, Sweden (n=23794), surveyed in 2002 and 2007. In this study LBP was measured in 2005 and 2006 with retrospective questions in the follow-up questionnaire: "During the last five-year period, have you had low back pain, for at least seven consecutive days, that has bothered you considerably?" If yes, which year/years? The one-year prevalence in 2006 was estimated in the full cohort (n=23794), the one-year incidence proportion in 2006 among the 17493 individuals without LBP in 2005, and the one-year incidence proportion of recovery in 2006 among the 5436 individuals with LBP in 2005.

Results
The mean age was 48 years and 56% were women. The one-year prevalence of bothersome LBP for at least seven consecutive days was 29% among women and 25% among men, highest in the age group 70-84 years among women (35%) and in the age group 40-49 years among men (30%), and lowest in the age group 18 - 29 years in women (26%) and men (20%). The one-year incidence proportion was 9% among women, and 8% among men, highest among women in the age group 18-29 years and among men in the age group 30-39 years and lowest in the age group 60 - 69 years in both sexes. The one-year incidence proportion of recovery was 12% among women and 16% among men, highest in the age group of 18-29 years, and lowest in the age group 70 - 84 years in both sexes.

Relevance
This is, to our knowledge, the first study to report on the age- and gender-specific prevalence and the incidence proportion of the onset and of the recovery from LBP that is bothersome, from a large population-based sample.

Conclusion
Bothersome LBP among men is most common in the middle ages but among women in the elderly (70-84 years). Women are more likely than men to have bothersome LBP, and less likely to recover from such pain.

Younger men and women have a higher incidence proportion and recovery rate than older persons.

Discussions

A strength is the large population-based sample, enabling analyses in subgroups of age and sex and that LBP that is bothersome is of high importance for the individual as well as for the society. A limitation is the risk of bias in the one- to two-year retrospective recall of BNP.

Implications

This public health problem probably makes a significant contribution to the global burden of disease.

Keywords

Low back pain, epidemiology, prevalence, incidence

12 MONTH RESULTS OF A RANDOMISED CONTROLLED TRIAL COMPARING PHYSIOTHERAPY GUIDED DIRECTIONAL PREFERENCE MANAGEMENT VERSUS ADVICE FOR REDUCIBLE LUMBAR DISCOGENIC PAIN

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Introduction

Providing specific treatment based on symptom response for people with low back pain (LBP) and a directional preference (DP) is a widely used treatment approach. However, the evidence is limited for the efficacy of treatment using the principles of directional preference management (DPM). A possible factor contributing to these findings is the clinical heterogeneity of participants in randomised controlled trials (RCTs) investigating DPM. Subgrouping participants with LBP in RCTs based on their likely response to DPM may lead to larger treatment effects.

Aim

The aim of this arm of the Specific Treatment of Problems of the Spine (STOPS) trials was to evaluate the effectiveness of physiotherapy guided specific DPM compared with advice for participants classified in the LBP subgroup of reducible discogenic pain (RDP).

Materials and Methods

A multi-centre parallel group RCT was undertaken with participants with RDP (6 weeks to 6 months) presenting with LBP with/without referred leg pain. The participants were randomly allocated to receive either 10 sessions of DPM or 2 sessions of advice over 10 weeks. The primary outcome measures included back pain and leg pain (0 to 10 numerical pain rating scales) and activity limitation (Oswestry Disability Index) that were followed up at 5, 10, 26 and 52 weeks post baseline. Data were analysed using linear mixed models for continuous outcomes.

Results

Seventy-eight participants (30 women, 48 men) were enrolled in the RCT. Data analysis demonstrated statistically significant and moderate sized between-group standardized mean differences (SMDs) favouring DPM over advice for back pain at 5 weeks (SMD 0.71, 95% CI: 0.26 to 1.16) and 10 weeks (SMD 0.64, 95% CI: 0.19 to 1.09), and leg pain at 10 weeks follow-up (SMD 0.53, 95% CI: 0.06 to 1.01). There were no significant between-group differences for back pain, leg pain or activity limitation at 26 and 52 weeks follow-up.

Relevance

The physiotherapy classification and DPM protocol utilised in this RCT appears to lead to more rapid and clinically important short-term improvement in low back and leg pain than guideline recommended advice.

Conclusions

Participants with RDP who received DPM experienced more rapid significant short-term improvement in low back and leg pain compared with those who received advice, however significant between-group differences were not maintained at intermediate and long-term follow-up.

Discussion

The development of the STOPS classification system, application of specific treatment for the LBP subgroup of RDP and mechanisms underpinning the results will be discussed.

Keywords

Low back pain, reducible discogenic pain, directional preference management, classification

METHODS FOR EPIDEMIOLOGICAL STUDY OF LUMBAR SPINE INJURY AND PAIN IN GREAT BRITAIN OLYMPIC SPORT: THE INJURY/ILLNESS PERFORMANCE PROJECT (IIPP)

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Introduction

Injuries to the lumbar spine and the occurrence of lower back pain are among the most prevalent and severe in the general population, and also among the elite sporting population. Prevention of lower back injury in elite sport can have not only athlete health benefits but also potential positive performance gains. As the first step towards prevention, valid injury surveillance data on the lumbar spine are needed.

Aim

To develop and implement a valid and sensitive multisport surveillance model for elite sport in Great Britain, to identify incidence, severity, nature, and risk factors for lumbar spine injury and the occurrence of pain.

Methods

A longitudinal prospective injury surveillance study was developed for individual and team Olympic sports. From June 2009 to August 2012, 550 Great Britain national team lottery funded athletes from 14 identified sports' national governing bodies (NGB) were involved in the study, with NGB medical staff recording all injuries occurring during training and competition that caused complete time loss or restricted participation.

Results

During the study there were 559 recorded injuries in total. Of all injuries 12% were reported to occur to the lumbar spine with on average 11 days lost per lumbar spine injury and athletes reporting a mean pain score 5.9 on the VAS pain score (0 = no pain; 10 = worst pain). At the date of return (to full and normal training) from injury 44% of athletes reported still experiencing residual lumbar spine pain (1.3 VAS). The most common type of lumbar spine injury was sprain (joint/ligament injury: 38% of all injuries) followed by lesion of disc (20%). The majority of impactful lumbar spine injuries resulted in restriction of training participation (73%; n = 48) with the remainder resulting in complete time loss. Time loss lumbar spine injuries were more severe in terms of days lost (time loss: 20 days; restriction: 8 days) and also more painful (time loss: mean VAS 7.1; restriction: mean VAS 5.4). Overuse was the most common cause of lumbar spine injury accounting for 68% (overuse sudden onset: 37%; overuse gradual onset: 31%), followed by recurrent injury (38%). Recurrent lumbar spine injuries tended to be more severe compared with new injuries (14 days versus 10 days).

Conclusions

The injury/illness performance project provides objective information to medical and coaching support staff, identifying lumbar spine injuries among the most prevalent and impactful of all injuries in elite sport in Great Britain. The majority were caused by overuse, and were recurrent in nature.

Discussion

Injury prevention initiatives focussed on identified risk factors for lumbar spine injuries and associated pain would be beneficial in terms of protecting athlete health and decreasing athlete training days lost.

Implications

The long term aim of the study is to reduce the number and severity (days lost and pain) of athlete lumbar spine injuries, and the detrimental effects to training and competition; and ultimately through this enhance athlete performance.

Keywords

Lumbar spine; pain; injury; elite sport

Thursday, October 31, 2013

Parallel Session VIII

Andre Farasyn
Jaana Suni
Ron Alexander
John Panagopoulos
Anna Moller
Harald Ekedahl
Sandra Lewis
Geoffrey Desmoulin
Sarah Slater
Deepak Sharan
Jan Vagedes
Narelle Stubbs

VALIDITY OF THE NEW BACKACHE INDEX (BAI) IN PATIENTS WITH LOW BACK PAIN

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Introduction
The Backache-Index (BAI) is applied to patients with low back pain (LBP) in order to help doctors/surgeons perform physical examinations easily and it is carried out within a short space of time (< 2 min.) without using inclinometric instruments.

Purpose/Aim
To explore the reliability, validity and responsiveness of this new BAI in patients with LBP, which can fulfil the existing need for a reliable routine examination in the clinical environment.

Materials and Methods
In total, 75 patients with subacute LBP participated in a randomized controlled study (1). The BAI consisted of a scoring system that includes pain factors and stiffness estimation at the end of a series of five different lumbar movements of a patient standing in an erect position.

Results
The (blinded) inter-observer reliability between two observers for the BAI was perfect (ICC = 0.96). A BAI change of one unit is able to exclude a measurement error. A significantly good correlation ($P < 0.001$) was found between BAI at baseline, and Oswestry Disability Index (ODI, $R = 0.62$) and MPQ-PRIT, as the total degree of pain rating index ($R = 0.57$). The effect size and discriminative ability were explored after two treatment sessions. The greatest level of distinction was found for MPQ-PRI-T and BAI (AUC > 0.93), followed by ODI (AUC = 0.92). A less distinction was found for MPQ-NWC-T and Visual Analogue Scale (VAS, AUC > 0.82).

Relevance
The BAI is available in different languages: English, Spanish, French, Dutch, German, Italian, Portuguese, Russian, Chinese, Thais and Turkish. www.roptrotherapy.info

Conclusions
The Backache Index or BAI appears to be a reliable and valid assessment of overall restricted spinal movements in case of LBP and discriminates between successful and unsuccessful treatment outcome.

Discussion
The interobserver reliability after a few minutes for the BAI was sufficient. The validity of the BAI was found to be good with the ODI and moderate with the VAS. A Backache Index change of one unit is able to exclude a measurement error.

Keywords
Low back pain; Outcome scales; Reliability; Validity; Responsiveness; Impairment; Pain rating scales

Implications

In a Spanish study (2) the test-retest after 3 days of the same group (n=46) revailed that the reliability for the 5 outcome scores was good (ICC=0.73). No significant difference was found between BAI1 (4.65 ± 4.15) and BAI2 (4.72 ± 4.20) and the absolute reliability was perfect with an ICC=0.97.

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NEUROMUSCULAR EXERCISE AND COUNSELING DECREASE ABSENTEEISM DUE TO LOW BACK PAIN IN YOUNG CONSCRIPTS - A RANDOMIZED, POPULATION-BASED PRIMARY PREVENTION STUDY

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Background

Low back pain (LBP) causes significant morbidity and absence from military service. An increased risk for LBP was recently reported in Finnish conscripts with a poor fitness level in trunk muscular endurance and aerobic performance, and a low educational level. Afore mentioned findings indicate that basic military training is physically demanding on the back and requires adequate physical fitness.

Objective

The study investigated the effectiveness of a 6-month neuromuscular exercise (NME) and counseling program for reducing the incidence of LBP and disability in young conscripts with a healthy back at the beginning of their compulsory military service. To our knowledge, there are no former randomized controlled studies in which these preventive interventions were targeted to healthy individuals.

Methods

Study design was a controlled intervention with group randomization. Participants were conscripts of four successive age cohorts (n=1409). In the pre-study year, before adoption of the intervention, two successive cohorts of conscripts of four companies (n=719) were followed prospectively for 6 months to study the baseline incidence of different categories of LBP. In the intervention year, conscripts (n=690) of two new cohorts of the same companies (intervention group: anti-tank, engineer; control group: signal, mortar) were followed for 6 months.

Outcome Measures

The date and diagnosis of each LBP case were registered in the electronic patient records at the garrison healthcare unit. The outcome measures were the number and incidence of LBP, total number of healthcare visits due to LBP, total number of off-duty days, and at least 5 off-duty days due to LBP. Off-duty included any physical restriction that prevented full participation in military training.

Statistical Analysis

All analyses were performed according to the intention-to-treat principle. The incidence of outcome measures was calculated by dividing the number of cases in each outcome measure by the exposure time and expressed per 1000 person-days. The primary analysis was intervention group vs. control group for assessment of a difference of incidence rates of LBP and disability between the pre-study year and intervention year. Hazard ratios (HRs) between the groups were obtained using the Cox proportional hazard model for categorical outcomes. The negative binomial model was chosen for count data due to a skewed distribution. Risk factors of LBP and possible confounders were added in the adjusted models based on a former epidemiologic study. Furthermore, the interaction of the company (intervention vs. control) and study period (pre-study year vs. intervention year) was entered into the model.

Intervention

Both NME and counseling were aimed at reducing the incidence of LBP by improving the control of the lumbar neutral zone (NZ) and specifically avoiding full lumbar flexion in all daily tasks. The theoretical basis of this was the hypothesis of microdamage occurring in spinal ligaments, discs, facets, and capsules. When the microdamage exceeds a certain threshold due to high loads, many repetitions, long duration, and/or insufficient rest, acute inflammation is triggered. This in turn elicits muscle spasms and significant changes in muscular activity and synchronization, leading to chronic LBP.

During the first 8 weeks of basic training, NME was conducted three times weekly as part of normal compulsory service in the intervention companies. The conscripts trained inside in small groups of 40 men per group led by two educated female instructors. One exercise session lasted from 30 to 45 minutes and nine exercises at moderate intensity. All exercises required control of the NZ and several emphasize the avoidance of full lumbar flexion.

Counseling was based on the cognitive-behavior modeling. The aims were to increase conscript awareness of tasks during daily military life potentially harmful for the lower back, and to increase personal knowledge, understanding, and skills regarding performance of these tasks in a less harmful manner, and thus reduce the fear of pain. For this purpose, the conscripts in the intervention companies received a guidebook. One 1-hour lecture was provided during basic training period. In addition, company leaders and the exercise instructors addressed the potential hazards of field service when appropriate.

Results

Total number and incidence of off-duty days due to LBP were significantly decreased in the intervention companies compared to controls (adjusted hazard ratio = 0.42, 95% confidence interval = 0.18 to 0.94, $p = 0.035$). The number of LBP cases, number of health clinic visits due to LBP, and number of the most severe cases showed a similar decreasing trend, but without statistical significance.

Discussion

Our study comprised a pre-planned NME and counseling intervention program to prevent LBP and disability in young men with a previously healthy back that were engaged in high level of physical activity including heavy military tasks. These rather simple preventive actions in the intervention companies were successful in reducing the total number of off-duty days by 58% compared to control companies. The incidence of health clinic visits due to LBP, however, was not different between groups.

The biological explanation for the findings could be that conscripts in the intervention group experienced less severe injuries to spinal structures than conscripts in the control group, which led to physicians prescribing fewer off-duty days. A psychosocial explanation for reduced off-duty days could be altered experience of LBP and related behavior.

Conclusions

These findings provide evidence that exercise and education to improve control of the lumbar NZ have a prophylactic effect on LPB-related off-duty service days in the military environment when implemented as part of military service among young healthy men.

Keywords

Primary prevention, low back pain, exercise, counseling, young population

TO INVESTIGATE THE EFFECTS OF FUNCTIONAL FASCIAL TAPING ON PAIN AND FUNCTION IN PATIENTS WITH NON-SPECIFIC LOW BACK PAIN: A PILOT RANDOMISED CONTROLLED TRIAL

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Introduction

To investigate the effects of Functional Fascial Taping [FFT] on pain and function in patients with non-specific low back pain: a pilot randomised controlled trial [RCT].

Aim

To compare the short-term and medium-term effect of FFT to placebo taping with a 2-week intervention, and 2-, 6- and 12-week follow-up. Forty-three participants with non-specific low back pain and pain on flexion for more than 6 weeks were recruited from local communities and randomized into either FFT group (n = 21) or placebo group (n = 22). Materials. Objective measures, Visual Analog Scale and modified Oswestry Disability Index. Rigid hypoallergenic tape, hypoallergenic adhesive undertape and self care and standardized flexion manual.

Methods

Participants were seen twice weekly for 2 weeks. Intervention, the FFT group the tissue was distracted in the direction of maximal pain relief. The tape was applied with tension in flexion. In the placebo group tape was placed over the area of pain in flexion. In the second week patients were given flexion exercises. The tape was removed, walking and flexion exercises recommended.

Relevance

Pain is an important inhibitor of movement in low back pain. Interventions that reduce pain may also improve movement and outcomes.

Results

The FFT group demonstrated significantly greater reduction in worst pain compared to placebo group after the 2-week intervention (P = 0.02, effect size = 0.74; 95% confidence interval 0.11–1.34). A higher proportion of participants in FFT group attained the minimal clinically important difference in worst pain (P = 0.007) and function (P = 0.007) than those in placebo group after the 2-week intervention. There were no significant differences in either group's disability rating or clinically important difference in average pain at any time.

Conclusions

FFT reduced worst pain in patients with non-acute non-specific low back pain during the treatment phase. No medium-term differences in pain or function were observed. Implications: This pilot study suggests that FFT could be used as an adjunct to treatment of non-specific low back pain to reduce pain and improve function when the tape is applied. Further research is required to fully elucidate its role in the treatment of this complex condition.

Keywords
Low back pain, functional taping, function, placebo

DOES THE ADDITION OF VISCERAL MANIPULATION IMPROVE OUTCOMES FOR PATIENTS WITH LOW BACK PAIN?

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Introduction

Visceral manipulation (VM) is a gentle, specific manual therapy aimed at assessing and treating abnormalities in the physiological motion of internal organs. Proponents of VM argue that, by specific manual treatment of the supportive fascia of the internal cavities of the thorax, abdomen and pelvis, VM modulates visceral pain signals. There have been no randomised controlled trials conducted to investigate the effectiveness of VM for the treatment of LBP.

Aim

The primary aim of this randomised controlled trial is to investigate whether the addition of VM, to a standard physiotherapy treatment regimen, improves pain 6 weeks post treatment commencement in people with LBP. Secondary aims are to examine the effect of VM on disability and functional outcomes at 2, 6 and 52 weeks post-treatment commencement and pain at 2 and 52 weeks.

Methods

64 patients presenting with non-specific LBP to a private physiotherapy clinic in Sydney were recruited. Baseline data taken was numerical pain rating, Roland-Morris Disability, patient-specific functional scale and presence/absence of visceral symptoms. Patients were randomly allocated to two groups: one received VM in addition to a standard physiotherapy treatment algorithm including manual therapy, specific exercises and functional exercise prescription. The other group received placebo VM in addition to the same standard physiotherapy treatment. All patients were treated for a minimum of one and a maximum of twelve sessions over 6 weeks. Follow up data was taken at Weeks 2, 6 and 52. At week 6, a treatment credibility question was asked to assess if blinding was successful. Analysis of data will be carried out by a statistician blinded to group allocation and by intention-to-treat.

Results

The final participant was recruited in September, 2012. We are currently in the process of collecting 52 week follow-up data and this will be completed in September, 2013. All 2 and 6 week follow ups have been completed and the follow up rates were 99% and 97% respectively. Complete results for all time points will be presented at the conference.

Conclusions

The results of the trial will provide the first high quality evidence of the potential efficacy of VM for LBP.

Keywords

Low back pain, visceral manipulation, randomised controlled trial

THE EFFECT OF FIRST BALLET CLASSES IN THE COMMUNITY ON VARIOUS POSTURAL PARAMETERS IN YOUNG GIRLS

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Introduction

There is much evidence in literature between ballet dancing and spine injuries in the adult ballet dancer but none have examined whether a single first season of ballet dancing in the community affects various postural parameters in young girls.

This unique training and pre-existing general joint flexibility may contribute to the 10 times higher prevalence of back related injuries and back pain in ballet dancers compared with the general population.

Purpose/Aim

The aim of this study is to examine the effect of first season ballet classes in the community on the thoracic kyphosis (TK), lumbar lordosis (LL), hip external rotation (ER) and joint flexibility.

Materials and Methods

This study is a single blind, longitudinal cohort study.

30 girls aged 6-9, recruited from the same primary school were divided equally into 2 groups: a group bi-weekly community ballet class and a sedentary control group.

TK, LL and hip ER, were measured using a digital inclinometer whereas the joint hyper-flexibility was quantified using the Beighton Score. Following validity and reliability trials, all measurements were taken prior to ballet classes (t0), following one season of ballet classes (t1.) and subsequent follow up 5 months later (tfu).The two groups of girls were examined, throughout one year, by one examiner (AM) who was unaware of their group assignment.

Results

LL at t1 became greater in the ballet girls' group (23.7º± 6) as opposed to the controls (19.5º±3.9) due to a decrease in LL in the controls from t0 to t1 (by ca.-16.5º). Following ballet classes, LL was reduced in the two studied groups, yet only significantly in the controls, resulting in a significantly flatter lumbar spine in the sedentary control group compared with the ballet group

TK decreased in ballet girls (mean difference ¼-26.1º) and controls (ca.-31.3º). Left hip ER decreased only in the controls from t0 to t1. (mean difference ¼-13.8º) remaining unchanged from t1 to tfu. The Beighton score at tfu was greater in the ballet girls (6.1 ± 2.3) versus the controls (4.4 ± 1.5).

Relevance

Ballet classes is a very popular extracurricular sport amongst young girls.

Conclusions

The results suggest that first season ballet classes for young girls in the community can be associated with greater lumbar lordosis and left hip ER, and joint hyper-flexibility.

Discussion

The combination of greater LL and left hip ER found in the ballet girls compared with the controls is kinematically linked, as dancers try to achieve greater hip ER by increasing their lumbar extension/hyperlordosis, which is also supported by the increase in the Beighton score.

Implications

This study identifies postural changes following first ballet season and is at this point reversible. The evidence of much higher incidence of spondylolisthesis in ballet dancers compared with the general population should be motivating for reorganizing the training.

Keywords

Lordosis, Kyphosis, Ballet, Hip rotation

THE SHORT-TERM EFFECT OF LUMBAR TRANSFORAMINAL EPIDURAL STEROID INJECTION: A COMPARISON OF MRI-DIAGNOSIS AND THE SLUMP TEST

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Introduction

Transforaminal epidural steroid injection (TESI) is a commonly used intervention for patients with lumbar radicular pain. TESI was proven effective in reducing radicular pain at a group level, however, non-responders to the treatment were also reported. MRI-diagnosis and the type of radicular pain reported by patients were suggested to be of importance for treatment effect but the efficacy of TESI in specific groups has not been thoroughly investigated.

Aim

This study aimed to evaluate the short-term (3 weeks) effect of TESI in patients with lumbar radicular pain stratified by MRI-diagnosis and the results of the neurodynamic Slump test (neural tension sign).

Materials and Methods

100 patients with lumbar radicular pain were included in this prospective trial performed in a single center hospital in southern Sweden. All subjects received TESI and were examined by MRI. The sample was stratified by MRI-diagnosis: Disk herniation low-grade nerve root compression (n=43), Disk herniation high-grade nerve root compression (n=19) and Foraminal stenosis (n=38), and by positive/negative Slump test (n=67/n=33).

Treatment effect was evaluated by Visual Analoge Scale for leg pain (VAS leg) on affected side and self-reported disability (Oswestry Disability Index [ODI]). A minimal clinically important difference (mcid) of 15 and 10 point, respectively, were used to define responders (improving at least one mcid) and non-responders (improving less than one mcid). Chi-square test was used to differentiate between the responders and the non-responders for all baseline variables. Furthermore, improvement in VAS leg, ODI, Fingertip-to-floor test (FTF) and Straight Leg Raise (SLR) over three weeks for each stratum was parametrically compared using T-test.

Results

The distribution of positive/negative Slump test was significantly different between the responders and non-responders (VAS leg, $p=0.012$; ODI, $p=0.003$), where negative Slump test predicted poorer outcome. The MRI-diagnoses were not significantly different between the responders and non-responders ($p=0.205$-0.792).

After stratification by results of the Slump test, all variables showed significant improvement for the positive Slump test group (VAS leg: M=15, $p<0.001$; ODI: M=4.4, $p=0.001$; FTF: M=6.5, $p<0.001$; SLR: M=3.8, $p<0.001$) while for those with negative Slump test no significant improvement was seen in any of the four outcomes (VAS leg M=4, $p=0.209$; ODI, M=0.8, $p=0.453$; FTF M=0.3, $p=0.802$; SLR M=0.4, $p=0.790$).

Conclusion

In patients with lumbar radicular pain, MRI-diagnosis failed to predict the treatment effect 3 weeks after TESI. However, patients with a positive Slump test had a good effect of TESI whereas

those with a negative Slump test had no or minor effect of TESI after 3 weeks. Thus, our results suggest that TESI should be recommended mainly to those with a positive Slump test.

Keywords

Transforaminal epidural steroid injection; Radicular pain; Magnetic resonance imaging; Predictive value of tests

THE RELATIONSHIPS BETWEEN MUSCLE ACTIVITY AND PSYCHOLOGICAL FACTORS IN PATIENTS WITH CHRONIC LOW BACK PAIN

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Introduction

Psychological factors are known to play an important role in low back pain and are sometimes viewed as ‘obstacles to recovery’. It has been suggested that one of the ways psychological factors may affect the condition is via increased spinal loading resulting from altered paraspinal muscle activity.

Purpose

This study aimed to investigate the relationship between muscle activity, pain, disability, and a number of psychological factors in a clinically relevant population of National Health Service patients with chronic low back pain.

Materials and Methods

Forty-seven patients were recruited from waiting lists for physiotherapist-led rehabilitation programmes. Paraspinal muscle activity while standing was assessed via surface electromyography and self-report of pain, disability, anxiety, depression, pain-related anxiety, fear of movement, self-efficacy and catastrophising were recorded.

Results

Correlations were found between muscle activity and both pain ($r = 0.48$) and disability ($r = 0.43$). Muscle activity was also correlated with self-efficacy ($r = -0.45$), depression ($r = 0.33$), anxiety ($r = 0.31$), pain-related anxiety ($r = 0.29$) and catastrophising ($r = 0.29$) and was a mediator between self-efficacy and pain.

Relevance

The findings confirm the importance of muscle activity within low back pain, in particular as a pathway by which psychological factors may impact on clinical outcome.

Conclusions

Paraspinal muscle activity is significantly related to both psychological factors and clinical outcome measures and in particular, is a mediator between self-efficacy and pain.

Discussions

Patients who demonstrated higher paraspinal muscle activity were those with more severe chronic low back pain, supporting the clinical relevance of this measure and suggesting that reducing muscle activity may improve outcome. In addition, muscle activity was significantly correlated with a number of psychological factors and was found to act as a partial mediator between self-efficacy and pain, confirming the link between psychological and biomechanical factors in chronic low back pain.

Implications

The results suggest that treatments that reduce paraspinal muscle activity may improve clinical outcome. In particular, the role of muscle activity as a partial mediator suggests that interventions that are able to reduce this measure may be of particular benefit to patients demonstrating low self-efficacy. This may help in the targeting of treatment for low back pain.

Keywords

Low back pain, psychology, self-efficacy, muscle activity

INTERVENTION AFFECTS BIOMECHANICS AND DISC GENES FOR LONG-TERM SPINAL HEALTH

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Introduction

There is a therapeutically novel means of addressing discogenic back pain at its root. The intervention is non-invasive and capable of correcting human spinal biomechanics and has been “tuned” to up-regulate the expression of bovine intervertebral disc (IVD) genes responsible for producing matrix proteins. The intervention is called KKT and is based on the application of specific vibration to the spine for ~10min/treatment, 2-3x/week, for about 6 weeks prior to re-evaluation.

Purpose/Aim

This abstract summarizes KKT safety and efficacy tests performed thus far.

Materials and Methods

Clinical reports were analyzed and experiments were designed to delineate KKTs safety and efficacy. First, a sham controlled human trial used spinal joint axes of rotation (MAR), reported pain, and a disability index as outcomes (n=44). Second, basic research experiments used bovine tissue as a means to measure both tissue injury and biosynthesis potential. Injury was assessed via visual inspection and TUNEL staining (1/condition). Tissue biosynthesis was assessed using Real-Time Polymerase Chain Reaction for a six-gene assay.

Results

Clinical reports showed no serious adverse events have occurred with treatment. Human trials showed that a) prior to treatment, 76% of patients had at least one accompanying “abnormal” MAR; b) post treatment 62% of MARs initially abnormal were corrected; c) if MAR was corrected over treatment period there was a significant improvement in both pain ($p=0.024$) and disability ($p<0.001$). Bovine tissue experiments showed no visible signs of injury or significantly different cell death rates between controls and treatments tested. Bovine biosynthesis experiments showed that KKT caused significant differences between treatments for several genes and post hoc analysis indicated that aggrecan and versican expression were significantly higher than control ($p=0.016$; $p=0.026$ respectively).

Relevance

Together, results suggest that the regulatory body cleared intervention is a safe and effective treatment for chronic back pain over the course of the typical treatment period.

Conclusions

KKTs loading protocol biomechanically changed human spinal joint motion making them more “normal”. This change was associated with improved symptoms and no reported serious adverse events. Bovine biosynthesis results indicate KKT may have a positive therapeutic effect on extracellular IVD matrix without increasing apoptosis rates.

Discussions

Early success in treatment is due largely to MAR correction and we hope to maintain that correction for long-term spinal health via tissue restoration through non-invasive up-regulation of disc genes. Positive correlations between gene expression and altered protein expression exist but have yet to be demonstrated in-vivo with KKT.

Keywords

KKT, Biomechanics, Injury, Disc, Restoration, Intervention, Pain

THE EFFECTIVENESS OF A PHYSIOTHERAPY PROGRAM WITH SPECIFIC MANUAL THERAPY COMPARED TO ADVICE IN A SUBGROUP OF PARTICIPANTS WITH SUB-ACUTE LOW BACK PAIN

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Introduction

Manual therapy is a common treatment for low back pain (LBP) however evidence of its effectiveness remains limited. One explanation may be clinical heterogeneity within randomised controlled trials of manual therapy. Sub-grouping participants with LBP in randomised controlled trials based on their likely response to manual therapy may lead to greater treatment effects.

Purpose/Aim

The aim of the Specific Treatment of Problems of the Spine (STOPS) trials was to determine the effectiveness of a physiotherapy program with specific manual therapy versus advice in a subgroup of participants with sub-acute low back pain considered to be of lumbar zygapophyseal joint (LZJ) origin.

Materials and Methods

A multi-centre parallel group RCT was conducted. Participants with sub-acute low back pain (6 weeks - 6 months) presenting with symptoms considered to be indicative of LZJ pain were randomised to 10 sessions of physiotherapy with specific manual therapy or 2 sessions of advice over 10-weeks. The primary outcome measures included back pain and leg pain (0-10 numerical pain rating scale) and activity limitation (Oswestry Disability Index). Data were analysed using linear mixed models for continuous outcomes.

Results

Analysis of the 64 participants enrolled in the trial (38 women, 26 men) showed a mean (SD) age of 45(12) years and a duration of back and leg symptoms of 16(6) and 16(16) weeks respectively. Linear mixed model analyses showed significant between-group differences for activity limitation in favour of the physiotherapy program with specific manual therapy compared to advice at 6 months (8.2, 95% CI 3.1 to 13.2, p= .002) and 12 months (8.1, 95% CI 3.0 to 13.2: p=.002). There were significant between-group differences for back pain in favour of the physiotherapy program with specific manual therapy compared to advice at 6 months (1.4, 95% CI 0.3 to 2.5, p=.01) but not at 12 months (0.7, 95% CI -0.4 to 1.8: p=.24). There was no significant between-group difference for leg pain at any follow-up point.

Relevance

These results suggest that participants with sub-acute low back pain, considered to be of LZJ origin, who received a physiotherapy program with specific manual therapy experienced a significantly greater reduction in pain and improvement in activity than those who received advice.

Conclusions

The analysis shows significant effects in favour of a physiotherapy program with specific manual therapy compared to advice for this sub-acute low back subgroup.

Discussion

The development of the STOPS classification system will be reviewed with discussion on the application of a subgroup specific treatment approach.

Implications

A classification approach to physiotherapy assessment and may be more effective than guideline recommended advice.

Keywords

Manual therapy, low back pain, classification

MYOFASCIAL PAIN SYNDROME OF THE LOWER BACK AND TREATMENT USING A SEQUENCED PROTOCOL

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Introduction

Myofascial Pain Syndrome (MPS) is a common source of low back pain, neck pain, shoulder girdle pain, chest pain and rib pain. Primary myofascial pain is not associated with any known etiology; secondary myofascial pain may be associated with significant osteoporosis, degenerative disk disease, postsurgical states, or other medical conditions. The hallmark of myofascial pain syndrome is the presence of a taut band within a trigger point in a skeletal muscle.

Aim

The aim of this study was to estimate the prevalence and to describe the clinical features and outcome of treatment of MPS of the lower back among cases of Work Related Musculoskeletal Disorders (WRMSD).

Materials and Methods

This retrospective study covered 7385 clients diagnosed with WRMSD, with a mean age 30 ± 5.92 years. The relevant clinical data were extracted from the treatment chart of WRMSD patients who received treatment at a Rehabilitation Centre. A single Rehabilitation Physician performed the clinical assessment and made the diagnosis of MPS using the modified Simons Criteria. All the clients received a sequenced, multidisciplinary treatment protocol incorporating manual therapy techniques including trigger point therapy, muscle energy technique etc, mind body approaches and exercises.

Results

Low back was the second commonest region affected with 46% of the total population. Among the subjects with low back pain 61% were diagnosed to have MPS of the lower back. Among the cases of MPS, 75% were male and 25% were female. 41% of the participants were working for 8-12 hours. The commonest job categories of the participants were Managerial (28%), Software Engineers (27%) and Application Engineers (22%). Prolonged sitting with static loading of the lower back was found to be the commonest risk factor. Commonest co morbidities were neck pain, upper back pain, leg and foot pain. Significant reduction in pain or discomfort ($P < 0.05$) was noted among the subjects following a sequenced rehabilitation protocol.

Conclusion

In view of the high prevalence of MPS in this study, clinical practitioners dealing with low back conditions need to be familiar with the current approaches to diagnose and manage MPS. Manual therapy techniques along with mind body approaches, exercise and ergonomics was found to be an effective method of treatment of MPS of the lower back.

Discussion

The study revealed that MPS was one of the major causes of LBP. Good palpation skills and awareness of MPS in the differential diagnosis of LBP could help in the successful non invasive management of LBP. The study also revealed the importance of sequenced protocol based therapy in the treatment of MPS.

Keywords
Myofascial Pain Syndrome, Low Back Pain, Prevalence

MYOFASCIAL-TRIGGER-POINT-RELEASE IN COMBINATION WITH HEART-RATE-VARIABILITY TRAINING REDUCES PAIN INTENSITY AND ANXIETY IN PATIENTS WITH LOW BACK PAIN: A RANDOMIZED CONTROLLED TRIAL

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Introduction

It has been suggested that chronic low back pain is correlated with different forms of degeneration and disc pathologies. However, in six different studies it has been found that in average 60% of patients without low back pain had MRI findings with confirmed disc pathology. Recent evidence that myofascial dysfunction may be involved in the pathophysiology of common musculoskeletal pain syndromes, affecting up to 95% of people with chronic pain disorders. In certain cases chronic back pain is associated with higher degrees of anxiety and vice versa. Here we evaluated the efficacy of a Myofascial Triggerpoint Release (MFTR) technique in conjunction with Heart rate variability (HRV) relaxation training in comparison to Core Stabilization Exercises (CSE).

Methods

124 patients (83 female; mean age = 53; range = 20-69) were screened for inclusion (pain at least for 3 months and with a rating of 4 or greater on a 10-point scale). Patients were randomized into 1 of 4 groups: Grp 1: CSE, Grp 2: CSE combined with HRV Training, Grp 3: MFTR, and Grp 4: MFTR combined with HRV Training. Each patient received ten 45-minute sessions, scheduled biweekly. Patients with HRV Training achieved a rate of 5-6 breaths/min, and practiced 15 mins twice/day. Pain Intensity of the German Pain Questionnaire provided key outcome measures. The degree of anxiety (HADS) served as secondary measure of outcome.

Results

The reduction of pain intensity in Grp 4 was significantly improved after 10 sessions in comparison with Grp 1 (p= 0,03): Grp 1 (21%), Grp 2 (31%), Grp 3 (38%) and Grp 4 (40 %) with the following effect sizes (cohens d): Grp 1 (0,71), Grp 2 (0,94), Grp 3 (1,29) and Grp 4 (1,41). Anxiety was more reduced after 10 treatments in Grp 3 (27%) and in Grp 4 (28%) in comparison to Grp 2 (10%) and Grp 1 (8%).

Conclusions

In summary, the results obtained from this study indicated that the combination of MFTR technique and HRV Training resulted in superior clinically significant improvements in pain relief and level of anxiety than traditional core stabilization exercises in patients with chronic back pain.

Thursday, October 31, 2013

Jan Hartvigsen
Jonathan Hill
Linda van Dillen
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Ron Donelson
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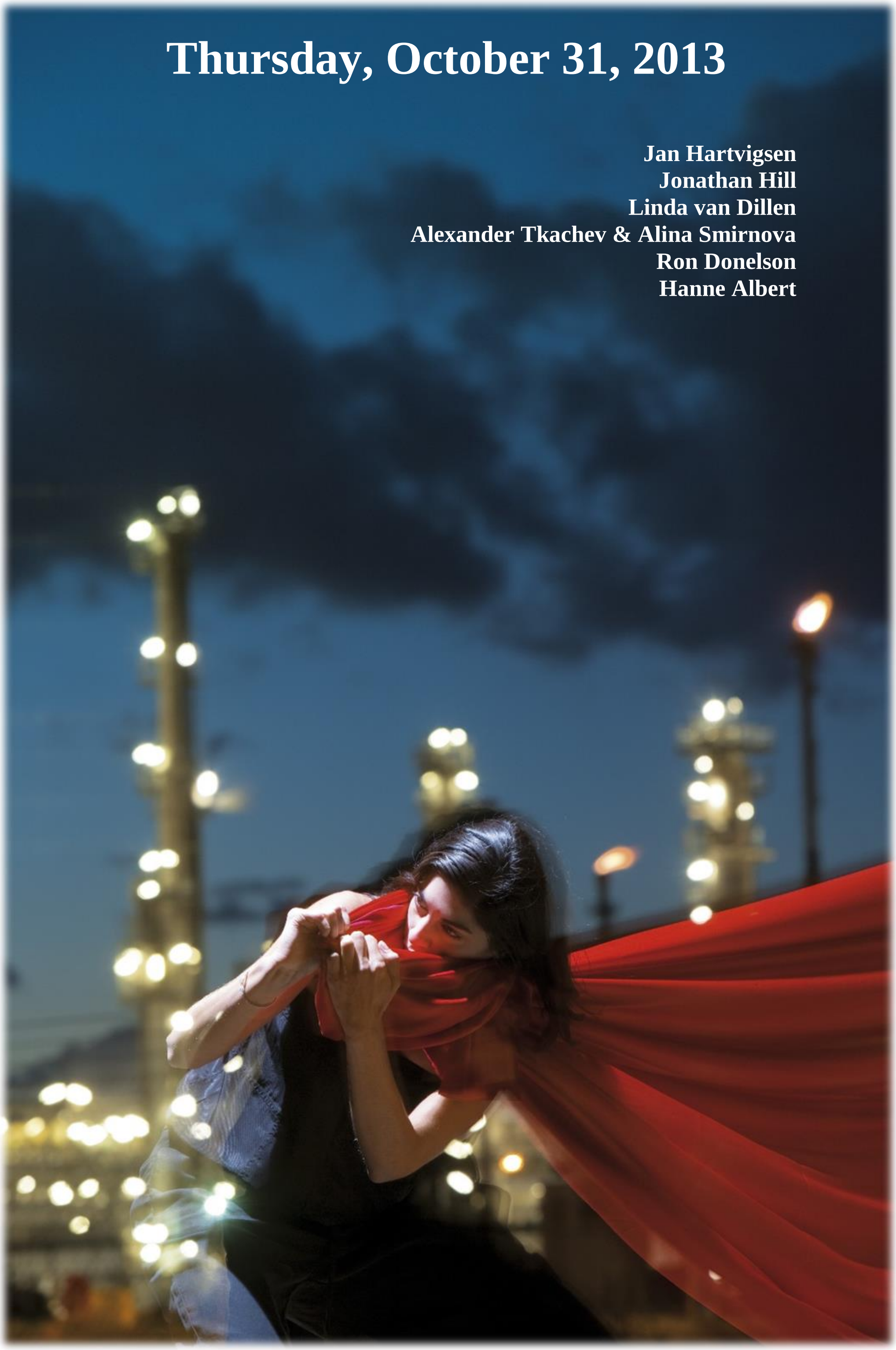

MOVING FROM NON-SPECIFIC TO SPECIFIC LOW BACK PAIN: HOW TO LOOK AND WHAT TO LOOK FOR?

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For many clinicians and researchers the term "non-specific low back pain " is intuitively unacceptable even though it is used as a description of or at times even a diagnosis in the majority of patients presenting with low back pain. This is because it is widely believed by both clinicians and researchers that there are subgroups of people in this non-specific group that contains as many as 80% of patients with spinal pain, who respond differently to treatment and have different prognoses. The underlying assumption is that if these subgroups of patients could be identified, the potential exists to significantly improve patient outcomes by targeting the right and effective treatment to the appropriate subgroup, which in turn would have a positive impact on healthcare system efficiency. However, in spite of over a decade of research and numerous research projects and opinions about the composition and characteristics of such clinically important subgroups of low back pain patients, there is very little consensus regarding the symptoms and signs that identify them. In opening a session dealing with progress in identifying specific subgroups of low back pain patients, this presentation will highlight a number of clinical and methodological issues that clinicians should be aware of when interpreting information about subgroups.
Many subgrouping systems have been proposed and these can roughly be divided into three categories:

Diagnostic subgroups

Diagnostic subgroups are based on identifying people whose pain is associated with a particular pathoanatomical condition or with their presenting symptoms and signs. Specific and identifiable pathoanatomic causes of pain in low back pain involve for example disc prolapse, Modic changes, degenerative changes, infections or fractures, however even in patients with these conditions there may still be doubt about the source of pain. Furthermore because these conditions account for only around 20% of low back pain patients – leaving the remaining 80% as non-specific low back pain - diagnostic subgroups are most frequently identified through different classification systems that take into account the patients presenting symptoms, signs and response to various loading and/or testing procedures. The framework for diagnostic research has been outlined by Sackett and involves a step-wise approach aiming to determine whether patients in the specific subgroups are truly different from persons without pain and patients with similar pain who belong to a different subgroup, and whether the application of diagnostic tests or classification systems improves patient outcomes. The latter require evidence from randomized clinical trials where the diagnostic test or classification system is analyzed as the unit of intervention.

Treatment effect modifier subgroups

Treatment effect modifier subgroups are based on identifying people who are likely to respond favorably to particular treatments or treatment regimens often without knowledge of the underlying biological differences between the subgroups. In low back pain, attempts have been made to identify subgroups whose clinical course is significantly altered through the application of for instance general or specific exercises or manipulation. Clinical prediction rules for identifying treatment effect modifier subgroups are initially developed in cohorts of patients with apparently similar characteristics but ultimately have to be validated in large randomized clinical trials.

Prognostic factor subgroups

Prognostic factor subgroups are based on identifying patients with particular prognoses such as risk of chronicity or work absence. Based on the presence or absence of certain characteristics or factors such as age, psychological characteristics, or even biological or genetic markers, patients can be stratified into prognostic groups that are independent of the treatment applied. For example older individuals typically take longer to recover compared to younger individuals, and patients with low back pain who have a high level of psychological distress are at higher risk of work absence compared patients with low levels of distress. Higher age and high levels of psychological distress thus identifies subgroups of patients with poorer prognosis regardless of the underlying biological cause of their problem and regardless of the treatment rendered. Typically prognostic factors interact in complex systems and are studied in cohorts of patients.

While there has been intense interest and methodological development in the area of subgroups in non-specific low back pain, there have been remarkably few breakthroughs, and while there is no shortage of opinions about the composition of clinically important subgroups, there is little consensus and hard evidence regarding the diagnostic tests, symptoms, and signs that identify them. Probably the greatest advances have been in the area of prognosis research, where important and modifiable prognostic factors have been identified and simple tools for prognostic stratification of patients with non-specific low back pain in primary care have been developed and tested with some success. The challenge is to develop more sophisticated instruments that stratify patients into streams of care that optimize their chance of a good outcome. This approach may eventually allow us to target the particular needs of subgroups of patients and subgroups in the population, such as older people, for whom back pain can lead to social isolation and reduction in physical activity or younger people, for whom preventing long-term work-related disability may change their life trajectory. The past ten years have taught us that progress is likely to be incremental but the quest for deconstructing the “non-specific low back pain beast” will undoubtedly continue.

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THE CLINICAL PRESENTATION AND TREATMENT OF HIGH-RISK PATIENTS

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Dr Jonathan Hill from Keele University, UK, will provide a presentation to describe the STarT Back Trial's combined physical and psychosocial treatment package for the high-risk subgroup of low back pain patients identified by the STarT back tool and provide a summary of the evidence for this approach.

Whether you're working as a clinician in the UK or Dubai, we all face the same universal challenge of providing effective treatments for low back pain within ever constrained resources. Identifying efficient ways to target back pain treatments more effectively is an internationally agreed research priority and is the focus of the STarT Back Trial. The study demonstrated significant patient benefits from a prognostic 'stratified care' approach compared to usual physiotherapy care, including pain, function, fear avoidance beliefs, patient satisfaction and time-off-work. There was also a concurrent small overall reduction in healthcare use. The trial provides positive evidence that matching patients according to their prognostic profile is an effective method of improving back pain care.

The talk by Dr Hill will focus on the management of the high-risk subgroup of patients identified by the STarT Back Tool. This complex and diverse group of patients are too often not systematically fast-tracked early on to ensure they are treated by the right person who is able to deal effectively with their complexity. Historical practices often mean patient appointment times are the same regardless of clinical complexity, and clinical services provide poor supervision to junior staff who may struggle to manage these complex cases or fail to utilise a truly biopsychosocial treatment approach.

The STarT Back 'stratified care' research suggests that 'high risk' patients need interventions which support them to address their complex physical needs and psychosocial barriers to recovery. With some appropriate training and supervision primary care physiotherapists were able to develop their clinical skills to better address and treat high-risk patients using a combined physical and psychologically informed approach. In addition, to being seen by the right person, early on, these patients were seen by clinicians equipped with extra resources and time than was used to treat low and medium risk patients, which enabled them to provide a more comprehensive treatment package.

Such was the success of this 'STarT Back' research that the approach is now informing the commissioning of clinical services and is being rapidly adopted in many UK physiotherapy services as well as the USA and Europe. Due to the speed of the uptake inevitably some misconceptions about the approach have arisen which are worth dispelling. These include myths about the high risk treatment package. For example, the belief that patients identified as high risk on the tool are generally chronic psychological cases that require hands off cognitive behavioural approaches to treatment. Whilst this might be true for some patients, 40% of high risk patients in the STarT Back trial had episode durations of less than 3 months and many had acute, severe leg pain extending below the knee which was not primarily a psychosocial problem. It has also been identified that many high-risk patients have clinical comorbidities and are complex cases for non-psychological reasons. As a result the STarT Back team are keen to highlight the message that a biopsychosocial approach does not mean the removal of the 'bio' component or imply that differential diagnosis skills are not important. Instead they stress that a combined psychologically informed hands on approach is needed. Another important mistake is that clinicians fail to notice the importance of monitoring high risk patients. The trial showed that while 85% of high-risk patients were no longer high-risk at 12 month follow up, 15% may need referral onto more specialist treatment beyond mainstream community physiotherapy.

In summary, the presentation by Dr Jonathan Hill will focus on describing what the high-risk patient subgroup looks like and seek to explain the emerging evidence about how best to treat these patients.

CLASSIFICATION-SPECIFIC VERSUS NON CLASSIFICATION-SPECIFIC TREATMENT FOR PEOPLE WITH LOW BACK PAIN

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Background

Several classification systems have been developed to guide judgments about prognosis and non-surgical treatment for people with low back pain (LBP).1 Because LBP often has a mechanical origin,2 some of the systems classify LBP based on the signs and symptoms that are observed when patients perform clinical tests which are designed to produce mechanical effects. The Movement System Impairment (MSI) classification system for LBP,3 is one system developed to classify a person's LBP using findings from clinical tests. A standardized clinical examination has been developed in which people perform movements (trunk or limb) or assume positions.4-6 During the examination, a trained therapist makes judgments about the presence of altered movements and alignments and monitors LBP symptoms. The LBP categories for prognosing and directing treatment are named for the altered movements and alignments that are (a) consistently displayed across clinical tests, and (b) associated with symptoms.3

The premise underlying the MSI classification system is that LBP develops because people repeatedly use direction-specific, stereotypic, patterns of lumbar spine movement and alignment throughout their daily lives. Theoretically, the patterns arise because of adaptations in the musculoskeletal and neural systems (e.g., changes in strength or muscle recruitment patterns) resulting from the repetition of the same movements and postures across the day. These adaptations are proposed to interact with characteristics of the person (e.g., anthropometrics, activity level), to affect the way a person moves and aligns himself when he performs daily functional activities.3, 7-10 The patterns are proposed to be used repeatedly for many different functional activities. Repetition of the same patterns across the day is proposed to contribute to sub-failure magnitude loading that, in turn, (1) produces concentrations of tissue stress in specific areas,11, 12 and (2) alters the tissue's tolerance over time.13 The result of the ongoing loading and related sequelae is pain, mechanical injury, and, potentially, tissue degeneration.

Several studies have been conducted to examine (1) the reliability of clinicians to make judgments about individual examination items and to classify people with LBP, and (2) different aspects of the validity of the MSI model.4, 14-26 No studies, however, have been conducted to examine differences in outcomes for a classification-specific treatment based on the MSI Model compared to a non-classification-specific treatment. The primary purpose of this study was to examine the efficacy of treatment based on a person's LBP classification (CSp) and a non classification-specific treatment (NCSp) for improving outcomes over a one year period in people with chronic LBP. We hypothesized that the CSp group would demonstrate greater improvement in LBP-related functional limitations than the NCSp group.

Methods

Design

The study was a 2 group, randomized clinical trial that was designed to compare 2 non-surgical treatments for people with chronic LBP.27 Measures were obtained at baseline, immediately after the 6 week treatment phase, and at 6 and 12 months after the treatment.

Setting and Participants

Data was collected using self-reports, a standardized clinical examination, and laboratory instrumentation. Treatment occurred at 2 university-based physical therapy clinics. Participants were included if they were between 18 and 60 years of age and had chronic LBP of at least 12 months duration. People were excluded if they were in an acute flare-up of LBP,27 had a specific LBP diagnosis (e.g., disc herniation, stenosis, scoliosis), pain or paresthesia below the knee,28 history of spinal surgery or fracture, a primary hip problem, other serious medical condition, or were pregnant. People also were excluded if they were referred from a specialized pain clinic, displayed magnified symptom behavior,29 or were involved in litigation due to their LBP.

Randomization

The sample was stratified based on LBP classification. Randomization was conducted using a computer-generated list of random numbers. The randomization schedule was performed by an investigator who was not involved in the assessment of outcomes. Clinics were provided sequentially numbered, sealed envelopes separated into 5 groups corresponding to each of the 5 potential LBP classifications.

Classification

Prior to randomization each person participated in a standardized examination performed by a physical therapist trained in the performance of the tests and use of the classification rules.19 The MSI-based categories for LBP into which a participant's condition could be classified included lumbar (1) flexion, (2) extension, (3) flexion with rotation, (4) extension with rotation, and (5) rotation.

Treatment Conditions

The CSp and NCSp treatment conditions both included 3 components, education, exercise, and training in performance of functional activities. In the CSp condition each component was prescribed based on the participant's LBP classification. In the NCSp condition the specifics of the components were the same for all participants. Overall, in both treatment conditions training in functional activities focused on maintaining a neutral lumbar spine alignment during performance of activities. Both treatment groups received 1 hour of treatment, once/week for 6 weeks. Standardized criteria were used for prescription and progression of each treatment.30 Home programs were prescribed at the 1st treatment visit and progressed according to the standardized criteria.

Outcomes and Follow-up

The primary outcome of interest in this report was the modified Oswestry Low Back Pain Disability Index (mODI), a measure of a participant's LBP-related functional limitations.31 The mODI was administered before participants were randomized to treatment, at each of the treatment visits, and again at 6 and 12 months after treatment ended. The secondary outcome of interest in this report was a standardized, self-report measure that was used to assess adherence to exercise and adherence to training in functional activities, separately. Adherence was measured at treatment visits 2 through 6, and at 6 and 12 months after treatment had ended.

Analysis

Hierarchical linear model (HLM) analysis was used to examine the effects of treatment and adherence on LBP-related functional limitations.

Results

Participants Characteristics

There were 47 participants in the CSP group and 54 participants in the NCSp group. There were no differences between the 2 groups on demographic, LBP history or initial outcome variables status (all ps>.05). The mean age of participants was 43±11 years, 49% were male, and the mean duration of LBP was 11±8 years. The distribution of LBP classifications in the sample were as follows: (a) lumbar rotation: 61%, (b) lumbar extension with rotation: 37%, and (c) lumbar flexion with rotation: 2%.

Treatment

For both the CSp and NCSp treatment groups, mODI scores demonstrated a significant curvilinear pattern (quadratic effect, p<.05) with initial, clinically important improvement during the treatment phase (pre: 22.45%±8.79%, post: 14.40%±5.85%; linear effect, p<.05). Improvements continued after the treatment phase and then leveled off at 6 months (8.79%±4.25%), followed by a gradual reversal at 12 months (9.76%±4.56%; quadratic effect, p<.05).

Adherence

Change in exercise adherence over time. Exercise adherence declined 40% but functional activity adherence only declined 15% over the study period. The rate of decline was much greater for exercise adherence than for functional activity adherence. Exercise adherence began to decline in the treatment phase (linear effect, p<.05) and continued to decline throughout the 12 month period (linear effects at 6 and 12 months, p<.05). Change in functional activity adherence over time. Functional activity adherence did not decline during the treatment phase (linear effect, p>.05) but began to gradually decline about 6 months after treatment (linear effect, p<.05); a similar pattern of change to that observed in mODI scores over the same period. Relationship between adherence and function. When both forms of adherence were included in the HLM analysis only the effect of functional activity adherence on mODI scores was significant (p<.05). Thus, functional activity adherence had a unique, independent effect on mODI scores above and beyond the effect of exercise adherence on mODI scores. A marginally significant interaction of treatment group and adherence (p<.05) indicated that the influence of functional activity adherence was larger in the CSp group than in the NCSp group

Conclusions

Both the CSp and NCSp groups attained clinically meaningful improvement in LBP-related function with treatment, and the improvement continued for 6 months after the treatment phase. There was a small deterioration in function between 6 and 12 months. Adherence to exercise and to functional activity training differed over time. Adherence to exercise declined more, and at a faster rate than did adherence to functional activity training. The pattern of improvement in LBP-related function depended on how much a person adhered to the training in functional activities and, potentially, to the type of training in functional activities, CSP versus NCSP.

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INVASIVE LOW-INTENSITY LASER THERAPY (ILLT) IN TREATING PATIENTS WITH CERVICAL PAIN AND LBP, AND THE USE OF NON-STEROIDAL ANTI-INFLAMMATORY DRUGS ON THE SPONTANEOUS REGRESSION OF INTERVERTEBRAL DISC HERNIATION

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Background

Acute and chronic cervical and low back pain with clinical symptoms – radiation of pain to extremities, tingling and weakness of muscle, with intervertebral disc lesions present as confirmed by MRI; pain related with herniated discs in the cervical and low back regions. Patients were administered two forms of treatment in separate groups – ILLT in the first group of patients, and conservative methods (use of NSAIDs and changes in lifestyle) in the second group of patients.

Methods

Over a period of 5 years invasive low-intensity therapy treatment has been used on over 3500 patients with various forms of back pain with disc herniation of various sizes present. The method of treatment uses the impact of low-intensity laser light through the LED, introduced through a needle at a wavelength of 630 nm placed at an angle of 45-90°. The needle is inserted at a depth of 20 – 25 mm to points located on the spinous processes of vertebrae, which have interverbral disc lesions (protrusions or disc hernias) as revealed by MRI scans. Treatment is used for 15 minutes, everyday, over a period of 10 days. Of the total number of patients treated, 600 participated in this particular study. 300 of the patients were treated using ILLT, while patients included in the study that did not undergo ILLT, were given conservative treatment using NSAIDs and recommendations in lifestyle changes, and observed for the same number of days.

Of patients treated with NSAIDs and conservative methods, a study of two groups, 40 patients each, was conducted. Group A – 28 men and 12 women; group B – 25 men and 15 women. The patients were between 29 – 35 years of age. At baseline these patients had complaints of persistent pain and limited mobility in the lumbar region, with or without the presence of leg pain, as well as hernias in discs L4 – L5. Patients in group A were given NSAIDs for a period of 15 days – diclofenac 50mg, twice a day. Patients of group B were not given any form of medication. Both groups were given advice on lifestyle changes, and were recommended to wear a lumbar corset twice a day (every morning and evening for 2 hours making a total of 4 hours).

Results

Patients treated using conservative methods and NSAIDs reported some reduction of pain and improvement of other clinical symptoms; however these were reported later than with the use of ILLT, with a majority of patients still complaining of tingling and weakness of muscle. Also these effects wore off, causing a relapse in treatment. MRI scans also showed some reduction of hernias (which we can also attribute to spontaneous regression), but this was significantly less in comparison to that which was achieved using ILLT.

Conclusion

Inflammation, as an active response, is accompanied by the attraction of monocytes and formation of macrophages. It is possible that the resultant actions of these bodies lead to a faster regression of hernias, and the use of NSAIDs while reducing pain, could cause extend the time of regression of hernias. However further studies are needed to confirm this. As for other patients with cervical and LBP presenting with clinical symptoms such as radiation of pain, tingling or weakness, ILLT treatment appears to produce longer-lasting effects within a short time span as opposed to conservative treatment.

CAN LARGE CERVICAL AND LUMBAR DISC HERNIATIONS PRODUCING RADICULOPATHIES BE INTENTIONALLY AND RAPIDLY IMPROVED?

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Background & Context
In patients with cervical or lumbar radiculopathies, rapid and complete non-surgical recoveries often occur when pain centralization (PC) is elicited during a Mechanical Diagnosis & Therapy (MDT/McKenzie) examination, as long as treatment consists of end-range spinal movements in the single direction that elicited PC during the examination. Scannell et.al. (2010) illustrated a possible mechanism for PC by reducing cadaveric intervertebral disc herniations (IVDH) using repetitive asymmetrical loads.

Purpose
To document immediate changes in range-of-spinal-motion, neurologic status, tension signs and IVDH size at the time of intentional PC of radicular pain during an MDT evaluation.

Study Design/Setting
Case series

Patient Sample
Patients with cervical or lumbar radiculopathy and neurologic signs or symptoms referred for MRI imaging

Outcome Measures
Body pain drawings, visual analog pain scales, neurological status, tension signs, range-of-spinal-motion, MRI imaging, functional measures

Methods
After initial MRI imaging, all outcome measures were completed followed immediately by an MDT examination consisting of repeated end-range testing conducted in the MRI suite. All outcome measures, including MRI, were promptly repeated. Imaging and outcome measures were repeated 3 mon. later. MRIs and outcome measures were compared at all datapoints.

Results
Each patient had a large baseline cervical or lumbar IVDH. A single direction of end-range movement was identified that completely and rapidly centralized and abolished all pain with immediate substantial reduction in the size of the IVDH and improvement of all other outcomes. Patients remained asymptomatic and regained full function within two weeks. MRI findings improved substantially.

Conclusion
Mechanical spinal testing that monitors patterns of pain response and MRI imaging are two diverse forms of patient evaluation that together appear to provide remarkable and valuable insight into the dynamic mechanism by which both lumbar and cervical intervertebral disc herniations causing radiculopathy can be rapidly and non-invasively corrected. This correction

resulted in simultaneous and full pain centralization and abolition, restoration of full spinal range-of-motion with elimination of related nerve tension signs and neural deficits. Further study is clearly warranted.

ANTIBIOTIC TREATMENT IN PATIENTS WITH CHRONIC LOW BACK PAIN AND VERTEBRAL BONE EDEMA (MODIC TYPE 1 CHANGES): A DOUBLE-BLIND RANDOMIZED CLINICAL CONTROLLED TRIAL OF EFFICACY

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Background

Modic type 1 changes/bone edema in the vertebrae is present in 6 % of the general population and in 35 %- 40% of the low back pain population. Modic changes are strongly associated with low back pain. The aim of the study was to test the efficacy of antibiotic treatment in patients with chronic low back pain (>6 months) and Modic Type 1 changes (bone edema).

Methods

The study was a double-blind RCT with 162 patients whose only known illness was chronic LBP of greater than 6 months duration occurring after a previous disc herniation, and who also had bone edema demonstrated as Modic Type 1 changes in the vertebrae adjacent to the previous herniation. Patients were randomized to either 100 days of antibiotic treatment or placebo and were blindly evaluated at baseline; end of treatment and at 1-year follow-up.

Outcome Measures

Primary outcome; Disease-specific disability, lumbar pain. Secondary outcome leg pain, number of hours with pain last four weeks, global perceived health, EQ-5D thermometer, days with sick-leave, bothersomeness, constant pain, Magnetic Resonance Image (MRI).

Results

144 of the 162 original patients were evaluated at 1 year follow-up. The two groups were similar at baseline. The antibiotic group improved highly statistically significant on all outcome measures and improvement continued from 100 days follow-up until 1-year follow-up. At baseline, 100 days follow-up, 1 year follow-up the Disease-specific disability RMDQ changed; antibiotic 15, 11, 5.7, placebo 15, 14, 14. Leg pain; antibiotics 5.3, 3.0, 1.4 placebo 4.0, 4.3, 4.3. Lumbar pain antibiotics 6.7, 5.0 3.7 placebo 6.3, 6.3, 6.3. For the outcome measures, where a clinically important effect size was defined, improvements exceeded the thresholds, and a trend towards a dose-response relationship with double dose antibiotics being more efficacious.

Conclusions

The antibiotic protocol in this study was significantly more effective for this group of patients, (CLBP associated with Modic I), than placebo in all the primary and secondary outcomes.

Acknowledgement

Trial registration. Approved by The Scientific Ethics Committee of the Region of Southern Denmark (no. S-VF-20050112), Government Clinical trial registry (NCT00302796).

Poster Sessions

RELATIONSHIP BETWEEN ISOMETRIC ENDURANCE OF BACK EXTENSOR MUSCLES AND SELECTED ANTHROPOMETRIC INDICES AMONG UNDERGRADUATES OF A NIGERIAN UNIVERSITY

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Background
The study aimed at investigating the relationship between isometric endurance of back extensor muscles and selected anthropometric indices, to establish reference value and pattern of back extensor endurance in apparently healthy young Nigerian adults.

Methodology
A total of 300 young adults (150 males and 150 females), participated in this ex-post facto study. The modified Biering-Sorensen test of Static Muscular Endurance (BSME) was used to assess isometric endurance of back extensor muscles. A height meter, bathroom weighing scale and flexible tape were used to collect data for the anthropometric indices- Body Mass Index, Height (BMI), Weight (W), Waist Circumference (WC), Hip Circumference (HC), Waist-to-Hip Ratio (WHR), Waist-to-Height Ratio (WHtR). Data obtained were summarised using descriptive statistics of frequency, percentages, percentile, range, mean and standard deviation, while the Pearson's Product Moment Correlation was used to ascertain relationships and Independent t-test was used to investigate differences. Alpha level was set at 0.05.

Results
Participants' age ranged between 17 and 30 year; mean endurance time (ET) for all participants was 97.56±43.96 secs. Mean height, weight and Body mass index (BMI) were 1.68± 0.77m, 66.09±10.05kg and 23.00±3.21kg/m2 respectively. No significant correlation was found between endurance time and anthropometric indices. The pattern of performance of isometric back endurance was categorized into good (24%), medium (51.7%) and poor (24.3%), in the ratio of 1:2:1 respectively. Significant gender differences (males > females) were found in the anthropometric indices ($p< 0.001$ in all cases) except in ET, WHtR and HC; although males had higher maximum ET than females (288secs vs. 254secs).

Conclusion
The mean isometric back extensor endurance of apparently healthy young Nigerian adults was found to be lower than normal Biering-Sorensen holding times. The results suggest that anthropometric indices may not be important factors in back muscle endurance in young adults, which may vary with gender.

Keywords
Back extensor muscles, Biering-Sorensen test, back extensor endurance

OCCURRENCE OF BACK PAIN AMONG BACKPACK-CARRYING SECONDARY SCHOOL STUDENTS IN SOUTHEAST NIGERIA

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Purpose
This study investigated the occurrence of back pain among backpack-carrying secondary school students in a southeast Nigeria community.

Method
The study was a survey which was carried out on students in five selected government-approved secondary schools using weighing scale, height meter, and a two part questionnaire with items adopted from a related study. Four hundred and two male and female students participated in the study.

Result
The result showed that more males (215) than females (187) participated. The occurrence of back pain among the backpack-carrying students was found to be 51%. This was slightly higher in males (51%) than females (50%). The back pain was attributed to backpack carriage by 91.7% and 92.6% of male and female students respectively.

Conclusion
This study has shown a high prevalence of back pain among secondary school students who use back-packs, but that they do not carry back-packs heavier than 10% of their body weight. It also suggests that the occurrence of back pain in secondary school students in this environment may be due to some other factors.

Discussion
More males (53.5%) carry back-pack than the females (46.5%). It may be assumed that reasons for higher usage by boys may be the fact that they are either more attracted to this trend or that they carry more unimportant (non-school items) than girls. There is occurrence of back pain among the backpack users represented by 51% and 50% in males and females respectively. This is related to the average percentage of back-pack to the body weight of the participants, which is 8.2% and 7.8% for males and females respectively. The result also shows that back pain is mostly associated with back-pack, as indicated by 91.7% in males and 92.6% in females.

This study has shown also that secondary school students in this environment do not carry back-pack heavier than (above) 10% of their body weight. The average backpack versus body weight was found to be 8.2% (mean) and 7.8% (mean) for males and females respectively.

The mean duration for which students in this study had carried their back-pack was found to be 24 months. The most common mode of transportation used by the students is walking (85.6%). This may be an important factor to consider because the longer duration may put the back at a greater stress. Most of the participants carried their back-packs for at least one hour (80.3%) against those that carry theirs for less than an hour (19.7%) per day. More participants were able to localized their pain to the upper back (80%) than the lower back (20%).

Although there is no yet established weight to be carried without health problems, most studies recommend the limit of 10%-15% of the body weight such as that by the American Academy of Paediatrics.

Keywords
Back pain, Backpack, School Children

MERCIÉR THERAPY HELPS INFERTILE WOMEN ACHIEVE PREGNANCY

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Introduction

Among women ages 15–44, 6.7 million have impaired ability to have children, 1.5 million are infertile, and 7.4 million have used infertility services in their lifetime (www.cdc.gov/nchs/fastats/fertile.htm). Now more than ever, women are having their fertility manipulated by reproductive endocrinology clinics and are undergoing multiple cycles without knowing the long-term effects of fertility drug use.

Purpose/Aim

Articles have been written about soft tissue abdominal and pelvic work alleviating fertility challenges, but no clinical research has been performed. The purpose of this study is to confirm that the use of Merciér Therapy—site-specific, manual soft tissue therapy—is valid as a standalone treatment and with assisted reproductive technologies to help women become pregnant.

Materials and Methods

Forty-eight women ages 28–42 were interviewed and underwent at least two sessions of Merciér Therapy. Merciér Therapy's research setting is a holistic, clinical, multidisciplinary environment in Illinois and Arkansas. The women selected for the study all complained of primary and secondary fertility challenges regardless of age, current or past pathological condition, prior surgical intervention, prior treatment, and history of no treatment.

Results

Eighteen women achieved pregnancy within the first six months of their first Merciér Therapy sessions. Twenty-two women achieved pregnancy within one year of their first Merciér Therapy session. Eight women did not become pregnant. Of the forty women who became pregnant, thirty-two used Merciér Therapy as a standalone treatment; six used in-vitro fertilization; two used a combination of Clomid and intrauterine insemination.

Relevance

By educating participants about their fertility and cycles and using Merciér Therapy soft tissue manipulation to increase organ mobility and blood flow while enhancing optimal organ function, women responded very well without use of heavy-handed reproductive methods.

Conclusions

Merciér Therapy has proven beneficial in helping couples to achieve pregnancy in a diverse group of women with various prior assisted reproductive technology backgrounds, ages, races, current pathologies, and medical histories.

Discussion

According to the Centers for Disease Control and Prevention, 147,260-assisted reproductive technology cycles were performed in the United States in 2010; 47,090 live births occurred—31.9% (www.cdc.gov/art). Why settle for mediocrity? In this study, Merciér Therapy helped 83% of participants achieve pregnancy; 80% of those women used Merciér Therapy exclusively. When used in conjunction with medical fertility treatments for the remaining participants, Merciér Therapy shortened the number of cycles, achieving pregnancy sooner than with fertility treatments alone.

Implications

This study reveals that fertility does not need to be medically manipulated in all cases. Medical fertility treatments bypass the core problem of poor reproductive organ function. Merciér Therapy creates more blood flow and mobility of the uterus, ovaries, and tubes, going to the source of the challenge and helping to fix it, gently and effectively.

Keywords

Conception, infertility, Merciér Therapy, pregnancy, reproduction, soft tissue manipulation

DIRECT AND PAN CORPOREAL CAUSATION FOR MUSCULOSKELETAL DISEASE THAT IS MEDIATED BY MECHANICAL STRESS

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This poster describes a broadening of the usual sense of causation for chronic musculoskeletal disorder (CMD) from that for which cause is bordering to pain (such as DJD, nerve entrapment, somatic dysfunction, or inflammation), to include a second, and heretofore not described, class of causation that directly mediates mechanical stress throughout the body, and thereby mediates the generation of the most common musculoskeletal disorders. Stated simply, we now understand the cause of most causes for this, the largest class of musculoskeletal disorders. This broadening of causation to include direct and pan corporeal causation enables a profound advance in both the basic science and clinical outcomes for enduring alleviation of chronic musculoskeletal pain.

Re-examination of the Definition of Causation

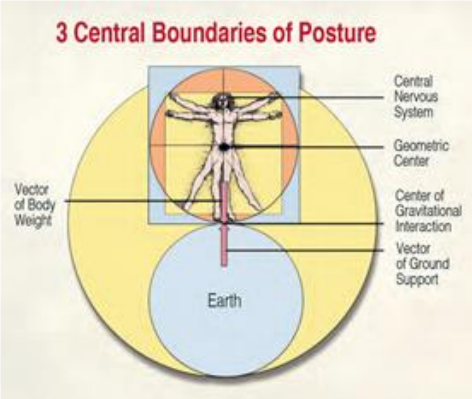
For causation, Hume relates that cause and effect are contiguous in time and space, where the second event (effect) is understood as the consequence of the first (cause). Several senses exist for contiguity of cause to effect.

Contiguity (def.): The state of (cause) being 1) bordering or 2) being in direct contact with something (effect).

The sense most commonly presupposed in modern medicine is that cause is usually bordering to effect. Direct causation for eccentric, excessive and pan corporeal mechanical stress, which in turn is generative of usual causes bordering to pain, lies with any (not just for abnormal extents) imbalance of two of three structures (Fig.), by virtue of their centrality to the overall postural control of the configuration and attitude of the body with respect to gravitation.

The 3 Central Structures that are Pivotal for Configuration and Attitude of the Body with Respect to Gravitation

1. The feet, which are central to the equal and opposing vector resultants of body mass and ground support.
2. The sacral base, which is approximately central to the outstretched frame, standing.
3. The central nervous system, which equilibrates posture, given the configuration for the feet and the attitude of the sacral base.



We have full control of the attitude of the sacral base, measured radiographically, via a heel lift, standing, and by a ischial lift, seated, and of the configuration of the feet, via custom foot orthotics (Irvin 2011). By this theory and method, we can control the generative mechanism for most causes bordering to the painful effects of CMD that are mediated by mechanical stress.

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DEFORMATION OF THE INNOMINATE AND MOBILITY OF THE PUBIC SYMPHYSIS DURING ASYMMETRICAL LOADING OF THE PELVIS IN VITRO

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Introduction
During clinical assessment and treatment of the pelvic joints manual force is often applied to one innominate while fixating the sacrum or the opposite innominate. It is unknown how much deformation within the innominate and movement within pelvic joints will occur during this asymmetrical loading.

Aim
To test the occurrence of deformation within the innominate and movement within the pubic symphysis during asymmetric moment application to the pelvis.

Material and Methods
In 15 embalmed specimens an incremental moment was applied to one innominate bone in the sagittal plane with respect to the fixated contralateral innominate. The three-dimensional (3D) deformation within the fixated innominate, as well as displacement of the pubic symphysis, was described during each increment of the moment. Maximal amount of deformation within the fixated innominate is compared with displacement in the pubic symphysis and tested for significant difference for all subjects and separately by gender.

Results
Mean range of 3D deformation of the innominate (3.39 ±2.92 mm) is comparable to the range of symphysis motion (3.20 ±2.58 mm; $p>0.05$). Largest deformation within the innominate in the transversal plane (endo/exorotation). Significant differences ($p<0.01$) occur in mobility of the pubic symphysis between male and female specimens. No significant gender differences are present in the deformation of the innominate.

Conclusion
Deformation occurs within both innominates, especially in the transversal plane during asymmetrical moment application to the pelvis.

Implications
Clinicians should be aware that outcomes of mobility tests and mobilising techniques of the pelvis may be influenced by deformation of the bony tissue.

Keywords
Pelvic bones, biomechanics, mobility

INTRA- AND INTER-RATER RELIABILITY IN PHOTOGRAMMETRIC PELVIC TILT ANGLES ANALYSIS

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Introduction

Digital images are feasible to use in clinical practice and can be an inexpensive and complete method for registering pelvic positions and their changes as a result of clinical intervention.

Purpose/Aim

The present study aimed to evaluate the intra- and inter-rater reliability of pelvic tilt angles from the anterior, posterior and bilateral views.

Methods

Subjects (n=93) photographed from the anterior, lateral and posterior views were analysed by the Alcimage® software, marking pelvic tilt angles (right and left side views, R and L, respectively) viewed between the anterior superior iliac spine (ASIS) and posterior superior iliac spine (PSIS) and one horizontal line; beyond the angle between the two ASIS and one vertical line (ANT); and between the two PSIS and another vertical line (POST). Three observers evaluated the photos twice. Intra- and inter-observer reliability were assessed using the t-test, correlation coefficient, coefficient of variation (CV) and intraclass correlation coefficient (ICC) ($p<0.05$). We hypothesise that these angles are suitable for diagnosing pelvic tilt and useful for clinical assessments.

Results

The intra- and inter-observer t-test showed no significant difference. The intra-and inter-observer correlation coefficients varied between 0.9994 and 0.9760 and between 0.9510 and 0.9941, respectively. The ICC and CV between intra-observer measures were classified as excellent for the angles R and L, but not for the angles ANT and POST. Inter-observer ICC was also high for the R, L and POST angles but poor for the ANT angle.

Relevance

Many of the methods for evaluating posture have limited application in clinical settings because of their costs and technical difficulties. In contrast, non-invasive, inexpensive and practical methods, as photogrammetry, are more suitable for clinical assessments.

Conclusion

The angles analysed from a sagittal view using photogrammetry enable the monitoring of possible longitudinal changes in pelvic tilt. However, the angles analysed from a frontal view may not be suitable for the diagnosis of pelvic asymmetries.

Discussions

Clinicians visually evaluate posture through anatomical landmarks; however, this method is limited when detecting small changes in posture, especially considering its poorer reliability compared to computerised measurements.

Implications

Sagittal plane alignment could affect the natural history and outcome of interventions for sacroiliac dysfunction and postural assessments. When movement occurs in the sacroiliac joint, trunk motions in the sagittal plane are also present (increased depth of the lumbar curve when anterior tilt occurs and decreased depth of the lumbar curve when posterior tilt is present). To support clinicians and researchers, these findings could provide information on asymmetries and disorders of the trunk, including aggregating outcomes on prescribing clinical procedures to treat the pelvis in addition to the lumbar spine.

Keywords

Physiotherapy, pelvic tilt, photogrammetry, low back pain, diagnosis, visual assessment

MECHANICAL BEHAVIOR OF SACRAL AND ILIAC CARTILAGE UNDER COMPRESSION AND PELVIC ROTATION

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Introduction

Articular cartilage is a complex viscoelastic macromolecular material that acts as a low friction surface to absorb and distribute the shearing forces that cross the sacroiliac joint under axial loading.1

Methods

Finite Element model of sacral and iliac cartilage developed from cadaveric specimen examines compressive shearing forces on sacroiliac joint cartilage during angular rotation. A 1.81 mm and 0.80 mm layers of sacral and iliac cartilage was modeled as a linear elastic material with 1.2 MPa Young's modulus and Poisson's ratio of 0.049.1,2 Sacral bone was modeled with a Young's modulus of 16,000 MPa and a Poisson's ratio of 0.26.1,2 The sacral and iliac surfaces had a contact coefficient of friction of 0.005.2 A 445 N vertical load was placed across the sacroiliac joint while the joint was rotated through angle □ about the x-axis from a neutral pelvic position of -11.0º to +11.0º, compressing layers of sacral and iliac cartilage against non-deformable sacral bone.2 Donor consent and university ethics committee approval was obtained for this study.

Results

Axial loading creates a lateral displacement of the sacrum and high shearing stresses at the sacral/iliac cartilage and cartilage/bone borders. Angular rotation from -11.0º to +11.0º created Poisson effect deformation of 0.08 MPa for sacral cartilage and 0.010 MPa for iliac cartilage. Contact pressures on sacral cartilage decreased from 0.496 to 0.488 MPa, while contact pressure on iliac cartilage varied from 0.488 to 0.493 Mpa. Von Mises stresses on sacral cartilage increased from 0.334 to 0.364 to 0.385 MPa while iliac cartilage stresses decreased from 0.191 to 0.185 MPa then increased to 0.190 MPa. The point of load application at the center of the z-direction on the pelvic side of the SI joint had a slight linear and angular motion in each of the x,y, and z directions. The out-of-plane motion of the pelvic center ranged from -0.0194 mm to +0.008 mm, increasing with □ while the reverse is true for maximum von-Mises stresses.

Discussion

The Poisson effect on cartilage restricted tissue deformation in one direction by the non-deformable sacral bone creating lateral displacement and high shearing stress between sacral and iliac cartilage. Angular stresses create irregular changes in cartilage that follow the geometric articular surface topography. The interosseous connection between sacral and iliac sides cause vertical shearing forces on sacroiliac side of cartilage surfaces to be compressed together. Axial loads applied across the joint cause the iliac side to exert a force on the sacral side displacing it superiorly in the y-direction compressing surfaces. These vertical displacements increased from 0.416 mm to 0.430 mm as the angle increased from 0º to 21.0º

Conclusions

As the pelvis rotates anteriorly sacral cartilage contact stresses decrease and iliac cartilage increases. Von Mises stresses however, increase on both sacral and iliac cartilage during rotation.

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EVALUATION OF THE ROTATIONAL STIFFNESS AND ELASTICITY OF THE LOW BACK AND IMPROVING THE LOW BACK DYSFUNCTION

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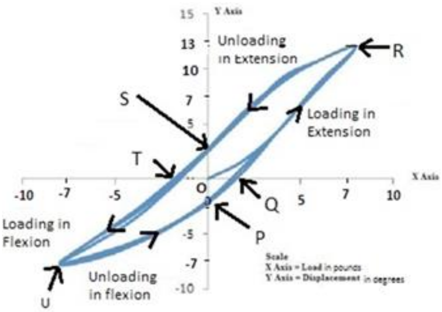
Introduction

A nonlinear system can have a hysteretic response. Hysteresis occurs when the output response of a system lags behind the input stimulus. Hysteresis Loop Area (HLA) is enclosed by the curve QRTUQ. HLA measures the Dissipation of Energy. The greater the area, the less elastic (resilient) is the system. A perfectly elastic system has zero area. Stiffness is the load applied divided by the displacement produced. This concept is applied to the Low Back Tissues in this project.



Purpose/Aim

To objectively evaluate the effect of frequency and amplitude of oscillations (applied to the right and left pelvis alternately) on the elasticity and stiffness of the low back.

Material/ Methods

1. Baseline Evaluation Procedure: The subject lies supine on the Anatomic Torsion Monitor (ATM) (Warner 1997). The laser platform is strapped to the subject's ASIS. The laser pointer projects a dot on target which is set at zero degrees angular displacement with no weight on weight carriers. Initially, lever arms are without weight at zero angular displacement. Weights are added to the right lever arm weight carrier in five-pound increments up to twenty-five pounds. This causes the right pad to rise displacing the right PSIS anteriorly. The right ASIS also rises in response causing the projected dot on the target to move upward. Right lever arm applied weight and dot above the zero mark on the target are recorded as positive numbers. Angular displacement for each applied weight is read from the target by the operator.. Weights are removed from the lever arm weight carrier in 5-pound decrements. Angular displacement for each removed weight is read from the target through zero weight. The above steps are repeated for the left lever arm.
2. Providing Oscillations to the Low back. This figure shows a subject on the automated anatomical bending monitor (A-ATM). A cam mechanism and a DC motor were fitted to the ATM. The cam mechanism is attached to pneumatic cylinders that provide the oscillation alternately to both sides of the pelvis. The frequency of the oscillations is controlled by a speed controller switch.

Procedure

The patient lies spine on the A-ATM. Baseline hysteresis loops HLA are measured using the procedure described above. Oscillations are imparted alternately to each side of the pelvis. HLA are remeasured to compare the resilience, and stiffness of the low back before and after imparting oscillations.

RESULTS

Ten subjects (9M, 1F) age 24-77 were given oscillation to the low back of 20 cycles per minute with amplitude of two inches for 5 minutes. HLA was measured before and after. For the 7 subjects with BMI <. 25, HLA decreased in every case by 64 + 26%; for the three subjects with BMI > 25, HLA increased in every case by 36 + 19% (Mean + SD). On a separate occasion, subjects received only 2 minutes of oscillation. HLA changes before and after were calculated but showed no consistent trend and are not reported here.

Relevance

Langevin (2011) found lumbar fascial thickness to be greater in persons with a history of low back pain. This project explores a method of both measuring and changing mechanical properties of the low back which may be useful in both evaluating and treating conditions of the low back.

Conclusion

Providing oscillations alternately to the right and the left pelvis for five minutes at a frequency of 20 cycles per minute results in improved elasticity of the low back for normal subjects whose BMI is 25 or less. An insignificant change in stiffness for all the subjects was observed.

Discussion

Five minutes mechanical oscillation can have an effect on the mechanical properties of the low back. This duration could be achieved in a clinical treatment program. For clinical application to low back injury the displacement, amplitude, frequency, and duration of treatment will probably depend additionally upon an individual’s medical and physical conditions as well as BMI.

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INTRA-ABDOMINAL PRESSURE: A FINITE ELEMENT MODEL TO EXPLORE ALTERED MOVEMENT STRATEGIES IN CHRONIC LOW BACK PAIN PATIENTS

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Introduction

Recent studies on movement strategies show altered Motor Control (MC) and distinct Intra-Abdominal Pressure (IAP) in Chronic Low Back Pain (CLBP) patients. While IAP and MC both contribute to lumbopelvic stability, their functional relationship is still unclear. Also, the consequences of distinct IAP for lumbopelvic stability and abdominal wall integrity are unknown. IAP is a result of the complex interaction between anatomical structures, depending on MC. Therefore for a proper analysis of this complex interaction, detailed modelling is required.

Aim

The aim of this study is to construct a finite element model (FEM) of the complete abdominal cavity to explore the complex relation between IAP, MC and anatomical structures.

Materials and Methods

In a FEM the mechanical properties of the different tissue-layers and MC of different muscles of the abdominal cavity will be incorporated. The FEM is constructed using ABAQUS® and will simulate the impact of IAP on lumbopelvic stability and abdominal wall integrity during both normal and altered movement strategies.

Results

The results will provide insight in the relation between IAP, MC and different abdominal structures. Preliminary results will be presented at the congress.

Relevance

This model will help to better understand the complex interaction between IAP, MC and abdominal structures in supporting lumbopelvic stability. It can also provide a basis for future in vivo measurements. Also, this model could help physiotherapists to explain CLBP patients the relation between IAP, pain and functional disabilities.

Conclusions

A model of the human abdominal cavity and its mechanical properties during physiological movements is defined. Our findings provide directions for future studies designed to measure the interaction between IAP, MC and passive anatomical structures in vivo.

Discussion

In the model anatomical structures and MC had to be simplified. Furthermore, the applied characteristics in the model are very individual specific. These limitations make it difficult to translate the results to the complex abdominal cavity and large variation in human beings. Therefore, future studies should validate the obtained results by performing in vivo measurements in both healthy participants and CLBP patients.

Implications

By acquiring more in depth knowledge about IAP with this model, it is possible to conduct studies on IAP in vivo. Currently, the most commonly used method to measure IAP is an indirect invasive measurement through the bladder. However, other methods are available. For example results from recent studies show that measuring Abdominal Wall Tension (AWT) is a reliable, non-invasive, easy and patient friendly method to measure IAP. More research has to be performed to see if measuring AWT could be a helpful diagnostic and evaluation tool in CLBP patients.

Keywords

Chronic low back pain, IAP, motor control, finite element model, altered movement strategies

DOES MUSCLE FATIGUE CHANGE THE LUMBAR KINEMATICS?

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Introduction

Low back pain (LBP) is one of the most common problems in industrialized countries and its direct and indirect cost is enormous. Digital videofluoroscopy is a technique which is used to investigate kinematics of lumbar motion segments during flexion and extension movements in vivo. It is possible to assess the quality and quantity of lumbar kinematics with this technique. Muscular fatigue is a condition which may change the movement strategies but its effect on spinal kinematics is not clear in healthy subjects or LBP patients.

Purpose

The aim of this study was to evaluate the effects of paraspinal muscular fatigue on intersegmental lumbar motion parameters in healthy subjects.

Methods

Fifteen healthy subjects (26±4.4 years old) were recruited and pulsed digital videofluoroscopy was used to investigate the kinematics of lumbar motion segments during flexion movement in vivo. Intersegmental linear translation, angular displacement and pathway of instantaneous center of rotation (PICR) were compared for each lumbar motion segment before and after muscular fatigue. paraspinal muscular fatigue was induced after maintaining of 60% of maximum voluntary contraction in these muscles.

Results

Arc length of PICR was increased in all lumbar motion segments after muscular fatigue during flexion movement in healthy subjects ($P<0.05$) but linear translation or angular displacement were not changed.

Conclusion

The results of this study indicated that paraspinal muscular fatigue may change the quality of segmental movements but its quantity may not change. As increase in arc length of PICR may represent loss of neuromuscular control of spinal stability, paraspinal muscular fatigue may increase the risk of spinal injury in healthy or LBP patients.

Keywords

Kinematics; Videofluoroscopy; Spine; Fatigue; Low back pain

TRUNK MUSCLE ENDURANCE AND LOW BACK PAIN IN CONTEMPORARY DANCE STUDENTS

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Introduction

Low back pain (LBP) is often cited as a common condition in all levels of dance. Evidence suggests that reduced endurance of the trunk muscles can predispose an individual to LBP.

Purpose

The purpose of this study was to examine differences in trunk muscle endurance in a sample of full time female dance students with and without LBP.

Methods

Seventeen full-time female dance students were divided into two groups: students with LBP (n=11); and students without LBP (n=6). To assess trunk muscle endurance, participants performed four isometric tests that assess trunk muscle endurance: the right and left side plank, double straight leg raise (DSLR), and the Sorensen test. A modified version of the Osaka City University test was used to assess the presence of LBP. All participants provided informed consent, and the study was approved by an institutional ethics review board.

Results

Dancers without LBP displayed significantly ($p<0.05$) higher levels of endurance in the right and left side plank, as well as the DSLR assessment. There was no significant difference between groups for the Sorensen test.

Conclusion

Dancers with LBP may have reduced endurance of the trunk muscles compared to dancers without.

Relevance and Implications

This study has implications for the prevention and treatment of LBP amongst contemporary dancers and provides direction for future research into back health in dance.

WITHIN- AND BETWEEN-DAY RELIABILITY OF FUNCTIONAL MOVEMENTS IN HEALTHY SUBJECTS USING 3D MOTION ANALYSIS: A PRELIMINARY STUDY

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Introduction

Movement analysis is often undertaken in subjects with low back pain to evaluate spinal movement. The variability of functional movements in healthy or back pain individuals however, is rarely reported. In order to explore potential movement dysfunctions in back pain subjects, variability of movement in healthy individuals needs to be better understood.

Purpose/Aim

To determine the reliability of repeated functional movements measured by 3D motion analysis in healthy subjects.

Materials and Methods

3D spinal-pelvic kinematic motion analysis (VICON) was performed on 6 healthy subjects (4 females, 2 males) (age 38.3±14.4years, height 172.2±9.9cm, weight 69.6±9.9kg) during three functional tasks (stand-to-sit, step-up and reaching) repeated on two separate days (minimum 7 days apart). Maximum flexion sagittal spinal angle for stand-to-sit and maximum extension angles for step-up and reach tasks were evaluated for thoracic, lumbar and pelvic regions. Four trials were recorded for each task on each day. Within-and between-day intra-class correlation coefficients (ICCs) and standard error of measurement (SEM) were calculated. Ethical approval was gained (10/0AE/4976).

Results

Within-day: Reach Thoracic ICC 0.92 (95% Confidence Interval 0.75-0.99) SEM 2.06°, Lumbar 0.85 (0.58-0.97) SEM 4.30°, Pelvis 0.95 (0.83-0.99) SEM 0.7°. Step-up Thoracic 0.92 (0.75-0.99) SEM 2.07°, Lumbar 0.25 (-0.97-0.78) SEM 8.11°, Pelvis 0.84 (0.55-0.97) SEM 2.11°. Stand-to-sit Thoracic 0.92 (0.74-0.99) SEM 2.93°, Lumbar 0.97 (0.91-0.97) SEM 1.52°, Pelvis 0.92 (0.75-0.99) SEM 1.79°.

Between-day: Reach Thoracic ICC 0.90 (95% Confidence Interval 0.46-0.99) SEM 2.26°, Lumbar 0.44 (-0.90-0.47) SEM 2.29°, Pelvis 0.75 (-0.02-0.96) SEM 1.05°. Step-up Thoracic 0.16 (-0.68-0.82) SEM 0.05°, Lumbar 0.22 (-0.64-0.84) SEM 1.64°, Pelvis 0.79 (0.09-0.97) SEM 1.69°. Stand-to-sit Thoracic 0.61 (-0.27-0.93) SEM 1.51°, Lumbar 0.11 (-0.80-0.71) SEM 3.41°, Pelvis 0.72 (-0.07-0.96) SEM 2.73°.

Relevance

These results indicate the natural variability of non-symptomatic human movement during functional tasks which need to be considered when evaluating and comparing spinal-pelvic movement in different populations.

Conclusions

ICC values for within-day functional movements of healthy subjects are consistently high in the thoracic, lumbar and pelvic regions with exception of maximum lumbar extension during step-up. Between-day reliability appears to be strongest in the pelvis in all tasks compared to thoracic and lumbar spine, suggesting that the pelvis may display more consistent movement patterns. Given the large confidence intervals, however, only tenuous conclusions can be made.

Discussions

The preliminary results suggest sagittal spinal movement in healthy individuals to be consistent when tested within a single day. The pelvis may demonstrate the least variable movement patterns during functional tasks when tested between days. Future research is required with larger samples and using symptomatic populations to further explore variability in human spinal-pelvic motion.

Keywords

3D Motion Analysis, Thoracic, Lumbar, Pelvis, Reliability, Functional Movement

RELATIONSHIP BETWEEN THE PERFORMANCE ON THE SIT-AND-REACH TEST AND NECK POSITION IN HEALTHY ADULTS

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Introduction

The Sit and Reach Test (SRT) was first described by Wells and Dillon (1950), in order to measure low back and hamstrings flexibility. On the other hand, Straight Leg Raise and Slump are clinical tests that examine nerve root compression, and are also useful to identify lumbosacral neural tissue mechanosensitivity, both as a normal response or due to lesions.

Purpose/Aim

To assess whether the scores on the Sit-and-Reach test (SRT) differ when performing the SRT in two different neck positions, full flexion and full extension.

Materials and Methods

Measurements took place in the School of physiotherapy laboratory. The sample consisted of thirty-four healthy volunteers (20 males, 14 females), aged between 18-38. All participants were measured on the same day. Each step of the protocol was supervised by a unique examiner. Informed consent was obtained, a demographic questionnaire was completed and then a stretching routine was given for warm up. Volunteers were asked to wear loose athletic apparel. The last step of the protocol was the sit-and-reach test measurements. The results gathering procedure was based on the methodology followed by Holt et al. (1999). A single-group experimental protocol testing the performance in the SRT Test under 2 controlled conditions, with repeated measures on each condition.

Main Outcome Measures

SRT scores with neck in extension and neck in flexion were assessed for reliability in each test position and also for differences between the 2 test positions.

Results

Reliability indices for the SRT test were very high for both neck positions (ICC=0.97-0.98). Paired samples t-test did not reveal statistically significant differences ($p>0.05$) in SRT scores between the 2 neck positions for the whole group (n=34). Mean paired differences between the 2 neck positions in the 'Expected' results group (n=15) were almost double (-4.41 to -4.77cm) of those in the 'Unexpected' results group (n=19), (2.24-2.30cm) in absolute terms and in the opposite direction. The Mann-Whitney U test identified a significant difference in the distribution of male-female participants ($p=0.012$) between the 'Expected' and 'Unexpected' groups but not for stretching habits ($p>0.05$). Unrelated samples t-test identified significant differences between those 2 groups for participants' height and weight but not for age.

Relevance

The neural tension component should also be taken into account when SRT measurement is required.

Conclusions

Males demonstrate higher scores in the SRT test whereas females the same or less scores with neck in extension.

Discussions

The statistical analysis of the results did not verify our experimental hypothesis. The majority of the volunteers demonstrated higher scores in the SRT with the neck positioned in full flexion rather than full extension.

Implications

It is recommended that SRT is performed with neck in neutral position to minimise confounding of muscle flexibility with neural tension signs.

Key words

Sit-and-reach, assessment, fitness testing, neural tension testing

LUMBAR LOAD IN COMMON WORK TASKS FOR AIRPORT BAGGAGE HANDLERS

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Introduction

Baggage-handlers have a history of frequent occupational injuries. The lumbar spine is often the site of these injuries. The baggage-handlers often work in confined spaces, necessitating sitting, kneeling or stooping positions. These positions have been associated with low back pain.

Purpose

The purpose of the study was to elucidate the biomechanical loading of the lumbar spine during common working tasks for airport baggage-handlers.

Materials and Methods

We selected ten common working tasks. The tasks were: 1) loading without belt-loader, 2) loading and 3) unloading with belt-loader, 4) sitting, 5) kneeling, and 6) stooped working position, 7) loading and 8) unloading baggage containers, and 9) pulling and 10) pushing baggage/container carts. For each task 10 baggage-handlers were filmed. Segment angles were measured on still-pictures using ImageJ (National Institute of Health, USA) and used as input to the software-program Watbak (University of Waterloo, Canada) which calculated the compression force of the L4/L5-segment. A linear mixed model with Tukey-adjusted post-hoc multiple comparisons was applied to determine significant differences between tasks. Significance was accepted at $p < 0.05$.

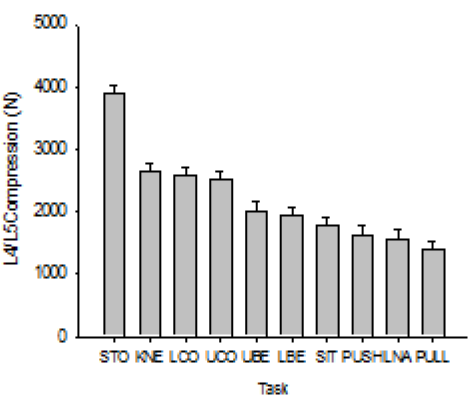

Figure 1. L4/L5 compressions. Error bars are SEM. STO=stooped, KNE=kneeling, LCO=load container, UCO=unload container, UBE=unload belt, LBE=load belt, SIT=sitting, PUSH=push carts, LNA=loading without belt, PULL=pull carts.

Results

The average compression force was largest in the stooped position (3893 N) (Figure 1), followed by kneeling showing the second largest compression force (2631 N). Third and fourth largest compression forces were found when loading (2582 N) and unloading (2522 N) baggage-containers. The lowest compression forces were found during pulling (1388 N) and pushing (1637 N) carts and loading aircrafts without belt-loader (1572 N). The compression force in the stooped position was significantly higher than all other tasks. Loading and unloading containers and kneeling posture were significantly lower than stooping, but significantly higher than the remaining tasks.

Conclusions

This study quantified lumbar compression force in ten working tasks of airport baggage-handlers. The stooped position produced the largest compression force at L4/L5.

Discussions

Only the compression force in the stooped task exceeded the limit of 3.4 kN, which has been suggested by The National Institute for Occupational Safety and Health (NIOSH). The NIOSH equations, however, do not take restricted workspace, seated or kneeling working position or one-handed lifting into account. The seated position produced a significantly reduced compression force compared to the kneeling position.

Implications

Stooping position should be avoided. Moreover, it may be feasible to recommend the seated position instead of kneeling. Further, these results can be used as a part of the job-rotation planning in airports.

PERCUTANEOUS AXIAL LUMBAR INTERBODY FUSION (AXIALIF) FOR DDD LBP

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Lumbar MISS fusion is commonly performed to alleviate chronic low back/LBP and leg pain secondary to disc degeneration, spondylolisthesis/spondylolysis with “black disk” DDD with or without concomitant lumbar spinal stenosis, or chronic lumbar instability. However, the risk of iatrogenic injury during traditional anterior, posterior, and transforaminal open fusion surgery is significant. The axial lumbar interbody fusion (AxiaLIF) system is a minimally invasive fusion device that accesses the lumbar (L4–S1) intervertebral disc spaces via a reproducible presacral approach that avoids critical neurovascular and musculoligamentous structures.

Since the AxiaLIF system received marketing clearance from the US Food and Drug Administration in 2004, clinical studies of this device have reported high fusion rates without implant subsidence, significant improvements in pain and function, and low complication rates. This paper describes the design and approach of this lumbar fusion system, details the indications for use, and summarizes the clinical experience with the AxiaLIF system to date.

Keywords
AxiaLIF=”ALIF for presacral approach”, fusion, lumbar, minimally invasive, presacral approach

SHORT LEG SIGN

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Introduction

Clinicians have long known of a physical examination finding named the Short Leg Sign (SLS). This sign, seen in patients when they move from supine to seated with legs horizontal and seen as a 0.5 cm or greater leg length differential, has been hypothesized to result from a hypermobile sacroiliac joint (SIJ). The SLS is undependably reproduced in the clinic, and biomechanical explanations have been elusive. During disengagement of the two sacroiliac joint wedge-like surfaces, of the conjoined sacrum and ilium, movement can occur in two directions, either counternutation or nutation. Each direction has a characteristic 3-dimensional set of bone shifts. Functional leg shortening, or SLS, manifests during counternutation within a seated patient who has SIJ disorder. Counternutation occurs whereby the iliac crest cants laterally and rotates (counter-clockwise as seen from outside the body on the left and clockwise on the right). As this shift occurs, the ipsilateral ischial prominence shifts posteriorly and slightly medially.

Purpose/Aim

To discover biomechanical explanation for the SLS.

Materials and Methods

Bone contours of the innominate and femur were imaged by placing an anatomical model (proportional to life-size) seated with legs horizontal onto a transparent 2-dimensional surface. Lateral and inferior views of the bone contours were sketched. Next, the model's innominate bone contours were shifted within dimensions compatible with real-life SIJ counternutation. Contours were compared (geometrically) at stations before and after counternutation. Analysis of bone contour geometry was supplemented by observations of femur head and femur neck shifts relative to the acetabulum. Two-dimensional geometric sketches obtained by this method enabled precise measurements of angular and translational movements of bones during counternutation. Since the 3-dimensional model was proportional to life-size, it was possible to extrapolate bone shifts to life-size dimensions.

Results

When the hip and SIJ biomechanisms activate during counternutation, three key biomechanical shifts occur. At the acetabulum there occurs a screw-like biomechanism. The femur moves relative to the innominate as a cam. The innominate rotates around a virtual transverse axis of the SIJ. Calculations revealed that these biomechanisms provided several magnitudes of cumulative mechanical advantage resulting in significant functional ipsilateral leg shortening.

Relevance

The findings enable clinicians to better understand the biomechanics of SIJ disorders.

Conclusions

The SLS results from specific mechanical biomovements within the sacroiliac and hip joints.

Discussion

Calculations indicated that minute rotational and translational movements within femur/acetabulum and SIJ biomechanisms, aroused by realistic degrees of SIJ counternutation and subluxation, resulted in functional leg shortening similar to dimensions (0.5-2.5 cm) historically measured in clinic patients with unilateral SIJ disorders.

Implications

Clinicians will gain enhanced understanding of SIJ diagnostic methodology and greater ability to properly diagnose patients with chronic low back pain.

Key Words

Counternutation, Sacroiliac Joint, Sacroiliac Joint Hypermobility, Short Leg Sign

RATIONALE FOR REAL TIME ULTRASOUND MEASUREMENTS OF TRANSVERSUS ABDOMINIS THICKNESS - A SYSTEMATIC REVIEW

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There is considerable evidence that the Transversus abdominis (TA) muscle, among others provides an important contribution in lumbo-pelvic stability (Hides, 2011). It is proposed that the Transversus Abdominis muscle can contribute to stability, defined as increased stiffens of the lumbar spine

a) via increasing fascial tension of the Thoracolumbar fascia (Hodges et al 2003, 2005, Barker et al 2006),
b) increased stiffness of the SI joint (Snijders et al 1995, Richardson et al 2002) and/or
c) by it's effect on intra abdominal pressure (Cholewicki et al, Reeves et al).

Changes in motor control of abdominal muscles, including TA are reported in subjects with LBP.

There is evidence of delayed activation of TA in both clinical and experimental studies of LBP (Hodges and Richardson 1996, 1998, Hodges et al 2003, Hodges et al 1999, Hodges et al 1996, Cresswell et al).

Moseley et al (2004) proposed that changes in motor control such as timing deficiencies (i.e. activation delay) of TA, are associated with higher long-term incidence of LBP.

The use of ultrasound imaging (RUSI) in rehabilitation medicine for the assessment of deep trunk muscle function, particularly TA, becomes increasingly more important (Teyhen 2007, Whittaker 2007).

Ultrasonography can be used to measure changes in muscle-thickness, muscle fiber pennation and muscle fascicle length during static and dynamic contractions (Hodges 2003). Because these architectural parameters often change markedly with contraction, attempts have been made to use these changes as a parameter to describe muscle activity. However in literature no direct linear relationship between change in muscle morphometry and muscle activity could be demonstrated. The explanation given in literature is that, besides muscle activity, too many factors can influence changes in muscle morphometry (Hodges 2005).

The reliability of USI techniques for measuring various muscles and parameters are reported widely in the literature.(Whittaker et al 2011) In general, these studies conclude that USI is a reliable method to measure the muscle parameter of interest.

It is commonly stated in the literature that the validity of USI for measuring muscle morphology is adequate (Whittaker et al 2011).

Validity is a catchall and should be specified. Criterion validity is the extent to which the results of the measurements are demonstrably related to concrete criteria.

Construct validity is the extent to what's proposed to be measured is actually measured. When making this validity-distinction it appears that validity marked as adequate is based on criterion validity. Unclear is, whether the architectural changes can be used to assess motor control and to assess specific timing differences of the TA. In other words, what is the rationale for measuring TA thickness or size with USI.

Aim of this part of the study is to search the literature systematically for a rationale to use USI measuring the TA muscle and to check the relevant literature for methodological quality.

Method

A systematic search of relevant literature was conducted in February 2012 in the following data bases; PubMed, Cinahl en Embase. Only articles in English German and Dutch were included. Initial search was performed by the first reviewer (VH) and checked by the second reviewer (AP) screened by title, keywords and abstract for eligibility.

Both reviewers (AP and VH) subsequently screened the selected abstracts independently with regard to the in- and exclusion criteria. In addition, both reviewers conducted a full text screening of the remained articles and finally performed a methodological assessment using the adapted QUADAS tool.

Conclusion

Thickness changes measured with RUSI cannot be used indiscriminately as a surrogate measure for muscle activity. For detecting differences in timings delay the only golden standard remains EMG and this poorly accessible for clinicians.

FACTORS INFLUENCING THE USE OF OUTCOME MEASURES FOR PATIENTS WITH LOW BACK PAIN: A SURVEY OF NIGERIA PHYSIOTHERAPISTS

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Purpose

Low back pain is one of the important patients' presenting complain that requires expert management from the physiotherapists. This study investigated the outcome measures used by Nigeria physiotherapists to evaluate patients with Low Back Pain (LBP) and the factors that influence their use.

Method

A survey questionnaire was posted to 306 randomly selected members of Nigeria Society of Physiotherapy (NSP). Descriptive statistics of frequency, percentages, and mean were used to summarise the outcome measures and the factors influencing their use. Inferential statistics of ANOVA and Pearson's chi square were used to establish the significance. Level of significance was set at the 0.05 level.

Result

Pain visual analogue scale (VAS) was utilised by 221 (52.9%) respondents, while only 110 (36.1%) used back related clinical outcome measures. The factors that influenced their use were belief, attitude, knowledge and choice. There was no significant difference association between these factors and the use of clinical outcome measures (p= 0.960, 0.648, and 0.760 for belief, attitude and knowledge respectively).

Choice was the only factor that significantly associated (p=0.029) with the use of clinical outcome measures.

Gender and post graduate qualification had no significant influence on the use of clinical outcome measures (p= 0.117 and 0.510 respectively).

Conclusion

The VAS is the outcome measure frequently used by Nigeria Physiotherapists to evaluate patients with LBP. Back related standardized clinical outcome measures were poorly utilized. The factors that significantly influenced the use of the outcome measures was choice.

Keywords

Outcome measures, Factors influencing their use, Low back pain

REPEATABILITY OF THE MUSCULOSKELETAL FITNESS TESTS AND THE MOVEMENT CONTROL IMPAIRMENT TEST BATTERY IN FEMALE NURSING PERSONNEL WITH SUB-ACUTE NONSPECIFIC LOW BACK PAIN (NSLBP)

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Introduction

Low back pain (LBP) is one of the most important reasons for work absenteeism in nursing personnel. Low performance levels in several components of physical fitness are risk factors for LBP. Movement control impairments (MCI) have been proposed to be risk factors for prolonged LPB. There is a need for reliable measurement methods to assess fitness and MCI.

Purpose

The aim of this study was to examine the repeatability (test-retest) of selected motor and musculoskeletal fitness tests and the MCI test battery in female health care workers with NSLBP.

Methods and materials

Participants (n=48) were volunteers with recurrent LBP working in geriatric wards. The mean age was 47.8 years (sd 5.8) and the mean of the working time in the current working place was 11.5 years (sd 9.3). Test-retest intra-rater repeatability of six field tests of fitness and the MCI test battery was studied. The mean number of days between the measurements was18 (sd 7.9, range from 3 to 34). Motor abilities (rhythm coordination, running figure of eight), flexibility (trunk lateral flexion) and muscular strength (dynamic sit-up, modified push-up, one leg squat) were measured. The six tests of MCI assessed movement control of the lumbar spine. The estimates of repeatability for interval scale measurements were typical (standard) error of measurement, indicating within-subject variation, calculated as the standard deviation of test-retests difference divided by the square root of two (s=sddiff/√2). The typical error was presented also as the relative measurement error i.e. coefficient of variation (CV): typical error divided by the mean of two tests [CV=s/mean(testi+retesti)/2]. Repeatability of nominal scale measures of MCI tests (0 or 1) were analyzed by the kappa coefficient (k).

Results

The smallest within subject variation was found in running figure of eight (s=0.22sec, CV=2.8%). Corresponding figures for trunk lateral flexion were s=1.35cm, CV=7.4%, rhythm coordination s=1,04 points, CV=7.5%, sit up s=1.89 repetitions, CV=11.2%, squat (n=47) s=1.04 rep., CV=11.9% and push up (n=46) s=1.04 rep., CV=12.1%. The kappa coefficients of MCI tests for intra-tester reliability ranged between 0.19—0.71. The highest kappa value was found for dorsal pelvic tilt (k=0.71) followed by sitting knee extension (k=0.56), anterior pelvic tilt ("waiters bow") (k=0.53) and knee flexion in prone (k=0.45). The kappa values were lower for rocking forwards and backwards (k=0.28) and one leg stance (k=0.19). LBP intensity (VAS) vas not significantly associated with any of the test results.

Conclusions

All of the tests assessing motor abilities, flexibility and muscular fitness had acceptable level of intra-rater repeatability. Three of the six tests of MCI had adequate repeatability.

Discussion
The results provide useful information for selecting measurement methods for persons with NSLBP.

Relevance and Implications
Repeatability of measurements is essential in evaluating clinical outcomes and effects of research interventions in persons with NSLBP. The three tests of MCI with low kappa values for repeatability need to be better standardized in order to be reliable clinical measurement tools.

Keywords
Nonspecific low back pain, movement control impairment, musculoskeletal fitness, repeatability

DIAGNOSIS OF LUMBAR SPINAL STENOSIS: AN UPDATED SYSTEMATIC REVIEW OF THE ACCURACY OF DIAGNOSTIC TESTS

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Introduction

A wide range of clinical, radiologic and electrodiagnostic tests are used to diagnose lumbar spinal stenosis. An accurate diagnosis is vital, because lumbar spinal stenosis may require specific medical advice and treatment. Therefore, it is important to know the accuracy of these diagnostic tests currently available.

Purpose/Aim

To update our previous systematic review on the diagnostic accuracy of tests used to diagnose lumbar spinal stenosis.

Materials and Methods

A comprehensive literature search was conducted for original diagnostic studies on lumbar spinal stenosis, in which one or more diagnostic tests were evaluated with a reference standard, and diagnostic accuracy was reported or could be calculated. Our previous systematic review included studies up to March 2004; this review is current up to March 2011. Included studies were assessed for their methodological quality using the Quadas tool. Study characteristics and reported diagnostic accuracy were extracted.

Results

Twenty-two additional articles over the 24 included in the previous review met the inclusion criteria. Combined, this resulted in 20 articles concerning imaging tests, 11 articles evaluating electrodiagnostic tests, and 15 articles evaluating clinical tests. Estimates of the diagnostic accuracy of the tests differed considerably.

Conclusions

At present the most promising imaging test for lumbar spinal stenosis is MRI, avoiding myelography because of its invasiveness and lack of superior accuracy. Electrodiagnostic studies showed no superior accuracy for conventional electrodiagnostic testing compared to MRI, with the exception of paraspinal mapping, which had a high specificity and may have some utility in specific instances. The most useful clinical findings for ruling in the diagnosis of lumbar spinal stenosis are bilateral buttock or leg pain, the absence of pain when seated, the improvement of symptoms when bending forward, and a wide-based gait.

Discussion

There is a need for a consensus on criteria to define and classify lumbar spinal stenosis. In the absence of widely accepted diagnostic criteria, almost all included studies devised their own construct. This limits the generalizability of findings.

Implications

Further research on lumbar spinal stenosis is essential, but the absence of diagnostic and/or classification criteria should be considered a major focus for international organizations and clinical investigators. Furthermore, we recommend the use of a clinical reference standard.

Keywords

Lumbar spinal stenosis, diagnostic accuracy, systematic review

DEFENSIVE HIGH ANXIOUS INDIVIDUALS WITH CHRONIC BACK PAIN DEMONSTRATE DIFFERENT TREATMENT CHOICES AND PATIENT PERSISTENCE

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Introduction

The way individuals interpret stressful stimuli, such as pain, can be classified according to their personality type (High-anxious, Defensive high-anxious, Repressor, Low-anxious). Much attention has been paid to the Repressor personality type in various chronic disease populations e.g. cancers, but little attention to the personality types of patients with chronic pain. Previous work within our group indicated that a higher proportion of individuals demonstrating a Defensive high-anxious personality type may be present in those with low back pain than in asymptomatic populations. It has been suggested that this may be because Defensive high-anxious individuals are more prone to back pain or that they are more likely to present for clinical management. However, the relationship between personality type and the management of pain remains poorly understood.

Purpose/Aim

The aim of this study is to determine whether treatment options and satisfaction in individuals with chronic back pain differ across the four personality groups.

Materials and Methods

Participants (n=142) completed a set of self-report questionnaires relating to their chronic back pain, depression, disability, treatment history and satisfaction with treatment. Trait anxiety and defensiveness were used to determine individuals' personality type.

Results

Defensive high-anxious individuals reported greater disability and sought more treatment options than other groups, with 92% using more than one intervention. Repressors predominantly self-managed their pain with only 10% reporting more than one intervention. Levels of self-reported pain did not differ between the personality type groups; however, the Defensive High-Anxious individuals reported greater levels of disability. There were no differences in pain or satisfaction with treatment.

Relevance

These findings demonstrate that personality type affects the way pain is interpreted, particularly the degree of disability associated with similar levels of pain. Personality type also influenced the treatment options of the patients thus suggesting there is a potential need to differentiate interventions for individuals.

Conclusions

The present study confirms that personality type is an important factor influencing patients' treatment choices.

Discussion

The present study indicates that Defensive High-anxious individuals are more likely to interpret their pain as debilitating and demonstrate a persistent representation for treatment. This persistence could explain the high proportion of Defensive High-anxious individuals seen in hospital based back-pain clinics. In contrast Repressors were less likely to interpret their pain negatively and most likely to self-manage their back pain without seeking secondary care. It is likely that personality type will have a moderating effect on many psychological factors associated with back pain and influence clinical outcome.

Implications

The present study provides a prima facia basis for further research into the influence of personality type on clinical populations with chronic pain. If treatment and management plans can be identified that specifically target the characteristics of the different personality types this may enhance their effectiveness, reduce drop-out rates and improve clinical outcome.

Keywords

Coping style, treatment options, back pain, Repressor, Defensive High-Anxious

PREVALENCE AND ASSOCIATED FACTORS OF LOW BACK PAIN AMONG PREGNANT WOMEN ATTENDING ANTENATAL CLINIC AT UNIVERSITY OF GONDAR HOSPITAL

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Introduction

Low back pain is one of the most common problems associated with pregnancy. Low back pain in pregnancy may be severe enough to cause significant pain and impaired physical functioning. No evidence is found that attempts to determine the magnitude and the risk factors of low back pain among pregnant women in Ethiopia.

Objective

To assess the prevalence and associated factor of low back pain among pregnant women who are attending antenatal clinic at University of Gondar Hospital.

Methods

Institutional based cross- sectional study was conducted among pregnant women who were attending the antenatal clinic from March 18- April 30, 2012. A total of 304 pregnant women were interviewed using structured questionnaire. Verbal Analog Scale was used to determine severity of the pain and disability rating index was used to determine physical functioning. Logistic regression was used to analyze the data. A 95% confidence interval with $p<0.05$ was taken.

Results

Of 304 pregnant women, 101(33.2%) experienced pain during their current pregnancy. Pain was most frequently felt over the back area (86.1%), buttock (5%) and (8.9%) in both areas. The severity of Low back pain during pregnancy was described mostly as being moderate (39.6%).Half (50.5%) of women with low back pain reported sleep disturbances secondary to the pain. Most (48.5%) of the pregnant women with low back pain complained impaired physical functioning. A history of low back pain and low back pain during previous pregnancy were significantly associated with low back pain during current pregnancy.

Discussion

There has been variety of reports on the prevalence of low back pain among pregnant women. Most studies estimating 50%, in this study the prevalence of low back pain was 33.2% and this can be due to the study populations' perception of pain, which is affected by society and culture. Other reason could be the difference in sample sizes and study designs used. In this study women who had a history of Low back pain before pregnancy, and Low back pain during pervious pregnancy were 3.68 times and two times more likely to develop low back pain during the current pregnancy respectively. The high risk of having low back pain may be due to the pre-existing abnormal back physiology.

Conclusion and Recommendation

One third of the pregnant women complained low back pain during pregnancy. History of Low back pain and Low back pain during previous pregnancy were factors significantly associated with Low back pain during current pregnancy. Antenatal care providers should consider assessing the presence of low back pain during pregnancy and referring to the physiotherapy department.

Implication

This study revealed the prevalence of low back pain among pregnant women attending antenatal clinic at University of Gondar Hospital, Gondar, Ethiopia. One third of pregnant women experience low back pain, in which the pain was significant and influence their physical function. It is considered that in light of this information Low back pain in pregnancy can be considered to be a significant problem in Ethiopian women during pregnancy. During assessment of pregnant women with low back pain taking the history of low back pain with or without pregnancy would be important to underline the contributing factors.

Keywords

Low back pain, Prevalence, Pregnant women

DISCRIMINATING NON-SPECIFIC CHRONIC LOW BACK PAIN CLINICAL SUBGROUPS AND MONITORING RECOVERY USING AN OBJECTIVE CLASSIFICATION METHOD

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Introduction

Heterogeneity of non-specific chronic low back pain (NSCLBP) can be deleterious to management success. Classification systems (CSs) that sub-classify NSCLBP to guide interventions often rely on clinical expertise and user familiarity. An objective classification method that alongside with clinical CSs aids classification and monitoring recovery with greater accuracy and less subjectivity is preferable.

Aim

To determine accuracy of an objective classification method based on Dempster-Shafer theory, the Cardiff Classifier (CC), discriminating healthy controls and NSCLBP subgroups using sensory, spinal-pelvic repositioning error (RE). To establish the most sensitive parameters discriminating NSCLBP subgroups from healthy and predicting recovery using CC.

Materials and Methods

Baseline and post-motor learning intervention (MLI) spinal-pelvic REs from 87 NSCLBP patients with flexion (FP,n=50), passive extension (PEP,n=14) and active extension pattern (AEP,n=23) control disorder subclassified using a multi-dimensional clinical CS and 31 healthy (H) were used. CC provided objective and visual indicators of NSCLBP subgroups, H and MLI effect. RE data were transformed into a set of three belief values (i) healthy (H) (ii) LBP (iii) uncertainty. Each subject's status was visually represented as a single point in a simplex plot (Figure 1). Subjects left of the central line have healthy function; to the right have LBP characteristics.

Results

CC accuracy to discriminate FP and H was 85.2%(Figure1a), AEP and H 96.3%(Figure1b), PEP and H 100%(Figure1c). Combining all NSCLBP reduced CC accuracy to discriminate from H to 68.6% (Figure1d). The most distinguishing parameter for FP: sitting lumbar RE, AEP/PEP: standing lumbar RE. CC distinguished pre/post-intervention REs with 85.7% accuracy for FP and 90% AEP with sitting lumbar and standing pelvic RE as the most sensitive predictors of recovery, respectively.

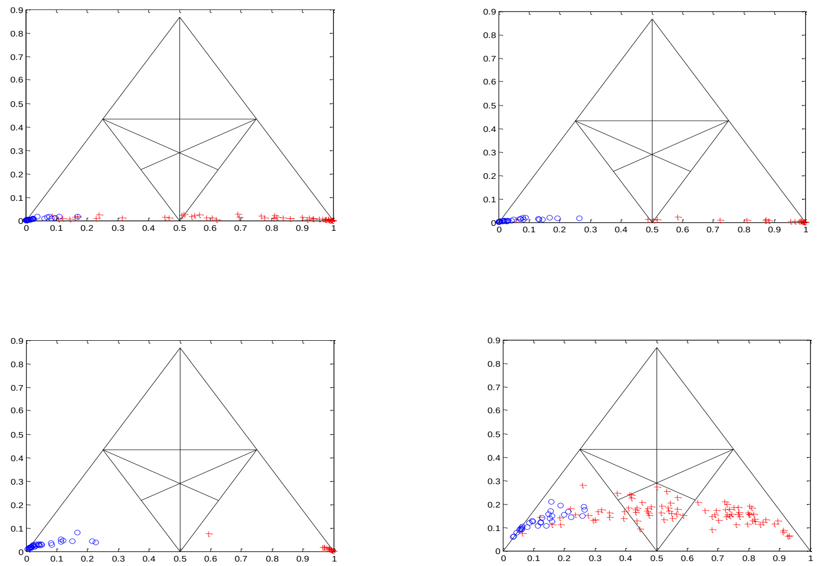

Figure 1. Simplex plots

a) FP+and H°
b) AEP+and H°
c) PEP+and H°
d) all NSCLBP+and H°

Relevance

Using CC in combination with clinical CS may enhance its accuracy by accounting for subjectivity related to varied clinical expertise levels and user familiarity. Using CC to identify key parameters characterizing each subgroup may focus recovery monitoring.

Conclusions

CC accurately discerned three clinical NSCLBP subgroups, concurring with clinical CS. CC identified parameters most accurately characterizing each subgroup and predicting post-intervention recovery.

Discussion

This is the first CC application in NSCLBP. Importance of classification was illustrated with CC enhanced accuracy to discern between NSCLBP and H when patients subclassified. CC should be further tested using clinical classification data.

Implications

NSCLBP classification is complex requiring synthesis of physical and clinical measures. CC can order complex data sets to aid clinicians' interpretation and identify most sensitive parameters to efficiently monitor recovery, enhancing classification robustness and usability.

Keywords

NSCLBP, objective classification, repositioning error, Dempster-Shafer

IS A BIGGER LESION BETTER FOR SACROILIAC JOINT PAIN?

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Albeit controversial amongst spine care providers, sacroiliac joint has been implicated as a source of low back pain and buttock pain at time up to 30% of the time. Slightly higher prevalence is noted in patients who have undergone lumbar spine fusion procedure and in the elderly population. This diarthrodial joint that supports some motion has also been incriminated in pain that is noted in posterior iliac spine, buttocks, groin, medial and posterior thigh, abdomen, calf and at times into the foot. The pain is often aggravated by sitting, bending and riding and noted to have some relief with walking and standing. Degenerative changes affecting the joint and altered joint mobility have been hypothesized as common cause of the pain. Often unilateral but about 20% of the time, it can be noted bilaterally. Pain or tenderness is often noted over the sacral sulcus and over the posterior sacroiliac joint but neurological deficits such as motor weakness, sensory changes or neural tension signs are absent unless there is a coexistent neural compressive pathology. Innervation is diffuse anteriorly and posteriorly. Anteriorly, it is believed to be innervated by L2-S1 and posteriorly it is innervated by the lateral branches from L4-S3 dorsal ramus.

Periarticular and intra-articular injections under controlled studies have shown short-term to long-term pain relief. Radio frequency ablation (RFA) or rhizotomy has been utilized to address pain stemming from the lateral branches that supply the posterior joint. Conventional rhizotomy lesions are 3-4mm in diameter and a more recent modality, Cooled-probe rhizotomy, a newer modality is allowing for lesions between 8-10mm. We will compare conventional rhizotomy to cooled-probe rhizotomy and review recent studies and articles that may provide us with supportive data in favor if bigger is truly better when it comes to thermal lesions of nerves supplying the sacroiliac joint.

TRANSLATION, ADAPTATION, AND VALIDATION OF THE CLASSIC ARABIC VERSION OF THE ROLAND MORRIS DISABILITY QUESTIONNAIRE

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Introduction
The RMDQ is a popular reliable and validated instrument for measuring functional disability in low back pain. However, no validated classic Arabic version was available.

Purpose/Aim
To test the reliability and validity of the classic Arabic Roland-Morris Disability Questionnaire (RMDQ) version to be used among Arabic population with chronic low back pain.

Materials and Methods
The RMDQ classic Arabic translation and cross-cultural adaptation was performed by the "forward translation/backward translation" method. The final version was tested among chronic low back pain patients. The internal consistency was assessed by means of the Cronbach's alpha coefficient. The convergent validity was assessed calculating Pearson's correlation coefficient comparing the RMDQ's results with: the amount of pain by visual analogue scale (VAS), the range of movement of the spine by fingertip-floor length test (FFL).

Results
A total of 25 participants (mean age 44.92 years (SD: 10.51), 52% female) were enrolled in the study. The internal consistency within a seven days interval with a Cronbach's alpha coefficient of 0.93 indicating adequate acceptance. The RMDQ's convergent validity was (r: 0.35; P<0.089) for VAS and (r: 0.47; P< 0. 017) for FFL.

Relevance
Arabic language is spoken in a wide arc of territory that counts more than 300 million first language speakers. The lack of a reliable LBP functional disability tool understood by our local Arabic-speaking patients represents an obstacle to measure its impact on their perceived level of functionality.

Conclusion
The classic Arabic version of the RMDQ has good reliability and is useful clinical instrument for the assessment of functional disability caused by LBP among general Arabic speaking population.

Discussions
This is the first classic Arabic RMDQ version tested for reliability and validity among Arabic speaking patients suffering from chronic LBP. Demographic and clinical characteristics of the studied sample coincide with similar studies.

Implications
RMDQ is a valuable tool to measure prognosis and for clinical and epidemiological research.

Keywords
Low back pain, translation, Arabic version, Roland-Morris Disability Questionnaire

SYSTEMATIC REVIEW OF PROGNOSTIC FACTORS PREDICTING OUTCOME IN NON-SURGICALLY TREATED PATIENTS WITH SCIATICA

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Introduction & Relevance

Identification of prognostic factors predicting persistent pain, disability and recovery are important for better understanding of the clinical course, to inform patient and physician and support decision making. Identification of prognostic factors for surgery in patients with sciatica is important to be able to predict surgery in an early stage.

Purpose/Aim

We aimed to systematically review prognostic factors predicting outcome in non-surgically treated patients with sciatica.

Materials and Methods

A search of Medline, Embase, Web of Science and Cinahl, up to March 2012 was performed for prospective cohort studies on prognostic factors for non-surgically treated patients with sciatica. Two reviewers independently selected studies for inclusion and assessed the risk of bias. Outcomes were pain, disability, recovery and surgery. A best evidence synthesis was carried out in order to assess and summarize the data.

Results

The initial search yielded 4392 articles of which 23 articles reporting on 14 original cohorts met the inclusion criteria. We found high clinical, methodological and statistical heterogeneity among studies. Reported evidence regarding prognostic factors predicting the outcome in sciatica is limited. The majority of factors that have been evaluated, e.g., age, body mass index, smoking and sensory disturbance, showed no association with outcome. The only positive association with strong evidence was found for leg pain intensity at baseline as prognostic factor for subsequent surgery.

Conclusions

Overall, evidence on prognostic factors predicting the outcome in sciatica is sparse. The majority of factors that have been evaluated showed no association with outcome. However, we found strong evidence for high leg pain intensity predicting subsequent surgery.

Discussion

One difficulty in predicting surgery in patients with sciatica is that different indications for surgery are used. Multiple testing bias and not complying to the rule of 10 cases per eligible variable in multivariable analysis may be other important biases.

Implications

Several baseline characteristics are believed to have prognostic implications and are frequently used in daily clinical practice for prognostication. However, our study shows that only strong evidence was found for high leg pain intensity predicting subsequent surgery. Furthermore, the majority of factors that have been evaluated showed no association with outcome. More research on prognostic factors in non-surgically treated patients is necessary to draw firm conclusions on other potentially prognostic factors.

Keywords
Sciatica, Prognosis, Systematic Review, Surgery, Outcome Assessment

CROSS-CULTURAL ADAPTATION AND VALIDITY OF THE ARABIC VERSION OF THE FEAR AVOIDANCE BELIEFS QUESTIONNAIRE IN PATIENT WITH LOW BACK PAIN

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Introduction
FABQ is used to detect the psychosocial impact of low back pain. However, no validated classic Arabic version was available.

Purpose/Aim
To test the reliability and validity of the Arabic Fear Avoidance Beliefs Questionnaire (FABQ) version for its use among Arabic population with chronic low back pain.

Materials and Methods
The FABQ Arabic translation and cross-cultural adaptation was performed by the “forward translation/backward translation” method. The final version was tested among chronic low back pain patients. The internal consistency was assessed by means of the Cronbach’s alpha coefficient.

Results
A total of 18 participants (mean age 37.6 years (SD: 7.6) were enrolled in the study. The internal consistency within a seven days period with a Cronbach's alpha coefficient of 0.98 indicating high reproducibility. The correlation with baseline parameters was statistically weakly correlated.

Relevance
Arabic language is spoken in nearly 29 countries with total population of 400 million. There is no translated psycho-social measure of LBP, making it difficult to do research in this area.

Conclusion
The Arabic version of the FABQ is highly reliable scale to assess perceived psychosocial impact of Arabic low back pain patients.

Discussions
This is the first attempt to translate and validate the FABQ into Arabic Language. Clinical characteristics and design corresponds with similar translation studies.

Implications
FABQ is a valuable tool to measure psycho-social impact of low back pain.

Keywords
Low back pain, translation, Arabic version, Fear Avoidance Beliefs Questionnaire

IATROGENIC SPINAL CORD INJURY

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Introduction

The Swiss Paraplegic Centre Nottwil is both an acute and rehabilitation hospital. A majority of all paraplegics and tetraplegics in Switzerland are rehabilitated here. We retrospectively studied in which proportion of the patients an anaesthesiological or analgesic intervention led to the spinal cord injury.

Materials and Methods

All data of in-patients of the Swiss Paraplegic Centre Nottwil were evaluated for the underlying cause of spinal cord injury. Demographic data, level of injury, type of invasive intervention and mechanism of spinal cord injury were recorded.

Results

During a 10 year period, 1557 patients were referred for rehabilitation after spinal cord injury. In 55 of the patients (36 men, 19 women) an iatrogenic reason for the spinal cord injury was identified. These patients' average age at the time of spinal cord injury was 57 years (range 9 - 79 years). In nine of these patients an anaesthesiological or analgesic intervention led to the spinal cord injury. The level of injury was cervical in two cases, thoracic in five cases and lumbar in two cases. In four cases spinal anaesthesia, in five cases epidural anaesthesia procedures were the reason for the spinal cord injury. In three of the four spinal anaesthesia procedures single injections were performed, in one case a catheter was inserted. One of the five epidural procedures was a single injection, in four cases a catheter was inserted. The pathology underlying spinal cord injury was infection in two cases, epidural hematoma in three cases, medullary ischemia in one case and a direct trauma of the medullary conus in one case. In two cases it was impossible to clarify the reason for the spinal cord injury.

Conclusion

Presuming that the proportion of patients with iatrogenic spinal cord injuries is the same in the other specialized hospitals of Switzerland, we calculated the number of spinal cord injuries in the area of anaesthesiology and pain therapy to be 1 to 2 cases per year in Switzerland.

NATURAL COURSE OF ACUTE NECK AND LOW BACK PAIN IN THE GENERAL POPULATION

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Introduction

Research and clinical management of neck (NP) and low back pain (LBP) must be guided by information on natural course of symptoms to assure that treatment is worthwhile. Natural course of NP and LBP should ideally be assessed in general populations unaffected by health care. This is the first study to monitor the early course of symptoms in general population cases with a new NP or LBP episode.

Purpose

To describe the natural course of acute neck and low back pain in the general population.

Materials and Methods

From a general population health survey in Norway we screened 9 056 subjects age 20-67 years for a new incident neck or low back pain episode within the previous month. The screening identified 219 subjects who formed the prospective cohort for this study. Pain intensity was then reported on a 0-10 numeric rating scale at 1, 2, 3, 6, and 12 months after start of the new pain episode. The course of pain intensity was described for neck and low back pain, different levels of baseline pain intensity and number of pain sites at baseline. We also described associations between pain intensity levels and health care attendance.

Results

One month after a new pain episode, the pain was reduced by 0.91 (95% CI; 0.50 – 1.32) and 1.40 (95% CI; 0.82 – 1.99) for NP and LBP cases, respectively, with little change in the follow-up year. Average pain reduction at 3, 6, and 12 months was 30%, 35%, 40% for neck pain, and 30%, 46%, and 42% for low back pain. However, pain intensity remained unchanged over the follow-up year for those with equal pain intensity in the neck and low back at baseline and for those reporting four or more pain sites at baseline. Overall, complete resolution of pain at 12-month follow-up was unattainable for the majority of the subjects regardless of the complexity of pain symptoms.

Relevance

The study provides important reference data for outcome of pain in clinical trials and practice.

Discussion And Conclusions

Pain declined rapidly within one month for those with either NP or LBP. The course of pain resembles that of patients in clinical trials despite that only one in five sought health care for their pain during the follow-up year. Some important subgroups with more complex pain patterns showed no change in pain over the follow-up year, pointing to subjects who should receive closer attention by researchers and clinicians.

Implications

The clinical course of NP and LBP in clinical trials and practice must be assessed against the natural course of pain symptoms.

Keywords
Pain intensity, low back pain, neck pain, natural course, general population

PHYSIOTHERAPY MANAGEMENT FOR NEUROPATHIC SPINAL PAIN: A SYSTEMATIC REVIEW

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Background
Neuropathic pain arises as a direct consequence of a lesion or disease of the somatosensory system. The literature suggests a high prevalence of neuropathic pain among people with chronic low back pain (LBP). Despite numerous efforts to introduce novel treatment approaches, evidence on efficacy of such approaches remain questionable. Failure of all available interventions in reducing chronicity and associated disability, has been partly attributed to lack of specific diagnosis. Clinical studies suggest specific characteristics of patients with neuropathic pain that could guide management of such patients.

Purpose/Aim
The aim of this paper is to explore the evidence related to the management of neuropathic manifestations associated with LBP.

Materials and Methods
A systematic review of published literature was conducted using: MEDLINE, ProQuest, and PubMed from earliest record until the year 2012. Key words used included: low back pain, physiotherapy, neuropathic pain, and/or radiculopathy. Authors reviewed the resulted list of paper abstracts. Full papers, which are relevant, according to the inclusion criteria, were reviewed again. The quality of studies was assessed using the guidelines suggested by Cochrane handbook.

Results
Over 65 papers met the inclusion criteria. Little evidence is available about the benefits of different physiotherapy techniques to manage neuropathic pain. The available evidence reported general goals for managing peripheral neuropathic pain to reduce the mechanosensitivity of the nervous system and restore its normal capabilities for movement. Educating patients about pain was suggested as one method that can alter negative beliefs about pain experience. Addressing non-neural tissue impairments could facilitate relative unloading of mechanically sensitive neural tissues. Other techniques such as neural tissue mobilization, gliding techniques, and tensile loading techniques, showed some efficacy in managing neuropathic pain.

Conclusions and Implications
It was recommended that diagnosing the neuropathic pain manifestation may be the first step towards better treatment. Mixed methods may provide better outcomes for patients with neuropathic spinal pain. Further research is needed to improve patient outcomes.

Keywords
Low back pain, neuropathic pain, physiotherapy, conservative management

SCREENING FOR RED FLAGS AMONG PATIENTS WITH LOW BACK PAIN IN OUTPATIENT SETTING: A SYSTEMATIC REVIEW OF OBSERVATIONAL STUDIES

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Background
The clinical manifestations of serious spinal pathologies such as cancer or infection can mimic neuromuscular or musculoskeletal dysfunctions. As autonomous professionals, physiotherapists must be able to identify abnormal tissue and red flag signs and symptoms in such cases.

Purpose/Aim
The aim of this paper is to investigate the use of red flags screening in the management of low back pain. Special emphasis was placed on studying the utility of guidelines in physical therapy in the Middle East.

Materials and Methods
A systematic review of published literature until the year 2012 was conducted using the key words: low back pain, red flags, physiotherapy, guidelines, and Middle East. Authors reviewed the resulted list of paper abstracts. Observational studies that met the inclusion criteria were assessed using the STROBE checklist of observational studies.

Results
There were no published papers on physiotherapy practice for screening for red flags among low back pain patients in the Middle East. The search identified over 80 relevant studies published between 2003 and 2012, of which the majority were cross-sectional studies or case-reports. Cancer and fracture were the most common spinal pathologies reported. Studies have shown that pain is rarely an early warning sign of cancer, however it occurs in 60-80% of patients with solid tumors. Pain and local swelling are common clinical features associated with sarcomas in addition to the usual red flags such as unexplained weight loss and fatigue. Studies have also shown that 68% of patients screened by physiotherapists, who required referral to a physician, were mainly presenting with neuromusculoskeletal disorders including cancer. The most common source of referral of those patients was family physicians and orthopedists.

Conclusion and Implications
Physiotherapists are required to have an understanding of the clinical findings associated with the presence of serious underlying diseases causing low back pain, as this information provides guidance as to when communication with the patient's physician is warranted. The lack of published guidelines in the region reflects inadequacies in the management of back pain, and warrants action to develop and implement red flags screening. Further studies are required to investigate the practice of screening for red flags among physiotherapists in the Middle East.

Relevance
The use of red flags has significant implications for patient safety. Regional efforts should be directed to developing national guidelines that will improve the overall management of back pain.

Keywords
Low back pain, red flags, physiotherapy, screening, Middle East

THE RELATION BETWEEN LOW BACK PAIN AND THE TIME OF USE OF THE BALLISTIC VEST IN MILITARY POLICE OF THE CITY OF CAXIAS DO SUL, RS, BRAZIL

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Introduction
Low back pain affects 70-85% of the population at some time in life and is the leading cause of disability and absenteeism in industrialized countries, affecting mainly adult workers. Labor activity can be the main trigger of pain in workers, performing major influence in this condition.

Objective
To identify the relation between the presence of low back pain according to the time of use of the ballistic vests by military police officers in the city of Caxias do Sul, RS, Brazil.

Material and Methods
This is an observational cross-sectional study, composed by a sample of 154 participants. The Nordic Musculoskeletal Questionnaire associated with an evaluation form to collect specific data to each individual, were used to analyze the variables.

Results
Through Pearson's correlation analysis, a statistically significant difference was found regarding the presence of low back pain and the time of use of ballistic vest in months ($p = 0.012$), where 66% of the sample had low back pain with an average time of exposition of approximately 32 months, and participants have an mean time of 42 months of corporation time. Among those who does not have back pain, this values reaches 13 months only.

Relevance
In the literature, few studies have attempted to evaluate the influence of ballistic vest on the prevalence of low back pain in the military. This question becomes important to quantify the actual influence of Personal Protection Equipment in the lumbar system and elaboration of possible preventive approaches for this population.

Conclusion
There is a significant correlation between the time of use of the ballistic vest in months regarding the prevalence of low back pain in the military of the city of Caxias do Sul, RS, Brazil.

Discussion
Prevalence studies in this area have also identified the existence of low back pain in this population of approximately 52% to 74%. The time of the military corporation, along with the usage time of vest can influence the existence of low back pain due to long exposure to the ballistic vest. It was observed at the end of this research that there is a relation between the total time in months of using ballistic vest and the development of low back pain, where the longer the use of the vest, the military are more likely to develop low back pain.

Keywords
Low back pain, Physical Therapy, Epidemiology

EPIDEMIOLOGICAL CHARACTERIZATION OF SIGNIFICANT PHYSICAL CHANGES OF A GROUP OF MILITARY POLICE IN THE CITY OF CAXIAS DO SUL, RS, BRAZIL

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Introduction

The military police stand out from the general population and other professionals due the heavy workload and psychological suffering, justifying therefore its biggest physical and mental stress, which makes them more susceptible to work related injuries.

Objective

To characterize epidemiologically the major physical changes of a group of military police officers of the city of Caxias do Sul, RS, Brazil.

Material and Methods

This was a cross-sectional study, conducted at the University of Caxias do Sul (UCS) in the second half of 2012, consisting of a sample of 154 participants. An evaluation form to collect specific data from each individual was used to analyze the variables.

Results

Through descriptive analysis, it was observed that 82% of this population is male, Caucasian (77%), the majority is married (57%) with a mean age of 31 years old. Regarding job characteristics, 70,4% refers back pain and the highest prevalence occurs at low back site (66%), 36% adopts mainly the orthostatic posture along the day. When the use of Personal Protective Equipment was questioned, 100% reported the use of bulletproof vest of approximately 5 Kg, with a mean time of 10 hours a day, with an average use around 32 months and participants refers a mean time of 42 months in the corporation. Regarding the physical changes, 27% have lateral pelvic tilt, 22% anterior pelvic tilt, 30% posterior pelvic tilt. In the Laseague test, Slump test and Piriformis test, 7, 6 and 11% respectively of the military showed positive results.

Relevance

In the literature, few studies are willing to trace the main epidemiological characteristics and evaluate the main physical changes in the military police. This question becomes important for the development of possible preventive approaches for this population.

Conclusion

After analyzing the data from this population, it is perceived the high prevalence of pain and physical changes in individuals, especially postural changes. Furthermore, there is a high workload of the police officers in the standing position due to the long exposure of the bulletproof vest.

Discussion

Prevalence studies in this area have also identified the existence of pain in this population of approximately 52% to 74%. These rates suggest higher prevalence of pains in military police than in other professions, for example, garbage collectors (34.48%). The data from the study suggest that limited postures, especially while standing, for a long period are extremely harmful to the musculoskeletal system, which is the case of the military police of the present study.

Keywords
Military, prevalence, pain, physical changes

PREVALENCE OF BACK PAIN IN A GROUP OF MILITARY POLICE IN COMPARISON TO A GROUP OF CIVILIANS WORKERS IN THE CITY OF CAXIAS DO SUL, RS, BRAZIL

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Introduction

Back pain is a common complaint. Most people in the world will experience low back pain at least once during their lives. Several risk factors are related to back problems such as physical fitness status, postural changes, age, sex, smoking and job activities.

Objective

To compare the prevalence of back pain of military police and a group of civilian workers.

Material and Methods

This was a cross-sectional study, conducted at the University of Caxias do Sul in the year of 2012, consisting of a sample of 107 police officers and 77 civilian workers. To analyze the variables was used an evaluation form to collect specific data from each individual, in addition to the Nordic Musculoskeletal Questionnaire. Descriptive statistics were used to present the data and, in order to verify differences between groups, the independent t Student test and relative risk (RR) were calculated.

Results

Through the Nordic questionnaire, it was observed that 70.4% of militaries experience back pain, versus 44% of the civilian population ($p = 0.0000$) with a risk of 1,88 (CI 1,3 – 2,6). Data for comparison between work journey and BMI had significant differences (respectively $p = 0.002$ and $p = 0.001$). The military police had a work journey of 8.96 hours / day, while the civilians work 8.1 hours / day, demonstrating that military group worked more hours than the comparison group. The same occurs with BMI, where the military had significantly higher values compared to the civilians (25.9 X 24.1).

Relevance

Military policemen are more susceptible to develop back pain than civilian workers. Any pain symptoms, especially of the spine can limit the practice of their functions, it increases stress, decreases the perception of well-being and can influence their judgment, resulting in the need for more attention from public healthcare in relation to these workers.

Conclusion

After analyzing the data of the groups the military group presented a higher BMI and longer work journey, also reported a higher risk to develop painful episodes, especially in the spine. Discussion: The prevalence of back pain found in the military group is consistent with other studies in the area. Regarding the work journey and BMI, was found that the military group had different characteristics than the civilian group. It is possible that these results could somehow justify the higher risk of back pain for the military group. Prevalence studies in this area have also identified the existence of pain in approximately 52% to 74% of militaries.

Keywords
Military, civilian, work related pain

THE EFFECT OF BALANCE EXERCISE USING A PILLAR ON DEEP-SEATED MUSCLE OF THE BODY TRUNK – EVALUATION OF ACTIVITIES OF TRANSVERSUS ABDOMINID BY USING MRI

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Background

On the basis of the importance of postures for prevention of low back pain, there have been many reports in recent years, showing that deep-seated muscles of the trunk play important roles in maintaining proper postures. Balance exercise in a sitting position is recognized as a method for exercise of deep muscles of the trunk. However, whether this method is efficient for the maintenance of proper postures has not yet been demonstrated, because it is difficult to evaluate activities of deep muscles from the surface of the body.

Design

The effect of the balance exercise on deep muscles was analyzed with changes in the thickness of muscle on magnetic resonance imaging (MRI) as an indicator of the muscle activities.

Objective

The effect of balance exercise in a supine position on a pillar on deep muscles of the body trunk was analyzed. The objective of this study was to estimate the efficacy of the exercise from the results of the analysis.

Methods

The subjects were 13 male adults (mean age, 20.5). They were instructed to take a supine position on a pillar [400mm * 150mm *75mmm; Pelvic board (Stretch Pole: LPN). The experiment was conducted on these three conditions. N: In stable supine posture without using the pillar. P: In supine posture using a pillar. E: In supine posture using the pillar, keep balancing with one lower extremity raised. The system used was 3.0-T (PHILIPS Inc.). The imaging technique was T1 emphasis picture,(TR)128msec,(TE)2.3msec. The muscles analyzed were the musculus transversus abdominis (TrA). A horizontal transverse image of the 4th lumbar vertebra was made for the analysis. First, the length of the muscle was measured. Then, the center point of the muscle was determined and its thickness was measured. The measurement data was analyzed using one-way ANOVA (Repeated Measurement).

This study was conducted with approval of the Ethics Committee, Tokyo Metropolitan University.

Results

Thickness of TrA in condition N averaged 3.19mm (sd 0.11), in condition P averaged 3.14mm (sd 0.09), and in condition E averaged 3.38mm (sd 0.10). Condition E was shown to be the highest value.

Discussion

The thickness of muscle shows response to muscle contraction. This, in turn, provides evidence for the presence of muscle activities. Thus, these observations and findings indicated that balance exercise with a pillar promotes activities of deep muscles of the body trunk.

Keywords

Low back pain, transversus abdominis, a sitting position, magnetic resonance imaging

RELATIONSHIP BETWEEN SITTING POSITION AND AMYLASE

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Purpose

It is assumed that performing a desk job for many hours may become a mental stressor. To reduce stress, it is believed that simple physical exercise is effective. Moreover, it is known that stress will cause low back pain. The mitigation of stress may be able to prevent low back pain. However, the relationship between sitting position and stress has not been fully identified. The purpose of this study was to clarify the relationship between sitting position and stress by using amylase as an index.

Subjects

19 healthy male adults (20-22 years old).

Methods

All subjects were instructed to take a sitting position on a hard chair and to perform a desk job for 30 minutes. Five (5)ml blood samples from each subject were collected from subjects' cubital veins before and after the experiment. The blood sampling was performed by Doctor Kinoshita. Samples were subjected to component analysis after the experiment. Salivary amylase (s-AMY) levels were determined. The data were statistically analyzed using a matched t-test, with significance level set at $p<0.05$.

This study was conducted with the approval of the Ethics Committee of the Tokyo Metropolitan University.

Results

The s-AMY level before the experiment, 54.29 (SD 14.65) U/L, increased to 56.59 (SD 15.28) U/L after the experiment, showing a significant difference.

Discussion

It is recognized that blood s-AMY levels increased under stressful condition. In the present experiment, the subjects were instructed to perform a desk job, and the results imply that stress increased by sitting on a hard chair. It is thought that it caused stress while the hard chair applied the burden to the body. Low back pain will be caused if this state is continued. Thus, the findings indicated that the application of light exercise is effective for improving blood circulation and for stress reduction.

Keywords

Low back pain, blood s-AMY, a sitting position

THE EFFICACY OF DIRECTIONAL PREFERENCE MANAGEMENT FOR LOW BACK PAIN: A SYSTEMATIC REVIEW

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Introduction
Providing specific treatment based on symptom response for people with low back pain (LBP) and a directional preference (DP) is a widely used treatment approach. The efficacy of treatment using the principles of directional preference management (DPM) for LBP is unclear.

Purpose/Aim
To determine the efficacy of treatment using the principles of DPM for people with LBP and a DP.

Materials and Methods
This study was an update of a previously published systematic review1 by the same author group. Computer databases were searched for randomized controlled trials (RCTs) published in English up to October 2011. Only RCTs investigating DPM for people with LBP and a DP were included. Outcomes for pain, back specific function and work participation were extracted. A qualitative analysis using the GRADE approach was performed.

Results
Seven RCTs with a total of 781 participants were included in this review, with six trials considered high quality. Clinical heterogeneity of the included trials prevented meta-analysis. GRADE quality assessment revealed mixed results, however moderate evidence was identified that DPM was significantly more effective than a number of comparison treatments for pain, function and work participation at short, intermediate and long-term follow-up. No trials found that DPM was significantly less effective than comparison treatments.

Relevance
Providing specific treatment based on symptom response for people with LBP and a DP is a widely used treatment approach. This systematic review provides some evidence supporting the effectiveness of treatment using the principles of DPM.

Conclusions
Some evidence was found supporting the effectiveness of DPM when applied to participants with LBP and a DP, particularly at short and intermediate term follow-up. However, the evidence was generally mixed with a number of trials revealing conflicting results or showing no effect.

Discussion
This review identified mixed evidence for the effectiveness of DPM. The findings of an updated systematic search to March 2013 will be presented.

Implications
Further high quality RCTs are warranted to evaluate the effect of DPM applied to people with LBP and a DP. Future research should consider replication of existing trials that demonstrated large effects and detailed operational definitions of classification and treatment protocols.

Keywords
Systematic review, low back pain, directional preference

Reference

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LOW LEVELS OF PAIN AND DISABILITY AT THE BASELINE PREDICTS POOR OUTCOMES IN NON SPECIFIC CHRONIC LOW BACK PAIN AFTER PHYSIOTHERAPY MULTIMODAL TREATMENT

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Introduction

Non-specific chronic low back pain (NSCLBP) is a widely referred clinical condition to physiotherapy (PT) practice, but the treatment effectiveness seems to be dependent of specific patient characteristics. The identification of these factors could help to better match treatments to patient characteristics and to improve PT treatment effectiveness.

Purpose/Aim

The aim of this study was to identify prognostic factors associated with poor outcomes after 6 weeks of physiotherapy, in non-specific chronic low back pain patients.

Material and Methods

A multicenter prospective study, including 119 NSCLBP' patients, was developed during 6-week multimodal physiotherapy treatment. Participants were considered eligible if they had NSCLBP, with or without leg pain, for at least 3 months, and were aged between 18 and 65 years. All participants were managed according to their clinical need.

Patients were assessed at the baseline and immediately after 6 weeks. Socio-demographic variables, characteristics of LBP, and psychosocial factors were included as potential predictors of the outcomes. Based on a previous study, poor outcomes were defined as changes in the Quebec Back pain Disability Scale (minimal clinically important difference-MCID–QBPDS-PT) of < 7 points (range values: 0-100) and Visual Analogue Scale (MCDI- VAS) < 2 points (ranging 0 to 10). Logistic regression analyses (backward method) were used to identify the associations between predictors and the outcomes at the 6 weeks follow-up.

Results

Of the 132 patients enrolled in the physical therapy treatment, 119 completed the follow-up (mean age of 47,1±12,4). Rates of non-success were at 6 weeks of physiotherapy treatment, 42,9% and 45,4% for disability and pain respectively. For the outcome "disability", in the final multivariate model, poor outcome was significantly associated with lower levels of disability at the baseline (OR 0,96 -IC95% 0,934-0,981). The logistic regression model was statistically significant ($\chi 2(6) = 15.067$, $p < .0001$) and explained 16,0% (Nagelkerke R2) of the variance of the non-improvement of the disability above the MCID. The model correctly classifies 68,1% of the patients (sensitivity, 52,9%; specificity, 79,4%).

For the "pain intensity", poor outcome was significantly associated with lower levels of pain at the baseline (OR 0,66 -IC95% 0,542-0,819). The model correctly classifies 66,4% of the patients with an explained variance of 18,5% (sensitivity, 64,8%; specificity, 67,7%).

Conclusions

This study provides evidence of clinically meaningful prognostic indicators of poor short-term outcomes in NSCLBP' patients following a PT treatment. Patients with low levels of pain and disability at the baseline are more likely to experience poor short-term outcomes after PT management. Pain localization, history of pain and kinesiophobia had no significant differences in pain or disability outcomes.

Keywords

Non-Specific Chronic Low Back Pain; Prognosis; Physical Therapy

ARE JOB STRAIN AND SLEEPING DISTURBANCES PROGNOSTIC FACTORS FOR NECK PAIN? A COHORT STUDY OF A GENERAL POPULATION IN WORKING AGE IN SWEDEN

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Background

Little is known of the prognosis of neck pain, and what determines how mild neck pain to turns into troublesome. It is proposed that workers who are exposed to a job strain situation (high job demands and low job control) have an increased risk of psychological strain and stress-related disease. A factor proposed to associate with the impact of job strain in the prognosis of neck pain is sleep disturbances.

Aim

We sought to study the risk of developing troublesome neck pain for persons with occasional neck pain at baseline if having high job demands and/or low job control, and the role of sleep disturbances on such an association.

Method

A population-based cohort of 6979 subjects (18-61 years) with occasional neck pain at baseline (in 2006) who were re-surveyed in 2010. Prognostic factors were high job demands and/or low job control and sleep disturbances at baseline. Logistic regression analyses were used to assess the association between exposures and outcome and to test and adjust for confounding.

Results

Subjects reporting high job demands (OR 1.5, 95% CI 1.2-1.9), low job control (OR 1.3, 95% CI 1.0-1.7) and job strain (OR 1.6, 95% CI 1.0-2.8) had higher odds of developing troublesome neck pain than those without theses exposures. Mild sleep disturbance (OR 1.5, 95% CI 1.3-1.8) and severe sleep disturbance (OR 2.2, 95% CI 1.5-3.1) was associated with higher odds of developing troublesome neck pain. The odds ratio for developing troublesome neck pain in those with job strain was increased in persons with mild or severe sleep disturbances but not in those with no sleep disturbances.

Relevance

Modifiable factors such as work-related and psychosocial factors are important to investigate in order to prevent troublesome neck pain.

Conclusion

In the general population of working age reporting occasional neck pain, job strain and sleep disturbances are prognostic factors for the development of troublesome neck pain. Our data suggests that severe sleep disturbances may act as an effect measure modifier in the association between job strain and troublesome neck pain.

Discussion

High job demands, low job control and sleep disturbance seem to be important factors to take into consideration among individuals with occasional neck pain. As of today we don’t know how sleep disturbances mediate psycho-social factors such as job strain in the pathway of developing troublesome neck pain. To investigate how sleep interact in the course of neck pain, further large prospective studied are needed.

Implications

It may be important in clinical everyday work to take job strain and sleep disturbances into consideration when evaluating the prognosis of neck pain.

Keywords

Neck pain, sleep disturbance, job strain, prognostic factors

TRABECULAR BONE SCORE AND BONE MINERAL DENSITY OF LUMBAR SPINE IN HEALTHY WOMEN: PROS AND CONS

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Introduction

Areal Bone mineral density (aBMD) of the PA spine and proximal femur remained the gold standard for WHO classification of osteoporosis, fracture prediction and patient monitoring. Unfortunately, with age it is not infrequent to observe the presence of degenerative disease such as spinal osteoarthritis which would have a positive artifactual impact on aBMD which could lead to an erroneous interpretation. In a previous study it has been demonstrated that apparently such artifact would have limited impact on the Trabecular Bone Score (TBS).

The aim of this study was to evaluate the PA spine TBS and site matched BMD (BMDLS) in healthy women of various ages and verify how the “normal” presence of such artifact would impact the outcome.

Materials and Methods

All women who had prior exposure to corticosteroids, systemic illness or who were taking medications known to affect bone metabolism were not included. Similarly all fractured subjects were excluded from this analysis. We’ve examined 176 healthy women aged 40-79 years (mean age – 53.4±0.6 yrs; mean height – 1.64±0.005 m; mean weight – 80.4±1.1 kg). The patients were divided into the following age-dependent groups: 40-49 yrs (n=53), 50-59 yrs (n=89), 60-69 yrs (n=17), 70-79 yrs (n=17). BMD of whole body, PA lumbar spine and proximal femur were measured by DXA method (Prodigy, GEHC Lunar, Madison, WI, USA) and PA spine TBS were assessed by TBS iNsight® software package installed on our DXA machine (Med-Imaps, Pessac, France).

Results

We observed a significant decrease of TBS (L1-L4) as a function of age (40-49 yrs – 1.334±0.016; 50-59 yrs – 1.289±0.013; 60-69 yrs – 1.194±0.034; 70-79 yrs – 1.205±0.050; F=6.56; p=0.0003) whereas PA spine BMD was significantly increasing with age (BMDLS: 40-49 yrs – 1.126±0.015 g/cm2; 50-59 yrs – 1.234±0.013 g/cm2; 60-69 yrs – 1.343±0.053 g/cm2; 70-79 yrs – 1.348±0.100 g/cm2; F=4.04; p=0.008). In this population, BMD of femoral neck didn’t show any significant variations.

TBS decreased with age significantly. BMD of lumbar spine significantly increased in healthy women depending on their age, as it seems to reflect the impact of aggravating spinal osteoarthritis. This contradiction can be traced to the spinal osteoarthritis and degenerative diseases progressing with age in the elderly patients.

Conclusion

Thus, TBS is an independent parameter which has a potential diagnostic value of its own, without taking into account the bone mineral density in case of bone degenerative diseases. We can also use the TBS method for the differential diagnosis of the process at the lumbar spine.

CHILDREN BACK PAIN: SCOLIOSIS AMONG FEMALE SCHOOL CHILDREN IN UAE

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The purpose of this study was to determine the percentage of scoliosis in female school aged children between (12-14) years old. Quantitative, observational cross sectional design study was conducted on 500 female children aged between 12-14 years old at ten public schools within UAE Study. Anthropometric measurements were done for weight, height and BMI, and then another measurement for spinal deviation, shoulder tilt and pelvic tilt were taken. The results showed that 42 % had thoracic and lumber scoliosis and 19 % had a double curvature. The percentage of spinal deviation which was ranged from (0 to 1.1 cm) represented 44.44%, while spinal deviation from (1 to 2.1 cm) represented 28.28% and 28.28 % represented the subjects who had spinal deviation from (2.1-5 cm). Also, there was statistically significant positive correlation between spinal deviations, Shoulder tilt and pelvic tilt. Conclusion: This study has provided us with the percentage of scoliosis among female aged school (12-14). Also, it shows us that the symmertrigraph posture graft and scoliometer is consistent, reliable and feasible to use for future studies. The Study was approved from College of Health Sciences- University of Sharjah research ethical committee

Keywords
Scoliosis, female, school aged children, United Arab of Emirates

PREDICTIVE VALUE OF BADGLEY BOOK AND FULCRUM SIGNS FOR EFFICACIOUS SACROILIAC JOINT FUSION

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Introduction

Report of novel provocation maneuvers to elicit signs (Badgley Book and Fulcrum Signs) with predictive value for operative correction of Sacroiliac Joint (SIJ) hypermobility disorder. The Badgley Book Sign (BBS) and Fulcrum Sign (FS) have been previously reported.1Provocation of these signs is measurable and reproducible. BBS and FS do not rely upon patients' subjective impressions of pain as an end point, and force of tissue deformation (body weight) is constant at each examination. BBS is elicited by a firm 2.8 cm bolster under ischial prominence contralateral to disordered SIJ of patient seated on a firm seat with legs horizontal. This maneuver shifts center of gravity superior to disordered SIJ eliciting hemi-pelvis counternutation and functional leg shortening, which might be likened to the historically known "Short Leg Sign". BBS is speculated to occur from iliolumbar ligament injury and laxity. FS is elicited by placing the ischial bolster on side of SIJ disorder to cause hemi-pelvis nutation. This maneuver elicits functional leg lengthening, which might be likened to the historically known "Long Leg Sign". FS is speculated to occur from abnormal SIJ subluxation secondary to an injured and lax sacrotuberous ligament.

Purpose/Aim

Comparison of preoperative and postoperative (SIJ fusion) examinations to determine operative therapeutic efficacy and provocation sign resolution.

Materials and Methods

Patients with suspected SIJ hypermobility were selected by history and physical examination and referred to a surgeon skillful at diagnosis and correction of this disorder with fusion. Preoperative and postoperative evaluations (including photographs) documented patients' functionalities, comfort levels, and provocation of BBS and FS. Patients' normal contralateral hemi-pelvices were the controls.

Results

Postoperatively, BBS and FS were absent in all patients; and dramatic symptomatic improvements were reported. Case studies of six patients are presented. Two dramatic symptoms, previously unreported, were the "giving away" phenomenon and transient unilateral global leg paresis associated with SIJ capsule tear and extravasation (seen on fluoroscopy) of injectate (local anesthetic and Isovue radiopaque dye) used in fluoroscopic-guided diagnostic block of patients' disordered SIJs.

Relevance

Diagnostic methodology based on measurability and reproducibility enhances understanding of a significant cause of chronic low back pain.

Conclusions

A standardized physical examination format can effectively identify symptomatic SIJ disorders amenable to surgical fusion.

Discussions

The physical examination method reported herein is easily applied, non-invasive, and readily interpreted. Marriage of patient symptoms and suffering with physical findings enables appropriate referral to surgeons who can evaluate patients for corrective surgery.

Implications

Clinicians have improved methodology for diagnosing SIJ hypermobility disorder to help resolve the epidemic of chronic low back pain.

Keywords

Counternutation, Long Leg Sign, Nutation, Sacroiliac joint fusion, Sacroiliac joint hypermobility, Short Leg Sign

Reference

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DELIVERING HIGHER VALUE LOW BACK PAIN CARE BY USING RISK STRATIFICATION TO DETERMINE ENTRY POINT IN A HEALTH CARE SYSTEM

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Introduction
The cost to manage low back pain (LBP) has continued to grow and the outcomes have worsened. Greater than 50% of people begin LBP care with primary care. Primary care physicians (PCPs) often have less training in assessing and treating LBP compared to physical therapists (PTs) and medical spine specialists (MSS), non-surgical spine physicians.

Purpose
This quality improvement pilot sought to determine if using risk stratification to guide a LBP patient's entry-point would deliver higher value care than customary care.

Methods
Patients seeking care from PCPs or PTs were routed to a provider based on their risk for long-term disability as a result of their LBP. High, Medium and Low risk levels were determined using the Keele STarT Back tool, a 9-question survey.

Patients calling their PCPs to schedule an appointment for LBP were directed to a nurse triage line. After passing a red-flag screen, the patients were risk stratified. In accordance with best practice, nurses provided Low and Medium risk patients reassurance and self-management instructions. Patients who still preferred a clinic visit were scheduled with a PT rather than with a PCP or MSS. High-risk patients were encouraged to schedule with a MSS. Quality of care was assessed on the appropriateness and safety of the referrals as determined by a spine surgeon who was not involved with the pilot. Patient experience was assessed through phone interviews one week after completing care.

Patients referred to physical therapy were matched to PTs based on their individual risk levels. PTs self-selected which risk levels they could competently treat after reviewing evidence-based, best practice care for each of the levels. Patient improvement was measured with the Oswestry Disability Index (ODI).

Results
All of the care and referrals for patients calling into the primary care nurse triage line were deemed appropriate and safe. Patients were referred onto PTs, MSSs, emergency departments and self management. Patients expressed satisfaction in being reassured their condition was not dangerous, speaking immediately with someone who could educate them in comfort and self-management, and saving both time and money by avoiding a physician visit. All patients were satisfied with the nurses' level of clinical expertise and did not seek a visit with a PCP or MSS when offered.

Forty three patients were referred to PTs; 88% were risk-level matched. The average ODI improvement of those matched was 42% in 5.1 visits. Standard care averaged a 27% improvement in 6.0 visits.

Discussion

Phone triaging by nurses can safely direct patients to an appropriate and satisfying, entry-level provider, reducing utilization by at least one physician visit for most patients. Risk stratifying LBP patients seeing PTs demonstrates significantly improved outcomes in fewer visits. The 56% improvement over standard care equates to .06 QALYs. Based on these results, a community could potentially save 21-42% in indirect costs associated with LBP.

FEAR AVOIDANCE BELIEFS ACTIVATE THE FEAR NETWORK IN CHRONIC LOW BACK PAIN PATIENTS

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Introduction

Fear-avoidance beliefs (FAB's) are represented by a specific fear related to movement and physical activity that is wrongfully assumed to cause pain or (re)-injury in patients with low back pain (LBP). In the acute stage of LBP such beliefs can have a supporting role, as pain has still a warning function and should facilitate withdrawal from usual activities to support the healing process. However, in the case of enduring pain, avoidance of activity results in deconditioning a patient due to negative changes in structure and function that can result in augmented pain. The FABs model represents a cognitive scheme that can be assessed by modern neuroimaging methods. It is surprising that to date only one functional magnetic resonance imaging (fMRI) study investigated the neural correlates of FABs, given the importance of this model in the process of chronification. However this study failed to show activation in the fear network.

Purpose/Aim

The present functional magnetic resonance imaging (fMRI) study aimed to reveal neural correlates of FAB's in healthy controls and chronic LBP patients.

Materials and Methods

Thirteen healthy subjects and 13 CLBP patients took part in this fMRI study. It is established that sensorimotor regions in the human mirror system, become active in response not only to the execution of an action but also during an observation of the same action performed by others. Thus, observation can be used as a proxy for physical execution of an action in order to investigate FAB's. In the MR environment we presented video-clips, showing harmful (lifting a flowerpot, shoveling, vacuum-cleaning) and harmless activities (walking, going up/down the stairs). The activations were selected based on the established fear hierarchy of the Photograph Series of Daily Activities (PHODA). We presented 45 harmful and 45 harmless video clips of 5s duration. Participants had to observe the activities. Immediately after the presentation they had to rate the harmfulness of the activity on a visual analogue scale (VAS). fMRI data were analyzed using SPM8. For the analysis of the fear networks we performed a region of interest approach with a limited voxel space, including the cingulate and insular cortex as well as the amygdale. The results were family-wise error corrected ($p<0.05$).

Results

The mere observation of videos displaying harmful daily activities activated the fear network in healthy subjects and CLBP patients. The contrast between the CLBP patients minus the control group revealed additional foci of activation bilaterally in the insular cortex and the amygdala. The inverse contrast did not show stronger activation in the healthy subjects.

The ratings for the harmfulness of the video clips revealed a significant difference between the harmful and harmless activities in the control group and the CLBP patients ($p<0.001$).

Conclusions

The observation of harmful daily activities activates the fear network in CLBP patients significantly stronger than in the control group, although the ratings for harmfulness were congruent. Thus, also healthy subjects show signs of FAB's in the absence of LBP.

Discussions

For the first time we were able to show neural correlates of FAB's in CLBP patients and the fMRI data is supported by the behavioral measures. The result supports the assumptions of the FAB's model that the experience of painful movements activates the fear network. However, also the asymptomatic control group showed an inappropriate perception of harmful activities.

Implications

The fact that the perception of harmful daily activities activates the fear network in CLBP patients and healthy controls has two important implications for preventive strategies. 1) Clinicians should provide appropriate information at an early stage of LBP to diminish unrealistic fears to prevent a chronification. 2) There is a need for greater public education regarding wrong perceptions related to FAB in back pain.

Keywords

fMRI, beliefs, fear avoidance, kinesiophobia, healthy, low back pain

EFFICACY OF LOW LEVEL LASER THERAPY (LLLT) IN LUMBAR DISCOPATHIC PAIN (RANDOMIZED-CONTROLLED STUDY)

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Introduction

It is important to find effective treatment method for lumbar discopathic pain as illnesses in spinal neuro-musculo-skeletal system causes a considerable number of sick-leave days in Iran .LLLT has not yet been fully adopted as a treatment method-research in laser has proved that laser light reduces pain by frequent responses such as: 1-Increase in b-endorphins.2-blocked depolarization of c-fiber afferent nerves &… Purpose: The purpose of this study is evaluating the effect of LLLT for lumbar discopathic pain .We combined laser therapy with regular physiotherapy to compare the results.

Material and Methods

A group of 42 patients between 25 and 65 old applied to our out-patient clinics with complaints of lumbar discopathic pain that had diagnosed of discopathy with MRI. Patients randomized in 2 groups (21 patients in each group). Their pain was estimated objectively & subjectively from 4 below tests before treatment, at the end of treatment (2 weeks, 5days in each week without weekends) and 2 weeks after treatment.Group1: Laser therapy with physiotherapy & Group2: physiotherapy without laser therapy. Tests: 1-Trigger point palpation pain. 2- VAS. 3- NHP: Nottingham health profile. 4- NPAINAD (non-verbal pain assessment in advanced dementia). The collected information was processed by computer. T-test was used for the statistical evaluation of data. Level of significance was minimum value of $P<.05$. Parameters for laser applicators: laser type: scanner semiconductor GA-AS 808 nm. Max. Power out put: 400mw. Max. Energy density: 10 J/cm2. polaris2

Results

There was no significant difference between two groups before treatment. There was significant improvement in the active laser group with PT group at the end of treatment and 2 weeks after completion treatment ($p<0.01$). PT alone seemed to aid relieving pain significantly while LLLT with PT had superior significant effect in reducing pain of discopathy within 2 weeks follow up.

Relevance

Randomized from all out-patients referred to our department with complaints of lumbar discopathy diagnosed of MRI & age limitation between 25-65 in both sex (female-male).Time of study: from 2011/10/01 up 2012/03/01

Conclusions

Therapeutic laser offer a safe often effective, easily utilized primary or adjunctive therapy that is relatively cost effective for clinician & patient. LLLT is more effective in pain relief and in the improvement of functional ability & quality of life thus LLLT can be an important adjunct especially in patients with adverse side effects to drugs and invasive treatment.

Discussion

In the planning stage of this study, we had difficulties in finding related documents. Still there are many open questions: what is the real mechanism of therapy? What is the correct dosage per point (area)? Because of the large number of positive reports and the innocuous of therapies, further clinical evaluation of laser therapy is recommended. Placebo controlled trials with high methodological quality in which the features of the laser are well documented are still required.

Implications

The study shows that LLLT has a significant, positive effect on lumbar discopathic pain compared with PT without laser treatment. Laser therapy has the most significant effect .In order to optimize the choice of treatment parameters, further studies are required.

Keywords

LLLT, lumbar discopatic pain, physiotherapy, pain assessment

MOTOR CONTROL EXERCISE FOR TREATMENT OF LOW BACK PAIN SECONDARY TO HERNIA: A PILOT STUDY

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Introduction

Most of the population will experience an episode of low back pain (LBP) during their lifetime, with a high recurrence rate. Chronic LBP is severely incapacitating and generates changes in feedforward mechanisms leading to a reduction of the motor control due to inhibition of the deep muscles. High levels of functional disability and pain are the main indications for surgical treatment of LBP.

Purpose/Aim

Verify the response of two physiotherapeutic treatments in pain of patients with lumbar herniated disc with surgical referral.

Material and Methods

It was performed a single blind randomized clinical trial. The sample included 10 volunteers divided in motor control exercise and mobilization associated to passive kinesiotherapy. The groups underwent 12 treatment sessions with a half-hour length and a two times a week frequency. Participants reported the intensity of your pain and responded the 2.0 Oswestry Disability Index at the beginning and end of treatment.

Results

The overall sample showed an reduction of the 2.0 Oswestry Disability Index (P=0,04) and the motor control exercise group achieved a reduction in pain intensity compared to baseline (P=0,05).

Relevance

Nowadays the main discussions of ways to treat low back pain involves the training of key muscles in the stabilization of the lumbar segment. Some theories try to explain the relationship that occurs between changes in motor control and pain. Recently a new theory suggests that there are changes at micro (motor unit) and macro level (muscle behavior) occurring a redistribution of muscle activation within and between muscles. Thus, motor control exercise may be a powerful tool in rehabilitation of LBP.

Discussion

O'Leary et al.1 suggest that specific exercises of motor control can have immediate effects of pain modulation, occurring relief of symptoms during movements and evaluation manual palpation after first exercise session of neck muscles. Results are similar to those found in our study, suggesting that motor training is effective to decrease pain.

Conclusions

In conducting our study, patients had a high algic state and not everyone were able to perform exercises pain-free, even so, there was a hypoalgesic response at the end of treatment. Therefore, motor control exercise seems to be an effective resource to be used in LBP of discogenic origin.

Keywords

Low Back Pain, Rehabilitation, Motor Control, Physical Therapy.

Reference

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THE INTERDISCIPLINARY APPROACH TO THE MANAGEMENT OF LUMBAR DYSFUNCTION IN ELITE ATHLETES

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Purpose

To demonstrate lumbar spine rehabilitation in an interdisciplinary model involving the disciplines of Medicine, Physiotherapy, Strength and Conditioning, Psychology, Nutrition and Physiology.

Relevance

A truly interdisciplinary approach has been shown to optimise medical rehabilitation when compared to that of an multidisciplinary team. We have developed a unique rehabilitation unit that involves an intensive programme of treatment and intervention.

Discussion

The rehabilitation process is based on a residential period of one to two weeks at key points in the return to play plan.

The integrated approach applies to all aspects of Assessment, Diagnosis, Intervention strategies and Monitoring

Assessment

Medically led multidisciplinary assessment to establish relevant medical history and contraindications to interventions. All disciplines involved to ensure clear communication to all. Physiotherapy assessments specifically to ascertain manual treatment approach to joint, myofascial and neural pain and dysfunction. Strength assessments to obtain quantitative data on neuromuscular force production and absorption. Conditioning tests to determine load tolerance of specific muscle groups. Sway test to determine directional proprioception deficits. Nutritional assessment to establish need to augment diet to aid Healing, Immunity, Muscle atrophy, or Recovery. Psychology asses to evaluate impact of pain, re establishing trust and confidence in body and the need for neurobiological facilitation to aid healing. Physiology assessment to optimise training adaptation and modifications.

Diagnostics

Clinical, Strength, EMG and Girth measures all done.

Intervention

Characterisation of the dysfunction from all disciplines and appropriate implementation of training regimes and treatment.

Monitoring

Aspects monitored were preparation, response to training load and recovery.

Conclusion

The clear benefit of an interdisciplinary solution is that it results in a far more targeted and effective care of the elite athlete.

Key Words
Interdisciplinary, problem based approach, integrated intervention

CORE MUSCLES EMG ACTIVITY IN HYPERLORDOSIS SUBJECTS DURING BRIDGING EXERCISES ON AND OFF A SWISS BALL

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The stability of the lumbopelvic region is crucial to provide a foundation for movement of the upper and lower extremities, to support loads, and to protect the spinal cord and nerve roots (Panjabi, 1992a). Research from the rehabilitation literature has demonstrated the effectiveness of core stability exercises for reducing the likelihood of lower back and lower extremity injuries (McGill & et al, 2003). The Swiss ball is widely used in the corrective exercises centers as a potential core stability training device. One such application is to use the Swiss ball in the bridging exercises. There is no evidence to indicate that the use of Swiss ball in these exercises is beneficial for people suffering from hyperlordosis.

A within-subjects cross-sectional design was used to investigate differences of core muscles EMG activity in normal lumbar lordosis (NLL) and hyperlordosis (HL) groups during bridging exercises on and off a Swiss ball. Twenty-five males from a convenience sample of college students volunteered. Each subject was then asked to complete a questionnaire which contained questions related to activity levels, training programs, lower back pain (LBP) and injury. On the base of these data, the subjects were included who were healthy and relatively inactive individuals without a LBP problem and abdominal or hip injuries that required care from a physician. Potential subjects were excluded from participation if they had any past or current back pain. Subjects were divided to 2 groups: NLL group (n=13, mean age= 21.00±1.58 years, height= 173±7 cm, mass= 66.69±9.9 Kg, BMI= 22.19±1.68) and functionally HL group (n=12, mean age= 20.42±1.24 years, height= 174±4 cm, mass= 66.76±6.07 Kg, BMI= 22.02±1.48) by the following process: After developing radiographic films, sacral angle were measured. Most of the cases were examined by goniometer on the horizontal light box manually. The same examiner measured the angles twice and the mean value was accepted. The lumbosacral angle was calculated as the angle from the horizontal line to the superior aspect of the sacrum (Nakang, Baekang & Moon, 1996). Surface electromyography activity was recorded from the selected core muscles – rectus abdominis (RA), external oblique (EO), internal oblique/transvers abdominis (IO/TA) and erector spine (ES) - while performing bridge exercises on the matt as well as on a Swiss ball and normalized to maximum voluntary isometric contraction (MVIC).

In both groups during the prone bridge the addition of a Swiss ball resulted in increased myoelectric activity in the RA, EO and IO/TA muscles ($P<0.05$). There were significant increases in the activation of RA, EO and ES muscles during supine bridging on the Swiss ball only in HL group ($P<0.05$).

Results of the study suggest that prone bridge on a Swiss ball is possible to be a useful exercise to restore the pattern of correct contractions of global and local abdominal muscles, specifically in HL group. The supine bridge is not recommended for employs in HL group through the high level activity of the ES muscles.

Keywords

Core Muscles, Surface EMG, Hyperlordosis, Exercise, Swiss Ball

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CLINICAL CHALLENGES OF ADOPTING CLASSIFICATION GUIDED MANAGEMENT FOR NON-SPECIFIC CHRONIC LOW BACK PAIN: WHAT DO THE CLINICANS AND MANAGERS THINK?

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Introduction

There is growing evidence that integrating classification (CS) into the clinical decision-making to guide management of non-specific chronic low back pain (NSCLBP) brings greater benefits to patients than current best practice and management based on guidelines. How this research evidence translates into clinical practice however, is not clear.

Purpose/Aim

To evaluate clinicians' and managers' views, own experiences and attitudes towards CS guided management of NSCLBP.

Materials and Methods

Data from semi-structured interviews with 2 physiotherapy service managers, an extended scope physiotherapy practitioner and a focus group with 5 physiotherapy practitioners from two Health Boards in Wales, UK, was thematically analysed.

Results

Five themes emerged. CS knowledge: Clinicians and managers know different classification systems and agree with its usefulness. Clinicians have specific CSs knowledge, managers viewed classification related to referral pathways and prognosis. Current CS use: Clinicians classify using their experience and clinical reasoning skills shifting between multiple CSs. Managers are confident that staff provide evidence-based service though believe classification is not always practiced across services.

CS advantages/disadvantages: Effectively targeting the right patients for right treatments using evidence-based practice is advantageous. Prevalence of "guru led" CSs developed for research and of limited clinical use is disadvantageous. Barriers: Patients' treatment expectations, threat to clinical autonomy, lack of sufficiently complex CSs, lack of resources to up-skill clinicians and overall CSs fit into complex referral pathways. Enablers: CSs sufficiently complex and placed within clinical reasoning process, mentoring for inexperienced staff, positive engagement with all stakeholders and patients.

Relevance

Clinicians' and managers' views on potential barriers/enablers integrating CS into the clinical management of NSCLBP provide an excellent platform for further development of the CS processes ensuring its clinical usefulness and acceptability.

Conclusion

Clinicians and managers believe that CS enhances therapeutic efficacy of NSCLBP management. Clinicians classify using clinical reasoning skills with no formalized CS process in place. Whilst clinicians view classification to guide specific therapy options, physiotherapy managers have a broader, whole service view.

Discussion

This study provides evidence for clinicians' and managers' positive attitudes towards CS guided NSCLBP management as well as shared concerns for adopting such systems within the highly complex referral pathways, inter-professional agendas and patients' expectations. Although clinicians of varied grades, roles and experience levels were interviewed, they were all physiotherapists, reducing the findings representativeness to other clinical professions.

Implications

To ensure successful integration of CS into clinical practice, future research needs to focus on developing and evaluating sufficiently complex CSs that can fit within the clinical reasoning process and are acceptable to all stakeholders. Multiple CSs that provide specific therapeutic guidance and determine patients' prognosis may need to be considered simultaneously to be useful and acceptable to clinicians.

Keywords

Non-specific chronic low back pain, classification, clinicians attitudes, barriers, enablers

MANIPULATION AND SELECTIVE EXERCISES DECREASE ANTERIOR PELVIC TILT AND LOW-BACK PAIN

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Introduction

Back pain is a major contributor to disability and the rising costs of health care in society. The sacroiliac joint (SIJ) has a close relationship with persistent back pain causes but physiotherapeutic treatment is poorly described.

Objective/Aim

To investigate the effects of SIJ manipulation associated to selective muscle training to treat non-specific low-back pain.

Methods

n=20 female, sedentary, 18-35 y-old, with anterior pelvic tilt and low back pain at least once every 15 days. Each patient performed 3 MVIC knee extension and flexion, with a 6 seconds duration and 3 minutes interval between contractions, measured by a HOMIS™ load cell and by MIOTEC™ electromyography (biceps femoris – BF and rectus femoris – RF) with the knee at 90°. The maximum load for each volunteer was set at 12% of the MVIC measured by load cell, with different numbers of sets and repetitions during 04 weeks of training (concentric exercises: BF; eccentric exercises: RF). A SIJ high-velocity, low-amplitude manipulative thrust preceded the proposed exercise. The photographic records were made with 12.1 mega pixel digital camera. Circular green markers were used for marking the anterior and posterior iliac spines. Digital images were analyzed using Alcimage™ software, measuring the sagittal angle of pelvic tilt. Perceived pain was measured by visual analogue scale (VAS). The volunteers were analyzed before the beginning of protocol (A1) and after the end (A2). Non-parametric test (Wilcoxon) were used to compare A1 and A2, with $\alpha=0.05$.

Results

Perceived pain symptoms decreased after treatment ($p=0.0001$). The differences in the pelvic angles ($p=0.0029$) showed a decrease between A1 and A2, and the electromyography activity of RF increased after the protocol ($p=0.0105$). We observed a significant increase of the load of BF at A2 ($p=0.0032$), with no changes in muscle electromyography activity.

Relevance

An easy and simple protocol seems to trigger the lead factors of pelvic stability, by improving motor control and balance of the pelvic girdle.

Conclusion

By providing specific stimuli to the joint and muscle; positional changes and pain response could be noted, suggesting that the protocol was effective for the subjects' needs.

Discussions

Neurophysiologic stimuli to deform joint and muscle structures, rich in sensory inputs, should lead to changes in the axoplasmic afferent inflow. We inferred that these changes brought awareness to the central nervous system (CNS), modifying motor patterns and contributing to decrease clinical symptoms. For dynamic stabilization of the SIJ, the ideal pattern to improve positional control seems to be a protocol that combines muscle control without exhausting the musculoskeletal system and concomitantly activates joint receptors.

Implications

It is important to notice that the patients showed significant improvement in pain, the initial objective of the study. More studies must aim to understand how the stabilization of the pelvis is neurologically processed to minimize symptoms.

Keywords

Physiotherapy, manipulation, electromyography, low back pain

CONTENT VALIDITY AND RESPONSIVENESS OF A FINNISH VERSION OF THE PATIENT-SPECIFIC FUNCTIONAL SCALE

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Background

The Patient-Specific Functional Scale (PSFS) questionnaire was developed by Stratford and colleagues to provide a method for eliciting, measuring, and recording descriptions of patients' disabilities. It can be used to guide treatment and assess patient outcome. The aim of the study was to translate and validate a Finnish version of the internationally used PSFS questionnaire, by testing it´s content validity and responsiveness and also to translate and conduct a cross-cultural adaptation of the measure.

Methods

The final version of the Finnish questionnaire underwent a cross-cultural adaptation before the validation study. The subjects of the study were patients receiving physiotherapy for low back pain (n=78). They completed the PSFS questionnaire prior to physiotherapy treatment and after treatment series. Roland Morris Disability questionnaires (RMDQ) and Visual Analoque Scale (VAS) were recorded before and after the treatment series.

Results

For content validity, a good correlation of the scores between baseline measures of PSFS and RMDQ were 0.65 (Pearson`s rho) ($p < 0.01$).

For responsiveness, moderate to good correlation among the measures between changes of the PSFS, RMDQ and VAS (0-100 mm) scores were analysed.

Conclusions

The Finnish translation of the PSFS questionnaire performs as the original, is proven reliable and responsive and could be recommended as the assessment tool for clinical and research use.

PILOT STUDY: THE EFFECT OF BALANCING LOAD AND LOAD CAPACITY IN PEOPLE WITH CHRONIC NON-SPECIFIC LOW BACK PAIN AND PELVIC GIRDLE PAIN

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Introduction

The effect of treatment of chronic low back and pelvic girdle pain patients (LBP/PGP) is determined by multiple factors. In behavioural programmes for chronic pain it is common practice to stimulate the patient to diminish rest and become more active. In contrast, internal evaluations of the Dutch rehabilitation centre, the Spine and Joint Centre (SJC) treatment showed that the effect of treatment is reduced when patients are not able to take adequate resting moments. To our knowledge the beneficial effect of resting moments has never been studied.

Aim

To determine the effect of resting moments on pain, limitation in daily activities, fatigue and endurance as prerequisite for adequate therapy.

Methods

This study will include 100 patients, who call in at the Dutch rehabilitation centre (SJC) for a diagnostic consultation prior to therapy. During this consultation patients receive written instructions to take a 15 minute break every 2 hours during their daily activities in the period between diagnostic consult and the start of therapy. Patients are instructed to lie down comfortably and focus on physically relaxing during the break. Evaluation parameters include pain (Visual Analoge Scale, VAS), and limitation in daily activities (Quebec Back Pain Questionnaire QBDS), fatigue (VAS) and pain endurance (duration of time before pain sets on during standing, walking, sitting and laying down). Patients are asked to what extend they succeeded in following the advice given by means of a questionnaire. Data will be collected just before the start of intervention, at the first diagnostic consultation, (T0) and at the beginning of therapy after 2 weeks (T1). Patients who follow the advice strictly will be compared with patients who did not or partially follow the advice.

Results

The results are due June 2013.

Discussion

The results of this study will show whether taking resting moments can be effective in diminishing pain and fatigue. Although this is considered a prerequisite for therapy, the effect of taking breaks on the actual therapy effect will need further study. Patients are asked to fill in the questionnaires frankly, however the possibility of socially desirable answers must be accounted for.

Conclusion

It is expected that the conclusion of this study will be that taking regular breaks will have a beneficial effect on patients as a requirement for effective therapy.

Implications
Patients with overloaded muscular systems due to compensation strategies should not be relentlessly re-activated. Regular short and controlled resting moments improve therapy results.

Keywords
Load, load capacity, resting moments

EFFECTIVENESS OF LUMBAR STABILIZATION EXERCISES FOR CHRONIC LOW BACK PAIN COMPARE TO TRADITIONAL THERAPEUTIC EXERCISES

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Introduction
Therapeutic exercise for chronic low back pain (CLBP) is one of the most important conservative treatments. Recently lumbar stabilization exercise (LSE) focused on deep trunk muscles has attracted considerable attention.

Purpose/Aim
This study investigated effectiveness differences between LSE and traditional therapeutic exercises for CLBP.

Materials and Methods
The subjects were fifty CLBP patients whose pain was persisted for more than 3 months. We divided subjects into the LSE group (31 subjects, 50.7±15.7 years old) and the control group (19 subjects, 58.4±16.7 years old). The LSE group performed drawing-in and prone kneeling, and the control group performed curl-up and back- extension. The exercises were performed during 3 month intervention period. Pain was evaluated using the Visual Analog Scale VAS, while QOL was estimated using the JOABPEQ. Two-way ANOVA with repeated and post hoc tests were used to investigate differences between values prior to and after performance of the therapeutic exercises. Significance was defined as $p < 0.05$.

Results
The median pain value and all scores about QOL of LSE group were significantly improved. On the other hand, the median pain value and all scores about QOL of the control group were not improved over the study period.

Relevance
Deep trunk muscles such as the transverse abdominal and multifidus muscles are involved in the stabilization of the spine. However, it is reported that activities of the deep trunk muscles are insufficient in LBP patients. In previous studies, it is observed that the LSE increase the activity of the transverse abdominal and multifidus muscles.

Conclusions
These results suggest that performance of LSE is more effective method for improving comfort in CLBP patients than traditional exercises.

Discussion
Because the LSEs increase the activity of deep trunk muscles, so we consider that the deep trunk muscle function of the LSE group in this study were improved. As the results, we showed that CLBP patients who performed the LSE decreases in pain, and increases in QOL.

UTILIZING METABOLIC CONDITIONING PRINCIPLES VIA MUSCLE SLINGS TO MANAGE LOW BACK PAIN

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Introduction

Worldwide trends clearly illustrate that co-morbidities such as obesity, metabolic syndrome, diabetes, and adverse cardiovascular health are the rule rather than the exception in patients presenting with low back pain. Management strategies must include intervention methodologies that incorporate exercise prescriptions that simultaneously target the low back condition and the accompanying co-morbidities.

Purpose/Aim

To describe how an understanding of muscle slings of the lumbar spine, pelvis and hips can be utilized to develop exercise methodologies for patients with low back pain that provide metabolic conditioning effects intended to impact co-morbidities, while simultaneously improving the neuromuscular efficiency of the lumbopelvic region.

Materials and Methods

Cadaver prosections (from author's lab) to illustrate essential muscle slings, followed by case series review of patients with lumbopelvic pain treated via exercise incorporating metabolic conditioning principles.

Results

While lowback pain outcome tools demonstrate improvement in perception of pain, objective health changes such as change in medications, lowering of BMI, improvement in dyspnea on exertion, decreased blood pressure, improved blood lipid profile, etc have result in health improvement and low back pain outcomes.

Relevance

With increasing attention to prevention and wellness worldwide, it is essential to revisit historic paradigms of managing low back pain and shift to a paradigm recognizing that the etiology and pathogenesis of back pain is increasingly being recognized as strongly influenced by the health and wellness of the individual, and secondarily as a biomechanical problem.

Conclusion

Detailed understanding of the muscle slings associated with the spine, pelvis, and hips provides the anatomical basis for exercise, which can then be successfully utilized to implement optimal and appropriate exercise physiological strategies intended to influence the health related factors influencing low back pain onset and recurrence.

Discussion

Numerous models of care, such as biomechanical models and pain models have been part of the landscape in the treatment of low back pain. Such models have the well-intentioned effect of modulating the patient's perception of pain. Theoretically, when the person "feels better" he returns to activity. Many outcomes measures are relevant to this approach. The Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale for example are excellent tools intending to measure the patient's perception of their low back problem and how it is influencing their life. However, the recurrent rate of low back pain is well documented and thus factors contributing to recurrence, perhaps even more influential that biomechanical or pain behaviors should be considered. The factors examined for this presentation were the elements of health and wellness, and specifically how incorporating those elements into the management strategy results in improved perception of not only low back health, but overall health as well. Such a strategy should be considered as one of the more realistic ways to impact recurrence rates of low back pain.

THE EFFECT OF A SELF MOBILIZING EXERCISE ON LONG DORSAL LIGAMENT PAIN

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Introduction

In 1995 R.L. DonTigny introduced self-mobilizing exercises (SME) to correct counter nutated sacro-iliac (SI) joints. He assumed that pain originates from the deep origin of the gluteus maximus muscle and the long dorsal sacroiliac ligament (LDL). The effect of this SME was never substantiated by scientific data. In 2002 Vleeming et al. introduced the LDL palpation test. In this study 76% of peripartum pelvic pain patients showed tenderness of the long dorsal ligament. They assumed a relationship between a positive LDL test and counter-nutation of the SI joint. Therefore, this study focuses on the question whether a specific exercise aimed at mobilizing the SI-joint to nutation diminishes long dorsal sacroiliac ligament pain.

Purpose/Aim

The aim of this study is to investigate the effect of a SME of the SI joint to nutation on LDL pain.

Materials and Methods

From a Dutch outpatient rehabilitation clinic, specialized in chronic low back, neck and pelvic pain, patients starting treatment were included from October 2012 to March 2013. Patients with serious structural pathology were excluded. All patients with a positive LDL were randomly assigned to SME or placebo exercise (PE). Effect on the LDL score and pain intensity (on a visual analoque scale) were evaluated for SME and PE.

Results

From 194 patients starting treatment 60 were excluded (41 had a negative LDL test and 19 subjects had incomplete data). SME n=74 and PE n= 60. Mean LDL score for SME decreased from 3.2 ±1.6 to 2.8± 1.7 (P=0.01) and increased in PE from 3.2±1.7 to 3.5±1.7. Although for many subjects in both groups (PE 60% and SME 51,4% the LDL score remained unchanged. Pain intensity on a visual analogue scale did not change in both groups.

Relevance

This study is the first step in determining the usefulness of the SME on LDL-pain and consequently, mobilization of the SI joint.

Conclusions

The SME has a positive effect on the LDL test in some patients. Physiotherapists may consider using SME to diminish tenderness of the LDL.

Discussion

The underlying mechanism, influencing the LDL test, needs further study. Especially why some patients do and others do not respond to SME. This study is based on subjective experience of the subjects.

Implications

Properly understanding of the effect of SME on LDL pain.

Keywords
Nutation, self-mobilizing, exercise, long dorsal sacroiliac ligament, pain, LDL test, SI-joint

AN UPDATED SYSTEMATIC REVIEW OF INTERVENTIONS FOR PREVENTING AND TREATING PELVIC AND BACK PAIN IN PREGNANCY

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Introduction

Over two-thirds of pregnant women experience low-back pain (LBP); approximately one-fifth experience pelvic pain. For many, the pain is severe enough to interfere with work, daily activities and sleep.

Purpose/Aim

To update the 2007 Cochrane Review assessing the effects of interventions for preventing and treating pelvic and back pain in pregnancy.

Materials and Methods

The Cochrane Pregnancy and Childbirth and Back Review Groups' Trials Registers were searched to July 2012; reference lists from relevant articles were screened. Randomised controlled trials (RCTs) of interventions to prevent or reduce the severity of LBP, pelvic pain or both in pregnancy were independently selected and assessed for risk of bias. The main outcomes of interest were pain and function.

Results

Twenty-six RCTs examining 4103 pregnant women were included. Eleven trials examined LBP (N=1322), four investigated pelvic pain (N=661) and 11 trials included women with combined lumbo-pelvic pain (N=2120). There was moderate quality evidence that acupuncture or exercise, tailored to the stage of pregnancy, significantly reduced lumbo-pelvic, back or evening pelvic pain significantly more than usual care; acupuncture was significantly more effective at reducing evening pelvic pain than stabilising exercises. There was low quality evidence that the reduction in evening pelvic pain was not significantly different after receiving either superficial or deep acupuncture. Low quality evidence suggested that LBP and physical function were similar when wearing pelvic support belts or receiving osteopathic manipulation (OMT). For lumbo-pelvic pain there was low quality evidence suggesting that OMT significantly improved pain and function; acupuncture improved these outcomes more than usual care or physiotherapy, particularly if started at 26- rather than 20-weeks' gestation. There were conflicting results for prevention of pelvic or back pain. Adverse events, when reported, were minor and transient.

Relevance

Many women appeared to experience some pain relief when they received more than usual prenatal care, and would consider some of the interventions in subsequent pregnancies.

Conclusions

Acupuncture or exercise, appropriately tailored to the stage of pregnancy, significantly reduced lumbo-pelvic, back or evening pelvic pain more than usual care alone; acupuncture reduced evening pelvic pain significantly more than stabilising exercises. There was no significant difference in pain or function for different acupuncture techniques or other interventions studied. No recommendation can be made for the prevention of these conditions.

Discussion

The quality of evidence for the prevention and treatment of pelvic and back pain in pregnancy has not improved appreciably since the last review in 2007, despite the addition of 19 new trials; no outcomes were supported by high quality and very few by moderate quality evidence. Clinical heterogeneity of population, interventions, comparisons and outcome measures precluded meta-analyses.

Implications

Future research would benefit from an agreed classification system for pelvic and back pain in pregnancy along with the use of standardised clinical outcome measures. This is likely to have an important impact on our confidence in the estimates of effect and to change the estimates.

Keywords

Low-back pain, pelvic pain, pregnancy, exercise and therapeutic interventions

OSTEOPATHIC MANIPULATIVE TREATMENT AND NUTRITION: AN ALTERNATIVE APPROACH TO THE IRRITABLE BOWEL SYNDROME

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Introduction

Irritable Bowel Syndrome (IBS) is chronic continuous or intermittent gastrointestinal tract dysfunction and occurs mainly in patients under 50 years of age. IBS is linked with low back and pelvic pain, depression, poor quality of life (QoL) and inability to work and appears due to dysregulation of brain-gut-microbe communication. In IBS osteopathic manipulative treatment (OMT) focuses on the nervous and circulatory systems, spine, viscera, thoracic and pelvic diaphragms in order to restore homeostatic balance, normalize autonomic activity in the intestine, promote lymphatic flow and address somatic dysfunction (SD).

Purpose/Aim of the Study

To define a treatment plan for osteopaths to reduce IBS-related chronic pain and inflammation.

Patients and Methods

20 female patients, mean age 29±7SD, with IBS fulfilling the Rome III criteria were randomly matched for IBS type and assigned to OMT, a modified diet and nutritional supplements or to no intervention (controls). All replied to IBS-QoL questionnaire at the start and end of the 6-month study. OMT included 2 sessions with a 7-day interval in month 1, 3 weeks rest period followed by a 3rd session and a check-up session at the end of the study. Diet: No milk or dairy products, non-starch polysaccarides, fermentable carbohydrates. Pre- and pro-biotics were taken daily. OMT consists of a range of direct, indirect, combined, fluid and reflex-based manual techniques that are applied specifically to a joint or non-specifically to a body area.

Results

Preliminary results suggest IBS was less severe in all patients and QoL improved, particularly in the abdominal pain domain.

Relevance

This successful, non-invasive OMT technique associated with dietary modifications is suitable for the majority of patients with IBS.

Conclusions

Visceral afferent stimulation released neurotransmitters and hormones such as corticotropin-releasing factor which may modulate emotions. The LPT and CRP stimulation increased lymph flow and improved blood circulation, thus facilitating healing and enhancing the efficacy of the dietary intervention.

Discussion

Although IBS is one of the most common intestinal complaints, it difficult to diagnose and treat. The present strategy eliminated dietary triggers while 3 OMT sessions relieved severity of symptoms, by changing the sympathetic tone.

Implications

The present strategy provides a feasible alternative approach for osteopaths.

Keywords

Irritable Bowel Syndrome, Osteopathic manipulative technique, Dietary intervention

THE EFFECT OF PELVIC EXERCISES CONDUCTED ON A TRUNK BALANCE TRAINER ON LUMBAR MULTIFIDUS AND INTERNAL OBLIQUE MUSCLE ACTIVITY IN HEALTHY SUBJECTS

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Introduction

Research indicates that increases in sedentary lifestyles may contribute to the persistence of low back pain (LBP). Altered trunk muscle activity in LBP patients has led to the suggestion that dynamic chairs or unstable surfaces may have a positive effect on trunk muscle activity and hence symptoms. The Trunk Balance Trainer system is an unstable sitting device that allows movement in all directions and is connected wirelessly to a screen delivering a series of real-time targeted exercise challenges.

Purpose

Little research has investigated the effects of using the Trunk Balance Trainer on trunk muscle activity whilst conducting the targeted exercise challenges. This study aimed to establish the effects of anterior posterior (AP) and side-to-side (SS) pelvic movements on trunk muscle activity, (lumbar multifidus (LM) and internal oblique (IO)) in healthy subjects whilst completing a series of targeted exercise challenges using the Trunk Balance Trainer.

Materials and Methods

Sixteen healthy subjects (11 females, 5 males, 21.75 (±2.67) years, Body Mass Index 22.72 ±2.66) were recruited according to specific inclusion and exclusion criteria. A same subject cross over design detected differences in muscle activity during 2 pelvic movement exercises on the Trunk Balance Trainer. Bilateral surface electromyography (sEMG) measured muscle activity, (amplitude), of LM and IO during AP and SS pelvic movements whilst completing the real-time targeted exercise challenges. sEMG data was normalised to maximum voluntary contraction (MVC) for each muscle. Institutional Ethical approval was gained. All subjects gave informed consent.

Results

Paired t-tests revealed significant differences ($p<0.05$) in sEMG (%MVC) muscle activity of LM and IO between AP pelvic movements compared to SS pelvic movements on the Trunk Balance Trainer, with AP movements demonstrating greater activity (%MVC) in both muscles (LM: AP 18.85(±11.11), SS 10.31,(±7.72). IO: AP 22.02 (±12.94), SS 15.53(±8.38).

Relevance

These results demonstrate that using the Trunk Balance Trainer is effective where an increase in LM and IO is required.

Conclusion

The Trunk Balance Trainer system appears to be effective in increasing activity of LM and IO during AP and SS pelvic movement targeted exercises. AP movement of the pelvis produces greater activity in both LM and IO compared to SS movement of the pelvis.

Discussion

There are many methods of exercise proposed for increasing trunk muscle activity. These results demonstrate that the Trunk Balance Trainer system is able to challenge the trunk muscles. The distraction of performing targeted exercise challenges via a screen can be a powerful tool to encourage compliance and at the same time specific trunk muscle activity.

Implications

The Trunk Balance Trainer system shows potential for improving trunk muscle activity. Further research should be conducted on patients with LBP to ascertain changes in muscle activity in this population to increase the clinical relevance.

Keywords

Trunk Balance Trainer, Internal Oblique, Lumbar multifidus Surface Electromyography

OSTEOPATHIC MANIPULATIVE TREATMENT AS ADJUVANT THERAPY IN PERIPHERAL ARTERIAL DISEASE

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Introduction

Peripheral arterial disease (PAD) is a manifestation of systemic atherosclerosis. Intermittent claudication, the predominant clinical symptom, is characterized by cramping, aching or fatigue, which typically involves the calf muscles, thighs and buttocks. PAD is associated with impaired endothelial function and by an increased expression of adhesion molecules. Conservative treatment includes dietary and pharmacological risk factor modification and exercise training.

The osteopathic manipulative treatment (OMT) may allow for a normalization of imbalances between the sympathetic and parasympathetic nervous systems and improved vascular motion which would result in a more balanced homeostatic mechanism. Recent study used their own findings in the area of nitric oxide (NO) research to explain the therapeutic vascular effects of OMT.

Purpose/Aim of the Study

The present pilot study investigated whether OMT, when combined with lifestyle modifications and pharmacological therapy, could be of benefit to patients with intermittent claudication.

Materials and Methods

Thirty male PAD patients (Fontaine stage II)(mean age 69±8 years) were recruited to the study. 15 patients were assigned to osteopathic treatment (OMT group) and the others, were considered controls. Groups were matched for age and medical treatment. The study lasted for 6 months. The monitored parameters were: blood tests (lipid and inflammatory parameters, brachial artery flow-mediated vasodilation-FMV, ankle-brachial artery index-ABI, treadmill test). All replied to a self-administered questionnaire (HRQoL SF-36) at the start and end of the 6-month study. The OMT protocol included one session every 2 weeks for 2 months, a one month resting interval and then an OMT session every 3 weeks for 2 months.

OMT technique: myofascial release, strain/counterstrain, muscle energy, soft tissue, high-velocity low-amplitude (thoracolumbar region, typically T10–L1), lymphatic pump and craniosacral manipulation.

Results

Compared to the control group, the OMT group had a significant increase in FMV, ABI, treadmill testing and physical health component of life quality (all $p < 0.05$) from the beginning to the end of the study. At univariate analysis in the OMT group there was a negative correlation between changes in brachial flow-mediated vasodilation and Interleukin-6 levels (r= - 0.30; p= -0.04) and a positive one between claudication pain time and physical function score (r= 0.50; p= 0.05).

Relevance

OMT was associated with longer walking times in our patients such as were achieved in other cohorts with supervised exercise training programmes.

Conclusions

OMT significantly improves endothelial function and functional performance in intermittent claudication patients along with benefits in quality of life. This novel treatment combined with drug and lifestyle modification might be an effective alternative to traditional training based on exercise.

Discussion

Improvements in brachial FMV, serum inflammatory markers and clinical parameters suggest OMT may promote NO release and consequently increase blood flow in peripheral vascular tissue. This effect may exert profound physiological consequences in PAD patients.

Implications

The OMT programme has the potential advantage to be cost-effective and logistically viable, since frequency and intensity are reduced and OMT does not necessarily need to be performed in a hospital out-patients setting.

Keywords

Intermittent claudication, osteopathic manipulative treatment, endothelial function

EFFECTIVENESS AND COST-EFFECTIVENESS OF EXERCISE THERAPY AFTER LUMBAR DISC SURGERY (REALISE): DESIGN OF A RANDOMISED CONTROLLED TRIAL

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Introduction

For patients who underwent lumbar disc surgery, two forms of post-operative management exist: a watchful waiting policy, or referral for exercise therapy immediately after discharge from hospital. There is low to moderate quality evidence that exercise programs starting four to six weeks postoperatively are more effective than no treatment and that high intensity exercises are more effective than low intensity exercises.

However, studies assessing effectiveness and cost-effectiveness of immediate intervention compared to a watchful waiting policy are lacking.

Purpose/Aim

The aim of this trial is to assess (cost-) effectiveness of exercise therapy after lumbar disc surgery, starting immediately postoperatively compared to a watchful waiting policy for the first six weeks.

Materials and Methods

Two hundred patients aged 18-70 years with a clear indication for lumbar disc surgery on a single level will be recruited. Exclusion criteria are: co-morbidities of the lumbar spine, spinal surgery in the past 12 months, previous lumbar disc surgery at the same level and same side, cauda equina syndrome, neurogenic claudication, pregnancy or contra-indications for exercise therapy. Participants will be randomly assigned to either a watchful waiting policy or exercise therapy starting immediately after discharge from hospital.

Exercise therapy, according to a protocol, will focus on resumption of activities of daily living and return to work. Therapists will tailor the intervention to the individual patient’s needs. Treatment sessions will take place once or twice a week. Patients in both groups will be followed up by the neurosurgeon 6-8 weeks postoperatively. Participants allocated to the watchful waiting policy may be referred for exercise therapy after this follow up. Main outcome measures are: functional status, pain intensity and global perceived recovery. Questionnaires will be completed preoperatively and at 3, 6, 9, 12 and 26 weeks after surgery.

Data will be analysed according to the intention-to-treat principle, using a linear mixed model for continuous outcomes and a generalised mixed model for dichotomous outcomes. A full economic evaluation will be performed alongside this trial.

Results
Start patient inclusion: April 2012. Results to be expected in 2015.

Relevance
The results of this trial may lead to a more consistent postoperative strategy for people who underwent lumbar disc surgery.

Keywords
Exercise therapy, rehabilitation, lumbar disc surgery, postoperative

IMMEDIATE EFFECTS OF FLEXIBLE AND RIGID LUMBOSACRAL ORTHOSES ON POSTURAL CONTROL IN CHRONIC LOW BACK PAIN PATIENTS

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Introduction
Low back pain is one of the most common musculoskeletal problems. Although orthotic treatments are prescribed in many chronic low back pain (CLBP) situations, few studies have been performed on the effects of lumbar orthoses for CLBP subjects. Furthermore, a suitable orthosis for these people is not introduced.

Purpose
The purpose of this study was to evaluate and compare the effects of flexible and rigid lumbosacral orthoses (LSO) on postural control of CLBP patients.

Material and Methods
Twenty-two healthy and 22 women with nonspecific CLBP were participated in this study. Center of Pressure (COP) displacement and Velocity of COP displacement for both anteroposterior and mediolateral directions were measured as balance performance. The balance performance was assessed in two situations; quiet stance and after internal perturbation (rapid hip flexion) on force platform while wearing no orthosis (control), flexible or rigid orthosis.

Results
In quiet stance COP excursion was significantly higher in both anteroposterior and mediolateral directions in subjects with CLPB compared to the healthy individuals ($P < 0.05$). Velocity of COP displacement in anteroposterior direction was significantly higher after perturbation and without orthosis condition ($P < 0.05$).

Both flexible and rigid orthoses had significant effect on CLBP subjects ($P < 0.05$) and no significant difference was found between flexible and rigid orthoses ($P >0.05$).

Conclusions
Patients with nonspecific CLBP exhibited greater postural instability related to the healthy controls, signified by greater COP excursions and displacement velocity. It seems that flexible and rigid LSOs may improve postural control in CLBP patients.

Keywords
Chronic Low Back Pain, Lumbosacral orthosis, Postural control, Center of Pressure

THE EFFECTIVENESS OF ELECTRONEUROMYOSTIMULATION AND POSTERIOR PELVIC TILT REHABILITATION IN PATIENTS WITH BACK AND PELVIC PAIN SECONDARY TO STROKE

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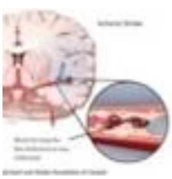
Introductory Perspectives

Back pain and stroke are the most common neuromuscular disabilities affecting humanity. Back pain originates from muscles, nerves, and other structures. Stroke (Cerebrovascular Accident) is a sudden neurologic deficit due to lack of oxygen in the brain resulting from ischemia (insufficient blood flow) or hemorrhage (excessive bleeding) (O'Sullivan, 1995).

Anatomical Foundation of Back and Spine Anatomical Eyeview of Circle of Willis and Stroke



(Medline Plus, 2009) (O'Sullivan, 1995) (Heart and Stroke Foundation, Canada,1952)

Objective

The paper was conducted to determine the effectiveness of electroneuromyostimulation and posterior pelvic tilt in stimulating recovery in patients with back and pelvic pain secondary to stroke.

Materials and Methods

Twenty five (25) patients with back, pelvic pain and stroke were evaluated and treated using 20 minutes of electroneuromyostimulation and 10 repetitions, 5 seconds hold, 3 bouts posterior pelvic tilt. Patient responses were obtained.

Results

Patients noted decreased back pains, increased abdominal, back and pelvic strength, control and stability significantly after electroneuromyostimulation and posterior pelvic tilt for 12 weeks.

Relevance

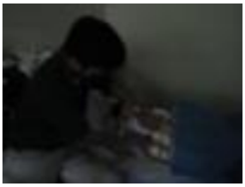
This paper helped people gain insights on the regimen/s to apply in response to pain and neurologic disabilities.

Conclusion

Back, pelvic pain and stroke are managed effectively with electroneuromyostimulation and posterior pelvic tilt treatments.

Discussion

Electroneuromyostimulation and posterior pelvic tilt are effective rehabilitation treatments of back and pelvic pain secondary to stroke. Electroneuromyostimulation activates muscles through myoneural reeducation and decreases pain via Gate Control Theory. Posterior pelvic tilt strengthens abdominals, back and pelvic muscles and decreases back and pelvic pains. Both regimens can promote greater trunk and pelvic development, control and stability.



Giving electroneuromyostimulation Instructing patient to do posterior pelvic tilts to patient for 20 minutes for 10 repetitions with 5 seconds hold, 3 bouts while exhaling. Then, relaxing while inhaling.

Implications

The fact that electroneuromyostimulation and posterior pelvic tilt can treat back and pelvic pains due to stroke suggests that these regimens can benefit patients having pain and weakness and/or paralysis. This serves as focal tool in patient rehabilitation.

Keywords
Back Pain, Stroke, Electroneuromyostimulation, Posterior Pelvic Tilt, Myoneural Reeducation, Gate Control

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IS THE SORENSEN TEST REALLY A FATIGUE TASK FOR TRUNK EXTENSOR MUSCLES?

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Introduction

The Sorensen test has been extensively studied and is still widely used as well by clinicians and scientists [1]. It is generally considered as a rapid, simple, and reproducible evaluation of the isometric endurance of the trunk extensor muscles. Although it is also often considered as a fatigue test because fatigue-related EMG parameters change throughout the test, no well-conducted study has quantified the effect of this test on the decrease in force during a maximal voluntary contraction (MVC), which best characterises muscle fatigue.

Purpose/Aim

The main aim of this study was to measure the extent of fatigue (i.e., the decrease in MVC torque) of the trunk extensors induced by the Sorensen test. A secondary aim was to compare the fatigability in males and females.

Materials and Methods

Eighty participants (students; mean age: 21.1 years; 40 males) without history of low back pain attended two sessions. After a familiarization session, including familiarization with the Sorensen test and an isometric MVC test of the trunk extensors, the participants were randomly divided into two groups as follows: a control group (CG) and an experimental group (EG), both including 50% of females. During the experimental session, the EG performed successively the MVC test (pre-fatigue test) and the Sorensen test which was immediately followed by the MVC test again (post-fatigue test). The CG performed only the pre and post-fatigue tests.

Results

The pre- and post fatigue tests comparison revealed a significant ($p<0,05$) decrease of the maximal relative peak torque (PT) in the EG (-13%, i.e. -1N.m-1.kg-1). In contrast, no significant change occurred in the CG ($p>0.05$). The decrease in relative PT observed in the EG was significantly greater for males than females (-16% vs. -9.7%, respectively; $p<0,05$) and the mean (SD) position-holding time was significantly longer for females than males (167.6 (39.9) s vs 151.8 (32.1) s, respectively).

Conclusions

This study confirms that the Sorensen test reduces MVC torque of trunk extensors, and does it in a greater extent in males than in females.

Discussion

The results of the present study agree with the results of previous studies which have used surface-electromyography to objective fatigue. Further research is required to deepen the understanding of the energetic pathways involved during this task and the reasons of the difference between genders.

Implications

Our results suggest the necessity of a resting period after the Sorensen test in case it is followed by another test that involves back muscles.

Keywords

Fatigability; spinal muscles; muscle endurance; low back pain;

Reference

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PREDICTING THE OUTCOME OF PATIENT SPECIFIC EXERCISE PROGRAMMES IS THE HOLY GRAIL IN SIGHT?

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Introduction

Recently there has been a sharpening focus on matching treatments to patients and identifying physical predictors of response to those treatments. In the clinical world there has been a growing trend toward exercise based treatment approaches and recent research examining clinical practice may now be able to bring a valid, reliable outcome prediction model into the research world.

Purpose/Aim

Despite expanding literature and knowledge there is less clear cut evidence of simple, quick clinical assessment tools for use in clinical practice that provide patient matched programmes with outcome prediction. Research has suggested that movement based approaches may be the better option over isolated muscle rehabilitation.

Materials and Methods

Two recent studies have investigated a subgrouping model using simple functional tests to match patients to a directional classification. Both studies assessed the effect of matched bias (MB/specific) vs unmatched bias (UB/non specific) exercise interventions on those same functional tests. In the first study Wajswelner investigated a chronic only low back pain population. In the second study, Tulloch refined the functional tests to measure the directional subgrouping model against validated dynamic postural stability tests in participants with chronic limb injury history.

Results

The Wajswelner study showed that both groups improved with exercise over a 6 week period, the Clinical Pilates exercise (MB) group improving by 46%. while the general exercise (UB) group improved by 29%. After baseline adjusting these scores recalibrated to 40% (MB) vs 32% (UB). While not statistically significant the trend was toward the MB group. ($P=0.07$). The Tulloch study showed substantial interrater reliability of the MB assessment process ($k = 0.75$). Following MB intervention, both components of dynamic stability were significantly improved ($P = .01$ and $P = .05$) compared with UB exercises. Compared with baseline, pairwise change in anterior/posterior time to stabilization ($P = .008$) improved following MB, whereas jump decreased following UB ($P =.036$). She found MB vs UB exercise intervention had a predictable outcome on dynamic postural stability.

Relevance

These studies suggest treatment outcome prediction is achievable by matching patients on a directional movement basis. Using simple movement assessment tools it would appear a valid, predictable, subgrouping process is possible, and the hypothesis that a "functional" approach may supercede the reductionist individual muscle approach to stability training.

Conclusions

Such simple tools may have a definite place in current health reform models where the dwindling health dollar is sharpening focus on the primary care sector for simpler, cost effective approaches.

Discussion

Further pilot studies are continuing in both sporting & neuro patient populations to study the efficacy of directional assessment / function tools on motor control.

Implications

Changes in motor control are possible with matched interventions and simple tests may be the key to establishing reliable intervention criteria for patient subgroups.

Keywords

Dynamic stability, Clinical Pilates, treatment predictors, motor control, directional intervention

HIP INTERVENTION CROSSES THE PELVIC GIRDLE – A THOUGHT PROVOKING CASE STUDY

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Introduction
It is common and simple for researchers to use the non affected limb of a subject as the control for the purpose of research. This practice allows for a comparison between limbs and is based on the premise that the limbs are independent of each other and exist and operate in relative isolation.

Purpose
This paper highlights the inherent flaw with utilising the opposite limb of a subject as the control for research, particularly in the pelvis and lower limb, and to encourage researchers to acknowledge the important myofascial connections that link and influence both sides of the body.

Method
Subject A volunteered for a Kinesio Taping intervention. Her history was of chronic left sided functional deficit with compensatory ache in the right hip, preferential lying on the right side with the left leg up for relief, unable to hop on the left leg with a sensation of lack of "power" on the left side. Objective assessment showed decreased capacity to hop on the left leg and normal hop on the right. Non-significant findings for hip range and non-significant isometric muscle testing (IMMT) for hip abduction on the left. Comparative testing on the right side showed significant loss of hip range on Faber's test, and decreased IMMT for hip abduction.

An intervention of Kinesio taping was applied to the significantly tight and weak muscles on the RIGHT side. The subject was immediately re-assessed for changes.

Results
On the taped right-side hip abduction power was instantly improved during IMMT, and hip range restored. More significantly, hopping ability on the symptomatic LEFT side was also immediately improved to normal.

For video of the Subject A before, during and after intervention please refer to www.youtube.com/watch?v=8VN3iry2AxE.

Conclusion
Taping of the right hip of subject A yielded immediate significant changes in her right hip testing as well as her left lower limb function. The changes in tissue tension with the taping intervention not only affect the taped side but crossed the pelvic girdle to affect the non taped hip. These changes were integrated neurologically with immediate effect and without the need for training.

Discussion
Subject A could have easily been a subject involved in a hip study whereby intervention to her chronic left side would have likely yielded a non significant finding with the intervention. This finding would not have been reflective of the intervention but rather the inaccuracy of the intervention being applied to the incorrect side.

If the subject had been sub-classified with the additional tests above and the right hip intervened as above, the findings may have been inconclusive had the left hip been used as the control; as both hips improved with the intervention to only one side.

Implication

This case challenges both clinicians and researchers to find the inherent cause of symptoms rather than just applying interventions to satisfy a protocol or to intervene based on subjective information.

CAN LOAD TRANSFER THROUGH THE PELVIS (AS MEASURED BY THE ACTIVE STRAIGHT LEG RAISE) BE IMPROVED THROUGH THE USE OF KINESIO TAPING?

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Introduction

Motion control of the pelvic girdle during everyday function requires the coordination and activation of various muscle groups in order to achieve optimal biotensegrity. Active Straight Leg Raise (ASLR) testing has been used to identify non-optimal stabilisation strategies for load transfer through the pelvis. Additional tests that supplement the forces to stabilise the pelvis have also been described and may be indicative of myofascial force transfer pathways that need to be addressed during treatment for restoration of efficient neuromuscular control.

Kinesio Taping has been utilised to stimulate immediate effects on neural-muscular function independent of patient training. The mechanism of activity is thought to be via stimulation on skin and fascia to influence function through proprioception and neural-modulation. The effect is to change the activity of mechanoreceptors in the area influenced by the tape. The primary role of the tape is to return the underlying skin, fascia, lymphatic and neuromuscular activity to homeostasis. The normalisation of these systems is anticipated to result in a decreased perceived effort during activity.

Purpose

This preliminary study explores whether Kinesio Taping can facilitate biomechanics to improve the reported effort in the ASLR test when increased effort is reported at the baseline test.

Method

20 subjects with symptoms in the lumbo-pelvic region were recruited. Failure in Pelvic load transfer strategies were identified with the ASLR effort testing. Patients were sub-classified into directions of force closure deficit and a Kinesio Taping protocol for intervention was created to address each direction of failure. The interventions were prioritised according to the sub-classification changes following manual force closures applied by the therapist. A self reported ASLR measure was recorded at each stage of intervention.

Baseline ASLR test

Therapist supplemented ASLR test

Example Kinesio Taping application.

Anterior Diagonal

Results

29 subject limbs tested positive for perceived effort in baseline ASLR. Of these, 25 reported improvement on testing after one Kinesio taping intervention and all 29 improved within three applications of the Kinesio Taping interventions. Of these, 21 were equal to or better than the best reported score with therapist applied manual compression during the ASLR test.

Conclusion

Kinesio Taping yielded significant and immediate improvement in self reported measures of ASLR testing.

Discussion

Kinesio Taping to improve muscle function during the ASLR may provide a simple beginning point for intervention that promotes better mechanical loading with decreased effort and symptoms. The Kinesio Taping Method may also be used as a tool to encourage better active compliance and involvement with exercise and stretching programmes as it demonstrates immediately to the patient the relevance of such exercises. The light tension application of the tape reinforces the value of subtle changes without having to exert excessive force to achieve improvements. The study also highlights how an “ordinary” clinician can conduct basic data collection utilising the ASLR as a validated measurement tool.

Implication

The study shows exciting potential in the use of Kinesio Taping to facilitate load transfer.

Keywords

Pelvic Girdle Pain, Low Back Pain

EVALUATION OF A RETURN-TO-WORK COGNITIVE-BEHAVIOURAL BASED PHYSIOTHERAPY BACK REHABILITATION PROGRAM

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Introduction

Low back pain is a common medical and social problem associated with disability and absence from work. Early and effective intervention is very important to prevent acute low back pain from developing into chronic pain and disability. Effective disability prevention and risk factors screening are very essential for acute back pain patients.

Purpose/Aim

To provide an effective intervention and management for back pain patients with better accessibility of care; (2) to prevent acute back pain from developing into chronic pain and disability; (3) to employ an early intervention with a tailored-made program to those acute back patients with high risk in developing chronicity to prevent the development of chronic disability; (4) to facilitate an early return-to-work for work-related injury patients.

Materials and Methods

A “Pre-test” vs “Post-test” design was employed. Patients were of (1) age range from 16-65 years old ; (2) back pain less than eight weeks; (3) injury on duty; (4) motivated to participate in the program. Patients with high fear avoidance beliefs (Fear-Avoidance Beliefs Questionnaire (FABQ)-Physical activity >=14 and FABQ-Work >=34) were invited to join the cognitive behavioral-based physiotherapy program (CBT). Outcome measures were (1) Numerical Global Rating of Change Scale (NGRS) for subjective reported improvement; (2) Numerical Pain Rating Scale (NPRS) for intensity of pain; (3) Roland Morris Disability Questionnaire (RMDQ) for functional disability; (4) Hospital Anxiety and Depression Scale (HADS-Anxiety and HADS-Depression) for screening of anxiety and depression; (5) FABQ-Physical Activity and FABQ-Work for fear-avoidance belief. SPSS software version 11 was used to analyse the data.

Results / Discussion

From 13 August 2007 to 15 Dec 2012, a total of 549 patients with high fear avoidance beliefs was recruited (mean age of 41.1 ± 22.5 years old with 243 female and 306 male). 441 patients completed the CBT program. All the outcome measures, including subjective reported improvement, intensity of pain, functional disability, anxiety and depression mood and fear avoidance belief, were significantly improved. The mean value of NGRS was 6.8 +/- 3.1. The post-program evaluation of NPRS (from 7 to 4, $p<0.001$), RMDQ (from 15 to 12, $p<0.001$), HADS-Anxiety (from 12 to 11, $p<0.001$), HADS-Depression (from 12 to 9, $p<0.001$), FABQ-Physical activity (from 22 to 18, $p<0.001$) and FABQ-Work (from 38 to 30, $p<0.001$) were found to be significantly improved. The return to work rate was found to be 54.4%.

Conclusions / Relevance / Implication

The CBT program was found to be effective in improving back pain, functional disability, fear-avoidance behaviors, anxiety and depressive mood in patients with work-related injury.

A PROSPECTIVE STUDY ON THE EFFECTIVENESS OF QIGONG EXERCISE (YIJINJING 易筋經) AS COMPARED WITH THE ACTIVE BACK CARE APPROACH IN PATIENTS WITH CHRONIC LOW BACK PAIN (CLBP)

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Introduction

Back pain is a common, costly problem, often associated with high recurrence rates and equivocal management efficacy. In the United Kingdom, approximately 9% of patients with back pain per year visited physiotherapists and 37% of the £1632 million on direct health care costs are related to physiotherapy and allied specialist associated with low back pain (LBP). Physiotherapy treatment of back pain may incorporate many approaches, but conventional treatment is normally individually tailored-made including advice, education, manual therapy, electro-therapy and exercise therapy. Back care programs and general exercise for chronic back pain have found to be effective, but evidence for the effectiveness of “specific” exercise is inconclusive.

Purpose/Aim

To evaluate the effectiveness of active back care approach combined with qigong exercise (Yijinjing易筋經) as compared with the active back care approach alone for patients with chronic low back pain.

Materials and Methods

Between October 2009 to November 2010, 70 subjects were recruited and assigned to the control group (active back care class) and experimental group (active back care class plus Qigong exercise class) in the Department of Physiotherapy of Tuen Mun Hospital. 56 subjects have completed the study (28 subjects in the experimental group and 28 subjects in the control group). Outcome Measures were: (1) Roland Morris Disability Questionnaire (RMDQ), (2)Numeric Pain Rating Scale (NPRS), (3)Numeric Global Rating Scale (NGRCS).

Results / Discussion

The result showed statistically significant difference (independent t-test) with better outcome in RMDQ, NPRS and NGRCS in the experimental group. Mean RMDQ improved with 2 marks out of 24 more as compared with the experimental group ($p<0.001$; mean value of 5 marks in the experimental group & 7 marks in the control group). NPRS improved of 2 marks out of 10 more as compared with the experimental group ($p<0.001$; mean value of 2 marks in the experimental group & 4 marks in the control group). NGRCS improved 22 marks out of 100 higher as compared with the experimental group ($p<0.001$; mean value of 53 marks in experimental group & 31 marks in control group).

Conclusions / Relevance / Implication

The result suggested that Qigong exercise (Yijinjing易筋經) plus active back care approach therapy achieved better therapeutic effect as compared with the active back care approach alone for chronic low back pain patients. It was concluded that Qigong (Yijinjing易筋經) combined with active back approach could be a safe and effective adjunct treatment for patients with chronic low back pain.

THE DEFINITION AND APPLICATION OF PILATES EXERCISE TO TREAT PEOPLE WITH CHRONIC LOW BACK PAIN: A DELPHI SURVEY OF AUSTRALIAN PHYSIOTHERAPISTS

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Introduction

Pilates exercise is recommended for people with chronic low back pain (CLBP). In the literature, however, Pilates exercise is described and applied differently to treat people with CLBP. This makes it difficult to evaluate its effectiveness.

Purpose/Aim

The aim of this study was to establish a consensus regarding the definition and application of Pilates exercise to treat people with CLBP.

Material and Methods

A panel of 30 Australian physiotherapists, experienced in the use of Pilates to treat people with CLBP, were surveyed using the Delphi technique. Three electronic questionnaires were used to collect opinions regarding the key features, benefits, and risks of Pilates exercise; appropriate exercise parameters, levels of supervision and equipment; identification of suitable candidates; and principles for exercise prescription and progression for people with CLBP.

Answers to open-ended questions were analysed thematically, combined with systematic literature review findings, and translated into statements about Pilates exercise for people with CLBP. Participants then rated their level of agreement with these statements using a six-point Likert scale. Consensus was achieved when 70% of panel members strongly agreed, agreed, or somewhat agreed with an item, or strongly disagreed, disagreed, or somewhat disagreed.

Results

Thirty physiotherapists completed all three questionnaires. Participants reached a consensus on 100% of items related to exercise parameters, supervision, progression, individualisation, and the benefits, clinical indications and precautions for people with CLBP. Consensus was reached on greater than 85% of items related to the definition and prescription of Pilates exercise for people with CLBP. Consensus was reached on less than 70% of items related to Pilates equipment, and risks and contraindications for people with CLBP.

Relevance

These findings contribute to a greater understanding of Pilates exercise and how it is utilised to treat people with CLBP. This information can be used to interpret existing evidence and direct future research into the effectiveness of Pilates exercise.

Conclusions

A panel of Australian physiotherapists have provided a consensus on the majority of aspects of Pilates exercise relevant to people with CLBP. Further research is required to understand the risks and contraindications of Pilates exercise and to prioritise various types of Pilates equipment.

Discussion

Due to the iterative process involved in a Delphi survey, participant opinions may be biased. The validity of findings are enhanced, however, by participants being physiotherapists experienced in Pilates exercise and CLBP.

Implications

Future research trials should examine the effectiveness of Pilates exercise regimes that are designed in accordance with consensus findings of this Delphi survey. This will assist in validating research findings, and clarifying the effectiveness of Pilates exercise in people with CLBP.

Keywords

Pilates, Exercise, Low Back Pain, Physiotherapy, Delphi

AN ARGUMENT FOR THE ROLE OF PROPRIOCEPTION IN UNDERSTANDING SIJ AND PELVIC DYSFUNCTION

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Introduction
There is much discussion amongst manual therapists as to the cause of SIJ pain and dysfunction with various models been put forward to describe normal pelvic biomechanics and pelvic stability. Although there has been extensive discussion of proprioception in peripheral joint integrity and a moderate to lesser extent in either the cervical or lumbar spine there is considerably less research or discussion on the key role in the pelvis or SIJ.

Purpose/Aim
To discuss a potential role for proprioception in contributing to SIJ stability and ensure that proprioception is considered within working models of pelvic stability and SIJ integrity. This may lead to further insight and clinical reasoning as to the cause of SIJ dysfunction with rehabilitation programs more focused on enhancing proprioception function within the SIJ.

Materials and Methods
A review of the current research looking at the presence of mechanoreceptors within the key ligamentous, capsular and myofascial components which may indeed play a role in a proprioception function in the SIJ. This will involve presenting an argument for the key role of sensorimotor alterations and deficits in functional stability of the SIJ.

Results
Further research and anatomical dissection work is needed to determine if the presence of mechanoreceptors within the structures of the SIJ may have an important proprioception role. Work is also needed in the key role that the fascial system may provide for proprioception function.

Relevance
The form-force closure model of pelvic stability which many therapists are familiar with provides for an understanding of the key features contributing to pelvic stability and how they interact with one another in the aim of supporting the joint biomechanics which place the SIJ in its functionally most stable position.

Conclusions
With joint injury, not only are the mechanical restraints disrupted but also, the sensorimotor system is affected. The sensorimotor system includes the sensory, motor, and central integration/processing components of the central nervous system that contribute to joint stability. Demonstrated deficits in both proprioception and neuromuscular control accompany joint injury.

Discussions
Although the form-force model may imply some role for proprioception there is not an explicit role for sensorimotor deficits in playing a key role in SIJ dysfunction.

Implications

Therapists may inadvertently be facilitating proprioception both in their manual treatments and more so with the various rehabilitation protocols that are been recommended. Further insight in the key role for proprioception may provide therapists with a more informed clinical reasoning on which to base their interventions and may ultimately lead to better patient outcomes.

Keywords

Proprioception, sensorimotor deficits, stability, SIJ

THE EFFECT OF USING A CHAIR BACKREST ON TRUNK MUSCLE ACTIVATION AND SITTING DISCOMFORT: A SYSTEMATIC REVIEW

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Introduction
Prolonged sitting commonly exacerbates low back pain (LBP). Several modifications to seated posture and chair design have been recommended, including using chair backrests.

Purpose/Aim
To systematically review the effect of chair backrests on trunk muscle activation and/or LBP or low back discomfort (LBD).

Materials and Methods
Electronic databases were searched by two independent assessors. Studies comparing the effect of sitting with and without a backrest were eligible, with no minimum follow-up period applied. Study quality was assessed using the PEDro scale, with studies rated as "poor quality" being excluded. Significant differences in the outcome measures used for both muscle activation and/or LBP/LBD, as well as the comparison sitting conditions used, did not allow for pooled analysis of the data.

Results
No randomised clinical trial (RCT) or longitudinal studies were found. Seven crossover studies examined trunk muscle activation, while two of these also examined LBD. Only one of the seven studies included participants with LBP. There was moderate evidence that chair backrests reduce paraspinal muscle activation, and only limited evidence that chair backrests reduce LBD. No study reported deleterious effects of using a backrest.

Relevance
Sitting is one of the most commonly reported aggravating factors for people with LBP, and it is important to clarify the benefit gained from interventions aimed at changing sitting behaviour, including the use of chair backrests.

Conclusions
Using a chair backrest appears to consistently reduce paraspinal muscle activation, yet there is only limited evidence that this is associated with reduced LBP or LBD.

Discussion
Several important limitations of the included studies are noteworthy, including the absence of RCT or longitudinal studies, the heterogenous nature of the crossover studies not allowing a systematic evaluation of effects, the presence of relevant confounding variables in several studies, and the fact that only one study included participants with LBP. Therefore, the results should be interpreted with caution.

Implications

Larger clinical trials involving people with LBP, with better control of confounding variables, are required to confirm these findings.

Keywords

Backrest, sitting, back pain, discomfort, systematic review

Funding

Health Research Board of Ireland

THE EFFECT OF CHAIR DESIGNS WHICH REDUCE HIP FLEXION IN SITTING ON TRUNK MUSCLE ACTIVATION AND SITTING DISCOMFORT: A SYSTEMATIC REVIEW

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Introduction
Low back pain (LBP) symptoms are commonly aggravated during sitting. It has been proposed that this relates to the increased lumbar flexion which occurs in sitting. Consequently, interventions focussed on reducing seated lumbar flexion are potentially relevant in the management of LBP. One method to reduce seated lumbar flexion is through the use of chair designs which reduce seated hip flexion, such as the use of saddle chairs and kneeler chairs.

Purpose/Aim
To investigate the effect of chair designs which reduce hip flexion on LBP, low back discomfort (LBD) and/or trunk muscle activation.

Materials and Methods
Electronic databases were searched by two independent assessors. Study quality was assessed using the PEDro scale, with studies rated as "poor quality" being excluded. 26 studies which compared sitting with at least two different hip angles were eligible, with no minimum follow-up period applied. 21 studies examined LBP/LBD, with 11 examining trunk muscle activation. Five studies examined the effect of the modified chair in a clinical trial for greater than one day. Seven studies included participants with LBP.

Results
Study heterogeneity did not allow a systematic evaluation of effects. Adequate blinding and control of confounding variables were commonly lacking in the included studies. Participants often subjectively preferred the modified chairs involving less seated hip flexion. However, there was no evidence that chairs involving less hip flexion reduced LBP/LBD, or consistently altered trunk muscle activation. In fact, kneeler chairs typically increased both LBD and paraspinal muscle activation.

Relevance
Since sitting is a commonly reported aggravating factor for people with LBP, it is important that the effectiveness of interventions aimed at changing sitting behaviour, such as chairs that alter seated hip flexion, are systematically evaluated.

Conclusions
There is no evidence that using chairs which reduce seated hip flexion reduces LBP/LBD or alters trunk muscle activation.

Discussion
The ineffectiveness observed in this review is consistent with that reported for other chair design features on LBP1,2. This possibly reflects the multi-dimensional nature of LBP where several

other factors besides sitting behaviour are important. In addition, the research demonstrates a lack of matching ergonomic prescriptions to the individual person with LBP.

Implications

Larger clinical trials involving people with LBP, with suitable blinding and control of confounding variables, and individualisation of ergonomic prescription, are required to expand on these findings.

Keywords

hip angle; sitting; low back pain

Funding

Health Research Board of Ireland

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CLASSIFICATION-BASED COGNITIVE FUNCTIONAL GROUP INTERVENTION IN SUBGROUPS OF NON-SPECIFIC CHRONIC LOW BACK PAIN: PRELIMINARY RESULTS

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Introduction

There is evidence that classification based cognitive functional therapy (CS-CFT) targeting specific pain provoking posture/movement behaviour in non-specific chronic low back pain (NSCLBP) patients is more beneficial than current best practice. Resources and clinical expertise needed for such interventions are substantial and modifications to make it deliverable in today's health care system are needed.

Purpose/Aim

To investigate whether classification based CS-CFT delivered in a group setting (CS-CFT/G) is feasible and effective in clinical setting.

Materials and Methods

NSCLBP patients were recruited into an experimental control study comparing the effect of (i) a 6 week CS-CFT/G (n=13) specifically designed for patients with flexion and extension control disorder with (ii) current best practice (C) (n=10). Primary outcome: disability (Oswestry Disability Questionnaire; ODQ). Secondary outcomes: pain (VAS), fear avoidance (Tampa Scale of Kinaesiophobia; TSK), physical activity (International Physical Activity Questionnaire; IPAQ), psycho-social status (distress and risk assessment method; DRAM,STarTBack) and global improvement satisfaction questionnaire. Unpaired t-tests assessed the difference between the mean change in each outcome in both groups ($p<0.05$).

Results

With no between-group difference at baseline, there was a statistically significant difference between the groups post intervention mean change (SD) in ODQ [CS-CFT/G=14.9 (8.0), C=5.2 (12.4) p=.034], VAS [CS-CFT/G = 2.1(1.5), C=0.7(1.8) p=.045], TSK [CS-CFT/G =12.4(7.2), C=4.1(2.6) p=.002], IPAQ [CS-CFT/G =1855.6min (1085), C=19min (1672) p=.000] and StarTBack [CS-CFT/G =2.5(1.6), C=0.2(2.2) p=.009]. DRAM also showed greater improvements in CS-CFT/G [8.3(4.7)] compared to C [-0.3(15.3)] but this was not significant (p=.067). The CS-CFT/G group element was perceived by the patients as very beneficial allowing them to learn from each other, enhancing awareness, understanding and coping abilities.

Relevance

Improvements in clinical outcomes and high perceived satisfaction levels provide a very encouraging indication for further development and evaluation of group based CS-CFTs that best engage patients, aid in recovery and are deliverable within the current health care system.

Conclusion

Group based CS-CFT is feasible in clinical setting, compared to current best practice brings benefits to NSCLBP patients and meets with high levels of patient satisfaction.

Discussion

CS-CFT/G brings post-intervention benefits to NSCLBP patients but long term effects need to be established. Concurrent evaluation of spinal movement/posture behaviour would aid in better understanding of the mechanisms underlying observed clinical improvements.

Implications

This study supports current evidence of CS-based targeted interventions beneficial effects in NSCLBP. This study was conducted in view of planning a well designed randomized clinical trial to evaluate the efficacy and cost-effectiveness on classification based therapies to manage a heterogeneous and diverse population of patients with NSCLBP.

Keywords

Non-specific chronic low back pain, classification, group cognitive functional therapy

THE IMPACT OF A COGNITIVE BEHAVIOURAL THERAPY PAIN MANAGEMENT PROGRAMME ON PHYSICAL FUNCTION, COGNITIVE FUNCTION AND SLEEP, IN CHRONIC LOW BACK PAIN

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Introduction

Chronic low back pain impacts of individual's quality of life. Disability relating to physical function is widely documented, however greater than 50% of CLBP patients complain of sleep disturbance1, and one third of individuals report cognitive function deficits.2 International best practice for the management of CLBP advocates CBT-PMPs.3 Minimal research has investigated the impact of CBT-PMPs on these quality of life variables.

Purpose

To investigate the impact of a cognitive behavioural therapy pain management programme (CBT-PMP) on physical function, cognitive function, and sleep in chronic low back pain (CLBP).

Methods

CLBP (>6months history) patients attending a four week, group, outpatient based CBT-PMP (including physiotherapy, psychology, occupational therapy, and pain education) were invited to participate. Assessment included self-report and objective measures; taken pre, post, and six months post, participation in a CBT-PMP:

<u>Physical function:</u> Roland Morris Disability Questionnaire (RMDQ), SF-36, timed trunk flexion (TTF), six minute walk test (6MWT), incremental shuttle walk test (ISWT), accelerometry.

<u>Cognitive function:</u> Prospective and Retrospective Memory Questionnaire (PRMQ), Repeatable Battery for the Assessment of Neuropsychological Status (RBANS).

<u>Sleep:</u> Pittsburgh Sleep Quality Index (PSQI), sleep actigraphy.
Data were analysed using non-parametric Friedman analysis and post hoc Wilcoxon Signed Rank testing using SPSS version 18 (SPSS Inc., Chicago, Illinois).

Results

Twenty-five patients participated (males n=9, females n=16, age 47.2±12.1yrs CLBP yrs 8.96±7.06). Self-report and objective physical function improved immediately following a CBT-PMP (RMDQ p=0.005; 6MWT p=0.015; ISWT p=0.009), improvements were not maintained at six month follow-up. Similarly, objective cognitive function improved immediately following a CBT-PMP (RBANS Delayed Memory p=0.02), with improvements maintained at six months. Physical activity levels (accelerometry), and sleep parameters (PSQI and actigraphy) did not change.

Conclusion & Implications

Physical function and cognitive function improved following a CBT-PMP; however, some improvements were not maintained at six months. This brings to light patients adherence to strategies learned during the CBT-PMP, and questions the need for more robust follow-up measures. Sleep did not change, perhaps indicating it needs to be specifically addressed.

Keywords

Low Back Pain, Cognitive Behavioural Therapy

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CHANGE IN PSOAS MAJOR MUSCLE SECTION BY TRUNK STABILITY TRAINING - AN MRI STUDY

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Deep abdominal muscles exercises are effective against lower back pain as well as activity of the psoas major muscle which attaches along the lumbar spine. We investigated improvement in muscle by postural instability exercises. Subjects comprised 13 healthy males (mean age; 20.0 yrs) with no significant medical history or current medical problem, who gave written informed consent. The experiment was approved by the Tokyo Metropolitan University Ethics Committee. Three exercise postures were compared. Lying supine on a flat surface, maintaining stability when lying on <the flat side of/the round side of> a half round foam roller with both feet flat on the floor or the right foot lifted. Magnetic resonance images (MRI) were obtained by 3.0 Tesla whole body system. T1-weighted images [echo time (TE)=2.3 ms, repetition time (TR)= shortest 128 ms, matrix=256×256 voxels, field of view (FOV)= 360 mm, slice thickness=8 mm] were obtained in transverse planes to allow identification of the anterior and posterior commissures, then twice by sequential scan protocol during a single end inspiratory breath hold (typical duration 16.8 s). For the abdominal scan, 8 contiguous 5-mm thick slices of the abdomen were acquired above level L4. Measurements of the rectus abdominis and oblique abdominis muscles and cross sectional area of psoas major muscle by image processing software ImageJ were analyzed using two way ANOVA for SPSS ver20.0 and Bonferroni's post hoc test with $P < 0.05$ indicating statistical significance. The cross-sectional area of psoas major muscle in right leg elevation posture was significantly greater than in supine posture. For rectus abdominal and medial abdominal muscles, no significant difference was found among postures. It is possible that the greater psoas muscle worked to maintain stability of the spine during exercise on the unstable roller and improved. No significant difference was found between the two postures on the half round roller. It is suggested that the posture with elevated right leg brings about activity of deep muscles. Moreover, it was possible to clarify activity of deep muscles from MRI images.

Keywords

MRI, abdominal muscle, psoas major muscle, stability exercise

ADVERSE REACTIONS AFTER NAPRAPATHIC MANUAL THERAPY AMONG PATIENTS WITH NECK/BACK PAIN – A RCT

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Introduction

The knowledge about unwanted side-effects after manual treatments is scarce. Naprapathic manual therapy is commonly practiced in Sweden, Finland, Norway and the US an is a combination of manual techniques as spinal manipulation/mobilization, stretching and massage, to treat the shortened connective tissues aiming to increase function and decrease pain/disability.

Purpose/Aim

To investigate the incidence and severity of adverse reactions (AR) shortly after naprapathic manual therapy for patients with neck and/or back pain, and to compare this between different combinations of naprapathic manual treatments, and between sexes.

Materials and Methods

A three-armed RCT (n=767) with patients, 18-65 years, seeking care for neck and/or back pain at the educational clinic at the Scandinavian College of Naprapathic Manual Medicine, Sweden. Treatments were given by experienced students in their 7th semester of total 8. Treatment arms:

1. Naprapathic manual therapy: Allowed to use all techniques within naprapathic manual therapy: typically spinal manipulation, spinal mobilization, muscle stretching, massage and other soft tissue techniques.
2. Naprapathic manual therapy excluding spinal manipulation.
3. Naprapathic manual therapy excluding muscle stretching.

Adverse reactions (AR): Within 24 hours after treatment (yes/no), duration (hours), and how bothersome (NRS 0-10), categorized into five groups: Short minor (NRS ≤ 3 and < 24 hours), Long minor (NRS ≤ 3 and ≥ 24 hours), Short moderate (> 3 and < 24 hours), Long moderate (> 3 and ≥ 24 hours), and Major (hospitalization, loss of bladder or bowel function, stroke or fracture).

Results

The participating rate was 97%, 72% were women, 54% had neck pain, and 29% had chronic pain. Most commonly reported were muscle soreness followed by increased pain, stiffness and tiredness. No major AR was reported and the majority was mild and transitory. Among the 556 patients who got at least three treatment sessions, 37% reported any kind of AR after every visit, 51% after some of the visits and 13% had no AR after any visit. Women more commonly experienced short moderate and long moderate AR. There were no differences between the sexes regarding short and long minor AR. The main result, the comparison between the three treatment groups, will be reported at the congress.

Relevance
Manual therapy is very common. The effect is well studied but knowledge about AR is scarce. This study adds to this knowledge.

Conclusion
AR was common but no major AR was reported and the majority of adverse reactions were mild and transitory.

Discussions
Strengths are the study design and the large study population with high participation rate. A weakness may be that the treatments were given by students.

Implications
The results will give detailed knowledge of duration and severity of AR related to manual treatments, important for clinicians and for patients.

Keywords
Manual therapy, adverse reactions, back pain, neck pain

PATIENT'S OUTCOMES OF A PHYSIOTHERAPY FUNCTIONAL RESTORATION TREATMENT PROTOCOL FOR PEOPLE WITH NON-REDUCIBLE DISCOGENIC PAIN: A QUALITATIVE STUDY

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Introduction

Traditionally, quantitative methods such as randomised controlled trials (RCTs) have been favoured as the gold standard for research investigating the effectiveness of certain treatment modalities and management approaches. However, quantitative outcomes may restrict the responses of participants depending on the measures chosen. Qualitative research is an alternative approach that provides participants an opportunity to discuss improvements not assessed by the outcome instruments chosen for the RCT. This information can be of value in evaluating effectiveness. Therefore, as part of the Specific Treatment of Problems of the Spine (STOPS) RCT, participants with sub-acute low back pain (LBP) enrolled and randomised into the physiotherapy functional restoration program treatment arm completed exit interviews.

Purpose/Aim

To explore the outcomes of a specific physiotherapy functional restoration program developed for people with non-reducible discogenic pain (NRDP) participating in the STOPS RCT.

Materials and Methods

A specific physiotherapy functional restoration program was developed as part of the STOPS RCT to treat participants classified with NRDP. At the completion of the program, participants who were randomised to the functional restoration treatment underwent semi-structured exit interviews. These were transcribed with two researchers independently coded the interviews using qualitative data analysis software before thematically analysing the results.

Results

A total of 22 participants were interviewed (13 women, 9 men), with a mean (SD) age of 42(11) years and a mean (SD) duration of back symptoms of 12(7) weeks. Most participants reported positive outcomes associated with the functional restoration program, including symptom reduction, functional and psychosocial improvements, in addition to knowledge gained. Although the majority of participants reported no negative outcomes, some participants noted slow progress and adverse effects such as allergic reactions to tape and anti-inflammatory medication.

Relevance

The positive outcomes reported by participants completing a specific physiotherapy functional restoration program may assist clinicians on their treatment selection for people with NRDP.

Conclusions

Participants with NRDP who completed a specific physiotherapy functional restoration program predominantly described positive outcomes.

Discussion

The outcomes described by the participants will be explored in light of the literature.

Implications

Physiotherapy functional restoration programs can be modified for NRDP and show predominantly positive outcomes.

Keywords

Functional restoration, low back pain, qualitative

THE ROLE OF THE SERRATUS POSTERIOR INFERIOR MUSCLE EVALUATED WITH SURFACE AND WIRE ELECTROMYOGRAPHY

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Introduction
"Chest gripping" is an abnormal trunk muscle activation pattern limiting lateral expansion of the lower thorax, which may reduce thoracic extension or even cause low back pain (LBP). Hypertonic upper abdominal muscles may be a cause. The serratus posterior inferior (SPI) is, in anatomy, considered an only antagonist to the chest gripping.

Aim
The aim of this study was to determine an effective exercise to activate the SPI.

Materials and Methods
Ten young males signed the consent form. Maximum voluntary isometric construction (MVIC) were recorded using surface-electromyography (SEMG). Activities of the 5 trunk muscles during 8 maximal exertion tasks and normalized SEMG values were obtained. Thickness of the SPI was measured using ultrasonography. A wire-EMG was used to measure SPI activities in three thoracic activities in one subject.

Results
During extended expiration and resisted ipsilateral trunk rotation, the SPI and latissimus dorsi (LD) activities were almost identical. Thickness of the SPI during extended inspiration, extended expiration, resisted ipsilateral trunk rotation was 2.66 ± 0.51 mm, 4.93 ± 1.44 mm, 5.00 ± 1.36 mm, respectively. %MVC of the SPI during the same tasks was 10.4 ± 7.0%, 43.9 ± 24.4%, and 75.1 ± 27.1%, respectively. A wire-EMG study revealed the SPI was active while the LD was silent during active trunk rotation at side lying, ipsilateral shoulder hyper-flexion compensated with trunk rotation from the all-four's position, and resisted back extension using the ATM®2 (Backproject corp.). Wire- and surface-EMG studies agreed on the activation of the SPI in the first two thoracic activities.

Relevance
Clinicians can utilize the exercises above to recruit the SPI activity.

Conclusions
The SPI were effectively recruited during active trunk rotation at side lying, ipsilateral shoulder hyper-flexion compensated with trunk rotation from the all-four's position, and resisted back extension using the ATM®2. SEMG was effective in detecting the activity of the SPI in the first two thoracic activities.

Discussion
We identified three exercises to activate the SPI in treating the chest gripping. To our knowledge, the effective exercise to activate the SPI has not been reported nor tested. A further study is needed to determine if these exercises are effective in treating LBP.

Implications
The three specific thoracic activities can be used in treating the chest gripping.

Keywords
Serratus posterior inferior, chest gripping, thoracic motion

THE EFFECT OF A NOVEL PELVIS-THORAX REALIGNMENT DEVICE ON THE ALIGNMENT OF THE PELVIS AND THORAX IN YOUNG HEALTHY INDIVIDUALS

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Introduction

Asymmetric posture, movement or gait may cause asymmetric alignment of the pelvis and thorax, which may further cause abnormal kinematics of the lumbar spine. Therefore, there is a need for achieving symmetry of the pelvis and thorax to maintain or restore normal lumbar kinematics. We developed a pair of pelvis-thorax realignment devices (ReaLine CORE, GLAB corp, Japan) to achieve simultaneous symmetry of the pelvis and thorax, and to allow gentle exercises and light activities.

Aim

The aim of the study was to determine if exercises with ReaLine CORE can achieve increased lower thoracic lateral expansion, pelvic symmetry and improved trunk mobility in healthy young individuals.

Materials and Methods

This is an IRB-approved, intervention study. Inclusion criteria were 1) healthy individuals and 2) aged from 15 to 25 years. Outcome measures were 1) thoracic expansion (sagittal and coronal diameters of the lower thorax on upright and trunk-extension), 2) pelvic asymmetry, and 3) trunk mobility (flexion and extension). An intervention period took approximately 10 minutes and the measurements were performed immediately prior to and following the intervention. The participants were equipped with ReaLine CORE and performed stepping, half squatting, and pain-free trunk flexion, extension and rotation exercises. Student t-test and $\chi 2$ test were used with statistical significance of $p<.05$.

Results

Twenty-two individuals (15 males) were enrolled. The coronal diameter of the lower thorax during trunk extension demonstrated a significant increase ($p<.01$) between the pre- and post-intervention measurements. Similarly, significant improvements were observed in the pelvic rolling test ($p<.01$), sacrum tilting angle ($p<.01$) and pelvic asymmetry ratio ($p<.01$) indicating improved pelvic symmetricity. A significant improvement in the trunk flexion ($p<.01$) and trunk extension ($p<.01$) were detected.

Relevance

ReaLine CORE applies pressure on the pelvis and thorax individually, designed to improve their symmetry, to induce lateral expansion of the lower thorax, and presumably to allow ideal lumbar motion. It may be useful in treating NSLBP.

Conclusions

The exercises with realigned thorax and pelvis may improve the sagittal trunk motion, lower thoracic expansion and pelvic symmetry.

Discussion

Gentle exercise with ReaLine CORE improved indices of the sagittal trunk motion, lower thoracic expansion and pelvic symmetry. Because the participants performed no exercises for flexibility, strength, balance, or endurance, exercises with realigned pelvis and thorax were considered the primary reason for the positive changes. No previous studies have demonstrated that realignment of the pelvis and thorax alone can improve motion of the trunk and, therefore, the result of this study may be applicable to spinal conditioning as well as treatment of low back pain.

Implications

Realignment of the thorax and pelvis may improve spinal motion in healthy individuals.

Keywords

Pelvis-thorax realignment device, malalignment, symmetry

THE EFFECT OF A NOVEL PELVIS-THORAX REALIGNMENT DEVICE ON PATIENTS WITH NON-SPECIFIC LOW BACK PAIN: A RANDMIZED CONTROL TRIAL

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Introduction

Low Back Pain (LBP) is of clinical importance in orthopaedics, in which many cases are classified as non-specific LBP (NSLBP). Asymmetry of the pelvis and thorax may cause pathokinematics of the lumbar spine, which may result in NSLBP.

Aim

The aim of this study was to examine the effects of simultaneous realignment of the pelvis and thorax on the symptoms and motions of the patients with NSLBP.

Materials and Methods

This is an IRB-approved randomized control trial. Inclusion criteria were 1) diagnosed as NSLPB and 2) aged from 15 to 25 years. Exclusion criteria were 1) neuropathy, 2) any known structural damages, 3) psychological or mental disturbances. Subjects were randomly allocated to intervention and control groups. An intervention session took approximately 10 minutes and the outcomes were measured immediately prior to and following the intervention. The realignment group was equipped with a pair of pelvis-thorax realignment devices (ReaLine CORE, GLAB corp, Japan) and performed stepping, half squatting, and pain-free trunk flexion, extension and rotation exercises. The control group performed the same exercises without wearing ReaLine CORE. Outcome measures were 1) thoracic expansion (sagittal and coronal diameters of the lower thorax on upright and trunk-extension), 2) pelvic asymmetry, 3) trunk mobility (flexion and extension), and 4) pain on standing, trunk flexion, trunk extension and trunk rotate on. Student t-test, $\chi 2$ test and Wilcoxon rank sum test were used with statistical significance of $p<.05$.

Results

Five individuals (3 males) for the intervention and six (3 males) for the control groups were enrolled. Lower thoracic diameter did not demonstrate significant differences between the groups. Significant improvements were observed in the pelvic rolling test ($p=.02$), sacrum tilting angle ($p=.02$) and pelvic asymmetry ratio ($p=.03$) indicating improved pelvic symmetry. A significant improvement in the trunk extension angle ($p<.01$) were detected. A significant improvement in pain was observed in trunk rotation ($p<.01$).

Relevance

ReaLine CORE applies pressure on the pelvis and thorax individually, designed to improve their symmetry, to induce lateral expansion of the lower thorax, and presumably to allow ideal lumbar motion. It may be useful in treating NSLBP.

Conclusions

The exercises with realigned thorax and pelvis may be the inevitable component in treating NSLBP.

Discussion

Gentle exercise with ReaLine CORE improved indices of the symptom, trunk motion and pelvic symmetry. The intervention group performed no exercises for flexibility, strength, balance, or endurance, and realignment of the pelvis and thorax was considered the primary reason for the positive changes. A limitation of the study involves small sample size which may have caused beta errors in thoracic realignment. To conclude.

Implications

Realignment of the thorax and pelvis may be a key component in the treatment of NSLBP.

Keywords

Pelvis-thorax realignment device, malalignment, non-specific low back pain

TECHNOLOGY-SUPPORTED REHABILITATION IN CHRONIC LOW BACK PAIN: A REVIEW

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Introduction
In Europe, 24.7 % of the population suffers from chronic low back pain. A raise of 14% is expected between 2000-2020 because of demographic changes and a sedentary lifestyle. Rehabilitation may reduce pain and improve the activity level in chronic low back pain patients. In the light of increasing pressures on the health system, technology supported rehabilitation may empower patients and may reduce the costs of therapy and absence from work.

Aim
The aim of this study is to investigate to which extent technology supported solutions have been used for the treatment of chronic low back pain, and to which extent they may influence treatment outcome.

Materials and methods
A systematic literature search (Pubmed, IEEE Xplore, ACM, Cochrane), a quality assessment and descriptive analyses were performed.

Results
21 studies were eligible: 12 randomized clinical trials, 4 clinical trials, 4 systematic reviews, and 1 review. The following technology supported rehabilitation systems were identified: electrical nerve stimulation to activate abdominal and paraspinal musculature in order to support exercise therapy, electrical nerve stimulation in order to obtain pain relief, and vibratory stimulation in order to obtain pain relief through sensory discrimination training. The evidence for electrical nerve stimulation with regard to pain relief was not unequivocal. Sensory discrimination training was unable to prove clinical effectiveness for pain relief. Electrical stimulation of abdominal and paraspinal musculature in support of exercise therapy seems promising: significant benefits are found with regard to pain relief and muscle strength. However, the level of evidence for the latter findings is still low, as to date no RCT evidence is available.

Conclusion
Technological systems in support of the rehabilitation of low back pain to date pertain to electrical stimulation. No clinically tested rehabilitation systems were identified that offer exercise therapy for low back pain patients.

Discussion
In other fields, such as neurorehabilitation, a myriad of technological systems exist that offer exercise therapy to support active rehabilitation approaches. In the field of musculoskeletal rehabilitation, limited clinical evidence is available on the feasibility and effectiveness of technology supported rehabilitation systems with regard to exercise therapy for chronic low back pain. Existing technology-supported training systems mostly offer nerve stimulation of abdominal and paraspinal musculature, as well as nerve stimulation for obtaining regional pain

reduction. Future research should aim to clinically test the value of rehabilitation technologies that support exercise therapy for patients with musculoskeletal problems.

Keywords
Low back pain, technology, rehabilitation, therapeutic intervention

COMPARISON OF CORE STABILIZATION AND GENERAL EXERCISES ON ABDOMINAL MUSCLE (OBLIQUES, RECTUS AND TRANSVERSE ABDOMINIS) THICKNESS USING REAL-TIME ULTRASONOGRAPHIC IMAGING

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Introduction

There is a lot of controversy about preference of core stabilization exercise over other types of exercise on chronic low back pain treatment in the literature. Different studies have compared these types of exercise using outcome measures such as pain, disability, health related quality of life and number of pain episodes. Measurement of muscle size using ultrasound has provided an accurate assessment of muscle wasting in various muscles. Muscle thickness can be regarded as a variable that indicates muscle force and spinal stability. Inter-rater reliability [intraclass correlation coefficient (ICC)] point estimates of 0.80 to 0.94 for assessing lateral abdominal and lumbar multifidus muscle thickness has been demonstrated. The aim of present study is to compare core stabilization exercise with general exercise (as a popular type of exercise which has most of exercise physiologic effects) using ultrasound imaging for measurement of abdominal muscles thickness.

Materials and Methods

23 patients with chronic non-specific low back pain were recruited. They were allocated to two groups randomly (core stability and general exercise). Both groups received a 16-session (three times per week) exercise program containing warm up (stretching exercises and stationary bicycling) and specific (core stability and general) exercises. Thickness of four abdominal muscles including: 1-rectus abdominis 2- external oblique 3- internal oblique 4-transverse abdominis was measured using real-time ultrasonographic imaging immediately before and at the end of 16th session of intervention. Measurements were taken during exhalation by putting patient in supine position, crossing arms over shoulders.

Results

Before training, there was no significant difference in four abdominal muscles thickness between two groups (P=0.10 to P=95). No significant increase in muscle thickness was found in either groups during the intervention time period (P=0.07 to P=.99). The results of independent sample t-test for thickness change in abdominal muscles revealed no statistically significant difference between two exercise groups (P=0.14 to P=0.91) in different muscles.

Conclusions

No significant difference in thickness change in abdominal muscles due to these two exercise types (core stability and general) could be concluded by this study.

Keywords

Low back pain, core stability exercise, general exercise, abdominal muscle thickness, ultrasonographic imaging

EFFECTS OF STRETCHING AND/OR VIBRATION ON THE PLANTAR FASCIA

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Purpose

An increase in flexibility has been described when bending forward after a treatment of the plantar side of the foot. This increase in flexibility is measured by finger-ground-distance (FGD). Our study seeks to determine viscoelastic changes in the plantar structures and the tension of the Achilles tendon. It also aims at documenting possible fluctuations in the amount of liquids within the tissue.

Relevance

Plantar fasciitis is a common reason for foot or heel pain. Stretching forms part of the generally recommended treatment. However, little research has been conducted in vivo about the foot's potential physical changes.

Methods

A total of 61 subjects are included in this study, 26 of which belong to the treatment group. The remaining subjects form three control groups. Two ways of stimulating the plantar fascia structures are applied on each individual: on one foot a vibration of 8-10 Hz is brought passively into the tissue with a Matrix Rhythmus® device. On the other foot the subjects are instructed to apply an active treatment using MELT® balls. Before and after these treatments biomechanical tissue properties are measured via myometry (MyotonPro®) at the two following points: point 1 in front of the heel pad, point 2 at the center of the sole. In addition FGD, electrical bioimpedance as well as the angle between the foot and the longitudinal axis of the fibula are measured before and after treatment.

Analysis

The Wilcoxon test is used for statistical evaluations.

Results

Vibration led to a significant (<0.05) change in stiffness, creep and decrement at point 1. Stretching showed highly significant (<0.001) changes in stiffness and creep at point 1 and significant (<0.05) changes in stiffness and creep at point 2. The impedance changed significantly (<0.05) through stretching. The Achilles tendon showed a significant (<0.05) relaxation induced by both applications. The FGD decreased significantly (<0.05) in both the treatment and the control group, but the differences between the two groups are not significant.

Conclusion

Vibration seems to have a more global effect on the viscoelastic qualities of the tissue near the heel, stretching appears to result in an at least temporary drainage effect.

Discussion

Effects on FGD in this study seem to be unrelated to plantar fascia treatment. Hence, using FGD to assess treatment effects of the plantar side of the foot via stretching and/or vibration seems questionable, and may require further research.

Implications

Treatment with vibration seems to have stronger effects on the viscoelastic parameters of the plantar fascia when applied close to the heel. Treatment with stretching seems to have stronger effects when applied to the more distal part of the plantar foot.

Keywords

Plantar aponeurosis, fascia, stiffness, viscoelasticity, finger-ground-distance, stretching, vibration

WEAKNESS OF DEEP NECK FLEXOR MUSCLES DETERIORATES FUNCTIONAL LEVEL AND CERVICAL JOINT POSITION SENSE IN PATIENTS WITH CERVICAL SPONDYLOSIS

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Introduction

There is still little data about neck proprioception although much study conducted about other joint's position sensibility (JPS) and its relevance in clinical rehabilitation protocols. Weakened and/or dysfunctional muscles may lead to abnormal joint position perception and diminished proprioception according to our knowledge till now, but there is a lack of evidence in such conclusion about cervical spine and its disorders.

Aim

Aim of our study was to evaluate possible correlations between strength of deep neck flexors (DNF), amount of cervical JPS errors and functional level in patients with cervical spondylosis.

Materials and Methods

40 volunteers were participated in our study. 20 patients (mean age 51,50±10.01 years) suffered from cervical spondylosis composed study group and 20 healthy subjects (mean age of 24±3.37 years) composed control group. Of these patients who had radiculopathy/myelopathy, acute cervical disc pathology/acute pain, thoracic outlet syndrome, rotator cuff problems, history of previous surgery and medication or physiotherapy for the last 6 months excluded. DNF muscle strength was measured with Pressure Stabilizer Biofeedback® device designed for testing and training spine muscles. Cervical JPS was assessed with an original system, developed by authors and consisted of a head apparatus placed a laser marker and goniometric platforms. Head repositioning method was used to analyze CJPS error. Target angles were for flexion, extension, right/left rotation 10° and 30°; for right/left lateral flexion 10° and 20°. Also Neck Disability Index (NDI) was used to evaluate functional level of patients in study group.

Results

Statistically significant differences were observed in DNF strength ($p=0.000$) and amount of JPS errors in nearly all directions (10° flexion $p=0.026$, 10° extension $p=0.037$, 30° right rotation $p=0.000$, 10° right lateral flexion $p=0,000$). There was a negative correlation between muscle strength and JPS error in study group ($r=-0.497$, $p=0.026$). Also there was a positive correlation between NDI and JPS error ($r=0.468$, 0.037; $r=0.480$, $p=0.040$).

Relevance

Contractile and ligamentous structure of cervical spine that contains mechanoreceptors particularly plays a key role in position sense.

Discussion

Most studies have focused JPS in ankle, knee and other peripheral joints. Although there were very limited studies on cervical JPS in the literature, some authors have found that cervical spondylosis decreases JPS. In this study, our results are in accordance with the other results from the literature.

Implications

Considering not only superficial muscles but also focusing DNF in neck rehabilitation may promises invulnerable results. To illuminate dark sides of proprioception more studies must be done.

Conclusion

Results of our study indicate that diminished deep cervical musculature force ascends JPS error and raises neck index scores that mean bad daily activities. Restoring these parameters as possible may generate better outcomes indeed.

Keywords

Cervical proprioception, Neck Disability Index, Deep Neck Flexors

AVOIDING SURGERY FOR LUMBAR STENOSIS THROUGH POSTURAL AND MOVEMENT RE-EDUCATION

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Introduction

This case study is about a 70 year old male patient with advanced DJD and spinal stenosis at L5-S1 resulting in moderate to severe radiculopathy into bilateral buttocks and Lower Extremities. Patient consulted three local surgeons all of which strongly suggested surgery after radiological confirmation. Through postural and movement re-education utilizing the Polestar Pilates Methodology patient was able to return to full activity and beyond without surgical intervention.

Purpose/Aim

This case study considers the possibility that through proper postural education in patients even with moderate to severe lumbar stenosis will benefit and possibly avoid complicated surgical intervention.

Methods

The case involves a 70 year old male with moderate to advanced lumbar stenosis. Subject was evaluated by a physical therapist and treated for Lumbar Stenosis. Treatment focused on increasing thoracic extension and mobility; and hip extension and mobility without perturbing the lumbar stenosis and respecting extension limitations in the lumbar spine. Pilates combined with manual therapies to the thoracic spine, hips and their surrounding tissues was the primary therapeutic intervention in the clinic. Home exercises were incorporated to reinforce optimal posture and mobility goals of the treatment.

Results

Pre-therapy measures of functional limitations as follows: unable to stand or walk greater than 10 minutes without severe pain. Subject perceived he would never participate in his normal work and recreational activities again. Subject had significant limitation in ranges of motion in hip extension and thoracic extension. Following 4 sessions of physical therapy and 3 months of Pilates two times per week and HEP, patient was able to return to ADL, work and recreational activity.

Relevance

Many patients with moderate to severe lumbar stenosis receive surgery that might be premature, when they could be returned to normal activities without surgery. We suggest that potential surgical candidates are provided with conservative Pilates intervention focused on increasing mobility, improving postural patterns, and changing movement strategies to distribute extension forces in the lumbar spine, they could avoid surgery.

Conclusions

The above subject had a successful outcome avoiding surgery and was able to return to an acceptable quality of life and continues with that quality of life two years later.

Discussion

Though this is a case study it warrants further investigation to evaluate the benefits of movement re-education to reduce cost and risk of surgical intervention with.

Implications

Qualitative movement education through Pilates and other movement strategy methods should be further investigated to determine if they can significantly reduce the number of surgeries performed on patients with lumbar stenosis.

Keywords

Pilates, Movement Re-education, Lumbar Stenosis, Surgery

HYPOCAPNIC STATES AND CHRONIC PAIN INTERVENTION IN PHYSICAL THERAPY

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Introduction

The use of a Fear Avoidance Beliefs Questionnaire has been shown to be useful in indicating higher risk for chronic pain and disability in persons with lumbopelvic pain in many settings. However, very few evidence based treatment protocols have been studied utilizing a capnometer to identify hypocapnic states coupled with multidisciplinary/multimodal interventions to effectively address and reduce FABQ scores, pain and functionality levels, especially in a physical therapy setting.

Purpose/Aim

The purpose of this study is to create and evaluate the use of capnometry and identification of hypocapnic states and their treatment in association with other multimodal and multidisciplinary treatments utilizing evidence based best practices in addressing high risk and chronic pain in physical therapy lumbopelvic patients.

Materials/Methods

This is a Longitudinal study with Repeated Measures Regression Analysis and Paired T-tests to Functional on Therapeutic Outcomes (FOTO) national database. Three months of outpatient orthopedic physical therapy patients with a diagnoses of lumbopelvic pain at Southwest Sport and Spine Center will be entered in to FOTO database at initial evaluation, 6 visits and at discharge. They will also be categorized in subgroups at intake through a STarTBack questionnaire into low, medium, and high risk subgroups. Medium and high risk identified patients will be assessed for hypocapnic states at initial evaluation utilizing a capnomenter by a certified breathing specialist using a 4 section test taking 21 minutes. Treatment protocols will include cognitive-behavioral interventions, exercise based on McKenzie assessment subgroups, breathing mechanics and education, pain modulation modalities, and aerobic/reactivation exercises as prescribed by the attending Physical Therapist. FABQ, STarTBack risk categories, FOTO outcomes, and Hypocapnic levels will be measured at the initial evaluation, 6 visits and discharge.

Results

The above results will be analyzed and presented at the end of the study.

Relevance

Appropriate and effective methods must be utilized to not only identify the lumbopelvic pain patients at high risk for chronicity and disability but moreover to effectively treat them back into wellbeing according to best evidence practice.

Conclusions

To be disclosed at the conference.

Keywords

LBP, subgrouping, FABQ, chronic pain, hypocapnic, capometer, pelvic pain, FOTO, physical therapy

THE EFFECTS OF PILATES TYPE OF EXERCISES USING FASCIAL MANIPULATION© CENTRE OF COORDINATION'S AS A REFERENCE POINT

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Introduction

Luigi Stecco in fascial manipulation© divides body into 14 segments and each body segments into 6 myofascial units. Myofascial units includes movement directions forward (ante), backward (retro), outside (latero), inside (medio), extrarotation (ekstra) and intrarotation (intra). Significant points are centre of coordination (later CC). The CC's are located in the point where vectorial forces meet in the fascia. Points are located in the muscle belly, part where the muscular traction occurs. CC's are in continuity and forms lines called sequences. Sequences can be thought as pairs, Ante-Retro sequence, Latero-Medio sequence and Ekstra-Intra sequence. Body in motion is a combination of these sequences. Efficient and functional body is balanced and working in flowing motion.

Purpose / Aim

Aim of the report was clarify how exercises alter perception of the CC. Also in this report it is discussed how different sequences work together in motion. Is it possible to have alteration in the palpation of CC by doing precise movements?

Materials and Method

This report includes 2 groups of 12 people, who suffer low back pain. The exercises are Pilates based and also based on fascial manipulation© sequences. Palpation is done in pairs supervised by one physiotherapist. Palpation is verified by verbal feedback; no pain, mild pain, severe pain, severe pain and radiation (densification). The points causing severe pain and radiation are used as a reference points after the exercises. The exercises are supervised and corrected by a physiotherapist. Images of the sequences are done with body paint into the one man's body to visualize how the sequences are working together.

Results

Before the exercises it was found several densified CC's (pain is severe and radiating when palpating tissues) amongst the people in the groups. After the exercises some of the densified CC's alters perception from severe and radiating pain to no pain or mild pain. Overall pain sensitivity is reduced. After the exercises people in the group feels generally more aligned, pain free and firm.

Relevance

Precise exercises improve an ability to control the movements and increases softness in the tissue. Through control it is possible to coordinate and produce the movement in balanced and efficient way. This report shows one possible way how to exercise and compare alteration in the tissue before and after the exercises.

Conclusions

The exercises can alter perception of the tissue. The changes can be analyzed using the CC's as a reference points.

Discussion

The therapist should palpate CC's before and after the exercises to have accurate information about the changes. Not exercises alone, not treatment alone makes the best result. The treatment is reasoned when painful or blocked movement can be identified. After the treatment the goal is to keep mobility, control and balance of the body.

Implications

The exercises used in this report can be done to improve the whole body balance and movement control.

HOW TURKİSH PHYSİOTHERAPİSTS ASSESS LOW BACK PAİN PATİENTS

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Introduction

In This study we investigated the assessment of acute (<12 weeks duration) nonspecific low back pain (NSLBP) by physiotherapists. The aim was to determine the methods used by the Turkish Physiotherapists.

Method

Online Survey data were gathered from 145 physiotherapists.

Descriptive statistics (proportions and frequency of use distributions) were used to describe assessment technique use.

Results

Level of Degree

71% BSc
29% MSc or PhD
72% Postgraduate Course

Content of the Postgrad. Course

38% Osteopathy
35% Mulligan
30% Mc Kenzie
26% Cyriax
16% Kaltenborn
3% Maitland

Do you assess all patients?

61% Yes
25% Not enough time
14% System/Doctors barriers

Types of Assessment Methods Used Assessment of Range of Movement

77% Observation most assessed movement is flexion by 99%

Orthopedic&Neurologic Tests

89% SLR
82% Observational Postural Analysis
62% SIJ Tests

Assessment of Muscular Function

91% Manual Muscle Test

Pain Assessment

74% Description of Pain

64% VAS

Conclusion

Turkish Physiotherapists who participated in this study know and use methods of assessment were cited in the literature. Physiotherapists are willing to improve themselves, and it was reflected clinical studies on low back pain.

THE EFFECTIVENESS OF PILATES IN THE MANAGEMENT OF CHRONIC LOW BACK PAIN: AN UPDATED SYSTEMATIC REVIEW

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Introduction
In recent years, Pilates has been introduced as a rehabilitation technique in health settings and used as an intervention for chronic low back pain. Numerous clinical trials and systematic reviews have studied the effectiveness of Pilates in people with chronic low back pain but with all reporting conflicting results.

Purpose
The objective of this systematic review is to provide an up to date evaluation on the effectiveness of Pilates in the management of chronic low back pain.

Methods
The search was performed in multiple databases for relevant articles from 1980 to 2013 using the key words Pilates and chronic low back pain. The process was then completed according to the PRISMA flow diagram which maps out the number of records identified and the reasons for exclusions.

Results
The final selection identified fifteen randomised controlled trials. The studies were critically appraised using the PICO (participants, interventions, comparisons and outcomes) method and the PEDro scale to determine the methodological quality. All studies reported different inclusion criteria, definition of Pilates intervention, use of different comparison group(s) and methodological quality.

Conclusions
Overall, there is inconclusive evidence on the effectiveness of Pilates in the management of chronic low back pain due to the heterogeneous methodology across the studies. Therefore, it is unknown whether Pilates is more effective than other interventions in the management of chronic low back pain and future well designed studies are needed to favour Pilates as the choice of intervention. Additionally, no adverse events are reported across all the studies when Pilates mat exercises are given as home exercises which appear to indicate the safe use of Pilates at home.

Discussion
It is vital to provide a choice of intervention options in the management of chronic low back pain, which is highlighted by European guidelines in considering patient's preference and expectations when recommending interventions. As such, Pilates could be offer as an intervention for people with chronic low back pain especially for those who previously did not respond to any other interventions.

Implications
The use of Pilates in health and community settings by trained professionals could potentially be safely implemented as part of a self-management program to benefit the large population of people with chronic low back pain.

Key Words
Pilates, chronic low back pain and systematic review

TREATMENT OF BACK PAIN IN CHILDREN

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Back pain in children is associated with structural and functional spine deformities.

This report is based on a study of the effectiveness of the treatment of 136 patients (68 boys and 68 girls) between the ages of four and 21 years (average age 14 ± 3.5). All patients were examined using clinical and instrumental methods, including diagnostic radiation (X-ray, CT, MRI) and functional testing. To comprehensively assess the functional state of the spine and the outcome of the treatment, the study used questionnaires and an evaluation system based on a set of equally weighted individual indicators (S.P. Mironov et al). The resulting data were subjected to a statistical analysis, which identified the following types of pathology resulting in dorsalgia: impaired posture – 19 patients (13.9%); scoliosis – 31 (22.7%); juvenile kyphosis – 18 (13.2%); spondylarthrosis – 10 (9.7%); spondylolysis – 7 (5.1%); spondylolisthesis – 12 (8.8%); lower back pain – 30 (22%); abnormal development of the vertebrae – 3 (2.2%); dysplasia of the vertebrae – 5 (4.4%).

The integral indicator (maximum of 5 points) before the start of treatment was 2.8 ± 0.6 points. Pain according to the VAS (Visual Analogue Scale) was 3.2 ± 0.4 points. The highest level was observed in spondylolisthesis, at seven points, and the lowest was in impaired posture, at two points. The indicators reflecting the functional state of the spine as a result of performing standard motor tasks were very low (less than three).

Treatment programs were based on the functional profile of the patient and the nature of the abnormality, taking into account the location and origin of the pain. The program included the following stages: 1) eliminating pain and extra-vertebral trophic disorders; 2) normalizing radicular and spinal functions; 3) strengthening the muscles that stabilize the spine, restoring their support ability; 4) restoring the spine's ability to bear static and dynamic loads and its stability; and 5) educating the patient on correct posture and correcting the functional component of the disorder.

In order to prevent the dorsalgia from intensifying, the patient was given daily physical therapy sessions at home, with follow-up examinations every three months during the first year, every six months for the next two years, and then annually thereafter. The effectiveness of the nonsurgical correction was evaluated based on the change in the integral indicator (II) at the various stages of treatment. The condition of the patients prior to treatment was considered decompensated, with an II below 3 (2.8 ± 0.6). As a result of nonsurgical treatment, the II rose above 4 (4.4 ± 0.4), indicating compensation.

After the course of treatment, pain relief was observed in 98% of cases, while the severity of the pain was reduced in 2% of cases. Improvement was seen in indicators that reflected the functional state of the spine: the strength of stabilizing muscles, the ability to use muscles for an extended period of time, etc.

The long-term results in 80% of the children were studied. Full compensation was achieved in 97% of cases. In 3% of cases, pain appeared occasionally under heavy loads.

Summary of the study by S.P Mironov and coauthors

This report describes the experience of 136 patients suffering from dorsalgia between the ages of four and 21 years. The treatment program included five stages. The effectiveness of it was studied for a period of three years. Compensation of the spine and pain relief were achieved in 98% of cases.

Keywords

Treatment, spine, pain, children

THE NEW INTERPRETATION OF BIOMECHANICAL PRINCIPLES OF FRYETTE

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The purpose of this study was to examine the effectiveness of modern methods of physical rehabilitation of patients with dorsopathy. It was measured using the principles of biomechanics of the spine movements made by the Harrison Fryette (1876-1960). These principles are:

Principle I: When the spine is in neutral, side bending to one side will be accompanied by horizontal rotation to the opposite side.

Principle II: When the spine is flexed or extended (non-neutral), side bending to one side will be accompanied by rotation to the same side.

The study involved patients of the neurology department of the military hospital with dorso-pathology of thoracic and lumbar spine. The study group included 48 people (27 men and 21 women aged from 29 to 62 years). The control group consisted of 52 people (29 men and 23 women aged 28 to 63 years). The average age of the surveyed patients and controls was 48.9 ± 4.3 years.

Electronic goniometry of the spine «ValedoShape» (Hocomat) was carried out in the sagittal (flexion, extension) and frontal (side bending) planes prior to the preparation of individual rehabilitation program. Obtained data were analyzed for the compliance with the principles of Fryetta depending on the location of pain.

The program of physical rehabilitation of study group patients consistently included: training of diaphragmatic breathing; training in group with gymnastics (PT); individually planned exercise with elastic expanders (Thera-Bands; Individual strength training to strengthen back muscle, using “Tergumed” system (Proxomed) with biofeedback.

Functional rehabilitation of the control group patients included a standard three step programs of physiotherapy consisting of the medication and physiotherapy group trainings.

To assess the effectiveness of risk factors,a questionnaire was applied (specially designed questionnaire), daily self-assessment check (with analog pain scale), as well as definition of a weekly mobility of the spine by ValedoShape («MediMouse»).

Primary assessment of the angle mobility of the spine in the control and the study groups showed that according to the principles of Fryette, patients in the acute stage were expressed insignificantly, may be due to regional muscle tension and the presence of local functional blocks of spinal motion segments.

Outcomes of the study:

- The results suggest an earlier pain relief in patients with DORSALGY, using modern methods of physical rehabilitation: pain in the study group was significantly decreased by the third day and in the control group only on the 4th-5th day of treatment ($p < 0.05$).
- There is a statistically significant difference in the severity of pain on the 2nd-3rd day treatment in study and control groups (relative to the initial value). Recovery of the mobility of the spine was faster in the study group than in the control group ($p < 0.05$), and summary results (increase of mobility) were significantly better at hospital discharge ($p < 0.01$).
- Restoration of normal spinal mobility was faster in the study group than in the control group as formulated as according to the law of Fryette ($p < 0.05$), but the final results of a comprehensive definition of mobility in the frontal and sagittal planes were not significantly different in the study and control groups ($p \geq 0,05$).
- Electronic goniometry of the spine allowed proving the relevance of the application of laws Fryette at the modern stages to assess the normal mobility of the spine and to confirm the presence of functional blocks in the period of exacerbation.

Conclusion

- In general, using the modern methods of physical rehabilitation in patients with dorsopathy helped to reduce the duration of treatment (hospital stay in the study group was 13.2 ± 2.3, and in the control group 15.5 ± 2.8).
- Self-assessment of the treatment effectiveness at the end of hospital stay in patients with dorsopathy from the study group was slightly higher than in the control group ($p < 0.1$), despite the fact that general state of self-esteem before the procedure of physical therapy was not different significantly ($p > 0.1$).
- The high efficiency of physical rehabilitation for functional training («Thera-Band»; «Tergumed») as well as the possibility of an objective evaluation of motor functions of the spine using the modern electronic goniometry («ValedoShape») and the time-tested principles of Fryette, show great prospects for further research in this area.

ELECTROPHYSIOLOGICAL STUDY FOR NERVE ROOT ENTRAPMENT IN PATIENTS WITH ISTHMIC SPONDYLOLISTHESIS

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Introduction

The affected nerve root in isthmic spondylolisthesis is generally believed to be entrapped by the fibrous cartilage that proliferated at the point of the pars interarticularis.

Purpose/Aim

To investigate the electrophysiological location of nerve root entrapment in patients with isthmic spondylolisthesis.

Materials and Methods

We performed an electrophysiological study in 12 patients with isthmic spondylolisthesis during single-level PLIF. After a total facetectomy, nerve root action potentials were recorded by stimulating the ipsilateral peroneal nerve at the popliteal fossa. Four needle electrodes were inserted into the affected nerve root at the intraspinal canal, pars interarticularis, disc level, and extra lateral to the disc. We also confirmed surgical records and preoperative images to investigate the relationship to the electrophysiological findings.

Results

An abnormal waveform pattern was demonstrated at the pars interarticularis in six patients, at the disc level in five, and at the extra lateral site in one. A relationship between the electrophysiological findings and surgical records or preoperative images was not found.

Conclusions

This study suggests that decompression only at the pars interarticularis may be insufficient for patients with isthmic spondylolisthesis.

Discussions

Electrophysiological investigation in this study shows that nerve root entrapment in patients with isthmic spondylolisthesis occurs not only at the pars interarticularis but also distal to the isthmus.

THE CLINICAL EFFECTS OF ACUPUNCTURE AND LOW LEVEL LASER THERAPY IN THE TREATMENT OF ACUTE LOW BACK PAIN AFTER ACUTE ISHAEMIC STROKE

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Introduction

Back pain is a frequent consequence affecting over 50% of patients after the stroke. The basic causes of back pain after the stroke are changes in muscle strength, tonus and activation, changes in sensibility, atypical movement and lessening movements. Reduction of pain, improvement of muscle strength and enzyme activity, improvement of static and stability during verticalization and walk, accelerates early rehabilitation treatment and returns of patients to everyday activities of life and work.

Aim

To compare clinical effects of acupuncture therapy and combined acupuncture and LLLT therapy in patients with acute low back pain after acute ischemic stroke.

Materials and Methods

Prospective, randomized clinical study included 30 patients divided in two groups. Group A: 15 patients (9 woman and 6 man) of an average age 57± 9 years were treated by needle acupuncture at acupuncture points - UB23,UB25,UB54,UB40,UB60,GB34,GB39,St36. Group B: 15 patients (10 woman and 5 men) of an average age of 60±6 years were treated by needle acupuncture at the same acupuncture points and LLLT therapy (GaAlA laser,808nm,20mW,100 Hz,3J per point, total 24J), applied to 8 correspondent spinal level points. Patients were treated with 14 treatments.

Both groups had individual training of protecting movements and kinesytherapy program for the acute phase of low back pain adjusted to functional report. Pain was measured by Visual analogue scale, lumbar mobility by Shober measurement and functional disability was assessed by The Functional Independence Measure (FIM). Subjects were evaluated on 1st and 14th day of treatment. Data were analyzed by standard statistical methods. Level of significance was 0,05 in all methods.

Results

Statistical analysis revealed no statistically significant differences between the groups in the intensity of pain, lumbar mobility and functional disability on entry to the trial. Analysis of differences within each group after 14 days of therapy revealed significant decrease in pain intensity and reduction in functional disability. Values of Schober measurement shoved significant improvement in lumbar mobility in group B but not in group A. When differences between the groups were analyzed after 14 days of therapy, a statistically significant difference was seen, reflecting reductions in pain intensity and functional disability and increase in lumbar mobility in the group B when compared with group A.

Conclusion

Acupuncture and LLLT are both effective addition to standard procedures in therapy of acute back pain affecting patients after the stroke. Combination of application of acupuncture and LLLT has better effectiveness in early rehabilitation of the patients with acute low back pain after acute ischemic stroke than monotherapy. It leads to significantly faster pain elimination and better results of early rehabilitation of these patients.

COMPARISON OF PRESSURE PAIN THRESHOLDS IN PATIENTS WITH NON-SPECIFIC LOW BACK PAIN AND HEALTHY SUBJECTS

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Introduction

In case of non-specific low back pain [LBP], a series of physiological and functional changes can lead to a deconditioning of thoraco-lumbar muscles.

Purpose

To investigate pressure pain thresholds [PPTs] measured with a FISCHER algometer (Kg/cm2) in respect to Erector spinae and hip musculature in patients with subacute non-specific LBP and to compare the results with those in healthy controls. The severity of LBP depending on Oswestry Disability Index (ODI) was examined in relation to their influence on PPTs.

Methods and Materials

PPTs were measured in 87 patients with LBP and 64 healthy subjects on the different Erector spinae levels and hip musculature. Patients with LBP completed Oswestry Disability Questionnaire and VAS.

Results

PPT mean values of Erector and hip at all examined points of the LBP group were significantly lower [P < 0.001] than compared with those of the healthy group (Table 1).

Table 1: Comparison of PPT in healthy subjects (n = 64) and patients with LBP (n = 87)

	Group healthy s.	*Group LBP*		*t-test (df=149)*	
PPTs	*Mn & SD*	*Mn & SD*	*M.D.**	*t-value*	*p sign.*
Triceps br.	*7.1 1.7*	*6.7 1.8*	*0.4*	*1.528*	*0.119*
Er.Sp. T6	7.6 1.1	6.6 1.1	1.0	5.258	0.000
Er.Sp. T10	7.4 1.1	6.4 1.2	1.0	4.937	0.000
Er.Sp. L1	**7.4 1.2**	**5.3 1.4**	**2.1**	9.840	0.000
Er.Sp. L3	**7.7 1.7**	**5.1 1.3**	**2.7**	11.555	0.000
Er.Sp. L5	**9.5 1.2**	**7.2 1.6**	**2.3**	10.127	0.000
Glut.max.	8.0 1.5	6.4 1.6	1.6	6.453	0.000
Glut.med.	7.2 1.5	6.1 1.6	1.1	4.443	0.000
TFL	7.1 1.4	6.3 1.5	0.8	3.705	0.000

* M.D. = mean difference

When the group of patients with LBP was divided in function of having an ODI < 40 [=moderate LBP] and > 40 [=severe LBP] it was surprising that there was no significant difference between PPTs of Erector and hip musculature, while the mean VAS of the subgroup moderate LBP was significantly lower [P<.005] than the VAS of the subgroup with severe LBP.

Discussion

PPT difference is maximal at Erector L3 level: the muscular tissue damage is probably most related to the level of maximal mechanical stress in the lumbar lordosis.

Conclusions

The correlation between PPT values and having LBP or not, in the whole group, was highest at L3 level of Erector spinae and supports the hypothesis of extreme muscular tenderness at the maximal distance overlap in lumbar lordosis. The results of comparing PPTs in function of their disability intensity do not differ significantly and it supports the hypothesis of fear-avoidance differences in patients with LBP.

Implications

In case of subacute LBP, there is a strong intra-individual difference in muscular fibrosis sensitivity at the L3 Erector spinae level, related to pain behaviour.

Keywords

Low back pain, pressure algometry, Erector spinae, thoraco-lumbar

KNOWLEDGE, ATTITUDES AND BELIEFS ON CONTRIBUTING FACTORS TO LOW BACK PAIN AMONG LOW BACK PAIN PATIENTS ATTENDING OUTPATIENT PHYSIOTHERAPY TREATMENT IN MALAWI

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Introduction

Low back pain (LBP) is a growing health problem worldwide, its aetiology is not well understood and there is varying opinion on the exact cause and contributing factors to LBP. Literature indicates that providing education to patients on their LBP enhances their knowledge and changes the negatives attitudes and beliefs regarding their pain.

Purpose

This study aimed to identify patients' knowledge, attitudes and beliefs on the contributing factors to LBP, among patients attending physiotherapy outpatient treatment in Malawi.

Settings

The study was carried out at physiotherapy outpatient departments of Kamuzu and Queen Elizabeth Central hospitals.

Materials and Methods

A quantitative cross-sectional survey was done, using a self-administered questionnaire. The six-part questionnaire included questions on demographic and social data, participants' attitudes and beliefs regarding their LBP, knowledge/understanding on the course and causes of LBP in general, beliefs regarding nine contributing factors to LBP (identified in a Delphi study), and the sources of the participants' knowledge and their views on their own LBP. The Statistical Package for Social Sciences (version 19.0) was used for data capturing and analysis. Descriptive and inferential statistics was used to summarize data. The Chi-square test was used to determine any association between variables and the Alpha level of significance was set at 0.05. All ethical issues relating to the study were sought and adhered to throughout the study period.

Results

There were 205 LBP patients participated in the study. The mean age of the sample was 47.74 years, (SD=13.29). Females constituted 53.2% of the study sample. Most participants were partially knowledgeable about the course and causes of LBP and more than half (67%) portrayed negative attitudes and beliefs about LBP in general. Furthermore, most participants (86.3%) agreed that the nine contributing factors identified through Delphi study, contribute to the development of LBP and may also worsen an existing LBP. The findings also showed a statistically significant relationship between knowledge, attitudes and beliefs ($p=0.04$).

Relevance

This study has identified the possible knowledge gaps and wrongful attitudes and beliefs about LBP among patients attending treatment at physiotherapy outpatient departments in Malawi. The results could therefore be used as basis to advocate for the establishment/ improvement of health promotion programs, in order to enhance patients' knowledge about LBP and to change their negative attitudes and beliefs regarding their pain.

Conclusion and Recommendations

LBP management programs should include education programs aimed at empowering patients with knowledge regarding LBP, its contributing factors as well as changing their negative attitudes and beliefs about their pain. Patient education may enhance the achievement of treatment goals. Patient health education programs should also be part of intervention regimens in the curricula for health professionals.

Conflict of interest

No conflict of interest with this study.

Key Words

Low back pain, Knowledge, Attitudes, Beliefs, Contributing factors.

PERCUTANEOUS DISC DECOMPRESSION UNDER CT-CONTROL

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Introduction

Interventional management of radicular pain using the Dekompressor® system aims to decrease the intradiscal pressure of herniated disks. In a prospective, non-randomized case study we examined the complications and long-term effects of this treatment using computed tomography as imaging method.

Purpose

To investigate if the minimal invasive percutaneous disc decompression shows good results over a longer period, the patients' data have to be analyzed.

Methods

In a prospective, non-randomized case study we treated patients using the Dekompressor® system (Fig. 1-3). Pain scores, analgesic usage and deficits in activities of daily life were reassessed in telephone interviews 6, 12 and 36 months after the procedure.

Results

64 patients were treated at 76 lumbar levels. Follow-up data after 12 months are available for all patients, data after 36 months for 48 patients. The average reported pain level was VAS 7.3 before the procedure, 2.1 after 12 months and 2.1 after 36 months. Before the procedure, 61 patients (95 %) used opioid or non-opioid analgesics regularly, after 1 year a reduction in analgesic use was seen in 51/64 patients (80 %) and in 38/48 patients (79%) after 3 years. None of the patients reported procedure-related complications.

Discussion

To choose the most effective treatment option for patients with low back pain is a great challenge. Open surgical decompression has complication rates of up to 13%, including discitis in 1%, serious neurological complications in 0.3-0.6% or death in 0.06-0.21%. Over the years, several less invasive methods of discectomy were introduced. All of these techniques share the same disc access approach as the one used for discography. To choose the most effective treatment option for patients with low back pain is a great challenge. Open surgical decompression has complication rates of up to 13%, including discitis in 1%, serious neurological complications in 0.3-0.6% or death in 0.06-0.21% [1, 2, 3, 4, 5, 6]. Over the years, several less invasive methods of discectomy were introduced. All of these techniques share the same disc access approach as the one used for discography.

Conclusions

If standardized patient selection criteria are used, treatment of patients with radicular pain associated with contained disc herniation using the Dekompressor® is a safe and efficient procedure.

Keywords

Percutaneous; lumbar; discectomy; Dekompressor; CT-control

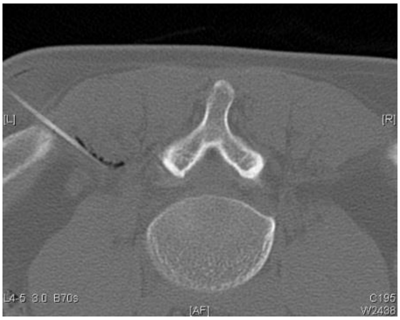

Fig. 1: CT-image of the needle during positioning into the disc

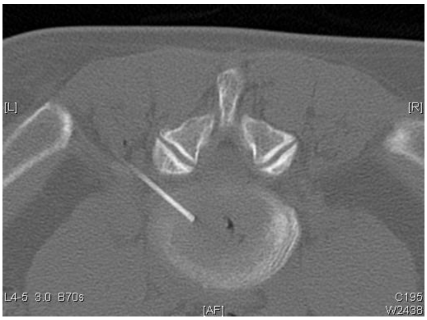

Fig. 2: CT-image of the needle in the disc during the discectomy

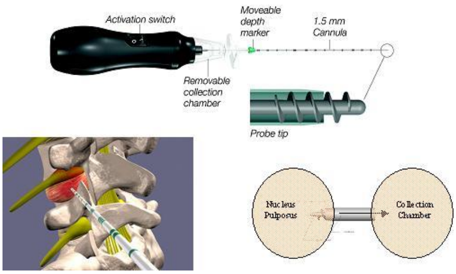

Fig. 3: Dekompressor® details

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ULTRASONIC THICKNESS OF LATERAL ABDOMINAL WALL MUSCLES IN RSPONSE TO PELVIC FLOOR MUSCLE CONTRACTION IN STRESS URINARY INCONTINENE WOMEN WITH AND WITHOUT LOW BACK PAIN

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Introduction

Stress Urinary Incontinence (SUI) as a common lower urinary tract dysfunction, affects many women after childbirth and results from Pelvic Floor Muscles' (PFM) under activity. PFM as a part of abdominal cavity, play an important role in generating and maintaining intra-abdominal pressure through their co-activation with the abdominal muscles and the diaphragm. Therefore, in recent years, studying PFM function in people who have lumbo-pelvic or pelvic floor dysfunction are strongly recommended.

Purpose

This study was aimed to investigate the changes in the ultrasonic thickness of the Lateral Abdominal Wall Muscles (LAWM), in response to PFM contraction in stress urinary incontinent women with and without Chronic Low Back Pain (CLBP).

Materials and Methods

28 women; 10 healthy, 18 SUI with and without CLBP (9 in each group) participated in this quasi-experimental study. After collecting demographic information and assessment of PFM function, changes in ultrasonic thickness of right LAWM were measured in response to PFM contraction. One way ANOVA, Kruskal-Wallis and Pearson's correlation tests were performed to analyze the data. Values of $p<0.05$ were considered statistically significant.

Results

No significant difference was found in thickness of the LAWM while PFM were at rest ($p>0.05$). There was a significant increase in thickness of the Tranversus Abdominis Muscle (TrA) during PFM contraction in control group comparing experimental groups ($F=7.531$, $p=0.03$). Women in control group showed significantly higher PFM strength and intravaginal pressure ($F=9.599$, $p=0.001$).

Conclusions

Changes in ultrasonic thickness of the TrA during PFM contraction revealed disturbance of co-activation of the LAWM and the PFM in SUI women with and without CLBP.

Keywords

Ultrasonography, lateral abdominal wall muscles, pelvic floor muscles, stress urinary incontinence, chronic low back pain

THE RELATIONSHIP BETWEEN ADIPOSITY AND CHRONIC LOW BACK PAIN: AN EXAMINATION OF REGIONAL AND TOTAL BODY ADIPOSITY TO PAIN AND DISABILITY

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Introduction

Obesity, or more specifically increased adiposity, has been previously linked to chronic low back pain (cLBP). Despite evidence for this potential relationship, past cLBP research has relied on the use of body mass index (BMI) as a measurement of obesity, which lacks consideration of body composition. In recent years, other methods of body composition and adiposity have arisen to the forefront of investigations in obesity-related research, such as bioelectrical impedance analysis (BIA) and ultrasound (U/S). Such measures are of importance since regional distribution of adipose tissue, particularly abdominal or visceral, as opposed to total body adiposity has been suggested to be related to metabolic dysfunction. It remains unknown, however, whether there is a relationship between regional or total body adiposity and pain or disability in a cLBP population.

Purpose/Aim

To examine the relationship of regional and total body adiposity with pain and disability in cLBP individuals.

Materials

BIA, U/S

Methods

Thirty (n=30) men and women with cLBP were assessed for their BMI, regional adiposity, total body adiposity and self-reported pain and disability. BMI was calculated by weight (kg) divided by height squared (m2). Weight was measured to the nearest 0.1kg and height to the nearest 0.1cm. Regional adiposity was measured using U/S images of minimum subcutaneous fat, maximum pre-peritoneal fat, maximum subcutaneous abdominal fat and maximum intra-abdominal fat. Total body adiposity was calculated using BIA. Self-reported pain was measured by a visual analogue scale (VAS), with ‘no pain’ on the left anchor and ‘worst pain imaginable’ on the right anchor. Self-reported disability was measured using the Oswestry Disability Index questionnaire as an indication of functional disability.

Results

Data will be analysed using SPSS Statistics 20 upon completion of the dataset. Correlation and regression statistical analyses will be performed on the complete dataset to investigate relationships between BMI, adiposity, pain and disability.

Relevance

The findings of this research will enhance the understanding of the pathophysiology underlying cLBP.

Conclusions

No conclusions can yet be made regarding this research until data analysis has been completed.

Discussions

The results of this research may provide additional support for the limitations of BMI as a clinical measurement of obesity. Furthermore, such findings may validate the importance of adiposity in cLBP populations if it is shown to be related to levels of self-reported pain and disability.

Implications

The findings of this study may provide important advancements in cLBP research and subsequently cLBP treatment. For instance, if adiposity is shown to be related to cLBP then the clinical implication will include the development of treatment programs directly targeting levels of adiposity in cLBP patients.

Keywords

Regional adiposity, total body adiposity, cLBP, ultrasound, BIA

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN ABDOMINAL ADIPOSITY AND BIERING-SORENSEN DURATION TIME IN CHRONIC LOW BACK PAIN INDIVIDUALS

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Introduction

The Biering-Sorensen (Sorensen) postural task is a widely used clinical test of lumbar muscle endurance. It is known that chronic low back pain (cLBP) individuals exhibit shorter Sorensen task duration times compared to healthy (asymptomatic) individuals. Past cLBP research has also suggested that increased adiposity may be associated with increased pain. It is unknown if the shorter Sorensen duration time in cLBP individuals can be explained by increased abdominal adiposity and consequently greater pain provocation in cLBP individuals. For this reason, regional distribution of adipose tissue in cLBP individuals requires exploration in the pain-provoking Sorensen postural task.

Purpose/Aim

To examine the relationship of task duration time in the Sorensen test with abdominal adiposity and acute pain levels in cLBP individuals.

Materials

Ultrasound, plinth

Methods

Thirty (n=30) men and women with cLBP were assessed for their body mass index (BMI), waist-to-hip ratio (WHR) and abdominal adiposity, and then required to perform the Sorensen lumbar muscle endurance test. During the Sorensen test, individuals were required to hold their upper body unsupported in a horizontal position for ‘as long as possible’. Self-reported pain was recorded every 20 seconds of the test. BMI was calculated by weight (kg) divided by height squared (m2). WHR was calculated by waist circumference (cm) divided by hip circumference (cm). Waist circumference was measured at the narrowest point between the lower border of the costal margin and the iliac crest. Hip circumference was measured at the widest point of the gluteal region. Abdominal adiposity was measured using U/S images of minimum subcutaneous fat, maximum pre-peritoneal fat, maximum subcutaneous abdominal fat and maximum intra-abdominal fat. Self-reported pain was measured by a visual analogue scale (VAS), with ‘no pain’ on the left anchor and ‘worst pain imaginable’ on the right anchor.

Results

Statistical analyses will be performed upon completion of the study, using SPSS v20. Correlation and regression analysis will be used to examine the relationships between BMI, WHR and abdominal adiposity with task duration time and acute pain development.

Relevance

The results of this study will enable task performance of a commonly used clinical test and acute pain provocation in cLBP individuals to be better understood.

Conclusions

The conclusions of this research will not be clear until the complete dataset has been analysed.

Discussions

Since task duration time is potentially a multi-factorial outcome, the examination of abdominal adiposity and its relationship to acute pain development and task duration time will provide a clearer understanding of possible factors affecting the outcome variable (task duration).

Implications

The findings of this study will influence the assumptions made from the use of the Sorensen test in cLBP populations. It will also provide an insight into the pathophysiology of cLBP, contributing to further research and treatment progression in the future.

Keywords

Abdominal adiposity, Sorensen test, cLBP, duration time, pain provocation

THE ESSENTIAL ROLE OF THE CRANIAL DIMENSION IN MUSCULOSKELETAL DISORDERS

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Introduction

Despite the vast amount of research into the causative processes of low back pain and pelvic disorders, there remains one area which has received little attention as to its relevance, if any, in addressing these conditions. That is in the significance of the presence of an involuntary cranial mechanism as first originally posited by William Garner Sutherland, DO.

Purpose

Within the past 30 years there has been focused research on the relationship between total cranial anatomy and its impact on the physiological component, which is to say the involuntary respiratory mechanism (IVM). The purpose is to establish if such a mechanism exists and, if so, whether its purpose is central, or peripheral, in the healing requirement.

Method

A visual examination of most craniums will exhibit easily observable anatomical imbalances between the left and right hemispheres on the vertical and/or horizontal planes. Such anatomical abnormality suggests that any involuntary respiratory movement taking place about the sutures would be less than full and free. A subtle wave like mechanism would therefore be limited in some degree. In the resting state the body's muscular structures should be in the fully relaxed state, referred to as relative inhibition. If however, that state is changed to one of relative facilitation, or stimulation, the musculature migrates to a state of contraction.

Conclusion

It can now be theorized that the ability of the musculature to assume normal (resting) tonus is directly related to the functionality of the central nervous system as facilitated by the anatomy of the cranial bones. Such a conclusion suggests that the predisposing (overcontraction) causative factors in many musculosketal disorders are already present before symptoms present. Although there is often a seemingly associated precipitating incident, such as a fall, a sports event or even a simple stretch, the onset of symptoms, and their resolution, will frequently be found to respond if addressed solely at the predisposing cranial level. The objective of this approach is to require the change of the cranial anatomical status in total, and not localized perceived lesions, to one of full openness known as anatomical flexion.

Implications

The methodology to achieve this objective has been developed and utilizes the patient's intra cranial forces along with other specifics to facilitate the cranial structures to decompress, or expand, to their maximum anatomical capability. There also follows resultant vertebral and dural re-alignment. This system, referred to as Bio Craniopathy, is applicable to low back, pelvic and an unlimited range of disorders. The methodology also tends to confirm the existence of an alternating intra cranial pressure presence, without which cranial anatomical changes would not take place.

ANALGESIC USE IN ELDERS WITH BACK PAIN: THE BACE STUDY

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Introduction
Older patients with back pain are more likely to visit their general practitioner (GP). No information is available about their analgesic use.

Aim
To assess the analgesic use in elders with back pain in general practice.

Materials and Methods
The Back Complaints in the Elders study in the Netherlands is a prospective cohort study. Patients (>55 years) with back complaints were included when consulting their GP. Measurements took place at baseline and at three and six months follow-up.

Results
Of the 675 patients included, 485 patients (72%) reported medication use at baseline. Non-steroidal anti-inflammatory drugs (NSAIDs) (57%) were more used than paracetamol (49%). Paracetamol was mostly obtained over the counter (69%) and NSAIDs were mostly obtained by prescription (85%). At baseline patients with severe pain (NRS >7) used more paracetamol, opioids and muscle relaxants. Patients with chronic pain (back pain >3 months) used more paracetamol, while patients with a shorter duration of pain used more NSAIDs. At three and six months follow-up there was an overall decline in medication use, but 31% still used pain medication at six months follow-up. Of all patients aged 75 years and over 36% still used NSAIDs at 6 months follow-up.

Relevance
There is no data regarding medication use in elders with back pain in primary care. This study provides additional information on this topic.

Conclusions
Most older patients (72%) who consult their GP with back pain used analgesics at baseline. Although there is a decrease in medication use at during follow-up, 31% of the patients still used analgesics at 3 and 6 months follow-up. Of all patients ≥75 years a substantial part (36%) still used NSAIDs at 6 months follow-up.

Discussions
Questionnaires were used to ask patients which analgesics they used for their back pain and therefore not known are the considerations of the general practitioner for prescribing specific analgesics.

Implications

Most elders reported medication use for their back pain. Over one third of the patients ≥75 years used NSAIDs at 6 months follow-up, general practitioners should be aware of this.

Keywords

Analgesics, elders, back pain, primary care

EFFECTS OF CHRONIC LOW BACK PAIN ON ENERGETICS AND MECHANICS OF WALKING

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Introduction

Chronic low back pain (cLBP) is often accompanied by changes in motor control strategy and posture, as evidenced by studies conducted using force platforms, repositioning tasks and electromyography measurements. Changes were also observed in gait patterns, including a decrease in preferred walking speed (PWS), maximal walking speed and step length, as well as difficulties in coordinating pelvic and thoracic rotations with increasing walking velocity. It remains to be determined whether these changes influence the metabolic cost and mechanical work of walking.

Purpose/Aim

We aimed to compare the energy cost and mechanical work of walking at different speeds between patients with cLBP and healthy participants.

Relevance

Better understanding changes in gait parameters associated with cLBP may serve as a basis for the promotion of walking in everyday activities.

Materials and Methods

Participants were 13 patients with cLBP and 13 controls individually matched for age, mass and height. The protocol consisted in treadmill walking at four fixed speeds (between 0.83 and 1.67 m·s-1) and at PWS. Mechanical work (in J.kg-1.m-1) and spatiotemporal parameters were assessed using tri-axial inertial sensors (MTx, Xsens, Enschede, The Netherlands) located in the lower back (L3) and on the left foot. A gas analyser was used to determine the net energy cost of walking (in J.kg-1.m-1). Pain intensity, disability and fear of movement were measured using a visual analogue scale (VAS), the Oswestry disability index (ODI) and the Tampa scale for kinesiophobia (TSK) respectively.

Results

Two-way ANOVA (group x speed) with repeated measures (speed) revealed no group differences in the mechanical work, spatiotemporal parameters and energy cost of walking ($P>0.05$). PWS was significantly lower for patients with chronic LBP compared to controls (1.17 ± 0.04 m·s-1 vs 1.33 ± 0.03 m·s-1, respectively; $P=0.002$). In patients with cLBP, no significant correlation was observed between PWS and pain VAS ($r=0.28$; $P=0.346$), ODI ($r=-0.02$; $P=0.938$), and TSK ($r=-0.14$; $P=0.659$).

Discussions

Metabolic cost and mechanical work of walking was not altered in our patients with cLBP. However, our sample presents moderate disability (mean ODI = 29.2) and may not be representative of the walking patterns of severely disabled patients. The decrease in PWS observed in patients with cLBP supports the results of previous studies. Decreased PWS may result from a strategy aiming to limit pelvic and thoracic rotations, decrease the load applied on the spinal column, reduce postural instability and set intensity on a lower percentage of maximal aerobic capacity.

Implications

Our results showed that such participants require an adapted protocol including lower walking speeds.

Conclusions

Patients with moderate cLBP do not change the biomechanics and energetics of walking but spontaneously adopt a lower walking speed.

Keywords

Gait, energy cost, mechanical work, spatiotemporal parameters

CHRONIC PAIN IN THE LUMBOSACRAL SPINE AFTER TOTAL HIP ARTHROPLASTY

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Introduction
Often, after a seemingly successfully executed total hip arthroplasty on the background of the restoration movement in the hip joint, change of length and support ability limbs, progresses clinic of lumbar osteochondrosis, manifested by pain syndrome. This can significantly reduce the results of the total hip replacement.

Purpose
To study the dynamics of chronic pain in the lumbar spine after total hip arthroplasty.

Materials and Methods
The study involved 84 patients after total hip replacement were divided into two groups:

I. Patients with coxarthrosis and high grade degenerative changes in the lumbosacral spine - 45 patients
II. Patients with coxarthrosis and low grade degenerative changes in the lower back - 39 patients

All patients were examined after 6, 12 and 24 months after unilateral total hip replacement (using the scale of Oswestry, Harris hip scale, VAS).

Results
In 45% of patients of the I group, a significant enhancement of low back pain with disease progression and regression of pain in 18% of cases. In 70% of cases the patients in II group there was regression of lumbar pain, in 25% of cases of the dynamics was not noted. Only in 5% of patients was increased pain

Conclusion
Hip replacement surgery at unexpressed changes of the lumbar spine significantly reduces chronic pain in the lower back by restoring the anatomy and biomechanics of the zone. However, with the express prior lesions of the lumbar spine is deteriorating state of health, the progression of pain and dissatisfaction expressed by patients arthroplasty.

Recommendations
Before total hip arthroplasty, all patients should be thorough neurological examination. MRI and CT scan is recommended for all patients with severe pain in the lumbar spine. If you have a confirmed during a survey of the destruction of the lumbar spine in many cases be the first step to raise the question of operative treatment in this area of the back, and in the future-joint arthroplasty.

Keywords
Chronic pain, total hip replacement, hip-spine syndrome

METHODOLOGICAL PROPERTIES OF HEALTH OUTCOMES AND UTILITY MEASURES USED BY LBP PATIENTS IN PRIMARY CARE

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Introduction

There is a growing interest in measuring the health benefits of treatments in primary care using generic instruments across different patient groups. Assessment of the performance and methodological properties of utility measures based on questionnaires such as SF-12, EQ-5D and 15D are therefore of particular importance. Utility measures are transformations from questions about health and quality of life into a generic scale and can be used across patient groups for evaluation of health economics. However, it is largely unknown how well these instruments perform in a population of primary care patients in general and LBP patients in particular.

Purpose/Aim

To determine the validity and responsiveness of SF-12, EQ-5D and 15D and their respective utility scores, as used by LBP patients and other patients in primary health care.

Materials and Methods

So far 152 patients from six physiotherapy clinics in primary health care volunteered to participate in a prospective study. The patients were recruited at the onset of a new treatment period (i.e. they had not been treated for the relevant problem the last 3 months). Self-reports of demographical factors and pain intensity (NRS scale 0-10), psychosocial variables (Ørebro screening questionnaire-short version) and generic instruments assessing function and general health (COOP/Wonca, Patient Specific Function Scale (PSFS), SF-12, EQ-5D-5L (5 response categories) and 15D) were collected electronically at baseline. At the end of the treatment period (or after 12 weeks) the assessment of function and general health were repeated. Global Perceived Effect was also included at the end of treatment. Utility scores were calculated form the SF-12, EQ-5D and 15 (0-1, 0 is worst possible and 1 best possible health). The study is ongoing and we will include about 250 patients with or without LBP. Data on generic health outcomes for the first 152 patients from the baseline registrations are analyzed and reported here.

Results

Among the 152 patients, 20 reported LBP or pelvic girdle pain as their main problem and 132 reported other musculoskeletal problems. Their mean (SD) age was 49 (16) years. Functioning assessed at baseline by COOP/Wonca ranged from mean values of 1.8 to 2.9 for each of the scales, with no differences between the patients with LBP or other problems (p-values 0.06-0.84). Mean (SD) of the PSFS score of the first activity was 7.5 (1.6) for the patients having LBP and 7.0 (2.2) for other patients (p=0,32). Mean (SD) pain intensity the last 14 days was 6.4 (1.9) for the patients with LBP and 5.4 (2.3) for the other patients.

There were no significant differences in the utility scores of SF6D (from SF-12), EQ-5D-5L and 15D for the two groups of patients (p-values 0.10-0.58). For the LBP patients the mean values (SD) of the respective utility scores were 0.61 (0.12), 0.67 (0.11) and 0.81 (0.07). The dispersion of the scores assessed by the SD-values was about 50% larger for SF6D and EQ-5D-5L than for 15D. There was a moderate to strong and linear association between the utility scores (r-values

0.61-0.69). The two patient groups showed almost identical associations. The associations between the utility scores and the score of PSFS were also poor, with r-values ranging from -0.04 to -0.24.

Relevance

Identification of adequate tools for assessing health benefits of primary care interventions is of utmost importance.

Conclusions

The results suggest that both EQ5D-5L, 15D and SF36 have a potential for identifying important differences in health conditions for patients in primary care. Further data including responsiveness is needed for a final conclusion regarding feasibility, applicability and validity of the utility measures.

Discussion

The relatively low values of the utility scores, especially for SF-6D and EQ-5D-5L, shows that there is a potential for improvement during the treatment period. Yet, it remains to be shown that the utility scores are sufficiently responsive for this group of patients. When we have completed our data collection we will be able to provide data regarding this.

Keywords

Health economic evaluation, utility measures, primary health care

ANALYSIS OF FATIGUE INDICES USING LARGE ARRAYS SURFACE ELECTROMYOGRAPHY DURING A MODIFIED SORENSEN TEST

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Introduction

The Sorensen test is commonly used to evaluate back muscle isometric endurance in patients with chronic low back pain (cLBP). In parallel, improvements have been made in the techniques for measuring muscle activation and fatigue. In addition to classic bipolar recordings, large arrays surface electromyography (EMG), a technique which provides a topographical representation of muscle activation, has recently been developed. EMG recordings conducted during back muscle fatiguing tasks usually report increased muscle activation over time, combined with decreased median frequency (MDF) and muscle fiber conduction velocity (MFCV).

Purpose/Aim

The aim was to measure the relation between global fatigue indices derived from multiple sEMG arrays during a modified Sorensen test.

Materials and Methods

Fifteen adult patients with cLBP were asked to perform an isometric back extension modified Sorensen test. Maximal voluntary isometric contraction (MVIC) was recorded before and immediately following the test. Surface EMG of right and left erector spinae was recorded using 2 adhesive matrix of 64 electrodes (LISiN-OT Bioelettronica, Torino, Italy). EMG variables (averaged for the left and right side) extracted from each electrode included the mean (MNF) and median (MDF) power spectral frequency and root mean square (RMS). The rate of change over the test was calculated for each EMG fatigue indice as the normalized slope of the linear regression. For each participant, the correlations between mean normalized MDF slope and MNF, RMS, MFCV slopes respectively were calculated. Patients' pain scores (VAS), disability (Oswestry questionnaire) and kinesiophobia (Tampa scale) were assessed prior to testing. Correlations between these clinical outcomes and the mean normalized MDF slope were calculated.

Results

Significant correlations were observed between left MDF slope and left MNF slope ($r=0.986$, $P<0.0001$), left RMS slope ($r=-0.563$, $P=0.029$), left MFCV slope ($r=0.545$, $P=0.035$) and MVIC change ($r=0.662$, $P=0.017$). Similar correlations were observed on the right side. No significant correlation was found between clinical outcomes and MDF.

Discussions

Global measurement of erector spinae muscle fatigue using sEMG electrode arrays shows that changes in MNF, RMS, MFCV and MVIC are all correlated with MDF (usually considered an accurate method to detect muscle fatigue). Correlations between MDF and MFCV, however, may result from trivial association since measurement of MFCV in back muscles has been shown to be challenging given the complex anatomical structure.

Conclusions

In presence of muscle fatigue, lumbar muscle activity recorded using sEMG arrays provides relevant global fatigue indices in patients with cLBP.

Keywords

Low back pain, electromyography, muscle fiber conduction velocity

TRUNK MUSCLE PERFORMANCE IN CLINICAL LUMBAR INSTABILITY

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Introduction

One of the subdivisions of nonspecific low back pain (LBP) is “segmental instability” which is the cause of 20%-30% of chronic LBPs (CLBPs). Whether patients with clinical instability demonstrate different trunk muscles strength or endurance compared to those without clinical instability is still unknown.

Purpose

The aim of this study was to investigate trunk muscles strength and endurance in CLBP patients with and without clinical instability.

Materials and Methods

32 CLBP patients (15 with and 17 without clinical instability) and 39 matched healthy subjects participated in this study. The standing extension test was performed to assess the strength and endurance of the lumbar extensor muscles while recording their electromyographic activity using bipolar surface electrodes. The maximal voluntary exertion (MVE) of the trunk extensors and time to fatigue (TTF) were collected for further analysis.

Results

Patients with clinical instability showed lower MVE and higher TTF compared to healthy subjects ($P=0.001$ and $P=0.008$, respectively) and patients without instability ($P=0.002$ and $P=0.02$, respectively). There was no significant difference in these variables between patients without instability and healthy controls ($P>0.05$).

Conclusions

The results of this study suggest that the strength training of trunk extensor muscles can be considered as part of the treatment protocol for CLBP patients with clinical instability. Although patients without instability suffered from pain or disability, they showed more similarity to healthy subjects in terms of trunk muscles strength and endurance.

Keywords

Low Back Pain, Instability, Muscle Strength, Endurance

PLATELET RICH PLASMA INJECTION THERAPY TO TREAT GLUTEAL ENTHESOPATHY AND FASCIA INJURY AS A MAJOR CAUSE FOR LOW BACK PAIN

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Introduction

The traditional model for lower back pain treatment focuses on bone, disc, and nervous system pathology. More progressive and more often successful treatment focuses on muscle and fascia, with emphasis on myofascial trigger points, myofascial release, and trigger point biopuncture. With the introduction of platelet rich plasma and stem cell injection therapies, we have learned that most of what is diagnosed as lower back and radicular pain is instead related to tendon, muscle, and fascia injury. These injuries can be quickly assessed and much more effectively and less expensively treated.

Purpose/Aim

This presentation will show a different and much more effective way to think about and treat lower back and radicular pain patterns.

Materials and Methods

Patients come to our center to get help for healing from various problems. Many come for treatment of lower back and lower extremity pain. These patients are all examined in the same fashion, and most are discovered to have injuries to their gluteal muscles and fascia. The predominant injuries are to gluteal tendons and the iliac and sacral origins of the gluteal muscles. These injuries are diagnosed by physical examination, and treated with injection of platelet rich plasma.

Results

Patients with lower back and SI joint pain are usually found to have injured gluteus medius, gluteus minimus, and piriformis tendons. Some also have injury to the iliac and sacral origins of the gluteal muscles. Those who have radicular pain usually have injury to their gluteus maximus insertion. Repairing these enthesopathies brings rapid reduction of pain symptoms and return to function.

Relevance

Most people with lower back pain continue to suffer despite surgical care of anatomic lesions, physical therapy, various biopuncture therapies, and medication. This presentation defines a different pathology and treatment theory that is much more successful for reducing lower back pain and restoring function.

Conclusions

Chronic and acute lower back pain is not as much related to disc and arthritis changes as we so often think. This pain is more related to muscle and fascia injury, and most people can be more quickly and successfully treated with attention to these tissues that do not show on x-ray or MRI studies.

Discussions

With the availability of platelet rich plasma injections as an office based procedure for healing muscle and fascia, new treatment can be offered to patients with lower back pain. This treatment is so quickly effective, it has become evident that tendons, muscles, and fascia cause most lower back pain.

Implications

We should re-think and change the model of how we treat lower back pain. This can stop considerable suffering and help to lower the cost of medical care.

Keywords

Lower back pain, platelet rich plasma, Blatman, tendonopathy, enthesopathy

META-ANALYSIS OF ADULT DEGENERATIVE SCOLIOSIS SURGICAL TREATMENT OUTCOMES: RESULTS OF UNIVERSITY OF MINNESOTA AND SCOLIOSIS RESEARCH SOCIETY EVIDENCE-BASED MEDICINE TASK FORCE.

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Introduction

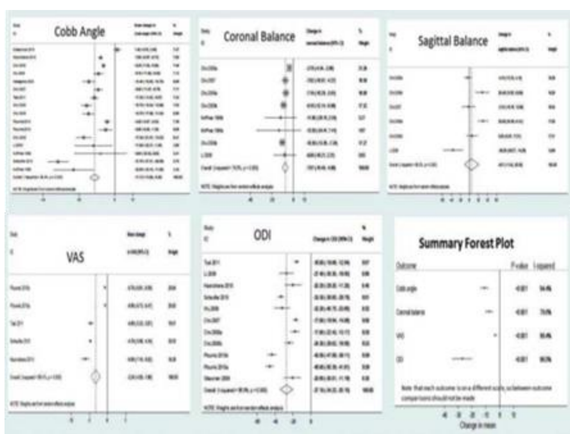
There is increasing awareness of adult degenerative or "de novo' scoliosis and its surgical treatment when indicated can be challenging and resource intense. Surgical randomized controlled trials are rare, and observational studies pose limitations due to heterogeneity of surgical practices, techniques, and patient populations. Pooled analysis of the current literature may identify effective treatment strategies and a guide future effort at prospective clinical research. The purpose of this meta-analysis was to synthesize existing data on the outcomes of surgical intervention for adult degenerative scoliosis.

Methods

Pubmed, Medline, Cochrane and Web of Science databases were searched using key words and limited to the English language. Abstracts were reviewed by fellowship-trained spine surgeons and were further evaluated if they contained surgically treated cohorts of adults (>18yrs) with degenerative scoliosis. Full text articles were reviewed as a team to determine inclusion, and relevant data abstracted. All meta-analyses were conducted on using random effects models and heterogeneity was estimated with I2. Random-effects metaregression models were used to investigate the association of treatment effects with baseline levels of each outcome.

Results

The literature search yielded 482 articles, and of those, 24 articles with 34 surgically treated groups (n=805) met inclusion criteria and were abstracted by a team of 8 spine surgeons and methodologists. Available outcomes included: Cobb angle correction, coronal and sagittal balance, visual analog scale for pain (VAS) and Oswestry Disability Index (ODI). Despite significant heterogeneity among studies, random-effects meta-analysis did show significant improvements in Cobb angle



(-11.13 degrees, 95% CI: -13.86, -8.40), coronal balance (- 7.674mm, 95% CI:-10.49,-4.86), VAS (-3.24, 95% CI:-4.5,-1.98) and ODI (27.18%, 95% CI:-34.22,-20.15) after surgical treatment (p<0.001). Meta-regression models showed that the pre-operative values for Cobb angle, coronal balance and VAS were statistically significantly associated with surgical treatment effect (p<0.05).

Conclusion

Exhaustive literature review yielded 24 studies reporting pre- and post-operative data regarding the surgical treatment of adult degenerative scoliosis. No randomized controlled trials were identified. Despite significant heterogeneity, a limited meta-analysis did show significant improvement in Cobb angle, coronal balance, and VAS following surgical treatment of adult degenerative scoliosis.

ADVICE FOR SUBACUTE LOW BACK DISORDERS: THE PATIENT'S PERSPECTIVE

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Introduction

Advice is recommended in clinical practice guidelines for acute and subacute low back disorders (LBD) despite mixed evidence. The patient's perspective when receiving advice has not been reported. Qualitative methods can provide valuable insight into patient perceptions of a treatment and its effects.

Purpose/Aim

To explore patient perspectives of a guideline-based advice program for patients with subacute LBD.

Materials and Methods

A guideline-based advice program was developed consisting of 2 x 30 minutes sessions over 10 weeks. The components of the program were based on the study of Indahl et al (1995) and included a pathological explanation of the participant's pain, reassurance regarding the generally favourable prognosis of their condition, advice to remain active and instruction regarding correct lifting technique. Participants in a randomised controlled trial who undertook this program underwent a semi-structured interview. Two researchers independently coded interview data using qualitative data-analysis software and thematically analysed the results.

Results

Twenty-one participants were interviewed (8 men, 13 women), with a mean(SD) age of 43(15) years and a duration of LBD symptoms of 15(7) weeks. Some participants reported improvements in their condition including reduced pain increased activity. They associated these changes with improved knowledge and increased confidence with activity based on the reassurance provided. However others stated that the advice was ineffective associated with a perception of the treatment as being not individualised and insufficient in number of sessions/type of treatment provided.

Relevance

Advice is recommended in clinical practice guidelines for LBD. An exploration of the patient's perspective may be of use for clinicians and researchers when considering using advice as a treatment.

Conclusions

Participants with subacute LBP had varying perspectives in response to guideline-based advice.

Discussion

Issues relating to patient perspectives on advice will be discussed.

Implications

Clinicians and researchers need to consider the patient's perspective on advice when planning treatment programs and future research projects.

Keywords

Low back pain, treatment, advice

THE EFFECTIVENESS OF PHYSIOTHERAPY FUNCTIONAL RESTORATION FOR POST-ACUTE LOW BACK PAIN: A SYSTEMATIC REVIEW

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Introduction
The effectiveness of multidisciplinary treatment for post-acute (>6 weeks) low back pain (LBP) has been established. Physiotherapists have sufficient training to conduct less intensive functional restoration however the effectiveness of physiotherapy functional restoration (PFR) has not been evaluated using current systematic review methodology.

Purpose/Aim
To determine the effects of PFR for post-acute LBP via a systematic review of the literature.

Materials and Methods
Electronic databases were searched including: MEDLINE, EMBASE, CINAHL, PsycINFO, PEDro and Cochrane CENTRAL. Randomised controlled trials were identified that compared physiotherapy treatment for post-acute LBP combining exercise and cognitive-behavioural intervention with other interventions, no intervention or placebo. Two authors independently extracted data. Risk of bias was assessed using the PEDro scale and overall quality of the body of evidence was assessed using GRADE (Grading of Recommendations, Assessment, Development and Evaluation). Treatment effect sizes and 95% confidence intervals were calculated for pain, function and sick leave.

Results
Sixteen trials were included. Meta-analyses showed moderate to high quality evidence of significant but small effects favouring PFR compared with advice for intermediate term function and intermediate and long term pain. Heterogeneity prevented meta-analysis for other comparisons. Based on qualitative evaluation there was low to moderate quality evidence that PFR was no more effective than a range of other treatment types.

Relevance
Physiotherapy functional restoration is potentially a widely accessible and cost effective treatment for people with post-acute LBP. The results of this systematic review provide an evidence update.

Conclusions
Physiotherapy functional restoration is effective compared to advice for post-acute LBD, but the effects are small. Further research is required evaluating the effects of PFR to other treatment types.

Discussion
The results are discussed with reference to relevant literature.

Implications

Physiotherapists should consider PFR as a treatment option for people with post-acute LBD.

Keywords

Systematic review; low back pain; functional restoration; exercise; physiotherapy

PRELIMINARY EVIDENCE FOR THE VALIDITY OF FEATURES OF NON-REDUCIBLE DISCOGENIC LOW BACK PAIN: SURVEY OF AN INTERNATIONAL PHYSIOTHERAPY EXPERT PANEL WITH THE DELPHI TECHNIQUE

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Introduction

The lumbar intervertebral disc is a known source of low back pain (LBP). Although evidence exists supporting the validity of certain clinical features associated with discogenic pain, many of the features believed to be indicative of discogenic LBP have not been validated.

Purpose/Aim

The objectives of this study were to obtain consensus from an expert panel on the features of discogenic low back pain (LBP), whether subgroups of discogenic LBP exist, in particular non-reducible discogenic pain (NRDP), and the associated features of NRDP.

Materials and Methods

An international panel of twenty-one physiotherapists with expertise in LBP participated in a three round Delphi survey. Panellists listed and ranked features that they believed to be indicative of discogenic pain as well as NRDP. On completion of Round three, features with ≥50% agreement between panellists were deemed to have reached consensus.

Results

After three rounds, ten features of discogenic LBP were identified with the most prevalent features being directional preference, presence of a lateral shift and symptoms aggravated by sitting. Nineteen of the panellists believed that NRDP was a subgroup of discogenic LBP and nine features of NRDP were identified, with no position or movement able to reduce symptoms and the absence of centralisation being the most prevalent features.

Relevance

The lumbar intervertebral disc is a known source of LBP. Aside from centralisation, the clinical features of discogenic pain and related subgroups have not been validated. An expert panel using the Delphi Technique has the potential to provide preliminary validation on the features of discogenic and non-reducible discogenic low back pain.

Conclusions

This study provides preliminary validation for the features associated with discogenic LBP. It also provides evidence supporting the existence and features of NRDP as a separate clinical subgroup of discogenic LBP.

Discussion

The literature discussing the mechanisms underpinning the clinical features of discogenic pain and NRDP will be reviewed.

Implications

With further validation, the features identified during the Delphi survey may assist physiotherapists in clinical practice to identify and specifically treat people with discogenic pain and NRDP, as well as assisting with further research.

Keywords

Discogenic low back pain, Delphi Technique, Intervertebral disc

THE IMMEDIATE EFFECT OF AN EXERCISE INTERVENTION USING ATM®2 ON PELVIC ALIGNMENT, LOWER THORAX EXPANSION AND PAIN IN PATIENTS WITH LOW BACK PAIN

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Introduction

ATM®2 (Backproject corp) is an exercise device to treat LBP, which allow patients to perform isometric exercises of the lumbar flexors or extensors with compression of the pelvis and lower thorax. We hypothesized that the compression of the pelvis and thorax contributes to improving symmetry of the pelvis and thorax, allowing for unconstrained motion of the lumbar spine, and reducing symptoms.

Aim

The aim of this study was to examine the immediate effects of an exercise intervention using ATM®2 on pelvic alignment, lower thoracic expansion and pain in patients with LBP.

Materials and Methods

Inclusion criteria were 1) diagnosed as LPB and 2) pain during trunk extension. Exclusion criteria were 1) history of spinal surgery, 2) medical risks, 3) psychiatric disorder and 4) pregnancy. Twelve patients (5 males, 7 females, mean age: 27.3 ± 25.7 years) participated. An intervention was conducted at their first rehabilitation visit and the outcomes were measured immediately prior to and following the intervention. The patients stood facing ATM®2 and performed maximal isometric trunk extension for 10 reps.

Results

Improvements were found in innominate symmetry from 7.5° to 3.5° (P=0.0007), height difference of the anterior superior iliac spine (ASIS) from 10.2 mm to 3.9 mm (P＝0.0003), number of patients with neutral sacrum alignment from three to 11 (P＝0.0028), lower thoracic expansion in standing from 22.3 cm to 23.5 cm (P=0.0099), maximal inhaling from 24.1 cm to 25.6 cm (P=0.0032), trunk extension from 22.9 cm to 25.0 cm (P=0.0007), finger to floor distance from -2.2 cm to 2.0 cm (P=0.0029), trunk extension angle from 27.8° to 35.6° (P=0.0048) and pain during trunk extension using VAS from 48 mm to 3.1 mm (P=0.0013).

Relevance

Clinicians can utilize this method in treating extension-typed LBP.

Conclusions

Extension exercises using ATM®2 may be useful in treating extension-typed LBP.

Discussion

Isometric exercise using ATM®2 improved the symptoms, alignment and function. The patients performed no exercises for flexibility, balance, or endurance, and therefore, realignment of the pelvis and thorax may be the primary reason for the positive changes. Limitations involved small sample size and lack of a control group.

Implications

Realignment of the pelvis and thorax may require greater attention in treating LBP.

Keywords

ATM®2, low back pain, therapeutic intervention

MISS/PERCUTANEOUS EXPANDABLE TLIF - A NEW TRANSFORAMINAL APPROACH FOR INTERVERTEBRAL SPONDYLODESIS FOR LOW BACK PAIN

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The current treatment of unstable DDD is highly invasive lumbar interbody fusion (TLIF, PLIF, ALIF, XLIF) by mini-open discectomy. The aim was to create the feasibility and efficacy of vertebral fusion through a less invasive percutaneous approach with new telescopic instrumentation. Oswestry Disability Index (ODI) and Visual Analog Scales (VAS) were performed at 3 weeks, 3, 6 and 12 months post-op with CT-scan control. My Inclusion criteria were DDD with discogenic pain and/or spondylolisthesis up to grade II with or without radicular pain. The posterolateral approach was performed with specially designed telescopic instruments through a minimal skin incision (12mm) under fluoroscopic guidance. In all cases a percutaneous minimally foraminoplasty was performed to widen the foramen and allow the transforaminal access. After careful endplate preparation, the expandable TLIF implant was delivered in to the disc under fluoroscopic control. Posterior transpedicular percutaneous screws were applied in all cases to achieve posterior stabilization.

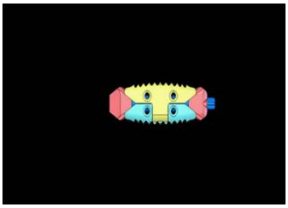
Results

Ten patients were evaluated. Mean age was 55.2 ± 17.4 years. Four patients presented DDD at L3-L4 and/or L4-L5 level and six patients presented spondylolisthesis at L4-L5 or L5-S1 level. The average follow-up was of 10.1 ± 7.2 months. The mean pre-op VAS back scores of (6.3± 1.2) dropped to (1.8 ± 2.6) post-op. Pre-op leg scores of (6.9± 0.5) dropped to (1.3 ± 2.3) post-op. Pre-op ODI scores of (33.3± 6.7) dropped to (11 ± 2.3) post-op. The patients showed a significant ($p < 0.05$) reduction in VAS back and leg pain. The outcome according to McNab scoring was excellent for both patients in group A, while for group B we obtained 6 excellent, 1 good, 1 fair and no poor results. Average recovery time for all patients was of 1-2 days post-op and no rigid brace was required.

Complications

Three patients experienced mild to moderate postoperative radicular pain (transient disesthesia) that resolved after 4 weeks with oral corticosteroids treatment. One patient experienced moderate leg weakness but recovered fully after two weeks.

Conclusions



The results show significant ($p < 0.05$) reduction in pain at all time points evaluated for both groups. This preliminary data suggests that a TLIF done with a percutaneous transforaminal approach using expandable TLIF cage seems promising for treating degenerative disc disease with or without spondylolisthesis up to grade II in a less-invasive manner than classic mini-open TLIF. The expandable titanium cage seems to deliver similar results to the classic PEEK cage. Nevertheless, additional cases should be performed to confirm the outcome in a larger patient series.

FATIGABILITY OF TRUNK AND LIMB MUSCLES DURING THE SORENSEN TEST IN LOW BACK PAIN: A METHODOLOGICAL COMPARISON

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Introduction

The Biering-Sorensen test (BST) is widely used to evaluate fatigability of back muscles. However, controversy exists regarding differential behavior of back muscles in people with chronic low back pain (CLBP) in this test despite the relatively large number of studies. Potential causes of this discrepancy may lay in the methodology used.

Purpose/aim

The present study examined two aims: (1) To examine differences in the fatigability of trunk and limb muscles during BST in CLBP and healthy subjects and (2) To evaluate fatigue differences between two methods (Predicted, non-predicted) of calculating the load applied in the test.

Material and Methods

Subjects with CLBP (N=25, Age=39.0±7.7, 36.0 % males) and healthy people (H) (N=26, Age=39.1±8.72, 34.6% males) performed in a random order two BST in two separate days, one with 55% of their predicted Maximum Voluntary Contraction (MVC) (LBP=2.18±3.39kg; H=2.42±3.41kg) and the other with 55% of their real MVC (non-predicted) (LBP=-7.51±6.71kg; H=0.42±6.55kg). Individual anthropometric values were used in the prediction method. Surface electromyography of spinal erector, multifidus, rectus abdominal, external and internal oblique, major gluteus and femoral biceps was recorded. The slope of the median frequency (MF) and the slope of the normalized root mean square (RMS) were analyzed over the first 30 second period for each muscle and over three periods of 1/3 of the whole fatigue test.

Results

No significance differences were found in time to failure between groups (CLBP=114.53±84.04; healthy=116.30±63.57, in sec) for the non-predicted BST, while group differences were significant (CLBP=50.5±26.5; healthy=91.6±42.6) ($p<.01$) in the predicted test. Overall, no differences were found on MF and RMS in the predicted test but flatter MF slopes and lower values of RMS slope for the CLBP were found in extensors muscles in the non-predicted BST.

Discussion

CLBP showed no more fatigability than H when examining MF and RMS slopes. The non-predicted method showed similar times to failure between the groups, but flatter MF slopes (less fatigue) in CLBP. The predicted method demonstrated shorter time to failure for CLBP compared to H while no slope differences existed. CLBP may abandon the test sooner due to fear. Calculating the test load as a direct percent of MVC may represent an underestimation for CLBP (lighter load). RMS slopes as fatigue indicators corroborated less relative effort (lower slope) in the non-predicted test for CLPB compared to H.

Conclusions

Group differences exist for time to fail while no differences were observed in fatigability of muscles between CLBP and H subjects using the prediction load method. Flatter MF slopes for CLBP in non-predicted test may be a consequence of the methodology and not a feature of CLBP.

Keywords

Low-back-pain, Sorensen test, fatigability

EVALUATION OF CENTRAL SENSITIZATION IN PATIENTS WITH SUB-ACUTE LBP

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Introduction

Differences in central pain-transmitting systems have been suggested as a cause for chronic pain. Central sensitization (CS) has been observed in chronic LBP, but not in sub-acute LBP.

Purpose/Aim

The purpose of this study was to determine 1) whether symptoms of CS can be recognized in an early stadium of LBP and 2) whether symptoms of CS evaluated by a questionnaire are related with conditioned pain modulation.

Materials and Methods

Patients with a new episode of LBP, lasting between 2-12 weeks, were included in a longitudinal study. Participants were asked to fill in validated questionnaires to determine pain intensity, functional disability, kinesiophobia and pain catastrophizing. In addition they were asked to fill in a self-established questionnaire aiming at recognizing the symptoms of CS based on previous work. Next, they were submitted to a pressure algometry protocol prior to and following a conditioned pain modulation test. A clusteranalysis was performed to identify groups. Students t–test were used to compare the 2 groups. Spearman correlation coefficients was used to analyze correlations between several parameters.

Results

Sixty-two patients volunteered for the study. A cluster analysis identified nine patients (15%) as having CS using the results of the self-established questionnaire. No significant differences were found in pressure pain thresholds between the 2 groups prior to and following the conditioned pain modulation test ($p>0,05$). A significant correlation was found between several aspects of the self-established questionnaire and the functional disability, as measured by the Quebeck Pain Disability Scale ($p<0,01$).

Relevance

The presence of CS in a subgroup of patients may be recognized in clinical practice by means of a questionnaire. The clinical importance remains to be established by the longitudinal design.

Conclusion

In patients with sub-acute LBP, 15% demonstrate symptoms of CS. However, preliminary results demonstrate no difference in conditioned pain modulation between patients with and without symptoms of CS.

Discussion

The proportion of patients with CS in the sub-acute phase is in accordance with the proportion found in patients with chronic LBP. Expanding the sample is necessary in order to allow definitive conclusions regarding the relation with conditioned pain modulation and the clinical importance.

Keywords
Central Sensitization, Sub-acute Low Back Pain, Conditioned Pain modulation, Pressure algometry

IDENTIFYING PSYCHOSOCIAL FACTORS FROM ACCOUNTS OF ACUTE LOW BACK PAIN IS NOT STRAIGHTFORWARD – LEARNING FROM COMMUNICATION SCIENCE

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Introduction

Identifying psychosocial factors has become an important focus in clinical contexts and as a research focus to determine patients at risk of chronic pain and disability, and to stratify for patients for targeted interventions. However, research indicates that these strategies are not as effective as expected.

Purpose

This research explored accounts of acute low back pain problems to gain insights for improving current knowledge and management of low back pain.

Method

Nineteen participants experiencing acute non-specific low back pain (<6weeks) were interviewed and completed diaries from onset through to recovery or 3 months. Data analysis drew from approaches within Discursive Psychology, Sociolinguistics and Communication Sciences.

Results

Analysis found that features within accounts often taken to indicate psychosocial risk factors and obstacles to recovery were strategies performing situated interactional functions. These functions included conveying problem significance and information credibility, as well as managing impressions of personal character, integrity and accountability. Importantly, descriptions of mental and emotional states and expressions of thoughts, attitudes and beliefs were being used as resources to manage impressions of the person, their circumstances, conduct and social relations within the interaction. These discursive strategies were increasingly evident with accounts of persisting problems, however hardly evident and interactionally unnecessary with recovery and positive circumstances.

Relevance

For professions seeking to identify psychosocial risk factors during clinical encounters, dialogue seen as indicating psychosocial risk factors may be serving interactional functions within the encounter and may have little transferability as entities outside that context. Consideration needs to be given to the communicative function of accounts. This includes the expression of concepts currently seen as ‘obstacles to recovery’, such as expressions of fear-avoidance, catastrophising, self-efficacy and personal control. Approaches to back pain management within research and clinical contexts may need to reconsider what is assumed possible to know about a person, their circumstances or ‘at risk’ status from information generated in clinical encounters. Significant limitations may exist when taking information out of context for other purposes such as ‘risk’ predictions and treatment stratification.

Conclusions

Dialogue within clinical encounters construed as psychosocial risk factors needs to be appreciated for the interactional functions being accomplished within those contexts. The nature of information elicited in clinical interactions is not straightforward. Caution is needed with extrapolating interpretations beyond these contexts and with the assumptions being applied when discerning risk factors.

Discussion/Implications

There is a need to rethink assumptions on the ability to identify psychosocial risk factors from information provided during clinical interactions. Further research into the nature of information elicited during clinical interviews will help support more informed approaches to its interpretation and use in both research and clinical contexts.

Keywords

Acute low back pain, qualitative, personal accounts, psychosocial factors, experience, beliefs

AN INTERVIEW STUDY OF PATIENTS' EXPERIENCES OF HEALTH AFTER A STRUCTURED PHYSIOTHERAPY TREATMENT MODEL OR SURGERY DUE TO LUMBAR DISC HERNIATION

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Introduction

In earlier studies evidence are formulated that surgery provides more rapid relief of leg pain than non-operative treatment. No differences can, however, be seen between treatments after two years, when using traditional outcome measures such as back-specific function and pain. However patients' experience of health is not earlier investigated with interviews using open-ended questions, which give the patients the opportunity to describe their experiences without being guided by standardized questionnaires.

Aim

Of this study was to describe the experience of health among patients three years after treatment with a structured physiotherapy model or surgery due to lumbar disc herniation.

Material and Methods

Twenty patients who were eligible for surgery were treated with either a structured physiotherapy model (n=10) or surgery (n=10). Open-ended interviews were tape-recorded, then transcribed verbatim and analyzed by content analysis. In the analysis the meaning units were coded according to its content. In order to better illustrate the two treatment groups, a choice was made to specify the amount of codes in each group. The codes with similar content were formed into subthemes. Finally, subthemes were formed into themes.

Results

Findings emerged into two themes: feeling of well-being and feeling of ill-being. In the group treated with structured physiotherapy there were high number of codes in feeling of well-being and the patients described being physically active despite symptoms. In the group treated with surgery there were high number of codes in feeling of ill-being and the patients experienced psychological symptoms and avoided activity because fear of pain.

Conclusions

These findings were surprising, as earlier studies have shown no differences between treatments after two years. One explanation could be that qualitative studies, reflecting the patients' own experiences, reveal results that cannot be obtained with standardized questionnaires. Another explanation could be the effect of the structured physiotherapy treatment that aims at increasing the patients' autonomy and give the patients tools to treat themselves.

Implications

The results in this study are interesting and future qualitative research may focus on developing post surgery rehabilitation that encourage empowerment and give the patients tools to be more physically active, as well as quantitative studies comparing the structured physiotherapy treatment model with surgery.

Keywords

Qualitative Research (Content analysis), Intervertebral Disc Displacement, Rehabilitation, Physical Therapy Modalities and Surgery

CHIROPRACTIC FOR CHRONIC RADIATING BACK PAIN ASSOCIATED WITH LUMBAR DISC BULGING AND HERNIATION PREVIOUSLY TREATED WITH ANTI-INFLAMMATORY DRUGS

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Introduction

The cooperation plan between Regional Government of Lombardy (Italy) and World Health Organization1 has promoted clinical trials protocols to verify effectiveness of complementary-alternative medicine. This is the review of the accepted study on chiropractic.

Purpose

To determine the effectiveness of chiropractic interventions for chronic LBP and sciatica associated with disc protrusion/herniation.

Materials and Methods

Selected patient sample of 44 patients with chronic LBP and preferably sciatica and evidence on MRI of lumbar disc protrusion/herniation. A combination of chiropractic techniques have been applied, including specific spinal manipulative techniques. At admission, before and after every visit, the following parameters were checked: pain (assessed with VAS); limitation/ improvement of mobility of lumbar spine (ROM measurement with inclinometers); signs of radicular pain, neural irritation or peripheral neural deficit (evaluated with SLR, Lasegue, sensory test, DTR); abstinence from or consumption of anti-inflammatory drugs. Quality of life changes were assessed with a specific questionnaire.

Results

44 patients received a series of treatments once a week by an experienced Doctor of Chiropractic. Average number of visits was: 8,86. Patients who had received at least 8 treatments (32 pts) had relevant reductions in symptoms, 12,5% absence of pain, 59,4% pain almost absent, 28,1% moderate pain, 0% unbearable or intense pain. Analysis of variation of mean VAS value had been also calculated. Lumbar spine ROM (Focusing on anterior trunk flexion): mobility substantially without variation for 13,7% of patients; mobility substantially improved for 47,7%; mobility substantially re-established for 38,6% of patients. There was lumbar flexion substantial improvement for 86,3% of treated patients. It was assumed that radiation of pain in the leg may be measurable by monitoring variation of degree of SLR on each visit: a higher value is a sign of decreased radiating pain and also the greater the angle of SLR without pain the greater the improvement. Average variation of SLR measurement: 38 degree when the study started; 42 degree after 3 treatments; 48 degree after 4 treatments; 59 degree after 6 treatments;73 degree after 8 treatments; 83 degree after 10 treatments; 90 degree after 14-16 treatments. Quality of life changes were not relevant after 3 treatments and start to be significant after 8 treatments.

Conclusion Discussion

Although the data must be evaluated cautiously, the study shows that chiropractic treatments may produce favorable outcomes: significant reduction of chronic LBP and sciatica associated with lumbar protruded/herniated disc, elimination or reduction of anti-inflammatory drugs intake, improvement of spine motion and patient quality of life. Limit of the study: a lack of specific follow up makes it difficult to evaluate if clinical improvement is maintained for the mid-to-long term.

Keywords
Chiropractic, SMT spinal manipulative therapy, activator, sciatica, disc protrusion, disc herniation

Reference

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ASSOCIATIONS BETWEEN NEUROMUSCLULAR ADAPTATIONS, PSYCHOLOGICAL FACTORS, PAIN MODULATION PROCESSES AND DISABILITY IN PATIENTS WITH CHRONIC LOW BACK PAIN

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Introduction

Disability in patients with chronic low back pain (LBP) has been associated with psychological factors and neuromuscular adaptations. Moreover, many chronic pain conditions are associated with abnormal pain modulation mechanisms. Chronic musculoskeletal pain has also been associated with the inability to disengage from pain, perpetuating avoidance behaviors through hypervigilance, and consequently, disability.

Purpose/Aim

The purpose of this study was to examine the links between neuromuscular adaptations, psychological factors and pain modulation processes in patients with chronic LBP. We further assessed the contribution of these factors to functional disability.

Materials and Methods

Twenty patients with chronic LBP participated in three experimental sessions. Disability, clinical pain, avoidance beliefs, pain catastrophizing and anxiety measures were collected at the beginning of the first session. This session included dynamic trunk flexion to evaluate baseline neuromuscular responses (electromyography - EMG of lumbar erector spinae) and changes in these responses during noxious thermal stimulation applied to the lumbar region. In the other two sessions, the modulation of pain and spinal nociceptive activity by heterotopic noxious counter-stimulation (HNCS) and by attention were characterized using electrical stimulation of the sural nerve, recording of the RIII-reflex, noxious or innocuous cold stimulation applied on the left forearm, and manipulation of selective attention. Exploratory analyses were conducted using correlations between all variables. We further examined the independent contribution of some of these variables to disability, using multiple regression analyses.

Results

No association was observed between neuromuscular adaptations, RIII-reflex modulation and pain modulation (by HNCS and attention). However, fear-avoidance beliefs were associated with decreased RIII-reflex inhibition by attention ($r=-0.61$, $p=0.004$). In addition, disability was associated with clinical pain ($r=0.68$, $p=0.001$), fear-avoidance beliefs ($r=0.59$, $p=0.007$) and anxiety trait ($r=0.51$, $p=0.02$). Moreover, multiple regression analyses indicated that clinical pain ($\beta=0.5$, $p=0.008$), fear-avoidance beliefs ($\beta=0.41$, $p=0.017$) and trait anxiety ($\beta=0.16$, $p=0.36$) were independent predictors of functional disability (multiple $R2=0.66$, $p = 0.001$).

Discussion

The association between fear-avoidance beliefs and R-III reflex modulation by attention is consistent with the inability of LBP patients to disengage from a painful stimulus. However, disability seems to be independent of pain modulation processes, although the lack of association between these variables should be interpreted with caution, considering the small sample size.

Conclusions

This study suggests that disability in patients with chronic low back pain depends on clinical pain intensity, fear-avoidance beliefs and anxiety but not on the integrity of pain modulation processes, although fear-avoidance behaviors may modulate spinal nociceptive processing.

Keywords

Psychological factors, Neuromuscular adaptations, Attention, Chronic low back pain

THE USE OF PSYCHOSOCIAL QUESTIONNAIRES IN ACTIVE CHRONIC LOW BACK PAIN PATIENTS

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Introduction

Clinical examination in chronic low back pain (CLBP) patients needs to include psychosocial assessment. However, some think that psychosocial assessment is mainly needed in chronic patients on sick leave to consider the risk of not returning to work or prolonged sick leave. Standardized questionnaires can be useful to perform also a quick evaluation in a larger population that is, although careseeking, still at work.

Aim

To demonstrate the scores of the hospital anxiety and distress scale (HADS), the Tampa scale for kinesiophobia (TSK) and the pain catastrophizing scale (PCS) in a working CLBP population and to investigate the relationship with the pain intensity level (numerical scale), the Quebec back pain disability scale (QBPDS) and the hours of sport participation per week.

Materials and Methods

Employees of the Belgian Ministry of Defense, who were referred to the Central Military Hospital for CLBP participated in the study: 246 men with a mean age of 41,46 (8,08) years and a mean BMI of 26,52 (3,81), and 54 women with a mean age of 43,48 (9,27) years and a mean BMI of 25,07 (4,39). After the medical examination, the patients electronically filled in several questionnaires. To be included in the study, patients had to present low back pain for longer than 3 months or at least 3 pain episodes during the past year. Patients on sick leave, insurance or pension were excluded from this study.

Results

There was no significant difference ($p \geq 0.08$) between the men and women in the duration of CLBP (140,11 (305,34) months). Men showed significantly lower pain intensity levels and anxiety HADS scores and higher TSK scores and hours of sport per week. Patients with a QBPDS score of more than 25/100 (N=131) showed significantly higher values of pain, HADS anxiety, HADS depression, PCS and TSK than patients with smaller functional disability scores. CLBP patients with a PCS score of ≥ 24 (N=82) (risk level) showed on all other questionnaires significantly higher scores than patients with lower PCS. Patients with a TSK ≥ 40 (N=166) demonstrated also significantly higher scores on all other questionnaires than patients with lower TSK values.

Discussion

Psychosocial assessment in active working CLBP patients is needed since a large percentage of the total population demonstrated risk levels for kinesiophobia or catastrophizing. There may be a risk for deterioration and perhaps sick leave if this is untreated. Although the questionnaires seem to show similar trends, the separate characteristics need to be evaluated and it seems that no questionnaires should be omitted.

Relevance

Psychologists cannot screen all CLBP patients by interview. Questionnaires and the information they provide need to be investigated.

Conclusion

This study suggests that psychosocial questionnaires and cut-off points (risk level indication) are useful in a CLBP population still at work.

Implications

Active working patients with CLBP demonstrating a functional disability level of more than 25/100 on the QBPDS may benefit from a multidisciplinary treatment approach.

Keywords

Psychosocial questionnaire, chronic low back pain, low back pain assessment

EMG PATTERN OF TRUNK AND LIMB MUSCLES DURING THE SORENSEN TEST: COMPARISON BETWEEN LOW BACK PAIN AND HEALTHY PEOPLE

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Introduction

The Biering-Sorensen test (BST) is widely used to evaluate fatigability of back muscles. However, controversy exists regarding differential behaviour of back muscles in subjects with chronic low back pain (CLBP) and health people (H) in a fatigue condition.

Purpose/Aim

The present study examined differences in EMG fatigue patterns of trunk and limb muscles during BST in CLBP and H.

Material and Methods

CLBP (N=25, Age=39.0±8.02, 36.0 % males) and H (N=26, Age=39.1±8.73, 34.6% males) performed a BST with 55% of their predicted Maximum Voluntary Contraction (MVC) (LBP=2.17±3.39kg; H=2.42±3.41kg). Individual anthropometric values were used in predicted MVC. Surface electromyography of spinal erector (SE), right and left multifidus (RM, LM), rectus abdominal (RA), external and internal oblique (EO, IO), major gluteus (G) and femoral biceps (FB) was recorded. The normalized root mean square mean (RMSMean), a co-activation index, the median frequency slope (MFSope), the normalized root mean square slope (RMSSlope), and muscle-pair root mean square ratios (RMSRatio) were analysed over the first 30 seconds period for each muscle and over three periods of 1/3 of the whole fatigue test (T1, T2, T3).

Results

Significance group differences were found in time to failure (CLBP = 50.5 ±26.5; healthy= 91.6 ±42.6; in sec) ($p<.01$) and higher values of RMSMean were found in most extensor muscles (SE, RM, LM and G) and OI in CLBP in all periods despite controlling for MVC values in the ANOVA. Co-activation of these muscles was also typically higher in this population. No group differences were found in MFSlope and RMSSlope except RM and LM in CLBP which showed higher values of RMSSlope (RM p=0.036; LM p=0.094). Lower MFSlope but higher RMSSlope were found when comparing T1 and T3 for SE in both groups. The same pattern was observed in RMSSlope for RM and LM. While no group differences were found in RMSRatio, some of them changed significantly across the time periodes (Figure1).

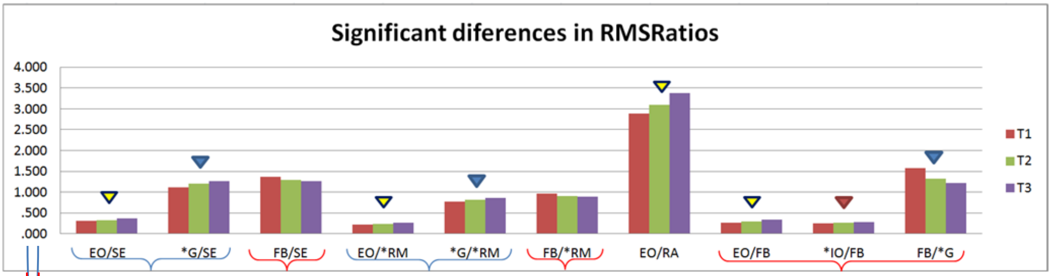
Discussion/Conclusions

RMSMean analysis and co-activation index indicated more relative activation of extensor muscles and OI for the same effort in CLBP people as a percentage of their MVC. This motor pattern could be a disadvantage for CLBP people when facing a fatigue effort.

Examining together RMSSlope, MFSlope, RMSMean and RMSRatio, a common fatigue pattern seemed to exist in both groups. While SE, RM and LM decreased their contribution along the test, G as an agonist and OI as an antagonist seemed to increase their contribution to hold the weight of the body and maintain the spine stability. This motor pattern could be a strategy to rescue the muscles with a greater initial contribution.

Keywords
Low-back-pain, Sorensen test, fatigue motor patter

Figure 1: RMSRatios values of T1, T2 and T3 of all subjects together (chronic low back pain and healthy people). Spinal erector (SE); right multifidus (RM); rectus abdominal (RA); external and internal oblique (EO, IO); major gluteus (G); femoral biceps (FB); Root Mean Square (RMS); Root Mean Square Mean (RMSMean)



As the fatigue test progresses, SE and RM decrease their RMS values in relation of other muscles

As the fatigue test progresses, FB decrease their RMS values in relation of other muscles

As the fatigue test progresses, G increase their RMS values in relation of other muscles

As the fatigue test progresses, IO increase their RMS values in relation of other muscles

As the fatigue test progresses, EO increase their RMS values in relation of other muscles

* Significant increase of RMSMean values along the fatigue test

EVIDENCE FOR NEUROPLASTIC CHANGES IN MOTOR PREPARATION AREAS OF LOW BACK PAIN PATIENTS

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Introduction

There is growing interest in using neuroimaging methods to investigate the role of somatosensory processing in low back pain (LBP) and especially in chronic low back pain (CLBP). However, only a handful of studies reported neuroplastic changes in CLBP patients in primary somatosensory cortex (S1) as well as enhanced cortical activity.

Purpose/Aim

The present functional magnetic resonance imaging (fMRI) study aimed to reveal neuroplastic changes in CLBP patients using a clinically relevant stimulus. Mechanical dysfunction plays a prominent role in the development and continuation of spinal pain. The stimulation of functional spinal units (FSU's) consisted of postero-anterior intervertebral movements (PA) which is a widely used technique in manual investigation and treatment of the lumbar spine.

Materials and Methods

An experienced manual therapist applied controlled, non-painful PA stimuli (30 Newton) to 7 healthy subjects and 7 CLBP subjects at three different lumbar vertebrae (L1, L3, L5). The pressure force was continuously controlled by four pressure sensors, attached to the subjects' spinous processes. The therapist followed a randomized stimulation protocol projected onto a screen in the MR room. The experiment consisted of 51 stimuli of 5 seconds duration and a randomized inter-stimulus interval between 6 to 8 seconds. A whole-brain fMRI approach was used and the data analysis was performed using SPM8. All results were family-wise error corrected ($p<0.05$).

Results

In comparison to the healthy subjects, the analysis of the CLBP patients did not reveal additional foci of activation. In contrast, the healthy subjects showed additional recruitment of sensorimotor areas in the dorsal premotor region. Furthermore, healthy subjects showed enhanced activation in the secondary sensory and insular cortex, in the hippocampus and in the thalamus.

Relevance

The findings of the present investigation supports earlier findings in CLBP patients describing diminished postural control, disturbances in the body schema as well as non-selectivity in chronic pain states.

Conclusions

Using PA movements, the lumbar stimulation elicited well-pronounced activation in sensorimotor areas in healthy subjects and CLBP patients. However, healthy subjects seem to activate additional brain regions pointing towards a differential cortical processing between the two groups. Especially the weaker activation of premotor areas in CLBP patients might support the idea of a diminished postural control.

Discussions

In contrast to previous findings of enhanced cortical activation, non-painful PA movements revealed a down-regulation of sensorimotor processing and proprioceptive memory networks in CLBP patients. This finding is in striking contrast to previous studies that were using tactile or thermal stimuli and reported enhanced activation patterns. We assume that the application of PA mobilisation induced strong proprioceptive responses, resulting in a strong input to somatosensory areas in both patients and control groups. However, the subsequent processing of the sensory information was different between the two groups. Further investigations to collect data in a larger patient group should aim to support the findings of these preliminary data.

Implications

These results support the work of clinicians involved in the restoration of normal spinal function and re-establishing of the postural control.

Keywords

fMRI, low back pain, chronic pain, manual therapies, reorganisation

BRAIN ACTIVATION PATTERNS OF POSTERIOR-ANTERIOR MOVEMENTS IN THE LUMBAR SPINE

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Introduction

Eight decades after Penfield's description of the so-called homunculus, there is still sparse and inconsistent evidence for the cortical representation of the lower back. Previous neuroimaging studies used thermal, electrical or mechanical compression at muskulo-skeletal tissues. Most important, these stimuli did not directly tackle the functional spinal unit’s (FSU, i.e. functional entity of two adjacent vertebrae including disc, ligaments, zygapophysial joints) of the lumbar spine necessary to reveal the cortical representation of the lumbar spine.

Purpose/Aim

The present functional magnetic resonance imaging (fMRI) study aimed to clarify for the first time the cortical representation of the lumbar spine by pain-free mechanical stimulation of the lumbar FSU’s. Stimulation of FSU’s by postero-anterior intervertebral movements (PA) is a widely used technique in manual investigation and treatment of the lumbar spine

Materials and Methods

Twenty right-handed healthy subjects (14 females) with and mean age of 35 years (SD 13.4) participated in this fMRI study. The participants were scanned in prone position with the face lying on a special pillow. An experienced manual therapist applied controlled, non-painful pressure stimuli (30 Newton) at three different lumbar vertebrae (L1, L3, L5) and the thumb as a control condition. The stimulation consisted of PA mobilization at these spinous process and pressure on the thumb. The pressure force was continuously controlled by four pressure sensors, attached to the subjects’ spinous processes and thumb, respectively. The therapist followed a randomized stimulation protocol projected onto a screen in the MR room. The experiment consisted of 68 stimuli of 5 seconds duration and an inter-stimulus interval of 7 seconds. A whole-brain fMRI approach was used and the data analysis was performed using SPM8. All results were family-wise error corrected ($p<0.05$).

Results

The lumbar segmental stimulation revealed strong bilateral neuronal activity within the S1 at the medial postcentral gyrus with a conservative threshold ($p<0.05$, family-wise error corrected). The activation maps did not significantly differ between L1, L3 and L5. However, the individual activation maps in S1 showed minimal intersubject variability. The thumb stimulations elicited much weaker responses contralateral to the stimulated site at the lateral convexity of the cortex. Furthermore, lumbar stimulations induced activations bilaterally in the secondary somatosensory cortex (S2), in supplementary motor areas, in the prefrontal, insular and cingulate cortex, as well as in the hippocampus and the cerebellum.

Relevance

For the first time, brain activation patterns were successfully recorded during the application of a commonly used manual therapy procedure using fMRI.

Conclusions

Non-painful PA movements revealed an extensive network of activation which suggests that the proprioceptive input to somatosensory cortical areas triggered a cascade of activation in brain regions previously described for attention, proprioceptive memory retention and preparation of anticipatory postural adjustments.

Discussions

The major new findings of the current study emphasis the need for a multidisciplinary collaboration of clinicians and neuroscientists to find new ways to investigate the function of the spine at brain levels in pain-free conditions.

Implications

By using a clinically relevant stimulus, this paradigm therefore represents one of the few promising areas for future investigations on the influence of back pain onto the processing of sensorimotor signals from the back. The acquired activation patterns of the lumbar spine in healthy subjects could be used as a baseline to investigate cortical plasticity in low back pain patients.

Keywords

fMRI, low back pain, chronic pain, manual therapies

CAPSAICIN 8% CUTANEOUS PATCH FOR TREATMENT OF RADICULOPATHY

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Introduction

The capsaicin 8% cutaneous patch has recently been approved for the treatment of peripheral neuropathic pain (pNP). To gain information on the routine clinical use, a large multicenter non-interventional study (NIS) was conducted. Patients diagnosed with painful radiculopathy were eligible for inclusion. Data in this indication were up to now lacking.

Purpose

To investigate the safety and effectiveness of the capsaicin 8% patch in patients with radiculopathy considering duration of pre-existing pain in the analyses.

Materials and Methods

Of the 1044 patients enrolled into this 12-week prospective NIS, 50 (4.79%) were diagnosed with radiculopathy as the sole pNP-syndrome and subjected to subgroup analysis. Study schedule: single treatment and subsequent visits at weeks 1/2, 4, 8 and 12. Assessments included 11-point Numeric Pain Rating Scale (NPRS) scores, safety (all visits), and quality of life (SF-12) at baseline and visit 5.

Results

Information on duration of pain was available for 37/50 (23 women, 14 men). Mean duration was 1.30 years (±0.55 SD) in the subgroup of patients with a history of pain of 3 months to 2 years (Group 1, n=14) and 9.62 years (±7.32 SD) in the subgroup with pain >2 years (Group 2, n=23). Mean number of patches applied was 1.14 (±0.84 SD) in Group 1 and 1.40 (±1.02 SD) in Group 2. Treatment was predominantly applied to foot, leg and lumbar area. Mean pain intensity assessed by NPRS at baseline was 7.50 (0.29 SEM, ±1.09 SD) and 6.83 (0.31 SEM, ±1.47 SD) in Groups 1 and 2 respectively. From week 1/2 to week 12 compared to baseline, mean NPRS scores declined significantly ($p \leq 0.001$, paired t-test) in both groups with corresponding values of -3.46 (0.53 SEM, ±1.97 SD) and -1.52 (0.4 SEM, ±1.86 SD). Mean ≥30% and ≥50% responder rates were 71.43% and 57.14% in Group 1 compared to 39.13% and 4.35% in Group 2. Looking at all 50 radiculopathy patients, 66% regarded treatment success as either good or very good. The safety profile was consistent with that from earlier investigations. Further data will be presented.

Conclusion

While the capsaicin 8% cutaneous patch seems to be a safe and effective treatment option for radiculopathy irrespective of duration of pain, treatment success was more pronounced in patients with a short history of pain.

Discussion

Although the overall data of this NIS were highly comparable to published data, a limitation of the current study is its non-interventional character. Further controlled clinical trials are indicated to confirm the above findings regarding radiculopathy. Furthermore, the effectiveness of capsaicin 8% on other neuropathic back pain syndromes should be evaluated.

Keywords

Radiculopathy, capsaicin 8% cutaneous patch, duration of pre-existing pain

IMMEDIATE EFFECTS OF MULLIGAN BENT LEG RAISE TECHNIQUE ON LIMITED STRAIGHT LEG RAISE IN MECHANICAL LOW BACK PAIN PATIENTS

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Introduction

Low back pain (LBP) is one of the leading causes why people seek physiotherapy. Mulligan techniques of manual therapy are popular in giving instant results.

Purpose/Aim

The purpose of this study was to find out whether the Mulligan Bent Leg Raise (BLR) Technique can immediately improve disability in mechanical or nonspecific LBP patients.

Materials & Methods

50 male subjects of acute/subacute/chronic mechanical LBP aged between 20 to 49 yrs were recruited. Overall Pain and Active Straight Leg Raise (ASLR) range (in degrees) were taken as the parameters of their disability. Visual Analogue Scale (VAS) of 1 to 10 and universal inclinometer were used to measure these parameters respectively. A rigid knee extension brace along with a knee strap and an ankle foot orthosis have been used to maintain the uniformity of ASLR movements in subjects. Patients were treated with three consecutive sets of mulligan BLR technique with around 10 minutes of interval in between. Each set comprises of 3 applications of the technique Each standard application of the technique consists of five isometric hip push and relax at five progressively greater hip flexion positions. The traction component maintained at the patient's hip by the therapist is the key factor to keep the technique painfree. Also medial or lateral gliding of the progressively flexing hip of the patient is helpful for therapist to find the pain free path for patient's greater hip flexion. Pre and post patient's pain levels and ASLR ranges have been recorded.

Results

Paired t test has been used Pre VAS mean score = 6.00 +\- 1.161 Post VAS mean score = 0.88 +\- 0.659 p value <0.001 Pre ASLR range mean score = 42.9034 +\- 8.94737 Post ASLR range mean score = 76.0170 +\- 9.01119 p value <0.001. So the after treatment effects were a significant reduction in average VAS score and a significant increase in average ASLR range.

Relevance

Statistical analysis suggests that the taken disability parameters are highly relevant with mechanical LBP to measure its current status as their relevance have been proved only on an immediate basis in this trial.

Conclusions

On the basis of obtained data it can be concluded that the mulligan BLR technique has excellent beneficial immediate effects over the taken sample population.

Discussion

In spite of the popularity of mulligan techniques there is a vacuum in available literature justifying their treatment mechanisms. This statement is also true in case of the BLR technique however obtained clinical efficacy of the technique could be justified by correction in the following alterations commonly seen in mechanical LBP population: 1) decreased extensibility of hamstrings; 2) disturbed lumbar spine vs hip joint kinetics & kinematics; 3) sacroiliac joint dysfunction; 4) movement impairments or control impairments; 5) higher activation of external oblique rectus abdominis and lower abdominal synergists; 6) increased back extensors fatigability and knee extensors inhibition 7)decreased lumbar stability.

Implications

There is scope to explore the efficacy of the technique on a follow up basis as well as over variable age and gender.

Keywords

Mechanical low back pain(LBP) Mulligan Bent Leg Raise (BLR) technique Active Straight Leg Raise (ASLR)

APPLIED CHIROPRACTIC SPINAL MANIPULATION RESEARCH TO IMPROVE CLINICAL OUTCOMES: A TRANSLATIONAL APPROACH BETWEEN CLINICIANS AND RESEARCHERS

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Introduction

Chiropractors have used spinal manipulation to treat low back pain and neck pain for more than a century. For the last four decades research is being conducted on spinal manipulation with federal research being funded for the last two decades to do chiropractic research. Chiropractic research generates new knowledge and provides opportunity for improved treatment options for the clinical chiropractor.

Purpose/Aim

The objective of this presentation is to demonstrate how clinicians and researchers have collaborated on flexion-distraction spinal manipulation research and how they have used the translational approach to understand better patient care.

Materials and Methods

This workshop was developed based on the initial interactions between clinicians and researchers on how the clinicians have developed the technique and have been using the technique in patient care. This led to the development of research ideas and submission of federal grants and federal funding on basic science biomechanical studies as well as clinical outcome studies. Past and current federally funded research studies are ongoing in the study of flexion-distraction spinal manipulation at chiropractic institutions and in collaboration with Hines VA hospital and Loyola University Stritch School of Medicine. The workshop will show how the research results are transferred to practicing doctors through seminars and individual demonstration of technique in small groups. The researchers were able to measure forces using transducers and visual feedback during the delivery of the treatment. This is being transferred to educate practicing clinicians to improve the skills of delivering the treatment. The application of these research findings to clinical chiropractic spinal manipulation will be demonstrated by a researcher and an experienced practicing clinician.

Results

We are able to effectively educate the practicing clinicians how important the research is to develop a translational approach and how the research results can be used in patient care.

Relevance

As first line care for low back pain, chiropractic distraction and decompression spinal manipulation offers relief for chronic low back and radicular pain. This presentation will show the relevance of this form of care in the total interdisciplinary treatment of back and radicular pain.

Conclusions

This presentation will focus on the research and clinical application outcomes of specialized chiropractic spinal manipulation for differing diagnostic causes of low back pain. Proper placement of spinal manipulation in the algorithm of spine care is outlined.

Discussion

This presentation informs both the practicing chiropractor and other spine practitioners of how the researchers and clinicians have interacted in treating spine conditions. Demonstrated chiropractic researched conservative care for low back pain can reduce surgical interventions while establishing a helpful treatment algorithm for the non -surgical care for spine pain

Keywords

Low back pain, Chiropractic, Randomized clinical trial, Biomechanics

THE ERROR OF USING BONY POSITIONAL FAULT ALIGNMENT IN ASSESSMENT AND DIAGNOSIS OF SIJ DYSFUNCTION

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Introduction
Amongst manual therapists various therapeutic models have been proposed in identifying and treating SIJ dysfunction. One such widely used model depends on identifying asymmetry of bony surface landmarks on the pelvis in order to determine a positional fault or misalignment. Based on these pelvic positional faults treatment is then directed towards correcting the misalignment and achieving positional symmetry.

Purpose/Aim
To look at the research findings of both the reliability and validity of such an approach and to question why this model continues to be so popular amongst a wide spectrum of manual therapists and to dominate the scene in post graduate training courses.

Materials and Methods
A review of current research articles looking at the reliability and validity of positional fault alignment in identifying and treating SIJ dysfunction and whether joint misalignment is related to joint dysfunction.

Results
Current research findings question the continued use of positional misalignment as a way of identifying SIJ dysfunction. Serious questions are raised on both the reliability and validity of using this method and bring into question the continued use of a therapeutic method of applying treatment techniques with the sole aim of correcting the misalignment in order to achieve symmetry of various pelvic bony surface landmarks.

Relevance
Much progress has been made in recent decades regarding the understanding of SIJ and pelvic function or dysfunction, its anatomy and biomechanics however this evidence does not always translate into evidence based practice in the clinical setting. In the absence of any substantiating evidence it would seem surprising that the method of positional faults based on bony palpations is still held onto by many therapists and that this concept of pelvic misalignment relating to SIJ dysfunction is taught in professional, post-qualification courses to manual therapists as a valid treatment model.

Conclusions
It would appear that bony landmarks are not reliable in determining asymmetry and that so-called asymmetry is unrelated to SIJ dysfunction and hence there is low validity in using this approach as a clinical therapeutic model. Proponents of this approach claim that positional misalignment represents altered joint positional sense or dysfunctional joint biomechanics and subsequent altered translational joint load forces however there is a lack of evidence that would support this approach.

Discussion

Although the treatment interventions may appear to show clinical improvement in signs and symptoms of SIJ dysfunction the mechanism may not be as a result of achieving positional alignment symmetry. Alternative treatment models need to be explored.

Implications

Manual therapists may need to question their continued use of this treatment approach.

Keywords

Pelvic positional faults, treatment model, SIJ dysfunction

CMRT AND ACUPUNCTURE IN THE TREATMENT OF DYSMENORRHEA (OLIGOMENORHEA) AND LOW BACK PAIN: A CASE REPORT

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Introduction

A 31-year-old female patient presented initially to this office for low back and foot pain 5 years prior and sought preventative wellness care and strategies. Approximately 5-years into care, February 2008, the patient discussed the possibility of utilizing acupuncture to help her cope with an irregular menstrual cycle (Oligomenorrhea), having only light periods (1-2 days) 2-3 times a year for over 10-years or more.

Purpose/Aim

An interdisciplinary treatment plan that can vary to treat patients with the multi-causal nature of female related menstrual type disorders with low back pain may be needed for a specific subset of patient. With the risk benefit ratios of pharmaceutical interventions any attempt to utilize alternative type methods that offer low risk and some benefit should be investigated.

Materials and Methods

The patient was assessed and treated using sacro occipital technique (SOT) chiropractic, chiropractic manipulative reflex technique, and acupuncture protocols to evaluate and treat both low back pain and any related viscerosomatic disorders possibly affecting her menstrual cycle.

Results

Following one-year of integrating SOT chiropractic CMRT procedures for liver (T8), adrenals (T9), and acupuncture her low back pain had been eliminated along with an increased ability to function and her menstrual cycle has been regulated with periods of monthly cycling and with only 3 months of amenorrhea one-time during a time of high stress and anxiety.

Relevance

Since some studies have found a relationship between dysmenorrhea and lumbopelvic pain and both chiropractic and acupuncture have been found helpful for some of these related conditions, interdisciplinary care may be an important part of the treatment for patients with these complex presentations.

Conclusions

The chronicity of the patient symptoms, over 10 years, and the temporal relationship between treatment and response to care is compelling. Further research is indicated to determine what subset of patients with dysmenorrhea and lumbopelvic pain is best suited for chiropractic and acupuncture integrated care.

Discussion

It is also of interest that the patient was receiving chiropractic care on an ongoing preventative basis but not until the treatment changed to include CMRT and acupuncture was there a consistent improvement in her lumbopelvic pain and viscerosomatic symptomatolgy.

Implications

Complex unresponsive lumbopelvic pain presentations, with seemingly unrelated co-morbidities of viscerosomatic origin may be worthy of consideration, along with integrated interdisciplinary care.

Keywords

Dysmenorrhea, Oligomenorhea, Low Back Pain, Chiropractic, Acupuncture, Interdisciplinary, Sacro Occipital Technique, Chiropractic Manipulative Reflex Technique, CMRT, Viscerosomatic Reflexes

SACROILIAC JOINT HYPERMOBILITY SYNDROME: A CHIROPRACTIC PERSPECTIVE – A PILOT SURVEY

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Introduction

Sacro occipital technique (SOT) has long discussed that the anterior and posterior aspects of the sacroiliac joint (SIJ) are completely different in both their anatomy and function. The posterior weightbearing aspect of the SIJ when mobile would be dysfunctional (SOT's category two) whereas the anterior nutative aspect of the SIJ when too “stable” would be dysfunctional (SOT's category one).

Purpose/Aim

The purpose of this survey was to see if an Internet survey might be feasible and if preconception of a possible syndrome might influence a doctor’s method of diagnosis and treatment.

Materials and Methods

As a pilot study questions regarding SIJ hypermobility or fixation were asked of Internet chiropractic groups related to just SOT and others not technique based. Those who stated they used SOT as a technique in their office were separated from those who did not use SOT’s method of chiropractic.

Results

A small sampling survey was taken of SOT practitioners (N=53) and some practitioners not familiar with SOT (N=11). Those who practice SOT found that relating to patient lumbopelvic presentations that 13.1% had SIJ fixation, 74.5% had SIJ hypermobility syndrome, and 16.4% had lumbosacral involvement. Those who did not practice SOT found that relating to patient lumbopelvic presentations that 43.1% had SIJ fixation, 16.6% had SIJ hypermobility syndrome, and 40.3% had lumbosacral involvement.

Relevance

As with most systems of healthcare the doctor’s bias and perspective can affect their diagnostic finding and treatment options.

Conclusions

If there were an entity such as a hypermobile SI joint it would behoove chiropractic to be cognizant of this syndrome and see if appropriate tools can be developed to help differentiate it from a fixated SI joint. More investigation into this phenomena could offer greater understanding into whether: (1) a greater number of patients who see SOT chiropractors have hypermobile SI joints, (2) SOT chiropractors are looking at patients with an assumption that the patient will likely have a hypermobile SI joint, and (3) it is possible that SI joint hypermobile is an overlooked syndrome in chiropractic.

Discussion

Is a dysfunction associated with the posterior weight bearing aspect or the anterior portion associated with normal nutation? It is important to differentiate between a fixated SI joint secondary to a anterior joint dysrelationship, such as a pelvic torsion, or a fixated SI joint secondary to a posterior hypermobile joint causing neuromuscularly a "splinting" due to increased nociception and local muscle hyperfaciliation leading to increased myofascial tension3. Most SOT category indictors are related to increased muscle tension or pain and related altered body function. One way of evaluating whether appropriate treatment is being rendered is the lessening of pain or tension at those specific indicator points as well as improved musculoskeletal function.

Implications

It is possible that being cognizant of SIJ hypermobility/fixation may improve patient outcomes and future research should investigate what subset of patients are presenting with this condition.

Keywords

Chiropractic, Sacroiliac Joint, Sacro Occipital Technique, SOT, Hypermobility, Sacral Nutation

CHIROPRACTIC AND DENTAL CARE OF A PATIENT WITH TEMPOROMANDIBULAR AND SACROILIAC JOINT HYPERMOBILITY: A CASE REPORT

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Introduction
A 47-year-old female patient presented with chief complaints of pain when chewing, jaw pain, limited mouth opening range of motion, and TMJ crepitus. She was found to also present with generalized joint hypermobility (GJH), a hereditary connective tissue disorder characterized by lax joints and the presence of musculoskeletal symptoms. Following dental evaluation and delivery of dental orthotics the patient was referred for concurrent chiropractic, which found indicators of sacroiliac joint hypermobility (sacro occipital technique's - SOT - category two).

Purpose/Aim
The purpose of this case report is to share a novel protocol for the treatment of chiropractic and dental treatment of a patient with a temporomandibular joint disorder (TMD) that presented with GJH affecting the SIJ and TMD.

Materials and Methods
Following orthotic and chiropractic care at 8-weeks, the capsulitis of TMJ was no longer present and procaine injections into the posterior TMJ capsule were initiated at one month intervals, followed by prolotherapy. Dentally the patient received prolotherapy injections every 2-3 weeks on the side of TMJ adhesions and joint restriction, secondary to the hypermobile retrodiscal tissue. The injections (2% procaine, initially 10% and then 25% dextrose and bacteriostatic water) were localized in the retrodiscal tissue and sometimes in the ligaments or adhesive tissues to break down scarring. The prolotherapy was also used to create increased retrodiscal tissue tension to facilitate a posterior pull' on the disc, owning to the anteriorly displaced disc. SOT chiropractic care facilitated SIJ stabilization and TMJ cranial function and dental care helped stabilize occlusion and condylar position, which were continued over a 10-month period.

Results
Following concluding treatment the patient was free of most pain, had full range of motion in the cervical and lumbar spine, negative sacroiliac hypermobility findings with improved function, and could open her mouth greater than 42mm (initially presented with 28mm opening) with normal joint tracking and translation.

Relevance
Patients with GJH with concurrent TMJ and SIJ hypermobility may represent a subset of patients needing concurrent chiropractic and dental interdisciplinary care.

Conclusions
Concurrently her sacroiliac joint hypermobility syndrome and related soft tissue tension patterns in the lower extremity, cervical spine, and jaw region have also significantly improved.

Discussion

In general, with chronic disc displacement without reduction, there are strained, stretched ligaments in the posterior joint space. When cranial/chiropractic manipulation reduces the disc but it doesn't stay reduced, prolotherapy is indicated to strengthen and tighten the posterior band of ligaments. The chiropractic care worked closely with the dental application of prolotherapy by informing the dentist when the disc and condyle were in an optimal position. Once in an optimal position the goal was to inject the retrodiscal tissue to help support the disc position on joint translation and preventing close-locked positioning.

Implications

With chronic unresolving TMJ or SIJ hypermobility a patient should be evaluated for GJH and concurrent chiropractic and dental care, incorporating prolotherapy for the posterior TMJ capsule, may be indicated.

Keywords

Temporomandibular Joint Disorder, TMD, Sacroiliac Joint, Generalized Joint Hypermobility, GJH, Interdisciplinary Care, Sacro Occipital Technique, SOT, Chiropractic, Dentistry, Prolotherapy

SOT CHIROPRACTIC CARE OF A 47 YEAR-OLD FEMALE WITH LEFT-SIDED SCIATICA CAUSED BY A 16MM LEFT PARACENTRAL DISC EXTRUSION: A CASE REPORT

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Introduction

A 47-year-old female, entered this office stating that 3-days ago she began to feel pain in her low back and left leg and has progressively gotten worse. The pain radiated from her low-back into her left buttock and down her leg to the ankle. She was barely able to walk, could not stand or sit for more than a few minutes, while lying down was somewhat better but she was unable to get comfortable or sleep for more that an hour. She described the pain as a 9-10 on a pain 1-10 pain scale with 10 being most painful pain imaginable and her functional capacity graded at 20%.

Purpose/Aim

The purpose of this paper is to share how conservative Sacro Occipital Technique (SOT) chiropractic care helped a patient with severe sciatica and lumbar disc herniation return to normal functional capabilities in a relatively short period of time.

Materials and Methods

Specific evaluation procedures were used to determine the appropriate treatment protocols in this case. SOT category three pelvic blocking procedures and orthopedic blocking (low force leverage adjusting using pelvic blocks in accordance with SOT indicators) was initiated. Pelvic blocks were placed under the prone patient at specific angles to reduce the pressure on the involved intervertebral disc decompressing the disc and corresponding nerve root. SOT soft tissue protocols to the psoas and piriformis were also included to facilitate pain reduction and improve function.

Results

After the initial two-weeks of care (March 10, 2010) the patient showed 90% reduction of pain with 90% improvement of her functional capacity. The patient continued to make excellent progress and continued to resume normal activities of daily living without pain or discomfort, and by June 2010 was asymptomatic, remaining so to date. To determine patient’s long-term functional status an MRI was taken on March 9, 2010, which revealed a “L3-L4 central disc protrusion and annular tear, listhesis at L4-L5, and 16mm L5-S1 left paracentral epidural mass effacing the descending left S1 nerve within the lateral recess.”

Relevance

SOT offers an indicator based system to differentiate and guide treatment of the various types of low back pain presentation and therefore may be a worthwhile first step low-risk intervention before attempting more aggressive pharmaceutical or surgical therapies known to have greater risk.

Conclusions

It is significant that the patient’s clinical symptoms, ability to function normally and positive clinical response had improved considerably even though her MRI findings were quite significant (L5-S1 16mm left paracentral epidural mass).

Discussion

This case is particularly interesting because of the patient's positive clinical response to a low-force intervention (SOT care) when presenting with exquisite levels of pain, antalgic positioning, and marked limitations of function.

Implications

Of significance is the patient's reduction of pain and increase in function in the presence of MRI findings, creating a clinical conundrum when therapies are based upon MRI findings alone.

Keywords

Disc Herniation, Epidural Mass, Sciatica, Low Back Pain, Chiropractic, Sacro Occipital Technique, MRI

STYLOID PROCESS SENSITIVITY IN A PATIENT WITH LOW BACK PAIN AND RADICULAR SYNDROME: A CASE REPORT

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Introduction
A 57 year-old right-handed white male, presented in our offices with a chief complaint of acute sudden onset left jaw pain. The patient gave a history of a three-day episode of jaw, neck and ear pain, with no known cause. There was concern, due to the nature and degree of irritation, that he might possibly have an infective process (e.g., swelling pain, discoloration and pain to palpation). Therefore, prior to beginning treatment, dental x-rays were obtained, which were found to be negative.

Purpose/Aim
Was the patient's exquisite styloid process pain related to a relationship between styloid process sensitivity and ipsilateral L5/S1 disc compression as proposed by DeJarnette?

Materials and Methods
Evaluation noted that with palpation marked sensitivity of the left styloid as well as exquisite sensitivity along the right sciatic track with a positive straight leg raise at 45 degrees. The patient was treated with sacro occipital technique (SOT) category three orthopedic blocking, which utilizes the left styloid process as a guide to possible related ipsilateral L5/S1 discopathy affecting sciatic nerve irritation. As decompression to the ipsilateral L5/S1 is produced the styloid process is palpated for sensitivity.

Results
As treatment was provided, the sensitivity to the styloid process was rapidly eliminated. Concurrently the right sciatic pain and related muscle tension in the right thigh significantly diminished. Diminished tension was found in the plantar fascia of the right foot with a visualized reduction in clubbing of that same foot.

Relevance
Interdisciplinary relationships may be of great importance for patients presenting with styloid process sensitivity and low back pain. In the field of dentistry styloid process sensitivity would likely be considered related to a tooth infection or temporomandibular joint disorder.

Conclusions
In this single subject case report of a patient presenting with acute styloid process sensitivity, differentiating the patient's presentation was essential. Once a dental contribution was ruled out, other factors were investigated. A relationship between the styloid process sensitivity, the lower back pain and antalgia was assessed and treated. As the lumbar spine was treated, the styloid process sensitivity was eliminated and the patient had significant improvement of function with a reduction of pain. Further studies are needed to determine what subset of the population has this relationship and to facilitate greater communication between professions treating this entity.

Discussion
Part of any differential diagnosis with a patient that presents with significant styloid process pain could include determining if there is concurrent low back pain related to L5 involvement.

Implications

Ruling out ascending myofascial imbalance from the lower back causing styloid process sensitivity could facilitate improved differential diagnostic protocols thus improving patient care and outcomes.

Keywords

Styloid Process, Low Back Pain, Disc, Chiropractic, Sacro Occipital Technique, SOT, Orthopedic Block Placement, Interdisciplinary Care

PREGNANCY, SACROILIAC SUPPORT BELTS, AND ACTIVE STRAIGHT LEG RAISE (ASLR): UTILIZING MULTIPLE TESTS FOR OPTIMAL OUTCOMES

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Introduction
Sacroiliac joint (SIJ) disorders during pregnancy are considered relatively common as the hormone relaxin increases SIJ laxity, which is assumed to induce pelvic girdle pain and/or low back pain (PPLP). Sacro Occipital Technique (SOT), a method of chiropractic, has one aspect of its analysis and care, which focuses on patients with SIJ laxity or instability, called category two.

Purpose/Aim
The purpose of this paper is to discuss the inclusion of the active straight left raise (ASLR) test as a potential part of SOT diagnostic regimen for the treatment of pregnancy-related SIJ disorders. In addition, this paper will also review the literature concerning the use of the sacroiliac support belt as both a diagnostic and treatment modality for this common presentation.

Methods
A review of the chiropractic literature was performed to evaluate the reliability or validity of SOT's arm fossa test (AFT), which is commonly used to diagnose and evaluate treatment for SIJ disorders, such as PPLP. A broad-based review of the literature was also performed to evaluate any other tests that could be integrated into the SOT paradigm of evaluation and treatment as well as the value of any pelvic support belts for SIJ instability.

Results
The literature for SOT's AFT indicated some intraexaminer reliability and validity. The broad-based review found that the ASLR test has good reliability and validity for the evaluation of SIJ disorders, particularly in pregnancy. In the later stages of pregnancy an unstable SIJ might be supported with a SIJ support belt and its need and successful use could be monitored by a combination of the AFT and ASLR tests.

Relevance
SIJ compression caused by the doctor's hands, a SIJ support belt, or the pelvic blocks may offer a good opportunity to use the ASLR and AFT as a means to study the need for treatment of SIJ instability and the efficacy of the treatment rendered.

Conclusion
Simple tests such as the AFT and particularly the ASLR may offer good options to monitor pre- and post-treatment of PPLP and SIJ in this specific subset of patients.

Discussion
The supine SOT pelvic block placement used to reduce SIJ or pelvic stability in pregnancy might incorporate both the AFT and ASLR as diagnostic and assessment tools.

Implications
Developing diagnostic and treatment strategies for pregnant patients with PPLP and SIJ instability is important due to the need for low risk modalities for the mother and fetus.

Keywords
Active Straight Leg Raise, Pregnancy, pelvic girdle pain, low back pain, Sacroiliac Instability, Sacroiliac Joint Laxity, Chiropractic, Sacro Occipital Technique, Arm Fossa Test

EFFECT OF DEEP CROSS-FRICTION MYOTHERAPY ON PRESSURE PAIN THRESHOLDS IN PATIENTS WITH LOW BACK PAIN

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Purpose

The intended effects of deep cross-friction myotherapy (FMT) on myofascial structures are to regenerate connective scar tissues and reduce local tenderness as a possible mechanism of pain relief. The aim of the study is to explore the effect of FMT on pressure pain thresholds (PPTs) in a group of patients with subacute non-specific low back pain (LBP), in order to verify the model of central sensitization [1, 2].

Methods

The primary outcome measures were the PPTs of levels L1, L3, L5 of the Erector spinae and the Gluteus maximus, Gluteus medius and Tensor Fasciae Latae, measured with the aid of a Fisher algometer. The PPT of the left Triceps brachii (Triceps) is measured as a-not-to-LBP related measuring point. Fifty healthy subjects were examined with respect to similar PPTs. In this study, a 3 x weekly FMT session is employed on a group of 58 patients with LBP and re-examined at a 3-month follow-up.

Results

At the 3-month follow-up examination, the original symptoms of LBP disappeared in the whole group. The mean PPT values of the Triceps showed no meaningful changes, while the PPTs at the level of the thoraco-lumbopelvic muscles reverted to the same mean values as healthy subjects (Table 1).

	Healthy subjects (N = 50)		*Patients with LBP*	*N = 58*	*Same patients after 3 FMT…*		*…compaired with healthy subjects*
PPTs (Kg/cm²)	**Mn [SD]**	**ANOVA** ***p***	**Baseline Mn [SD]**	**M.D.**	**3-month follow-up Mn [SD]**	**ANOVA** ***p***	**Mean Difference**
Triceps br.	7.5 [1.6]	0.070	6.9 [1.5]	- 0.6	7.2 [1.0]	0.28	- 0.3
Erect.sp. T6	7.6 [1.0]	**0.000**	6.7 [1.2]	- 0.9	7.4 [1.1]	0.39	- 0.2
T10	7.4 [1.2]	**0.000**	6.3 [1.3]	- 1.1	7.6 [1.0]	0.79	+ 0.2
L1	7.3 [1.3]	**0.000**	5.1 [1.5]	**- 2.2**	7.5 [0.8]	0.48	+ 0.2
L3	7.6 [1.5]	**0.000**	4.9 [1.4]	**- 2.7**	7.6 [1.2]	0.93	=
L5	9.5 [1.2]	**0.000**	7.3 [1.7]	**- 2.3**	9.7 [1.1]	0.41	- 0.2
Glut.max.	8.0 [1.4]	**0.000**	6.4 [1.6]	**- 1.6**	7.9 [1.2]	0.55	- 0.1
Glut.med.	7.4 [1.4]	**0.000**	6.2 [1.6]	- 1.2	7.3 [1.3]	0.60	- 0.1
TFL	7.4 [1.5]	**0.001**	6.4 [1.5]	- 1.0	7.1 [1.4]	0.25	- 0.3

Conclusions

The effect of deep cross-friction myotherapy in patients with subacute non-specific low back pain may be explained rather as a local resporation of connective tissues in the thoraco-lumbopelvic myofascial structures and buttock musculature. More equivalent stuies are nevertheless needed to confirm those findings.

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COMPARISON OF ANKLE JOINT DORSIFLEXION AFTER CLASSICAL MASSAGE OR SPECIFIC MYOFASCIAL RECEPTOR MASSAGE TECHNIQUE ON THE CALF MUSCLE: RESULTS FROM A RANDOMIZED CONTROLLED TRIAL

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Introduction

Classic massage is commonly used by licensed naprapaths with the aim of increasing range of motion (ROM) in joints. Over the last few years several soft tissue techniques has been developed to aim the manual therapy to specific receptors and locations in the connective tissue.

Purpose/Aim

This study investigates the range of motion in dorsiflexion of the ankle joint after specific myofascial receptor massage technique in the distal myotendinous junction of the calf compared with classic massage in the calf´s muscle belly.

Materials and Methods

One hundred healthy participants aged 19-37 years (mean 24,2) were randomly divided in two groups. One group got transverse specific myofascial slow friction massage in the myotendinous junction for three minutes and the other group got classical massage in the whole calf muscle for the same period of time. Goniometric measurements where used to study the ROM in dorsiflexion of the ankle joint. The measurements where performed before, immediately after and 10 minutes after intervention.

Results

Comparison between the two groups showed a difference in favour of the specific massage group measured direct after the intervention (0.70 º, $p<0.001$) and also after 10 min (1.32º, $p<0.001$). The specific massage group showed a within group average ROM increase of 2.50º ($p<0.001$) immediately after intervention, and 2.00 º ($p<0.001$)10 min after intervention. The within group improvement after the classical massage treatment was 1.80º ($p<0.007$) immediately after intervention and 0.68 º ($p<0.001$) 10 min after intervention.

Relevance

There might be benefits in the clinic targeting specific areas with high density of mechanoreceptors. This result might not be exclusive for the ankle joint. It might be transferable to other regions such as the lower back, pelvis, hip and other areas, but more research is needed.

Conclusion

Even though the difference in ROM between the two groups was moderate this study suggests that a specific myofascial receptor massage technique not only may improve the ROM of ankle dorsiflexion more than classic massage, it may also have a more long lasting effect.

Discussion

Specific myofascial receptor massage could be seen as an alternative to classic massage. Depending on the aim of the treatment the therapist should be encouraged to aim his or hers techniques to a lesser area with a high density of mechanoreceptors.

Implications

Evaluation of a specific technique aimed towards a smaller area than classical massage.

Keywords

Mechanoreceptors, massage, myotendinous junction, ankle dorsiflexion, goniometric measurements, connective tissue

EFFECT OF OSTEOPATHIC MANIPULATIVE TREATMENT ON HEALTH AND ON RISK OF DEPRESSION IN CHRONIC LBP PATIENTS: RESULTS FROM THE ESOQOLIO TRIAL

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Introduction

Low back pain is frequent in Western culture and can simultaneously coexist with other diseases in a patient. Previous authors have reported that 49% of patients with low back pain/sciatica report depression as a co-morbidity.

Purpose/Aim

The aim of this study is to explore the extend to which a 1 month osteopathic treatment can improve the quality of life and reduce the risk of depression in subjects affected by chronic LBP.

Materials and Methods

This control before-after study was conducted as part of a larger cohort research (ESOQOLIO study) enrolling people with chronic pain from central and south Italy. The referring population was 521 outpatients with chronic LBP, aged between 35 and 50 and no co-morbidities associated. Health related outcomes were measured at entry and after 1 month using SF36v2. Generic depression scale was derived using continuous and categorical MCS subscale. 4 osteopathic manipulative treatments were performed during the study period. Changing in pre-post general health (GH) score was used as primary outcomes. Body pain (BP) and mental component summary (MCS) were considered as secondary outcomes. Paired t-test and linear mixed effect analysis were performed controlling for socio-demographic factors, drugs assumption and SF36v2 subscales.

Results

521 patients with diagnosed chronic LBP (mean LBP period in months 6±2) were selected. At the end of the 1-month treatment period, the GH showed a statistical significant improvement ($t0=44.7\pm21.5$; $t1=77.0\pm18.6$ $p<0.001$) as well as BP ($t0=30.0\pm18.0$; $t1=81.3\pm21.5$; $p<0.001$) and MCS ($t0=31.8\pm11.6$; $t1=51.1\pm10.5$; $p<0.001$). Linear mixed effect analysis showed positive associations between GH and OMT ($p<0.001$), BP and OMT ($p<0.001$) and MCS and OMT ($p<0.001$). OMT decreased the RR of depression (RR=0.19, 95%CI: 0.11 - 0.30).

Relevance

The study is relevant in shading light the role of OMT in the complex interaction between chronic clinical disorder, changing in general and mental health.

Conclusions

The research showed that OMT is positively associated with an improving of general health and bodily pain. Moreover OMT decreased the risk of depression in a large sample of chronic LBP patients.

Discussion

Chronic LBP is characterized by tissue and brain reorganization. OMT, resolving somatic dysfunctions, might interfere with these changes enhancing bodily functions and self-perceived health status.A cascade of health care implications can be considered in particular for LBP management and the role of OMT in mental health associated to chronic muscle-skeletal disorders.

KEY CLINICAL DIAGNOSTIC SIGNS IN SACRO-ILIAC SYNDROME

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Introduction

Sacro-Iliac Syndrome (SIS) causes approximately 25% of all cases of Low Back Pain (LBP), yet is rarely taught to medical doctors. SIS is often missed in primary care, with significant patient morbidity and cost. LBP is the 2nd most frequent reason that patients consult primary care physicians. SIS is ideally diagnosed by clinical exam, not by MRI, and is readily treatable by manual medicine therapy.

Purpose

Pathognomonic signs elicited on examination can: 1) confirm the diagnosis of SIS 2) direct treatment to specific Spine Manipulation Therapy, 3) avoid unnecessary MRI or CT imaging tests, overmedication, surgery, 4) prevent chronicity with attendant disability. SI Syndrome “cluster” signs can be taught successfully to family doctors.

Key Clinical Signs

A new clinical exam sign, the Perlman Knee-Chest Gap Test, is introduced. Key clinical signs of SIS are: 1) Unilateral Stork Test 2) Pubic Ramus Sign 3) Perlman Knee-Chest Gap Test. This triad, if all positive, confirms SIS. Other signs of SIS include 4) FABER/Patrick Test 5) Pelvic Tilt 6) SI traction/distraction 7) Pyriformis tension 8) “Duck Walk” 9) Secondary Cascade of dorsal and cervical facet signs.

The Perlman Knee-Chest Gap Test is a modified version of Gaenslen's test, described in 1927. To elicit Perlman’s sign, the patient lies supine, the clinician flexes both the ipsilateral hip and knee of one leg at 45 degrees. The clinician’s free hand is placed as a clenched fist rested on the patient’s chest wall, along the mid-clavicular line. The contralateral leg remains flat in neutral position on the exam table. The examiner then grasps the flexed knee, and slowly brings it towards the examiner’s fist on the ipsilateral chest wall, accompanied through flexion at the hip, until the patient’s knee reaches the end-range of flexion. The distance between the patient’s knee, and the examiner’s fist at this end-range of flexion, the ipsilateral Knee-Chest Gap, is then measured in centimeters (cms). This manoeuvre is repeated on the contralateral leg, and the Knee-Chest Gap is then compared for the right and left leg. The Knee-Chest Gap difference between the right and left leg will be zero in most normal patients. In active SIS, the “injured” SI joint will demonstrate a positive Knee-Chest Gap on the affected side, defined empirically as positive when the Knee-Chest Gap on the ipsilateral “affected” side is 4 or more cms at the end-range, from fist to knee, compared to the unaffected contralateral side. A tentative positive Perlman’s test is recorded when the Knee-Chest Gap is 4 or more cms on one side. A confirmed positive Perlman’s test is recorded after both sides are measured, and the difference between the ipsilateral Knee-Chest Gap, compared to the contralateral Knee-Chest Gap, is 4 or more cms. By using the difference in Gaps between the two sides, the clinician can partly control for bilateral loss of flexibility in the SI joints, hips, or knees.

In hypermobile patients, a modified Knee-Chest Gap is used. The examiner’s clenched fist is eliminated. The patient’s ipsilateral knee is moved slowly towards the patient’s’ ipsilateral chest wall at the mid- clavicular line, and the end-range is measured, in the same way, bilaterally. An active SIS may be missed in hypermobile patients, if the modified test is not used.

The Perlman Knee-Chest Gap test reliably signals SIS. When the ipsilateral Stork sign is up-going (abnormal), instead of down-going (normal), the Perlman Knee-Chest Gap is positive, and the Pubic Ramus sign is positive (ramus acutely tender to palpation), the 3 key signs are pathognomonic for SIS. No further tests or imaging (MRI) are necessary. MRI or CT imaging will not pick up SIS, it is a clinical diagnosis. Treatment for SIS may be started with specific Spine Manipulation Therapy, by a qualified clinician familiar with SI manual techniques.

Discussion

Triggers of SIS include trauma and pregnancy, sometimes years later. SIS often co-exists with lumbar disc herniation. A "Cascade" effect often causes secondary ipsilateral neck pain & headache. Back pain rehab fails if active SIS is not diagnosed. Untreated SIS is a major cause of morbidity, and may last for years. Manual therapy is highly effective, and relatively inexpensive.

Conclusions

The Perlman Knee-Chest Gap test is specific for diagnosing SIS.

Keywords

Sacro-Iliac Syndrome, Low Back Pain, Perlman Knee-Chest Gap Test

EFFECTS OF DIFFERENCES IN THE PART OF THE PELVIS RECEIVING PASSIVE COMPRESSION ON LOCAL MUSCLE ACTIVITY DURING ACTIVE STRAIGHT LEG RAISING

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Introduction

The active straight leg raise (ASLR) is used in the diagnosis and classification of chronic pelvic girdle pain. Although there are no studies on the differences in the part of the pelvis receiving passive compression on Local muscle activity during ASLR.

Purpose/Aim

Aim of this study was to determine how to facilitate Local muscle activity during ASLR during passive compression of different parts of the pelvis.

Materials and Methods

Thirty-one healthy pain-free males participated in this study (age 21.5 ± 1.5 years, height 171.6 ± 5.7cm, weight 61.8±7.1kg). Ethical approval was granted from The Human Research Ethics Committee of Hokkaido Bunkyo University. The ASLR was performed in the supine position with the feet 20 cm apart, without bending the knees. This was done three times per leg per condition. Ultrasound imaging (Tokyo Medical Systems, 3.75 MHz, 60-mm curvilinear arrays) was used to measure muscle depth of the right transverse abdominis (TrA) and lumbar multifidus (LM) in 0.1mm units. The mean of 3 measurements under each of the following 4 conditions were compared: at rest, during ASLR alone, during ASLR with anterior pelvic compression applied to close the bilateral ASISs (ASLR with APC) and during ASLR with posterior pelvic compression applied to the pelvis perpendicular to the spinal column to close the bilateral PSISs (ASLR with PPC). Pelvic compression was applied using a hand-held dynamometer (HDD; μTas, F-1 ANIMA) at 100N. Further, the weight of the lower limbs during elevation for ASLR was evaluated using a semantic differential (SD) method on a 5-point scale: 1=not at all light, 2=not so light, 3=neither heavy nor light, 4=rather light and 5 =extremely light.

Results

The TrA thickness is 4.37±0.82mm during supine position, 4.37±0.82mm during ASLR, 5.06±1.12mm during ASLR with APC and 4.53±0.86mm during ASLR with PPC. The LM thickness is 28.46±3.99mm during supine position, 29.97±3.85mm during ASLR, 30.33±4.57mm during ASLR with APC and 32.81±4.83mm during ASLR with PPC. The SD method is 3.0 during supine position, 3.87±092 mm during ASLR with APC and 3.74±0.77 mm during ASLR with PPC.

Discussion/Conclusion

The TrA during ASLR with APC and the LM during ASLR with PPC showed significantly increased muscle thickness than under any other conditions. Subjective evaluation using the SD method revealed that it was significantly easier to raise the lower limbs with the TrA during ASLR with APC and the LM during ASLR with PPC. It is, therefore, thought that pelvic compression is effective in bringing the origin and insertion of each muscle into close proximity, thus promoting contraction.

Keywords
Active straight leg raise test, pressure, pelvis

PATIENT EXPERIENCES OF A PHYSIOTHERAPY PROGRAM WITH SPECIFIC MANUAL THERAPY FOR LOW BACK PAIN: A QUALITATIVE STUDY

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Introduction

Manual therapy is a common treatment for low back pain. To date much of the manual therapy research has used quantitative designs. Given the multi-factorial and complex nature of low back pain, investigation using qualitative methods may provide valuable insight into patient perceptions of manual therapy and its effects.

Purpose/Aim

To explore patient perspectives of a physiotherapy program with specific manual therapy for patients with sub-acute low back pain considered to be of lumbar zygapophyseal joint origin.

Materials and Methods

A physiotherapy program with specific manual therapy was developed which primarily targeted the symptomatic lumbar zygapophyseal joints. The program also included the provision of patho-anatomical information relevant to lumbar zygapophyseal dysfunction, strategies for managing pain, inflammation, sleep disturbance and psychosocial barriers to recovery, as well as specific motor control retraining exercises. Participants in the Specific Treatment of Problems of the Spine (STOPS) randomised controlled trial who undertook this program underwent a semi-structured interview. Two researchers independently coded interview data using qualitative data analysis software and thematically analysed the results.

Results

Twenty participants were interviewed (7 men, 13 women), with a mean age of 43 years (SD 13) and a mean duration of LBP symptoms of 16 weeks (SD 6). Participants reported improvements in their condition that included reduced pain, return to activity, improved knowledge and increased confidence. Some participants reported negative experiences, including post-treatment soreness, but for most, these were discussed in the context of an overall positive experience. Participants placed particular importance on individual treatment components but it was the combination of manual therapy, exercise and information delivered by the physiotherapist that was considered most important by the participants.

Relevance

The perception by participants that it was the combination of manual therapy, exercise and information delivered by the physiotherapist that was the key to their improvement has important implications for clinical practice.

Conclusions

Participants with persistent LBP considered to be of lumbar zygapophyseal joint origin identified a range of perceived improvements after participating in a specific manual therapy program.

Discussion

The development of the STOPS classification system will be reviewed and the sub-group eligibility criteria discussed further.

Implications

A physiotherapy program with specific manual therapy may be a suitable treatment option for patients with sub-acute LBP considered to be of lumbar zygapophyseal joint origin.

Keywords

Manual therapy, Low back pain, Qualitative

THE EFFECTIVENESS OF SUB-GROUP SPECIFIC MANUAL THERAPY FOR LOW BACK PAIN: A SYSTEMATIC REVIEW

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Introduction
Manual therapy is frequently used to treat low back pain (LBP), but evidence of its effectiveness is limited. One explanation may be sample heterogeneity and inadequate sub-grouping of participants in randomized controlled trials (RCTs) where manual therapy has not been targeted toward those likely to respond.

Purpose/Aim
To determine the effectiveness of specific manual therapy provided to sub-groups of participants identified as likely to respond to manual therapy.

Materials and Methods
A systematic search of electronic databases of MEDLINE, EMBASE, CINAHL, and the Cochrane Central Register of Controlled trials (CENTRAL) was conducted. Identified trials were assessed for eligibility. RCTs that provided manual therapy to participants identified as belonging to a sub-group of LBP likely to respond to manual therapy were included. Data from included trials were extracted by two authors independently and the methodological quality of each trial graded using the PEDro scale. Treatment effect sizes and 95% confidence intervals were calculated for pain and activity, and the overall quality of evidence rated according to the GRADE domains.

Results
Seven RCTs were included in the review. Clinical and statistical heterogeneity precluded meta-analysis. Significant treatment effects were found favouring sub-group specific manual therapy over a number of comparison treatments for pain and activity at short and intermediate follow-up. However, the overall GRADE quality of evidence was very low.

Relevance
Preliminary evidence that sub-group specific manual therapy may lead to greater improvement in outcomes has important implications for selecting patients with low back pain likely to respond to manual therapy.

Conclusions
This review found preliminary evidence supporting the effectiveness of sub-group specific manual therapy, however the overall quality of the evidence was very low.

Discussion
This review provides preliminary evidence for the effectiveness of sub-group specific manual therapy for low back pain based on a systematic search up to October 2010. The systematic search will be updated to September 2013 and the subsequent results presented.

Implications
Further high quality research on LBP sub-groups is required.

Keywords
Manual therapy, Low back pain, Classification

EVALUATION OF EFFECTIVENESS OF CHIROPRACTIC TREATMENT IN PATIENTS PREVIOUSLY TREATED WITH DRUGS (NSAIDS AND STEROIDS) AFFECTED WITH CHRONIC LOW BACK PAIN WITH OR WITHOUT RADICULITIS, IN PRESENCE OF LUMBAR DISC BULGING AND HERNIATION

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Introduction

The plan of cooperation between Regional Government of Lombardy (Italy) and World Health Organization1 has promoted clinical trials protocols to verify effectiveness of complementary-alternative medicine: this is a review of the study on chiropractic that was accepted.

Purpose

To determine the effectiveness of chiropractic interventions for chronic LBP and sciatica associated with disc protrusion/herniation.

Material and Methods

Selected patient sample of 44 patients with chronic LBP and preferably sciatica and evidence (on CT/MRI) of lumbar disc protrusion/herniation.

A combination of chiropractic techniques was utilized, including specific spinal manipulative techniques.

At admission and before and after every visit the following parameters were checked: pain (assessed with VAS); limitation/ improvement of mobility of lumbar spine (ROM measurement with inclinometers); signs of radicular pain, neural irritation or peripheral neural deficit (evaluated with SLR, Lasegue, sensory test, DTR); abstinence from or consumption of anti-inflammatory drugs. Disability quality of life change was assessed with specific questionnaire.

Results

44 patients received a cycle of treatment once a week given by experienced Doctor of Chiropractic. Mean number of visit was: 8,86. Patients who has received at least 8 treatments (32 pts) had relevant reductions in symptoms, 12,5% absence of pain, 59,4% pain almost absent, 28,1% moderate pain, 0% unbearable or intense pain. Analysis of variation of mean VAS value was also calculated. Lumbar spine ROM (Focusing on anterior trunk flexion): mobility substantially without variation for 13,7% of patients.; mobility substantially improved for 47,7%; mobility substantially re-established for 38,6% of patients. There was lumbar flexion substantial improvement for 86,3% of treated patients. It was assumed that radiation of pain in the leg may be measurable by monitoring variation of degree of SLR on each visit: a higher value is a sign of decreased radiating pain and also the greater the angle of SLR without pain the greater the improvement. Average variation of SLR measurement: 38 degree when the study started ; 42 degree after 3 treatments; 48 degree after 4 treatments; 59 degree after 6 treatments;73 degree after 8 treatments; 83 degree after 10 treatments; 90 degree after 14-16 treatments. Disability-quality of life change were not relevant after 3 treatments and start to be significant after 8 treatments.

Conclusion Discussion

Although the data must be evaluated cautiously, the study shows that chiropractic treatments may produce favorable outcomes: significant reduction of chronic LBP and sciatica associated with lumbar protruded/herniated disc, elimination or reduction of anti-inflammatory drugs intake, improvement of spine motion and patient disability.

Limit of the study: a lack of specific follow up makes it difficult to evaluate if clinical improvement is maintained for the mid-to-long term.

Keywords

Chiropractic, SMT spinal manipulative therapy, sciatica, disc protrusion, herniation

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NON OPERATIVE MANAGEMENT OF FAILED BACK SURGERY SYNDROME – A CASE SERIES REVIEW

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Introduction

The failure rate of surgery for low back pain is very high. On average, about 53 percent of all L5-S1 disc surgeries fail to produce relief of symptoms. In such cases, the patient often ends up in worse condition than before the operation.

Aim

The aim of the study was to review the clinical features, diagnosis, co-morbidities and outcome of treatment of patients with failed back surgery syndrome.

Materials and Methods

It is a case series review in which 11 subjects with failed back surgery syndrome, who received treatment at a tertiary level rehabilitation centre in India, were reviewed. All the subjects were evaluated by a single orthopaedic and rehabilitation specialist. All the 11 subjects had complaints of pain in the lower back which was radiating to one on both the lower extremities. Intensity of pain was measured using a Visual Analog Scale and Functional level was measured using Oswestry back disability index. All the 11 subjects were treated with a sequenced rehabilitation protocol for a period of 4 to 8 weeks. Outcomes were measured after the treatment and was analysed statistically.

Results

All the subjects were aged between 22 to 46 years except one, who was 78 years old. The reason for the surgery were prolapsed disc (n=9), spondylolysis (n=1) and lumbar canal stenosis (n=1). Level of surgery was at L5,S1 (n=7) and L4,L5 (n=6). 2 subjects were operated in both the levels. 1 subject has undergone a revision surgery on 2 occasions. All the subjects were diagnosed to have Myofascial Pain Syndrome (MPS) of the lower back with Neuropathic Pain. Other co-morbidities included Fibromyalgia (n=3), Rheumatoid Arthritis (n=2), Seronegative Arthritis (n=1) and Hypothyroidism (n=1). Significant decrease in the pain level and increase in functional status was noted in all the subjects following a sequenced rehabilitation protocol.

Conclusions

The study suggests that treatment of failed back surgery syndrome with a sequenced rehabilitation protocol which includes sensory desensitisation, soft tissue and myofascial mobilisation, Imagery, mind body approaches and exercises was an effective method to decrease pain and attain functional improvement.

Discussion

FBSS might be caused by several identifiable causes related to the initial surgery, including poor patient selection, mismatch of the procedure with patient pathology, unrealistic expectations etc. FBSS may also arise from new sources of pain that may or may not be related to the initial surgery.

Implications

The diagnostic evaluation of low back pain should endeavor to accurately identify symptoms, rule out extraspinal causes, identify a specific spinal etiology, and assess the psychological state of the patient. Only after these factors have been assessed can further treatment be planned.

Keywords

Failed Back Surgery Syndrome, Manual Therapy, Myofascial Pain Syndrome

PRE-MANIPULATIVE TESTING OF PATIENTS WITH LOW BACK PAIN AND LUMBAR DISK HERNIATION

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Introduction

Only 2-4% of patients with low back pain and lumbar disc herniation (LDH) have indications for surgical intervention. The primary goal of conservative care for patients with LDH is relief of disc compression pain and improvement of patient function. The use of manipulative therapy for the patients with LDH is most of suite for this. But in many countries lumbar spinal manipulations are contraindicated for patient with LDH and low back pain with leg pain or radicular syndrome.

The aim

Of this study was to work out pre-manipulation testing of patients with low back pain and LDH in order to identify contra-indication to lumbar spine manipulation as well as to ensure the safe application of manipulative techniques.

Methods

The subjects were 122 patients (67 male and 55 female) between 20 and 59 years of age with low back pain and radiographically proven disc herniation admitted to the neurologic clinic. All patients were studied clinically.

Results

Eighty-seven patients (71,3%) had unilateral single-disc herniation. In 31 patients (25,4%) two-level disc herniation was observed, in 4 patients (3,3%) – three-level disc herniation. In all patients functional blockages at the affected levels were noted. Clinical syndromes observed at the examination included low back pain with leg pain (nociceptive pain) in 70 patients (57,4%), with radicular syndrome (neuropathic pain) in 52 patients (42,6%).

A detailed history together with the objective examination was directed to exclude patients with high risk of development of root and vascular-compression syndromes (conus medullaris, cauda equina syndrome, radiculoischemia) and/or further extrusion of disc material. In this order special pain provocation tests have been used. Test included rotation locking of intervertebral joints of involved lumbar motion segment in opposite directions. The test was conducted in the position on the one hand most effective for spinal manipulation and on the other hand with shortest diameter of the vertebral canal. The provocation of pain down the leg or evidence of increase nerve root irritation or compression is contraindication for spinal manipulation. If full rotatory thrust would be applied there is considerable danger of further compression a nerve root, or of following further extrusion of disc material. The application of pre-manipulation provocation test helped us to performed manipulative therapy for the whole group of patient without any complications. Ninety-one percent of patients had a satisfactory treatment outcome without an operation.

Conclusion

Negative lumbar rotation mobilising (pain provocation) test is one of the main prerequisites for application of specific manipulation for patients with HNP and low back pain.

Implications

Our results may help manipulative physiotherapists identify contra-indication to lumbar spine manipulation in patients with LDH and low back pain, apply safe manipulative techniques and patients avoid surgical treatment.

Keywords

Low back pain, lumbar disc herniation, spinal manipulation, pain provocation test

CASE STUDY: DENSIFIED CENTRE OF COORDINATION - DOES IT EXISTS OR NOT? BASED ON FASCIAL MANIPULATION © BY LUIGI STECCO

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Introduction

World of anatomy is changing and more attention has been given to fascia in recent years. A little is known about living people and things which are affecting to fascial system. Fascial manipulation © developed by Luigi Stecco focuses on the fascia, especially the deep muscular fascia, including the epimysium and the retinacula. This model considers myofascial system as a 3 dimensional continuum. The base of this method lies in the identification of a specific, localized area of the fascia in connection to a specific limited or painful movement. Every manual therapist has the perception of tissue stiffness and variety amongst patients. Nowadays when the ultrasound technology has been improved a lot, imaging is more precise and it has created new opportunities and perspectives.

Purpose/Aim

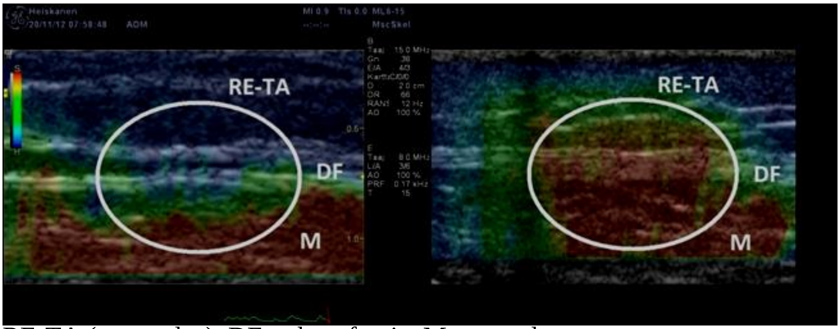
The aim of this case study is to image densified centre of coordination (later CC) and compare it before and after treatment. CC's are located in the point where vectorial forces meet in fascia. The points are located in the muscle belly, part where the muscular traction occurs. To our knowledge, this is the first case study where CC is visualized with ultrasound and elastography.

Materials/Methods

This case study was conducted in Finland with ultrasound machine GE Healthcare's LOGIQ P6 that is equipped with elastography. It uses color codes from blue to red to signify the elasticity of the tissue. The color blue indicates stiffer tissue, the color green softer and the color red the softest tissue. In this case study, fascial manipulation © was used as a treatment technique.

Results

Hypoechoic and stiff area around RE-TA CC can be seen in ultrasound with and without elastography before treatment. After treatment ultrasound image shows better permeability and elastography image shows better viscoelasticity in the tissue. Before fascial manipulation©, no movement is visible in the superficial part of the deep fascia. However, the middle layer and the deepest layers moved some amount. After fascial manipulation©, all of the layers seem to glide more.



RE-TA (retro-talus), DF = deep fascia, M = muscle
RE = retro, meaning backward motion.
TA = talus, meaning ankle.
RE-TA = Myofascial unit which produce backward motion of the ankle in the sagittal plane.

Relevance/Conclusion

This case study shows densified CC and its location in the deep fascia. It also indicates that fascial manipulation © changes viscoelasticity of myofascial tissue and improves gliding between fascial layers in the area of the densified CC. This case study encourages manual therapists to trust the sensitivity of their hands in clinical work.

Discussion

Longterm results can't be predicted just by treating one point. In this study focus is in the local tissue changes. Overall examination and treatment protocol must be done in real treatment situation, in that way balancing effect to the whole body can be achieved.

Implications

Fascial manipulation © as a treatment technique appears to change local viscoelasticity in the tissue and increases amount of the fascial gliding between the fascial layers.

A CASE REPORT UTILISING OSTEOPATHIC VISCERAL MANIPULATION – ILLUSTRATING A NOVEL HYPOTHESIS FOR THE ROLE OF VISCERAL FASCIA IN LUMBO-PELVIC FUNCTION AND STABILITY

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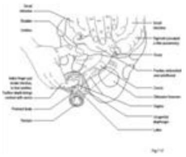

Introduction

Lumbopelvic pain and stability has been studied for gross motor coordination between abdominal, lumbar and pelvic floor muscle groups. Somatic myofascial contributions have also been considered. Motor coordination between abdominal and pelvic muscle groups is related to organ movement, but the organ movement is currently understood to be mostly secondary to the somatic muscle contraction. However, consideration of the relationship between organ mobility, visceral fascial attachments / ligaments and abdomino-pelvic motor coordination in gait may have relevance in the clinical management of biomechanical pelvic pain.

Case Background

A 33 year old multigravidas with diastasis recti, bladder and anterior vaginal wall prolapse, lumbo-sacral back pain, right hip pain and reduced movement, and obstetric related pelvic floor muscle and connective tissue tearing 6 months prior to presentation. Pelvic floor physiotherapy had assessed the levator function as reasonable, but kegel type exercises had not influenced the pain levels or reduced the prolapse.

Methodology / Osteopathic Clinical Approach

Digital vaginal and external perineal assessment of the urogenital diaphragm and pelvic floor muscle revealed uneven contractions, lack of closure of the urogenital hiatus and displaced organ positions of the bladder and uterus. Coccygeal mobility was reduced and held anteriorly. Limited movement of the lumbar spine and sacro-iliac joints was noted, the pubic symphysis was tender and moving asymmetrically. Abdomino-pelvic visceral palpation revealed poor mobility of the organs and reduced stretch and pain on palpation of the fascial visceral ligaments was identified. Gentle osteopathic visceral manipulation was given to the visceral peritoneum and organs, the peritoneal ligaments (mesenteries), the pelvic connective tissues such as the transverse cardinal ligaments, to the coccygeal ligaments, and to the parietal peritoneum covering the lower part of the lumbar region and the upper part of the sacral region.

Outcome

Post treatment the contraction of the pelvic floor had increased on the right side closing the urogenital hiatus more effectively. For some days post treatment the patient was less aware of her prolapse, less uncomfortable in her perineum, had reduced lumbo-pelvic pain and greater mobility of the right hip joint and less tenderness as the pubic symphysis. This treatment regime has been applied 3 times, each with partial relief of symptoms.

Discussion

Asynchrony in motor unit coordination in reflex related somatic structures such as the abdominal muscles and the pelvic floor muscle group is induced by sensory receptor firing from pelvic visceral peritoneal and visceral connective tissue 'ligaments'. Functional integration of movement between organs and their myofascial containers (pelvis and abdomen, including the skeletal components of the pelvic bowl and spine) during gait, micturition, defecation and respiration could indicate that the visceral sensory information drives the motor coordination responses in relevant somatic muscle contraction patterns – giving rise to the hypothesis that clinical syndromes of pelvic and low back pain and instability may be partly induced by motor instability arising from viscerosomatic afferent sensory irritation from fascial mechanical changes in a variety of peritoneal and pelvic connective tissue structures (possibly as a result of inflammation from trauma, infection or other adhesion forming and tissue healing events, or from increased or decreased tone / tension in visceral fascial structures).

Conclusion

The visceral fascial structures lining the walls of the abdomino pelvic container and running through it supportive various organs appear to have an influential role in determining muscle action in various somatic motor structures which warrants further investigation. The sensory role of the visceral fascia and the application of manual osteopathic visceral manipulation seem to be relevant in the clinical management of this case of lumbopelvic pain and organ prolapse.

MICROSCOPIC DECOMPRESSION VIA RESECTION OF OSTEOPHYTES FOR LUMBAR FORAMINAL STENOSIS

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Introduction

Lumbar foraminal stenosis is recognized as a cause of multiply operated back syndrome; however, the treatment plan currently in use is still controversial. In 2010, we implemented microscopic resection of osteophytes as a minimally invasive surgery for patients with cephalocaudal type of lumbar foraminal stenosis.

Purpose

To determine the limitations, advantages, and clinical outcomes of this new method.

Patients and Methods

Twelve patients with cephalocaudal type of lumbar foraminal stenosis were treated with surgical resection of osteophytes. The mean age at surgery was 70.3 years, and the mean follow-up duration was 11.5 months. During surgery, the facet joints were accessed via a 3-cm paraspinal longitudinal skin incision. The upper lateral portion of the facet joint was removed. In some cases, the ala of sacrum and transverse process were partially resected. The nerve root and intervertebral disc were visualized by removing the yellow ligaments and lumbosacral ligaments. The disc materials were resected and the part of annulus fibrosus that was closest to the root was preserved for protection of the nerve root. The osteophytes arising from the posterior edge of the vertebral body were shaved down using a high-speed drill. Patients were permitted to walk unaided the day after the operation.

Results

The mean Japanese Orthopedic Association (JOA) score was 14.7 before surgery and improved to 23.9 at the final follow-up. The mean recovery rate was 66.8%. There were no major perioperative complications.

Discussion

Microscopic resection of osteophytes is a minimally invasive procedure that offers greater preservation of anatomical structures. Direct resection of osteophytes has an advantage over partial pediculectomy in that it can preserve pedicles. This allows for insertion of larger screws into pedicles when salvage procedures (such as posterior lumbar interbody fusion [PLIF] and transforaminal lumbar interbody fusion [TLIF]) are required. However, careful attention must be paid to the nerve root, which runs very close to the osteophytes. The safety of this method depends on the location of the osteophytes in relation to the nerve root. It is important to convert to partial pediculectomy if examination and safe resection of the osteophytes are not possible.

Conclusion

Although more clinical data are needed to characterize long-term effectiveness, we can conclude that microscopic decompression with resection of osteophytes is a minimally invasive surgical option for lumbar foraminal stenosis.

Key Words

Foraminal stenosis, minimally invasive surgery, microscopic decompression, lumbar spine

IS SPINAL ANESTHESIA GOOD CHOICE FOR HERNIATED DISC BACK SURGERY?

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Introduction

Herniated disc back surgery is usually performed under general anesthesia. Although regional anesthesia offers many advantages, it is not commonly used for herniated disc back surgery. Surgeon and patient preference play important role for type of anesthesia. In our study, we aimed to determine whether spinal anesthesia gratifies patients and surgeon for herniated disc back surgery.

Materials and Methods

In our observational /non-interventional study, we compared 54 patients, ASA I-II, who were scheduled to herniated disc back surgery under spinal anesthesia or general anesthesia over three year period at Kasimpasa Military Hospital. Patients selected their type of anesthesia they preferred. Besides routine procedure including premedication, monitoring, anesthesia and record we additionally followed all patients for complication of spinal and general anesthesia. Patient and surgeon satisfactory score for perioperative and postoperative period were evaluated.

Results

Patients and surgeons were satisfied for perioperative circumstances under spinal anesthesia. Postoperative period were more comfortable under spinal anesthesia than general anesthesia.

Conclusions

Spinal anesthesia is comfortable enough for herniated disc back surgery as much as general anesthesia in well prepared and sedated patients during pre and perioperative period.

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DOES THE SURGICAL TREATMENT FOR LUMBAR RADICULOPATHY FULFILL PATIENTS PREOPERATIVE EXPECTATIONS?

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Introduction

Several studies have reported the benefits of surgery for lumbar radiculopathy. However, improvement of clinical outcomes does not necessarily mean that patients expectations have been fulfilled.

Purpose/Aim

The aim of this prospective cohort study was to examine the expectations of patients undergoing a microdiscectomy and to assess the fulfilment of these expectations.

Materials and Methods

Twenty-three patients (15 males; mean age: 45.5 years) who underwent a surgical treatment (microdiscectomy without associated fusion) for lumbar radiculopathy were included. They completed pre-operatively an expectation questionnaire relative to the global expected change (GEC) but also to some more specific expected changes (regarding the pain in the leg (PLEC) and the walking capacity (WCEC)) by means of 0-3 Likert scales (0=no change expected, 3=full recovery expected); a 0-10 numeric rating scale (NRS) and the Oswestry questionnaire were also used to assess the instantaneous intensity of pain in the leg (IPL) and the disability, respectively.

At hospital discharge, participants completed a questionnaire to assess the fulfilment of the global and specific expectations by means of 0-5 Likert scales (0=important worsening, 3= no change, 5 = full recovery) as well as the NRS. The latter assessment tools as well as the Oswestry Questionnaire were also used at a 3-month follow-up.

Results

Preoperatively, most patients (>74%) expected a full recovery regarding GEC, PLEC and WCEC; their mean Oswestry score was 44.4±11% and leg pain intensity was 6±3.1/10.

At discharge, a significant reduction of the IPL (1.1±1.4/10) was observed ($p<0.001$) and most patients (>77%) reported at least a slight improvement for GEC, PLEC and WCEC. However, a full recovery of these outcomes was reported by only 45.5%, 59% and 45.5% of participants, respectively and a worsening in walking capacity was observed in two patients.

At the 3-month follow-up, IPL level (2±2/10) and Oswestry score (21.4±17%) were significantly lower than preoperatively ($p<0.001$). Although only less than a third of the patients reported a full recovery for GEC, PLEC and WCEC, more than 80% of participants reported al least slight improvements and none reported a worsening of these.

Conclusions

Although most patients reported significant improvements at the 3-month follow-up, these improvements failed to meet expectations (i.e. a full recovery in most cases) in most patients.

Discussion

The present study suggests that patients should be informed about the low probability of full recovery at the 3-month follow-up so that they have more realistic preoperative expectations.

Implications

These results will have to be confirmed in a larger sample and with a longer follow-up. Further research is required to study the importance of preoperative expectations in spine surgery and to identify the predictors of low fulfilment of expectation.

Keywords

Surgery, expectation, low back pain, discectomy

RADIOFREQUENCY NEUROTOMY FOR SACROILIAC JOINT PAIN: A PROSPECTIVE STUDY

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Introduction

The sacroiliac joint is one of major sources of chronic low back pain, implicated in 15-30% of all cases. While radiofrequency neurotomy (RFN) is the interventional treatment of choice for spinal pain originating from the facet joints, its efficacy in the treatment of sacroiliac joint pain has not been fully investigated, and its long term efficacy is unknown.

Purpose/Aim

This study set out to assess the pain relief in patients following sacroiliac joint RFN. It also set out to investigate the impact of sacroiliac joint RFN on patient analgesic use and to measure patient overall satisfaction with the treatment.

Materials and Methods

A cohort of 179 patients underwent fluoroscopically guided sacroiliac joint RFN of the dorsal and lateral branches of S1-S3, the medial branch of L4 and the descending branch of L5 nerves. All patients had previously had their diagnosis of sacroiliac joint pain confirmed by controlled comparative analgesic blocks of relevant nerves. Their pain levels were assessed before and after the procedure using the 11-point numerical rating scale. After receiving RFN, patients were divided into four different groups: patients followed up at <6 months (n = 31); 6-12 months (n = 77); 1-2 years (n = 39); and >2 years (N = 32). Pain measurements taken at follow up time points were compared with the pain measurements prior to RFN procedure. A Likert scale was also administered to measure alterations in analgesic use, changes in paid employment status and patient satisfaction.

Results

The results of the study with data collected over five years revealed the following: 58.1% of patients followed up at <6 months; 66.7% of patients followed up at 6-12 months; 81.6% of patients followed up at 1-2 years; and 71.9% of patients followed up at >2 years reported pain relief following RFN procedure. A decrease in analgesic use following the procedure was reported by 43% of patients. Overall, 66% of patients were satisfied with their outcome post RFN and no complications occurred.

Relevance

The sacroiliac joint is thought to be one of the leading sources of low back pain. More aggressive treatments such as intra-articular injections and RFN may be considered in refractory cases.

Conclusions

RFN is a safe and effective treatment for pain confirmed to originate from the sacroiliac joint.

Discussions

Considering the improved pain relief reported by patients that underwent sacroiliac joint RFN in the present study and the reported low risk of complications, sacroiliac joint RFN may be considered a good pain management option for patients suffering low back pain originating from the sacroiliac joint, particularly in cases where conservative treatment has failed.

Implications

Whilst not a permanent means of treating chronic low back pain, sacroiliac joint RFN is a temporary treatment for chronic pain that can facilitate patient mobilization and thus rehabilitation.

Keywords

RFN, radiofrequency denervation, radiofrequency ablation, sacroiliac joint pain, patient outcome measures

A COGNITIVE APPROACH TO LOW BACK & PELVIC PAIN, FOR REDUCING EMOTIONALLY INDUCED LATERALIZED BRAIN ACTIVITY IN ORDER TO CORRECT MUSCLE IMBALANCES

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Introduction

Stress resulting in increased muscular tension is widely agreed upon. Less well known is that this tension is often asymmetric with a higher muscular tension on the right side, regardless of hemispheric dominance. This imbalance is found in the vast majority of pain patients, among people experiencing anticipated anxiety or perceived threat and among those with poor self-esteem. Anticipated anxiety and perceived threat have been shown to activate the left amygdala. I hypothesize that this left amygdala activation in turn activates the left hemispheres supplementary and cingulate premotor areas and the left dorsal premotor cortex causing a state of sustained right lateralized motor response readiness. A sustained generalized higher right-sided muscular tension causes a trunk bending sideways towards the right, together with a trunk rotation to the left. Other common clinical findings of this imbalance are lowered and abducted scapula, arm and leg inward rotation, sacral counternutation with right innominate bone rotated forward. This affects intervertebral disks, facet joints, the lumbosacral plexus and the sacroiliac joints, thereby predisposing for lumbar and pelvic disorders. Neck and shoulder pain, thoracic outlet-, fibromyalgia- and hip/knee-syndromes may also develop.

Purpose

The purpose of initiating treatment with a cognitive approach is to achieve changes in the described lateralized “amygdala-activated” premotor areas to improve muscle balance and postural stability.

A Three-Step Cognitive Method

1. The incongruent colour-word Stroop task. Correct Stroop inhibitions decrease the activity in the anterior cingulate cortex affective subdivision (ACad) left hemisphere, and instead activate the cognitive subdivision (ACcd) right hemisphere, where cingulate premotor areas are also located.
2. Extinction. Extinction is a learning process forming a new memory. First the therapist pinches or applies friction over certain muscles on the right side. Usually a startling ticklish/painful experience. When the patient immediately thereafter is given control of the therapist´s hand action, the initial anxious pain and startle reflex disappears instantly. As the patient reappraises the experience, the medial and the lateral prefrontal cortices are activated. This results in a decrease in activity firstly in the medial orbitofrontal cortex and then in the left amygdala. The steps 1+2 changes the activations in the medial nociceptive system. This leads to widespread effects as ACad and amygdala are coupled with autonomic and endocrine reactions and with endogenous anti-nociceptive modulation systems.
3. Visuo-spatial working memory exercises. To further reduce the left ACad and the left amygdala activity and in order to induce neuroplastic motor control changes, the patient is instructed to pay attention to details about various items, memorize them and

immediately recall them from memory. This activates the left dorsolateral prefrontal cortex and the right-hemisphere premotor cortex.

Results, Conclusion

The left extensor hallucis longus muscle (L5) is almost always significantly strengthened immediately after the initial Stroop task, before the therapist has even touched the patient. This demonstrates the relevance of including cognitive approaches when treating low back & pelvic pain. Right-sided fascia and connective tissue changes restricting symmetry and microcirculation also need to be treated.

Keywords

Back-pain, Lateralized amygdala, ACad, Stroop, Extinction, Working-memory, Premotor

Conflict of Interest

None.

A COMPARISON OF PRONE AND STANDING LUMBAR MULTIFIDUS MUSCLE SIZE AND PERCENTAGE THICKNESS CHANGES AMONG PATIENTS WITH UNILATERAL CHRONIC LBP AND HEALTHY CONTROLS

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Introduction

Lumbar multifidus (LM) muscle function is a commonly proposed mechanism contributing to low back pain (LBP) recurrence1. Research to date, using Rehabilitative Ultrasound Imaging (RUSI) to assess LM has focused on prone positions, however as LM is a stabilising muscle, standing is a more functional position. This study aimed to assess the contractile function of LM in standing.

Purpose

To compare between side differences in resting muscle thickness of LM, between painful and non-painful sides in patients with unilateral chronic LBP (CLBP) in prone lying, and standing, using RUSI. To determine differences in percentage thickness change of LM from resting to contracted state using a Contralateral Arm Lift (CAL) in prone and standing (comparisons between groups and between painful and non painful sides).

Materials and Methods

Twenty individuals were recruited; ten unilateral CLBP patients, and ten healthy controls. Thickness measurements of LM at L4/5 and L5/S1 were taken using RUSI (Aquila Scanner, Esaote Pie Medical, Philipsweg, Maastricht, The Netherlands) in four positions; prone at rest, prone with a CAL, standing at rest and standing with a CAL. Thickness changes for within group comparisons were assessed using paired t-tests. Thickness changes for between group comparisons were assessed using independent t-tests.

Results

No statistically significant between side differences were found in the resting thickness (in cm) in either prone or standing in the CLBP group. No difference in percentage thickness change in prone at L4/L5 ($p=0.58$) and L5/S1 ($p=0.31$) between the CLBP and control group were observed. This was also the case for L4/5 in standing at rest to standing with a CAL ($p=0.06$). A statistically significant difference in L5/S1 from standing at rest to standing with a CAL was observed (*$p=0.04$).

Relevance

Further highlights altered LM function in a CLBP population.

Conclusion

Lumbar multifidus L5/S1 in CLBP has an altered pattern of activation in standing compared to the healthy controls.

Discussion

An altered pattern of contraction was observed in standing in CLBP patients, demonstrated by greater percentage thickness changes during CAL. It is feasible that LM may not have been activating sufficiently in its stabilising role during standing at rest in the CLBP group, and therefore relatively greater levels of muscle activity were required during CAL.

Implications

Lumbar multifidus should be retrained in functionally challenging positions.

Keywords

Lumbar multifidus; Rehabilitative Ultrasound Imaging; standing

Reference

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EFFECT OF STABILIZATION EXERCISE ON PAIN AND DISABILITY IN PATIENTS WITH CHRONIC LOW BACK PAIN

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Introduction

Low back pain (LBP) is a highly prevalent problem and one of the main causes of disability in the society. Although the etiology is diverse, many causes have been related to weakness or injury of the soft tissue in the lumbar area.

Purpose/Aim

This study investigated the effect of stabilization exercise on chronic pain and disability in patients with chronic low back pain.

Materials and Methods

A total of 122 patients (44 males, 78 females) with non-specific chronic low pain back (NCLBP) were recruited from Orthopaedic Clinic of Lagos University Teaching Hospital (LUTH), Idi-Araba, Lagos and National Orthopaedic Hospital Igbobi, Lagos, Nigeria. They were assigned to four different groups (1, 2, 3 & 4) that went through stabilization exercise only (Group 1), stabilization exercise combined with transcutaneous electrical nerve stimulation (TENS) (Group 2), stabilization exercise combined with TENS and massage (Group 3) and the control (Group 4). Patients were assessed for pain severity, functional disability and fear. Data were analysed using descriptive statistics of mean and standard deviation. Kruskal Wallis test was used to analyse each of the outcome measure parameters. Wilcoxon test was used to compare baseline and 8th week values of the outcome measure parameters.

Results

Patients in three groups (1, 2 and 3) recorded significant improvement in pain severity, functional ability and fear avoidance belief following intervention ($P<0.05$). There was no significant improvement in the outcome measure parameters assessed in the control group.

Conclusion

The study provides evidence that stabilization exercise only and in combination with TENS and massage is effective in managing patients with chronic low back pain.

Keywords

Stabilization exercise, Lumbar multifidus, Low back pain

RELATIONSHIP BETWEEN VARIABLES OF TASK-ORIENTED BALANCE TESTS WITH DIFFERENT BODY CONTROL DEMANDS

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Aim

The study provides a correlation analysis between variables of two task-oriented balance tests with different demands on control of the center of mass (COM) position and its regulation in pre-defined direction.

Materials and Methods

A group of 37 physical education students (age 21.7 ± 1.9 y, height 174.2 ± 7.2 cm, weight 67.8 ± 8.3 kg) performed in random order two task-oriented balance tests. In the first, subjects had to hit the target randomly appearing in one of the corners of the screen by horizontal shifting of COM in appropriate direction.

The test consisted of 2 sets of 20 responses while better result was taken for the evaluation. The COP velocity, time, and distance covered between stimulus appearance and its hit by COM movement were registered by means of the system FiTRO Sway Check based on force plate (FiTRONiC s.r.o., SK). In the second, subjects were provided by feedback on COM displacement on a computer screen while standing on force plate. Their task was to trace, by shifting COM, a curve flowing either in horizontal or vertical direction. The test consisted of two 30-second trials randomly performed in antero-posterior and medio-lateral direction. The deviation of instant COP position from the curve was recorded at 100 Hz by the same system.

Pearson correlation was used to assess commonality between variables of these tests.

Results

Results showed moderate correlation (r = 0.457) between variables of the visually-guided COM target-matching task and the visually-guided COM tracking task. Additionally, the common variance among them was only 13%, suggesting that these tests measure distinct qualities. This is because voluntary feedback control of COM movement was provided under two different conditions, i.e. the subjects concentrated either on a goal of the task (e.g., hitting the target) or on movement themselves (e.g., the positioning of the COM).

Conclusions

The visually-guided COM target-matching task and the visually-guided COM tracking task measure distinct balance functions. Such variations of different task-oriented balance tests may allow for the assessment of accuracy of regulation of COM movement that requires less or more feedback processing.

Implications

Different testing conditions (e.g., the velocity and positioning of flowing curve, time-generation of visual stimuli, etc.) allow adjust the task difficulty to specific individual needs and performance capabilities. In doing so, task-oriented balance tests based on visual feedback control of COM position and its regulation in pre-defined direction may be applied in testing of balance functions in children and elderly population, as well as in highly-skilled athletes (e.g., dancers).

FUNCTIONAL BALANCE CONTROL IN SUBJECTS OF DIFFERENT AGE AND SKILLS LEVEL

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Aim

The study compares the speed and accuracy of visual feedback control of the centre of mass (COM) in pre-defined direction in subjects of different age and skills level.

Materials and Methods

A group of latinoamerican dancers (n=24, age 20.5±2.6 y, height 173.4±8.7 cm, weight 61.7±11.3 kg), PE students (n=37, age 21.7±1.7 y, height 176.2±7.2 cm, weight 66.8±8.7 kg), physically active children (n=26, age 9.3±1.2 y, height 140.9±8.1 cm, weight 34.0±8.6 kg) and older subjects (n=30, age 56.2±1.8 y, height 166.4±7.1 cm, weight 73.5±12.8 kg) performed in random order two task-oriented balance tests. In the first, subjects had to hit the target randomly appearing in one of the corners of the screen by horizontal shifting of COM in appropriate direction. Test consisted of 2 sets of 20 responses while better result was taken for the evaluation. Time, distance, and velocity of COP trajectory between stimulus appearance and its hit by visually-guided COM movement on the screen were registered by means of the system FiTRO Sway Check based on force plate. In the second, subjects were provided by feedback on COM displacement on a computer screen while standing on force plate. Their task was to trace, by shifting COM, a curve flowing either in horizontal or vertical direction. The test consisted of two 30-second trials randomly performing in antero-posterior (A-P) and medio-lateral (M-L) direction. The deviation of instant COP position from the curve was recorded at 100 Hz by the same system.

Results

Mean response time was significantly lower in dancers (1480.2±307.2 ms) and students (1650.7±412.2 ms) than in children (2570.0±607.5 ms; p<.01) and older subjects (2835.3±821.4 ms; p<.01). Though at the same time the distance covered was significantly lower in dancers (0.212±0.057 m) and students (0.251±0.092 m) than in children (0.420±0.147 m; p<.01) and older adults (0.508±0.171 m; p<.01), mean COP velocity during reactions was significantly higher in older subjects (0.178±0.088 m/s; p<.01) and children (0.165±0.072 m/s; p<.05) than in students (0.150±0.053 m/s) and dancers (0.144±0.041 m/s). Similarly, mean COP distance from both horizontally and vertically flowing curves was significantly lower in dancers (12.3±2.0 mm and 10.5±1.8 mm) than in students (15.6±2.2 mm and 13.4±2.1 mm; p<.05), older subjects (16.7±2.6 mm and 14.7±2.5 mm; p<.05) and children (19.3±2.9 mm and 18.8±2.7 mm; p<.01).

Conclusions

Dancers are able to more precise perceive COM position and regulate its movement in A-P and M-L direction than others. This may be ascribed to their training adaptation as they learn to focus on a particular source of movement feedback (e.g., feeling the position of the feet and COM). On the other hand, children and older people regulate their COM movement in a more conscious, effortful fashion (i.e., observed as a longer COP trajectory) with their decisions about the action being handled in a slow, attention-demanding way (i.e., shown as a slower response time).

NORMAL ANTICIPATORY ACTIVITY OF TRUNK MUSCLES DURING UNILATERAL LIMB MOVEMENT

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Introduction
Previous studies demonstrated controversies regarding normal anticipatory activity of Transversus Abdominis. It will not be possible to prescribe an appropriate exercise for patients who suffer from chronic low back pain (CLBP) unless the normal activation pattern of the trunk muscles in healthy subjects becomes clear. There are, also, limited studies concerning bilateral activation of trunk muscles during a self-induced perturbation.

Purpose
The aim of this study was to evaluate bilateral anticipatory activity of trunk muscles during unilateral arm flexion.

Materials and Methods
18 healthy subjects (13 women and 5 men) participated in this study. They were asked to raise their right arm as fast as possible in response to a visual stimulus and 10 repetitions of rapid arm flexion were recorded. The electromyographic activity of the right Anterior Deltoid (AD) and bilateral trunk muscles including Transversus Abdominis/Obliquus Internus (TA/OI), Superficial Lumbar Multifidus (SLM) and Lumbar Erector Spinae (LES) was recorded. The onset latency of the recorded trunk muscles was calculated.

Results
The first muscle activated in anticipation of the right arm flexion was the left TA/OI. The right TA/OI activated significantly later than all other trunk muscles ($P<0.001$). The anticipatory activation of the SLM and LES muscle groups was observed during rapid arm flexion. There was no significant difference in onset latency among other trunk muscles ($P>0.05$).

Conclusions
Healthy subjects did not show bilateral co-activation of TA/OI in anticipation of unilateral arm elevation. The SLM and LES muscle groups did not show any bilateral differences in onset latency during rapid arm flexion. Further investigations are required to evaluate normal muscle activation pattern in other functional tasks in healthy subjects prior to prescribing bilateral activation training of Transversus Abdominis for patients with CLBP.

Keywords
Anticipatory Postural Adjustments, Low Back, Self-induced Perturbation

CHANGE IN TRUNK AND LOWER EXTREMITIES MUSCLE ACTIVITIES AND STAND-TO-SIT MOVEMENT FOLLOWING BACK TRUNK MUSCLE FATIGUE

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It is known that the trunk muscles affect posture and stability of movement. Many studies of trunk muscle fatigue have examined its effects on static postural control, but few have examined its effects on dynamic postural control1). This study investigates kinematic and muscle activity during stand-to-sit movements under condition of back trunk muscle fatigue. Subjects, 11 healthy males (mean age; 21.0 yrs) with no significant medical history or current medical problem, who gave written informed consent were enrolled. Fatigue was induced according to the Sorenson protocol2). Before and after the induction of fatigue3), three-dimensional kinematic (MAC3D system ; nac) and electromyography (Noraxson ; Noraxon U.S.A.) data of the trunk and lower extremities during stand-to-sit movements were collected. A statistical analysis was performed using the paired t-test before and after muscle fatigue for SPSS ver20.0. The level of significance was set at 5%. There was a significant increase in forward trunk bending motion and trunk extensor and right gluteus maximus muscle activities after fatigue induction. The heightened baseline activity with fatigue suggests that there may have been increased spinal stiffness whenever the spine was fatigued. It is believed that postural control increased in the orientation related to the working of the muscles due to the fatigue, and that muscles activity increased to compensate. A significant change in postural control was observed during stand-to-sit movements due to fatigue.

Keywords
muscle fatigue, stand-sit movement, motion analysis, muscle activity, back trunk muscle

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MUSCLE PERFORMANCE DURING FUNCTIONAL ACTIVITY AFTER MINIMAL INVASIVE LUMBAR FUSION SURGERY

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Introduction
Lumbar fusion surgery is thought to decrease the symptoms of low back pain (LBP) patient efficiently. However, mounting evidence shows high re-operation rate after spine surgery. Swelling, atrophy or fat infiltration of the muscles at the surgery site can cause weakness and pain. High probability of back muscle damage has been reported during operation procedure, but only few studies have addressed the changes in muscle and functional performance after spine surgery.

Purpose
To identify the changes in muscle activity of the trunk and the lower extremities as well as the forward reach performance in patients with LBP at one-month post lumbar fusion surgery.

Methods
Sixteen patients with LBP underwent minimal invasive lumbar fusion surgery and 16 age- and gender-matched healthy participants were recruited in the study. The muscle activation of the trunk and lower extremities was evaluated at pre/post-surgery. Sixteen electromyography (EMG) sensors were placed on the trunk and the lower limb muscles bilaterally. Subjects were asked to perform a maximum forward reach task with their self-selected speed. The outcome measurements were forward reach performance, center of pressure (COP), and EMG activities. The difference in the outcome measurements among the 3 groups (healthy control: CONTROL; patient group at pre-operation: PRE-OP; and at post-operation: POST-OP) were examined by one-way repeated measure analysis of variance (ANOVA).

Results
The patient group was significantly different than the CONTROL group both at pre/post-surgery in back muscle strength ($p<0.001$), reaching distance ($p<0.001$), reaching velocity ($p<0.001$), and COP displacement (anterior-posterior, $p<0.001$). The muscle activity of the erector spine muscles ($p<0.001$), multifidus ($p<0.01$), and medial gastrocnemius muscles ($p<0.001$) were significantly decreased in the patient group at both pre/post-surgery compared to the healthy control group.

Conclusions and Discussion
The LBP patients showed improvement in the pain intensity one-month after surgery, but not for the reaching performance. The patients also demonstrated a decreased muscle activation pattern during forward reach in comparison to the healthy control. It seems that the LBP patients were afraid of moving their trunk forward, even after the surgery.

Relevance and Implications

Clinicians should focus on the back muscle training in LBP patients after lumbar fusion surgery and restore their functional activities.

Keywords

EMG, surgery, functional activity, low back pain

INTER-RATER AND INTRA-RATER RELIABILITY OF THREE MOVEMENT CONTROL TESTS FOR THE LUMBO-PELVIC COMPLEX

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Background

Impaired movement control of the lumbo-pelvic complex has been found in people with non-specific low back pain (NSLBP). Reports show that movement control interventions in people with NSLBP may increase function, thus decreasing pain. Reliable and valid tests designed to discern weak links in a kinetic chain may be of importance for implementing optimal rehabilitation and for evaluating such interventions.

Aim

The aim of this study was to test inter-rater and intra-rater reliability of a test protocol including three functional movement control tests for the lumbo-pelvic complex; standing knee flexion, static lunge and dynamic forward lunge.

Method

The three tests each consist of 5-7 items that were scored yes or no. Thirty-eight subjects, 19 with NSLBP (NRS□3) and 19 healthy, were recorded whilst completing the test protocol. Four physiotherapists independently scored the recordings yes or no according to a standardised test protocol. Reliability was calculated with free margin multirater kappa (□free) adjusted for prevalence for inter-rater reliability and prevalence and bias adjusted kappa (PABAK) for intra-rater reliability. The methodology of the study followed a strict protocol to minimise risk of bias.

Results

Values for the different items in each test ranged between □free=0.32-0.91 for inter-rater reliability and PABAK=0.42-1.00 for intra-rater reliability. Best inter-rater reliability in the knee flexion test was identifying the item back extension (□free=0.91), in the static lunge identifying the item arm lowering (□free=0.91) and in the dynamic forward lunge identifying the item shoulders moving back (□free=0.77). Best intra-rater reliability in the knee flexion test was identifying arm-lowering (PABAK=0.84-1.00), in the static lunge identifying arm-lowering (PABAK=0.95-1.00) and in the dynamic forward lunge identifying shoulders moving back (PABAK=0.79-0.95).

Relevance

It is important to evaluate level of reliability of tests identifying impaired movement control in order to be able to recommend them for clinical use.

Conclusion

The three tests show between fair to very good both intra and inter rater agreement for certain items within the tests used for identifying impaired movement control in the lumbo-pelvic complex.

Discussion

Results show low kappa values according to a standard kappa but high indexes of prevalence and low indexes of bias indicating that the proportion of chance agreement is high with little bias. Therefore, kappa calculations were adjusted according to prevalence and bias. A reason may be low levels of pain or inadequate training of the raters. The included tests are complex with several items to be rated which makes the observation more difficult than rating a simple test of yes or no.

Implications

Due to differences of frequencies of yes and no of the different items of the three tests, the tests may not be sensitive enough to identify impaired movement control of the lumbo-pelvic complex in subjects with NSLBP compared to healthy. However more research is required to draw such a conclusion. The tests show low to very good agreement and could therefore be used and recommended in the clinic.

Keywords

Low-back pain, movement screening, motor control, clinical tests

DOES NEUROMOTOR CONTROL EXERCISE THERAPY INFLUENCE TRUNK MUSCLE RECRUITMENT PATTERNS IN PATIENTS WITH CHRONIC LOW BACK PAIN?

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Introduction

Several studies demonstrated that trunk muscle activation could be altered in patients with chronic low back pain (CLBP), suggesting that neuromotor control exercises should be very important in the rehabilitation of these patients. But it is not clear if neuromotor control exercise therapy could induce changes in the activation of trunk muscles.

Aim

Objectify changes in trunk muscle activation in patients with CLBP, after neuromotor control exercise therapy. This study focuses on subjects with a lumbar extension give.

Materials and Methods

13 patients (11 men and 2 women) with CLBP participated in this study. They were working for the Ministery of Belgian Defense. All patients were tested in the Locomotor Centre of the Military Hospital Queen Astrid in Brussels, by an examinator trained in the concept of Kinetic Control. In all patients a lumbar extension give was present. Following the testing, they received 18 sessions of specific neuromotor control exercise therapy, by a trained physiotherapist. After treatment, they were tested again by the same examinator. In all the patients, the lumbar extension give was resolved or attenuated after therapy. On the same day of the pre– and posttest, surface electromyography (sEMG) was recorded during the sitting and the standing bow test. Relative muscle activity of the internal obliques (IO), the external obliques (EO), the lumbar part of the multifidus (LMF) and the thoracic part of the iliocostalis (ICLT) were recorded on both sides. All the physiotherapists and the examinator were blinded for this study.

Results

The relative muscle activity of the IO significantly improved ($p<0.05$) on both sides after therapy, during the standing bow test.

Discussion

The increased activity of the IO observed in this study, could be the reason why patients with extension dysfunction improved after neuromotor control exercises. IO acts as a segmental stabilizer and prevents hyperextension of the lumbar spine. However, the sample is very small, so further testing is needed.

Relevance

This is a first step to objectivize changes in muscle activation after neuromotor exercise therapy. Further research is needed in larger populations. Comparison should be made with patients who have other direction of gives. More specific classification could be made between segmental and regional gives.

Conclusion

This study suggests that neuromotor control exercises could improve the use of the IO in patients with an extension give, to resolve this erronated movement pattern. sEMG could be a way to objectivize these changes.

Implications

Electromyography may serve to detect objectively changes in trunk muscle activation after neuromotor control exercise therapy in patients with CLBP who demonstrated an extension dysfunction.

Keywords

Neuromotor control exercises, trunk muscle activation, electromyography, kinetic control, low back pain

LUMBOPELVIC MOVEMENT CONTROL IN ELITE FOOTBALL

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Introduction

Lumbopelvic movement control is of great interest in the game of football due to the nature of the movement skill. Poor lumbopelvic movement control can be detrimental to a player's performance, but also set the neuromusculoskeletal system up for undue stress and strain, hence increase the risk for injury or re-injury.

Aim

The aim of the exploratory study was to assess the players Kinesthetic Awareness (KA) relating to the lumbopelvic region during a set of functional movement tasks of the lower limbs called Primary Movement Challenges (PMC) 1,2.

Materials and Methods

Twenty football players from a Women's National squad, aged 17-31 (mean 24,5) with an official game number of 3-119 (mean 65.4), was presented with the functional movement tasks of the PMC and given the opportunity to practice one day prior to testing. All the players verified prior to being videotaped that they understood the principle of maintaining the lumbopelvic region in the relative same position as they would position it during a two legged stance of equal weight bearing with soft knees. A references line on the floor was given to standardize the foot position during testing. The KA was labeled good if two separate assessors agreed on the player's ability to maintain the lumbopelvic position, conversely poor if the player was unable to control the lumbopelvic position in a consistent manner (2 of 3 attempts). In the case of assessor disagreement the specific video was replayed once with both assessors present. In the instance of persistent disagreement the task was categorized as good on the judgment that it was not an obvious loss of lumbopelvic position.

Results

	Ability to control lumbopelvic position (n=20 players)			
Movement Task	Left-Leg Weightbearing	%	Right-Leg Weightbearing	%
Single leg stance	13	66	17	85
Single leg small knee bend	5	25	6	30
Single leg stance with pelvic turn out	11	55	12	60
Single leg stance with leg swing	5	25	4	20
Single leg heel raise	5	25	8	40

Discussion/Relevance/Implications

Based on the exploratory nature of the study and number of observations, the results can only warrant a further interest on the topic. However, if poor lumbopelvic control is a common feature in football players, it is of relevance to establish standardized methods of assessing lumbopelvic movement control and determine the influence this might have on performance and the risk of injury /re-injury 2.

Conclusions

The results demonstrate that the majority of the female elite football players had their lumbopelvic movement control challenged by simple functional movement tasks, demonstrating poor kinesthetic awareness of the lumbopelvic region. This warrants further investigations.

Keywords

Lumbopelvic, movement control, kinesthetic awareness, football

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A COMPREHENSIVE REVIEW ON THE METHODOLOGY OF MOTOR CONTROL STUDIES IN PATIENTS WITH LOW BACK PAIN

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Introduction

Altered or impaired motor control of the lumbar spine in patients with low back pain (LBP) has been reported in a number of studies. Despite an abundance of literature in the field of trunk strength and endurance measurements, it seems that motor control studies in patients with LBP have been limited to only a few tasks.

Purpose

The main purpose of this study was to review the methods used to assess changes in trunk motor control in patients with LBP.

Materials and Methods

We systematically searched the following electronic databases from their inception to December 2012: MEDLINE, CINAHL, PEDro, and Cochrane library. We included studies concerned with movement and motor control of trunk. Postural control studies were beyond the scope of this review.

Results

Overall, a total of 1864 potentially relevant articles were identified. Of these, after screening the titles and abstracts, 1572 articles were found to be irrelevant to current review, leaving 232 articles to be examined further. Of these articles, 82 matched inclusion criteria and were included in the study.

Relevance

Perturbation tasks including loading and unloading tasks were the most commonly used methods to assess motor control changes in patients with LBP. Predictable and unpredictable as well as internal and external perturbations in quiet standing position were common tasks in these studies. In most of these studies changes in timing onset, reaction time, activation patterns, co-activity, variability and other EMG-related changes of trunk muscles have been assumed as indicators of altered trunk motor control in patients compared to healthy control group. Measures of kinesthesia, proprioception and repositioning error have been other methods to assess possible changes of motor behavior in patients. Assessment of motor control impairments based on altered pain behavior during different trunk movements has been recently used to identify specific subgroups of patients with LBP. Our search failed to identify any longitudinal or prognostic study.

Conclusions

Although a number of research groups are now studying various aspects of trunk motor control in patients with LBP; only a limited number of research methods have been employed in current studies. Most of the current trunk motor control studies dealt with discrete actions and movements. Developing research tools based on continuous motor performance tasks may also provide meaningful insight into the effect of LBP on the trunk neuromuscular function.

Implications

As a better understanding of motor control of the lumbar spine and its possible impairments in patients with LBP will eventually lead to design more efficient and effective treatments, developing novel research tools to challenge central nervous system and identify possible motor control changes in patients with LBP seems necessary. Longitudinal studies to find prognostic and risk value of assessment of motor control in transition of acute LBP to a chronic disabling pain will be encouraged.

Keywords

Low back pain, Motor control, Methodology, Review

MOTOR CONTROL EVALUATION OF GLUTEUS MAXIMUS: DESCRIPTION, RELIABILITY AND LEARNING OF A NOVEL CLINICAL TEST

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Introduction

Altered gluteus maximus muscle recruitment in terms of both excessive or insufficient force closure and aberrant timing of muscle activation is thought to be a contributing factor to pelvic girdle pain disorders. A clinical test to quantitatively evaluate motor control of the gluteus maximus is lacking.

Aim

To describe a novel clinical test to assess gluteus maximus control and to evaluate intra-rater reliability and learning effects.

Materials and Methods

Twenty-five healthy controls (men/women: 13/12; mean(SD) age:22.5(1.5)yrs; BMI:21.7(2.1)kg/m2) participated in this prospective study. All subjects performed the Gluteus Maximus Activation Test (GMAT) on 3 time points (day1, day4, day7), reflecting a classical schedule of physiotherapy sessions. With the subject in supine lying, two three-folded pressure biofeedback units were positioned under each gluteus maximus and inflated to sixty mmHg. Subjects were asked to perform ten maximal isometric and isolated contractions of a single gluteus maximus. No corrective feedback or training was provided. Intra-rater reliability was assessed for the first three trials and all ten trials of day1, and between the means of all trials of day1 and day4, using the intraclass correlation coefficient (ICC) and standard error of measurement (SEM). A general linear model for repeated measures (p-level<.05) informed on learning effects with time points as the within-subject variable and gender and side as the between-subject variables. Post-hoc tests were Bonferroni corrected.

Results

For both the right and left gluteus maximus, good intra-rater reliability was found for both the first three (right: ICC: .89(.78-.94); SEM: 6.65mmHg; left: ICC: .90(.81-.95); SEM: 6.25mmHg) and ten trials (right: ICC: .88(.81-.94); SEM: 6.79mmHg; left: ICC: .91(.85-.95); SEM: 6.03mmHg) on day1. Good but slightly lower intra-rater reliability was observed for the mean of all trials between day1 and day4 (right: ICC: .76(.53-.87); SEM: 9.73mmHg; left: ICC: .85(.68-.93); SEM: 7.76mmHg). Mean pressure achieved on day3 (109.86(2.59)mmHg) was significantly higher compared to both day1 (101.03(2.77)mmHg, p<.001) and day2 (103.76(2.15)mmHg,p=.001). Time points interacted with gluteus maximus side (p=.040) with larger pressure increase across days for the right side (day1: 100.27(3.92)mmHg; day2: 105.43(3.04)mmHg; day3: 113.61(3.67)mmHg) compared to the left side (day1: 101.79(3.92)mmHg; day2: 102.09(3.04)mmHg; day3: 106.10(3.67)mmHg). In contrast to side (right: 106.44(3.26)mmHg; left: 103.33(3.26)mmHg;p=.503), a gender effect (p<.001) was observed with higher pressures for men (114.64(3.19)mmHg) than women (95.12(3.32)mmHg).

Relevance
This novel clinical test may help to unravel the role of aberrant motor control in pelvic girdle pain.

Conclusions
The GMAT exhibited good intra-rater reliability. Marked learning inherent to repeated testing can be expected after 3 sessions, more pronounced for the right gluteus maximus. GMAT scores are lower in women compared to men.

Discussion
Future studies should establish inter-tester reliability and concurrent validity with EMG.

Implications
New tool for clinical practice available.

Keywords
Gluteus maximus, Motor control

PRIMARY DYSMENORRHEA AND STRETCHING EXERCISES: CONTROLLING BMI AND SEDATIVE DRUGS EFFECTS

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Introduction

Painful menstruation is one of most frequent pelvic complaint in girls. The aim of this investigation is studying the effects of 8 weeks of stretching exercise on primary dysmenorrhea by controlling the effect of BMI and drugs as a interfering variables.

Material and Methods

179 volunteer high school students, 15-17 aged and not athlete bachelor girls with moderate or severe primary dysmenorrhea selected from 6 high schools with 519 students in two zone of Arak and assigned in experimental (4 high schools, 124 persons) and control (2 high schools,55 persons) groups randomly. This investigation design is semi-experimental study with two groups. In pre-test, all of subjects were studied in pain severity, height, weight and number of sedative tablets in two menstruation cycles. All participants in EX-Group performed thigh adductors, Iliopsoas, Calf and hamstring muscles for 8 weeks, 3 sessions per week. Pain severity was measured by using Visual Analog Scale (VAS) and all participants completed an investigator's administered questionnaire included family information, medical history, 1st menstruation age and etc. Post-test was given 8 weeks later. We used of Repeated Measures by inserting BMI and number of sedative tablets that used in each menstruation cycle as a Covariate Factor for data analyzing. Confidence interval was considered to be at 99% (P-Value>0.01).

Results

After 8 weeks, in experimental group pain severity decreased from 7.65±1.94to 4.88±1.92 (P=0.004), but the effect of BMI (P=0.874) and sedative drugs (P=0.055) was not significant. Pain severity in control group was reduced from 7.77±1.5 to 7.16±1.42, but this change was not significant statistically (P=0.053), and the effects of MBI (P=0.222) and Drugs (P=0.029) was not significant, too.

Conclusion

This study showed that regardless the effect of BMI and Drugs, stretching exercises are effective in reduction of pain severity in girl students with primary dysmenorrhea.

Keywords

Primary dysmenorrhea, stretching exercises, girl students

PREVALENCE AND RISK FACTORS FOR PELVIC GIRDLE PAIN AND/OR LOW BACK PAIN DURING PREGNANCY AND POSTPARTUM

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Introduction

Reported prevalence of pelvic girdle pain and/or low back pain (PGP/LBP) in pregnancy and postpartum varies greatly. Several risk factors have been reported.

Purpose/Aim

The purpose of the study was to assess the prevalence of the PGP/LBP during pregnancy and postpartum and its possible risk factors.

Materials and Methods

Included in the study were all women delivering at the Maternity hospital during the period of one month. 501 (87.1%) out of 575 participant gave their written consent to participate in the study. 72 hours after delivery, the women were asked to fill in the questionnaire which included items relating to symptoms of PGP/LBP and items relating to heavy lifting, body mass index before pregnancy, parity, pelvic floor muscle training during pregnancy, physical activity before pregnancy, age and breastfeeding. 85 random women were further tested for joint hypermobility. Twelve weeks postpartum the phone interview was used to gather the data on the symptoms of PGP/LBP after delivery. 313 women were interviewed. Statistical analysis included descriptive statistics, chi-square tests and t-test. Level of significance was set at .05.

Results

The number of women reporting symptoms of PGP/LBP during pregnancy was 290 (59.5%) and postpartum 116 (37.1%) (Figure 1). History of previous PGP/LBP (OR = 9.6 (95% CI 6.24-14.79)), previous trauma to the pelvis ($p = 0.008$), PGP/LBP during a previous pregnancy (OR = 9.0 (95% CI 4.07-20.0)) and urinary incontinence during pregnancy (OR = 2.27 (95% CI 1.48-3.48)) or before pregnancy ($p = 0.010$) were the only statistically significant risk factors for developing PGP/LBP during pregnancy. Statistically significant risk factors for PGP/LBP postpartum were a history of previous PGP/LBP (OR = 2.4 (95% CI 1.40-3.98)), previous trauma to the pelvis (OR = 7.1 (95% CI 0.78-64.24)) and PGP/LBP during a previous pregnancy (OR = 3.5 (95% CI 1.64-7.34)).

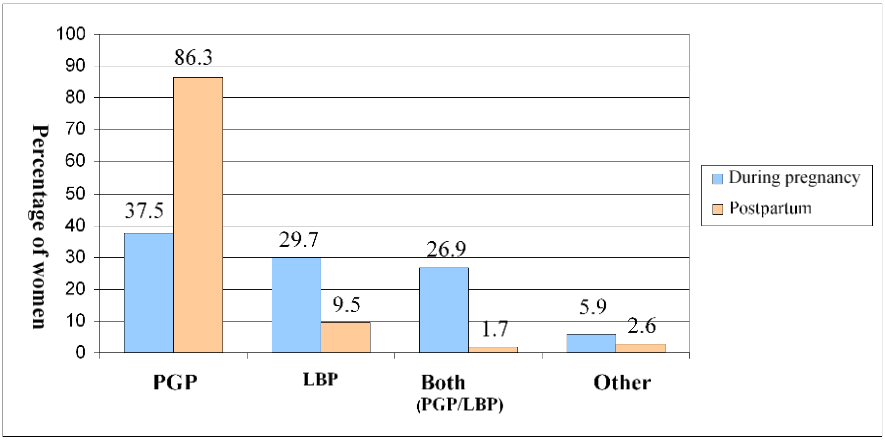

Figure 1. The location of pain based on pain drawings (PGP - pelvic girdle pain; LBP - low back pain)

Relevance

Our study has contributed to the understanding of the magnitude of the problem.

Conclusions

The results show that almost 60% of women suffer from PGP/LBP during pregnancy and almost 40% postpartum. A history of previous PGP/LBP, previous trauma to the pelvis, PGP/LBP during a previous pregnancy have proved to be the most important risk factors for PGP/LBP during pregnancy and postpartum.

Discussion

The most important strength is the prospective nature of the study's design which established the prevalence of and the identification of the main risk factors for the development of PGP/LBP during pregnancy and three months postpartum. The major weakness of the present study lies in the fact that no differential analysis of the risk factors was performed for the development of PGP and LBP respectively.

Implications

PGP/LBP is a very common complaint during pregnancy and the postpartum period and therefore deserves much greater consideration than it has so far received.

Keywords

pelvis girdle pain, low back pain, pregnancy, postpartum, prevalence

COCCYDYNIA CAUSED BY INTERDIGITAL NERVE ENTRAPMENT

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Coccydynia (pain in the tail bone) can be debilitating in some patients with no apparent trauma or localized pathology. There have been reports of Sciatica-like symptoms involving the lower extremities caused by peripheral nerve entrapment but not as a cause of coccydynia.

I treated 3 cases of coccydynia in the past year. The first case was a 41 year old female with 3 years of coccygeal pain who had extensive work up and different pain interventions without relief. She had no symptoms of foot pain. On exam she was found to have tenderness in the inter-digital spaces of both feet and a musculoskeletal (MSK) ultrasound revealed inflammatory changes. She responded well to a steroid and lidocaine mixture injected into the affected area in both feet.

The second case was an 85 year old woman with coccygeal pain for a few months. Prior to my evaluation she underwent a surgical excision of a cyst in the sacral area without relief. That cyst was thought to be the cause of her pain by her gynecologist and surgeon. On exam she was found to be tender in the inter-digital spaces of both of her feet. MSK ultrasound confirmed inflammation in the inter-digital nerve and a mixture of steroid and lidocaine achieved complete symptom relief.

The third case was a 79 year old gentleman who presented with a month's history of pain in the tail bone with no antecedent history of trauma. There was no pain in any of the extremities. He was also found to have tenderness in the inter-digital spaces in both of his feet. MSK ultrasound confirmed inflammation of the inter-digital nerve and a mixture of steroid and lidocaine injected in the affected area provided complete relief.

The inter-digital nerves are extensions of the medial and lateral plantar nerves and are subject to entrapment and injury at the metatarsophalangeal joints and the deep tarsal ligament. The nerve of the 3-4 spaces may arise from both the medial and lateral plantar nerves which may cause it to be relatively fixed and prone to trauma.

Inter-digital nerve trauma may be acute as well as due to chronic conditions, such as wearing high heeled shoes which forces hyperextension of the toes and produce mechanical irritation of the nerve by the deep tarsal ligaments.

Recent advances in musculoskeletal ultrasonography have made it easier to visualize peripheral entrapment neuropathies, many of which have been described by 1Koppell and Thompson (1963) and 2Pecina (2001).

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DETERMINANTS FOR LUMBOPELVIC PAIN SIX MONTHS POSTPARTUM

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Introduction

About every fourth woman report postpartum lumbopelvic pain. Identification of women at risk of future pain would allow concentration of resources toward those most in need of further attention.

Purpose/Aim

To evaluate potential determinants of self-reported lumbopelvic pain six months postpartum for pregnant women with and without lumbopelvic pain in late pregnancy.

Methods

Questionnaires were answered in weeks 34–36 of pregnancy and at six months postpartum. The Pain Catastrophizing Scale was used to assess exaggerated negative thoughts about pain experiences, the Fear-Avoidance Beliefs Questionnaire to assess beliefs about how physical activity affects back pain, the Visual Analogue Scale to assess pain intensity, the Disability Rating Index to assess physical ability, and the Nottingham Health Profile to assess health-related quality of life. Cox proportional hazards model was used for analysis.

Results

Of the 260 women, who answered at both occasions, 161 had lumbopelvic pain in pregnancy and 99 did not. For pregnant women without pain, a higher level of catastrophizing and a lower health-related quality of life more than tripled the risk of postpartum lumbopelvic pain (HR=3.17; 95% CI=1.0-9.4; and HR=3.9, 95% CI=1.2-12.9, respectively). For pregnant women with lumbopelvic pain no significant determinants were found.

Relevance

Increased knowledge is necessary for identifying women at risk for postpartum lumbopelvic pain and for finding preventive targeted interventions.

Conclusions

Catastrophizing and health-related quality of life predict postpartum lumbopelvic pain for women without pain in late pregnancy. Hence, women at risk might be identified by the use of a biopsychosocial approach in pregnancy.

Discussion

Women with pain in pregnancy more often reported postpartum pain, compared to women without pain in pregnancy. None of the instruments used at this time point determined postpartum pain for women with pain during pregnancy. However, when the same instruments were used earlier on in pregnancy high levels of catastrophizing and more limited physical ability, in combination with pain during pregnancy, determined postpartum lumbopelvic pain. Furthermore, a lower health-related quality of life seemed to increase the risk for postpartum pain among women without pain during pregnancy. Several of the used instruments seem suitable for prediction of postpartum pain. Further studies are required to find suitable time points for measurement that are predictive of outcome and have clinical relevance.

Implications

The results contribute to the understanding of the development of postpartum lumbopelvic pain, and should be considered when identifying women at risk of future pain. It is indicated that targeted interventions should address also psychosocial factors.

Key words

Back pain, disability, fear of movement, pelvic pain, predictor, women's health

A NEW PARADIGM FOR THE MECHANISM OF PGP DURING PREGNANCY, AND RATIONALE FOR MANAGEMENT

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Approximately 70% women experience PGP during their pregnancy (7,8). It has been stated that PGP in pregnancy may be a specific condition (8). The underlying biomechanical changes of pregnancy necessitate alteration to the motor control of both local and global muscles around the trunk and pelvis Imbalances in the in the functional length and recruitment of muscles can result in poor control of the neutral joint position (3).

Relaxin has been shown to increase laxity of connective tissue during pregnancy, however serum levels of relaxin do not correlate to degree or severity of PGP (2,11). Stability of a joint requires dynamic control of the neutral zone, which is increased during pregnancy via connective tissue remodeling. Proprioception from muscles and connective tissue restraints is a primary sensory mechanism for motor control (6). There is moderate level evidence to support a correlation between altered mechanics or motor control and Pelvic Girdle Pain (1).

Local muscles, Transversus Abdominus, posterior Pelvic Floor, and Multifidus, control shear forces through the SIJ (12). If the angle of pull of Transversus Abdominus changes to a more anteriorly orientated vector, as happens during pregnancy, this potentially increases the shear force in an anterior direction at the SIJ during loading. If there is not appropriate anterior restraint from dynamic structures such as the Pelvic Floor muscles and associated fascia, microtrauma, resulting in pain, may result. The Pelvic Floor appears to play a role in Pelvic Girdle Pain however this is not a pelvic floor weakness deficit, as there is no association between Pelvic Girdle Pain and pelvic floor weakness (5). Pregnant women with Pelvic Girdle Pain are more likely to have tenderness of the deep pelvic floor muscles and Obturator Internus (4). It has also been noted that post partum women with Pelvic Girdle Pain have a smaller levator hiatus possibly indicating over-activity of the pelvic floor muscles (10).

Adequate dynamic motor control requires sensory, biomechanical and motor processing strategies, to produce coordinated muscle action at the right time, with the right intensity for the right duration. During pregnancy there is a constantly altering length tension relationship of the abdominal and pelvic floor muscles, and sustained load on the visco-elastic tissue. It has been hypothesized that there is an "internal model of body mechanics"/ "virtual body" within the CNS, against which sensory input is compared to produce a coordinated response of local and global muscles to produce well controlled movement (6). During pregnancy the sensory input via both muscle and connective tissue is significantly altered, so there is likely to be a mismatch of "virtual body" VS "real pregnant body" within the CNS. This mismatch is hypothesized to affect the motor programming capacity within the CNS to control increased range and direction of movement under load of the pelvic joints. Joint range at the SIJ is approximately 2 degrees in the non-pregnant state, and may increase to 4 degrees during pregnancy. This is a small range of movement, however it is a 100% change for the CNS to control. General exercise, via group classes, has been shown to have a small improvement in capacity to manage disability and pain on PGP (9). It is suggested for optimal results, management strategies during pregnancy should be individualised, focused on specific exercises to address identified motor control deficits, and modified continually throughout pregnancy to reflect the ongoing biomechanical changes. This will augment alignment within the CNS of the "virtual body" with the "real body" and optimize motor control during pregnancy.

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PELVIC GIRDLE PAIN DURING PREGNANCY: IS THERE AN ASSOCIATION WITH PRE-PREGNANCY HORMONAL CONTRACEPTIVE USE?

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Introduction

Pelvic girdle pain severely affects many women during pregnancy. Smaller studies have suggested that pre-pregnancy hormonal contraceptive use is involved in the underlying mechanisms, but evidence is inconclusive. Oral hormonal contraceptives have been reported to influence collagen synthesis in connective tissue and to alter bone metabolism. Such changes may interact with the normal changes that occur in the pelvis during pregnancy and increase the woman's susceptibility to pelvic girdle pain.

Purpose/Aim

To study the association between pre-pregnancy hormonal contraceptive use and pelvic girdle syndrome (PGS; pain in anterior and bilateral posterior pelvis) in pregnancy week 30.

Materials and Methods

We included 91,721 pregnant women in the Norwegian Mother and Child Cohort Study (1999-2008). Data was obtained by two self-administered questionnaires in pregnancy weeks 17 and 30. The outcome was PGS at 30 weeks of pregnancy. The risk of PGS was estimated as adjusted odds ratios (aOR) with 95% confidence intervals (CI) by using generalized estimating equations (GEE).

Results

Based on preliminary analyses, we found that the use of a progestin uterine device the final year before being pregnant was associated with increased prevalence of PGS (aOR 1.20; 95% CI: 1.11-1.31) compared with no use of hormonal contraceptives. Neither the use of combined oral contraceptive pills nor progestin-only contraceptive pills during the final year before being pregnant, during the final four pre-pregnancy months or at the time of being pregnant was associated with PGS. However, long lifetime exposure to progestin-only contraceptive pills was associated with an increased risk of reporting PGS (aOR 1.49; 95% CI: 1.01-2.20).

Relevance and Discussion

The causes of pelvic girdle pain are poorly understood. However, because pelvic girdle pain often occurs in the early stages of pregnancy and the symptoms typically regress shortly after delivery; hormonal factors likely play a role. We have previously reported that PGS was inversely associated with age at menarche, suggesting that pre-pregnancy endogenous hormonal factors are linked to the cause. Also, an influence of pre-pregnancy exogenous hormonal exposure is conceivable.

Conclusions and Implications

Our results suggest that combined hormonal contraceptives can be used without fear of developing pelvic girdle pain during pregnancy. However, the influence of progestin intrauterine devices and long-term exposure to progestin-only contraceptive pills requires further study.

Keywords

Hormonal contraception, Pelvic girdle pain, Pregnancy, Risk factors

SACROILIAC JOINT ARTHRODESIS FOR SEVERE SACROILIAC JOINT PAIN

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Introduction

Most patients with sacroiliac joint (SIJ) pain response to conservative therapies. But in some cases, these therapies fail to manage the pain and only the SIJ arthrodesis would have the possibility to relieve the pain.

Purpose

To evaluate the surgical outcome of the SIJ arthrodesis we performed.

Materials and Methods

We diagnosed as having SIJ pain when the patient showed all three criteria: 1) lumbo-gluteal pain on one side, 2) positive findings on at least one of the three provocation tests: Gaenslen's test, Patrick's test, modified Newton's test, 3) pain relief more than 70% after the SIJ injection. Patients who had been not adequately responsive to conservative treatments for more than 6 months and been markedly restricted their daily living, were our indication for the SIJ arthrodesis, which included 27 patients. The SIJ arthrodesis was performed through only anterior approach in 23 patients and combined anterior and posterior approaches in 4. Among them, 21 patients with a minimum 2-year follow up were selected for the present study, including 7 males and 14 females, mean age 48.4 years (24-86). Postoperative follow-up period was averaged 5.4 years (2.6-8.4). Clinical outcomes were assessed according to the MacNab Criteria. Eleven-point postoperative pain score (0-10), Roland-Morris disability questionnaire (RDQ), sitting time on the chair without backrest, walking time, were also evaluated pre-and post- operation.

Results

The surgical outcome was excellent in 4, good in 10, fair in 5, poor in 2. Postoperative pain score was averaged 4.2 (0-10). RDQ was improved from 21.5 (17-23) to 7.2 (1-14). Sitting time and walking time was improved from 4.9 minutes (0- 20) to 92.5 (10- 180), from 9.8 minutes (0- 30) to 64.4 (1- 180), respectively.

Relevance

SIJ arthrodesis via mainly anterior approach could relieve the severe SIJ pain and could improve sitting time and walking time.

Conclusions

The surgical outcome of the SIJ arthrodesis was relatively good.

Discussion

As a final option to relieve the severe SIJ pain with unsuccessful conservative therapies, SIJ arthrodesis has to be considered. For the SIJ arthrodesis, we adopt the anterior approach prior to the posterior approach. Because the anterior approach have the advantage to visualize the SIJ joint directly and to perform the decortication of joint surface, wide bone grafting, and rigid fixation by the plate and screws. Posterior approach is relatively easy, but is not enough to immobilize SIJ and then relieve the severe SIJ pain.

Conflicts of interest

The authors declare that they have no conflict of interest.

PAIN AREAS BY SITTING ORIGINATED FROM SACROILIAC JOINT DYSFUNCTION ARE DIFFERENT FROM THOSE FROM LUMBAR DISORDERS

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Introduction

Sacroiliac joint (SIJ) dysfunction causes pain by sitting. Lumbar disc herniation (LDH) and lumbar spinal canal stenosis (LSCS) can also cause this kind of pain.

Aim

To investigate the incidence of pain by sitting and to clarify the difference of pain area among SIJ dysfunction, LDH, and LSCS.

Materials and Methods

112 cases with significant SIJ dysfunction (26 cases), LDH (37), and LSCS (49) whom we treated between November 2010 and October 2011 were the subject of this study. There were 66 males and 46 females, with a mean age of 60.4 years old (range, 18 to 82 years). When they had pain by sitting on a chair without a backrest, the triggered pain areas were pointed out using their one finger, which were recorded in the medical charts.

Results

The pain by sitting was observed in 19 cases (73.1%) with SIJ dysfunction, 18 (48.6%) with LDH, and 10 (20.4%) with LSCS. The pain areas of cases with SIJ dysfunction were at the posterior superior iliac spine (PSIS) in 12 cases, the ischial tuberosity in 6, the groin in 3, the posterior thigh and the lateral side of lower extremity in one each. Those of cases with LDH were at the corresponding nerve root dermatomes in 10 cases, the central buttock in 5, and the posterior thigh in 4. Those of cases with LSCS were at PSIS in 2 cases, along the L5 dermatome in 3, at the posterior thigh in 3, and the coccygeal region, the upper buttock, the central buttock, and the lateral side of lower extremity in one each.

Relevance

The pain areas by sitting originated from SIJ dysfunction are clearly different from those from lumbar disorders.

Conclusions

The pain by sitting originated from SIJ dysfunction is higher at incidence than LDH or LSCS and the areas of pain mainly detected around PSIS and the ischial tuberosity is different from those of these lumbar disorders.

Discussion

When the ischial tuberosity is fixed on the seat, the load of the trunk through the sacrum would directly strain the SIJ. As a result, the pain would be mainly detected the characteristic pain areas of SIJ dysfunction. The pain areas around of PSIS and the ischial tuberosity are relatively not familiar with lumbar disorders. Therefore the pain area by sitting should be observed to distinguish SIJ dysfunction from lumbar disorders, not only the existence of pain by sitting.

Conflicts of Interest

The authors declare that they have no conflict of interest.

HOW MANY IMPLANTS CAN BE PLACED IN MINIMALLY INVASIVE SACROILIAC JOINT FUSIONS?

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Introduction

Sacroiliac (SI) joints are a common pain generator in patients with low back pain. When non-operative treatment fails, fusion is a treatment option. A number of techniques have been described. Recently a minimally invasive (MIS) SI joint fusion with porous ingrowth implants has become a viable option. The recommended technique involves placing 3 implants across the SI joint. But this is not always possible. The purpose of this study was to determine how many implants were placed in each patient.

Methods

A consecutive series of MIS SI joint fusion surgeries performed by a single surgeon using image guided surgery using intra operative CT scanning were reviewed. Anatomy of the sacrum intraoperative determined the number of placed implants. Demographic data and number implants were collected. T-test was used to compare mean body mass index (BMI), height & weight between number of implant groups.

Results

From June 2010 to October 2012, 50 patients underwent 71 Navigated MIS SI Joint fusions. 4 of 71 were revisions and excluded. There were 14 males and 36 females with a mean age of 49+14 years (19-78). 3 implants were placed in 60% of cases, 2 implants in 30% of cases (all were females), 4 implants in 6% and 1 implant in 4% of cases. In all 14 of the male patients 3 or more implants were placed, with 4 implants placed in 5.9% of total cases. However in female patients 3 remained most common number of implants placed (52%). Of the 17 patients that had bilateral implants placed across each sacroiliac joint there was a matching number of components in 88% of cases. Mean BMI and weight was significantly higher with 3 implant group than 2 implant group. Interestingly, there was no significant height difference between the two groups however the 3 implant group trended to be taller (Table1).

Table 1. Comparing mean BMI, Height and Weight

	2 implants (n=15)	3 implants (n=30)	*p value*
Mean BMI (SD)	27kg/m2 (5)	31kg/m2 (6)	***0.020***
Mean Height (SD)	161cm (7)	165cm (18)	*0.462*
Mean Weight (SD)	70kg (14)	92kg (27)	***0.005***

Conclusions

In approximately 2/3 of patients 3 or more implants were able to be implanted. It is still unknown if this affects patient outcomes or not. Further study is needed to investigate factors that may predict the number of implants placed. Great variability in the size and shape of the sacrum was observed.

FOR SACROILIAC (SI) JOINT FUSION WHAT IS THE RELATIVE WORK EFFORT OF OPEN VERSUS MINIMALLY INVASIVE TECHNIQUES?

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Introduction

Currently in the United States procedures are reimbursed based upon the relative value units (RVU's) assigned to that particular procedure code. This is a composite measure reflecting the time, intensity, complexity, risks and cognitive factors. For SI joint fusion there is a debate about the relative work effort of open versus minimally invasive surgery (MIS) techniques. There are at least 17 different described techniques for SI joint fusion and variability within a specific technique or amongst different approaches is not known. Previous studies comparing open anterior to trans-iliac MIS techniques performed at a single institution had 27 MIS and 26 open cases with similar demographics. They compared length of surgery 75 vs. 210 minutes, EBL 46 vs. 650 cc, LOS 1.8 vs. 3.5 days.

Purpose

This study is simply an effort to sample resource utilization for surgeons doing SI joint fusion in order to look at the order of magnitude of the intervention.

Methods

A convenience sample of surgeons known to do SI joint fusions (open, MIS or both) were queried for participation. Collected were number of cases, operating room time, estimated blood loss and length of stay. T-test used to compare mean OR time and surgical time between open and MIS SI joint fusions.

Results

4 surgeons had available data for 117 cases. Operating room time varied from 1 hour 20 minutes to 4 hours 9 minutes. EBL ranged from 25 to 400cc. LOS ranged from <23 hours to 3 days. 66% (77) were Unilateral while 35%(40) were bilateral cases. Open SI joint fusion 29% (22/77) is outnumbered by MIS procedures performed at 71% (55/77). There were more MIS SI Joint fusions 70% (28/40) in bilateral cases than open procedures 30(12/40). MIS procedures had significantly less OR and Surgical times compared to Open procedures in both bilateral and unilateral cases (Table1).

Table 1. Summary of results

Unilateral cases	**Open**	**MIS**	***P value***
Surgical time (SD)	1:26 (0:49)	0:50 (0:12)	*P < 0.0001*
OR time (SD)	2:17 (0:53)	1:36 (0:18)	*P < 0.0001*
Bilateral cases	**Open** N=12	**MIS** N=28	***P value***
Surgical time (SD)	1:35 (0:29)	0:59 (0:30)	*P < 0.0001*
OR time (SD)	2:22 (0:31)	1:43 (0:33)	*P < 0.0001*

Conclusion

In current data series, the resource utilization appears comparable between MIS and open SI joint fusion techniques. There is a similar magnitude of length of surgery between MIS and open procedure while EBL and LOS may be slightly less. Although there is probably significant heterogeneity of resource utilization between various open techniques this variability maybe greater than that of open and MIS surgery.

PREVALENCE OF MINIMALLY INVASIVE SACROILIAC JOINT FUSIONS AND SITE OF SERVICE

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Introduction

Sacroiliac Joint (SIJ) Fusion is emerging as a well-accepted treatment option for SIJ disruption or sacroiliitis that has failed conservative management. Over the last 4 years technologies have emerged that allows fusion of the SIJ using Minimally Invasive (MIS) techniques, resulting in reduced blood loss and complications, faster return to activities of daily living, and reduced hospital stay. Prior to the development of these minimally invasive techniques, traditional open approach was the only option. This study aims to determine the prevalence of MIS SIJ fusion procedures among surgeons.

Methods

International Society for the Advancement of Spine Surgery (ISASS) and Society for Minimally Invasive Spine Surgery (SMISS) conducted an internet-based survey of their members to determine key variables to support a Category I CPT application for MIS SIJ arthrodesis. The surgeons included members of ISASS and SMISS. Surgeons who have not performed a SIJ fusion were excluded. Survey included number of open & MIS procedures performed annually (2009-2012), site of service, and average length of stay (ALOS).

Results

Total survey population was 2,200. Of 212 respondents, 121 had performed at least one SI joint fusion in the previous 3 years and therefore eligible to participate. MIS procedures increased from 39% (99/256) in 2009 to 87% (889/1022) in 2012. Conversely, open procedures decreased from 152 in 2009 to 123 in 2012. 97% of open procedures were hospital inpatient based. 78% of MIS procedures were inpatient-based, while 15% were outpatient-based, with 6% in ambulatory surgical centers. ALOS for MIS is 1.69 days vs. 4.3 days for open. 80% of the respondents said “No,” if the open procedure were the only option available for patients with SI joint conditions other than major traumas.

Conclusion

Arthrodesis of the SI joint is becoming a more viable treatment option. Data supports that the progression of the surgical technique to a less invasive approach has provided surgeons with a viable option for treatment of patients with sacroiliitis and SIJ disruption. The growth of MIS techniques substantiates that this procedure is becoming well a well-accepted treatment option.

OUTCOME OF NAVIGATED MINIMALLY INVASIVE SACROILIAC JOINT FUSION: DOES SURGICAL HISTORY MATTER?

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Introduction

The sacroiliac (SI) joint has been implicated as a cause of chronic low back pain in 13–30% of patients. Conservative management is usually treatment of choice but when it fails, SI joint arthrodesis is a viable alternative. Recent studies have implicated that a history of lumbar fusion may be a cause of SI joint pain which may in turn affect treatment. This study aims to describe the effect of low back or hip surgery history on SI joint fusion outcomes.

Method

Medical records of a consecutive case series of patients who have undergone navigated minimally invasive surgery (MIS) SI joint fusion by a single surgeon were reviewed. Comparative statistical tests on Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS) pain scores were conducted to determine if differences were evident among patients with or without lower back surgery prior to SI joint fusion.

Results

From June 2010 to October 2012, 49 patients underwent navigated MIS SI joint fusions. 1 was lost to follow-up leaving 48 included in the analysis. Average age was 48 years (18-77). There were 13 males and 35 females. 56% (27/48) were unilateral and 44% (21/48) were bilateral. Revision rate was 8% (4/48) of these 2 were unilateral and 2 bilateral MIS revisions. 62.5% (30/48) of patients had a history of back or hip surgery while 37.5% (18/48) were isolated SI joint diseases. Among bilateral procedures 3 were simultaneous, 4 had contralateral side done by other surgeons, and 1 revision from another surgeon. Average time to contralateral SI joint fusion was 6 months. Mean change in ODI and VAS scores over variable interval did not differ significantly in patients with or without surgical history (ODI□ 11+19 vs 9+13; VAS□ 2.5+2.4 vs 1.3+2.2; p>0.05) although scores trended to be better in patients with isolated SI joint disease (Table 1.)

Table1: Statistical Analysis Summary

Surgical history	Hip (n=4)		Lumbar (n=24)		Isolated (n=20)		Lumbar+Hip (n=28)		*T-test*
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*p value*
Preop ODI	59.8	7.8	59.3	12.2	51.9	15.0	59.4	11.6	*0.057*
Postop ODI	42.5	10.8	51.3	12.2	**41.2**	17.5	**50.0**	16.4	*0.082*
Change ODI	17.3	12.6	8.1	12.6	10.6	18.9	9.4	12.8	*0.780*
Preop VAS	7.3	0.5	7.5	1.7	7.8	1.4	7.4	1.5	*0.421*
Postop VAS	4.8	2.2	6.3	2.1	**5.4**	2.35	**6.1**	2.1	*0.249*
Change VAS	2.5	1.9	1.2	2.2	2.5	2.42	1.3	2.2	*0.106*

Conclusion

More than half of patients undergoing MIS SI joint fusions have a history of lumbar or hip surgery which more likely affects patient outcomes scores especially the ODI. Both pain and functional outcome scores at final follow-up trended to be better in patients with isolated SI joint disease. However, the ODI and VAS may not be adequate measurement for patients with bilateral SI joint disease, and concomitant lumbar and/or hip disease undergoing unilateral SI joint fusion. Patients were satisfied by self-report although this was not fully reflected by ODI and VAS change. When considering SI joint fusion for patients with sacroiliitis or SI joint disruption, any history of lumbar surgery or disease can be a factor in a successful outcome.

CENTRAL SENSITIZATION IN UROGYNECOLOGICAL CHRONIC PELVIC PAIN: A SYSTEMATIC LITERATURE REVIEW

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Introduction

Chronic pelvic pain (CPP) is a complex pain syndrome. Since its pathogenesis is still poorly understood and structural alterations in brain regions may be present, there is a greater acceptance that sensitization of the central nervous system (CNS) plays an important role in the development and maintenance of chronicity.

Purpose

The purpose of this study is to systematically review the scientific evidence regarding central sensitization (CS) in female patients with urogynecological CPP.

Study Design

Systematic review of the literature.

Methods

A systematic literature search was conducted in “PubMed “and “Web of Science” using different keyword combinations related to “urogynecological CPP” and “central sensitization”. Full text clinical reports addressing CS in female adults with urogynecological CPP were included and assessed for methodological quality by two independent reviewers.

Results

After screening for the eligibility, a total of 29 full-text articles with low to good methodological quality were retained. All studies were observational of which 27 case-control and 2 cohorts. Sensitivity of the central nervous system was investigated by a variety of methods. Although different central mechanisms seem to be involved in pain processing, the present evidence suggests hyperexcitability of the central nervous system in patients with urogynecological CPP. Altered brain morphology and function, generalized hyperalgesia to different type of stimuli, overactive bottom-up nociceptive mechanisms, and autonomic dysregulation were established in different patients with urogynecological CPP. Nevertheless, diffuse noxious inhibitory control seemed normal in one study and therefore the contribution of impaired endogenous pain inhibition mechanism to CPP requires further study. The same goes for the contribution of psychological factors.

Relevance

The recognition of the presence of possible involvement of CS has after all important implications for the development of specific therapeutics and better clinical management, going further than the traditional practice of focusing on peripheral pathology. A multidisciplinary approach is needed to understand pain variability in this chronic pain syndrome, accounting for cognitive and emotional factors and augmented pain sensitivity.

Conclusion

Although the majority of the literature provides evidence for the presence of central sensitization in urogynecological CPP with changes in brain morphology/function and sensory function, it is unclear whether these changes in central pain processing are secondary or primary to CPP, especially since evidence regarding the function of endogenous pain inhibition and the role of psychosocial pain facilitation is scarce.

Discussion

Due to the observational study designs, the level of evidence is overall low and a wide range of diagnoses and assessment methods are used. Future studies with good methodological quality are needed in order to clarify exact mechanisms.

LOW BACK PAIN IN NURSING STAFF: UNDERSTANDING AND PREVENTION

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Introduction

The aim of this study was to investigate the incidence of Low Back Pain (LBP), associated skeletal pain, to understand possible risk factors for LBP and to investigate the actual implementation of LBP prevention among nursing staff in Jahra hospital with a questionnaire.

Methods

500 Nurses took part in the survey with distribution in all departments of the hospital in appropriate gender ratio. They received the questionnaire directly from the Staff Development Unit (SDU). 400 nurses (80%) completed the questionnaire, 65 (13%) did not return and 35 (7%) were incomplete.

Results

72% of the subjects had experienced LBP and 28% had not. 85% of those who had LBP acquired it after employment in Kuwait and 15% had before employment. The major risk factors given for LBP in nurses were prolonged standing, Lifting heavy objects, Bending, and Patients care. The degree of LBP in visual analog scale (VAS) was moderate degree of pain. The associated skeletal pain was more common in shoulder, neck, knee and elbow regions. The rate of those taking preventive measures is higher among subjects with LBP (60%) than in those without (40%). The most common preventive methods used were use of proper body mechanics, proper ways of caring, giving patient care in pairs, doing exercises to prevent LBP, improving general fitness and use of back supports.

Conclusions

The prevalence of LBP is high in nursing staff in Jahra hospital. Most of the subjects began using preventive measures after LBP had already started. It is important for nurses to learn the best way to prevent LBP and relieve pain. Physical therapists play an important role in teaching and promoting the prevention of LBP.

THE ASSOCIATION BETWEEN DAILY PHYSICAL ACTIVITY AND THE ONSET OF LOW BACK PAIN IN OFFICE WORKERS

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Introduction

Office workers are one of occupations that have high prevalence of musculoskeletal symptoms in the low back1. Daily physical activity, which is physical activity at rather low to moderate levels, when performed sufficiently is widely known to have important health benefits. A recent systematic review has shown conflicting evidence for the association between physical activity and low back pain (LBP) in both general population and school children2. No study has been conducted on the effect of daily physical activity levels on preventing LBP in office workers. The purpose of this study was to examine a causal relationship between daily physical activity level and LBP in office workers.

Materials and Methods

This study is a 1-year prospective cohort study using conveniently sampling with participants aged between 18-45 years from workplaces in Bangkok, Thailand. Office workers were included if they were free from LBP in the previous 3 months. Participants were excluded if they reported pain on the low back greater than 3/10 on VAS, pregnancy or had a history of specific LBP. At baseline, participants completed a self-administered questionnaire and underwent a physical examination. For daily physical activity measure, each participant was given a pedometer to measure daily physical activity for 7 consecutive days (Mon-Sun). The participants were asked to carry the pedometer on the belt from getting up in the morning until going to bed at night. The incidence, severity of LBP and daily physical activity were prospectively followed over a 12-month period.

Results and Discussions

Data analysis is currently underway and the results, discussion and conclusion will be presented at the conference.

Keywords

Physical activity, Lifestyle, Low back pain, Office workers, Prevention

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ASSOCIATION OF ABDOMINAL OBESITY WITH LUMBAR DISC DEGENERATION – A MAGNETIC RESONANCE IMAGING STUDY

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Introduction
The role of obesity in lumbar intervertebral disc degeneration (DD) is largely unknown. However, we have recently found that persistent high body mass index at 16 years was associated with lumbar DD at 21 years.

Purpose
To evaluate whether midsagittal (abdominal) obesity in magnetic resonance imaging (MRI), waist circumference (WC) and body fat percentage are associated with lumbar DD in early adulthood.

Materials and Methods
We obtained the lumbar MRI (1.5-T) of 325 females and 233 males at a mean age of 21 years. Lumbar DD was evaluated using Pfirrmann classification. We analysed the associations of MRI measures of obesity (abdominal diameter (AD), sagittal diameter (SAD), ventral subcutaneous thickness (VST), and dorsal subcutaneous thickness (DST)), WC and body fat percentage with DD sum scores using ordinal logistic regression.

Results
A total of 155 (48%) females and 147 (63%) males had DD. AD and SAD were associated with a DD sum score of ≥ 3 compared to DD sum score of 0–2 (OR 1.67; 95% confidence interval (CI) 1.20–2.33 and OR 1.40; 95% CI 1.12–1.75, respectively) among males, but we found no association among females. WC was also associated with DD among males (OR 1.03 per one cm; 95% CI 1.00–1.05), but not among females.

Conclusions
Measures of abdominal obesity in MRI and waist circumference were associated with DD among 21-year-old males.

Implications
Waist circumference is a good measure of abdominal fat tissue and can be used in clinically to evaluate the risk of lumbar DD among young adults.

Keywords
Disc degeneration, magnetic resonance imaging, obesity, young adult

THE NIOSH LIFTING EQUATION: RISKS OF LOW BACK PAIN AND SEEKING CARE IN THE BACKWORKS PROSPECTIVE COHORT STUDY

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Objective

Evaluate relationships between the Revised NIOSH Lifting Equation (RNLE) and risks of (i) low back pain (LBP) and (ii) seeking care for low back pain (SC-LBP).

Background

The RNLE is commonly used to quantify biomechanical stressors to low back from lifting/lowering of loads in workplaces. There is no prospective study on relationship of RNLE with LBP or SC-LBP while accounting for relevant covariates.

Methods

A cohort of 897 workers was enrolled from 30 diverse manufacturing facilities. Biomechanical stressors were measured and quantified as peak Lifting Index (PLI) and peak Composite Lifting index (PCLI). Worker demographics, medical history, psychosocial factors, hobbies, and current LBP were obtained at baseline. The cohort was followed monthly for up to 4.5 years to ascertain LBP and SC-LBP status, and changes in physical exposure. The associations between PLI and PCLI (treated as time varying covariates), and LBP and SC-LBP were tested in multivariate models using proportional hazard regression.

An incident case of any LBP was defined as regional LBP of any pain intensity in lumbosacral area and lasting at least one day; and SC-LBP as seeking care for LBP from any caregiver. Workers who reported their LBP was due to an accident were excluded from becoming incident cases.

Results

At baseline, LBP point and lifetime prevalences and SC-LBP lifetime prevalence were 7.1%, 75.1% and 31.9%, respectively. During follow-up there were 123 and 24 incident cases of LBP and SC-LBP. Factors predicting development of LBP included: job physical exposure (PLI and PCLI), history of LBP, psychosocial factors, and housework. In adjusted models, risk (hazard ratio, HR) increased per unit increase in PLI and PCLI ($p=0.05$ and 0.02, maximum HR=4.3 and 4.2, respectively).

Job physical exposure (PLI and PCLI), history of LBP, age, female gender and lower BMI predicted SC-LBP. In adjusted models, risk increased per unit increase in PLI and PCLI ($p = 0.03$ and 0.02, maximum HR = 23.0 and 21.9, respectively).

Both PLI and CLI showed non-linear increases in risk for both LBP and SC-LBP. LBP and SC-LBP risks increased continuously with increase in PLI and PCLI, respectively.

Conclusion

Both biomechanical stressors and history of LBP were associated with increased risk of developing LBP and SC-LBP. While work-related psychosocial factors were associated with a new episode of LBP they appeared to be relatively unimportant in SC-LBP. Female gender and age were associated with SC-LBP but not with LBP.

Biomechanical stressors are associated with increased risk of LBP and SC-LBP. Data suggest that both the PLI and PCLI are useful metrics for estimating exposure to biomechanical stressors and for designing jobs to reduce work-related LBP.

Key Words
NIOSH Lifting Equation, Low Back Pain, Seek Care, Epidemiology, Risk Assessment

A SUCCESSFUL LOW BACK INJURY PREVENTION PROGRAM ON AN OIL AND GAS PLATFORM

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Introduction

Workers on oil and gas platforms off the west coast of Australia generally work 12 hour shifts over a two-week swing. Most of the work is heavy and performed in cramped conditions, leading to a high number of low back injuries occurring on site. Low back injuries that result in the worker being flown back to the main land and therefore unable to complete their shift are costly for both the company and the worker involved.

Purpose/Aim

Platform NRA was averaging 4 low back injuries flown off site per month. A physiotherapy prevention program was implemented with an aim to decrease recordable low back injuries by 50% over a 12-month period.

Materials and Methods

The majority of staff on the platform were included in the program from the most senior staff member to the most junior, with 200 staff across two swings enlisted for the three week trial. All staff signed consent forms. The physiotherapist was on site for one week per month for 3 consecutive months.

Reading material was distributed to all workers one week prior to the arrival of the physiotherapist. This reading material included a summary of low back anatomy and function, common low back injuries, a summary of current pain literature, and the importance of self management for low back health and rehabilitation and protection of self from injury.

On day 1 the physiotherapist assessed the work place and physical requirements of each job on site. Each worker on site was assessed and educated for 30 minutes including screening of hip range and function, movement patterning for low back, hips and pelvis, breathing pattern, lifting/bending technique, spinal range and function, stress or anxiety, and real-time ultrasound assessment of automatic function of lumbo-pelvic muscles. Workers were given specific exercises with respect to their findings, and educated with regard to improving movement and function and attitude to decrease their risk of future injury.

Following the completion of the assessment of all workers on both swings (week 1 and 2), those subjects with the most significant findings were re-assessed, further educated, and shown progression of exercises (week 3).

The medicos on site continued to encourage all staff to participate in the prevention program by showing one or two slides during daily tool-box talks to remind staff of ideal breathing, bending, lifting, exercises, and attitudes. This continued for a period of 6 months following completion of the intervention.

Results

Following the intervention there were no low back injuries flown off site for the 12 month period after the conclusion of the physiotherapy intervention. This was a 100% reduction over the 12 month period. At the three year follow up the site was averaging less than 0.5 low back injuries per month flown off site.

Relevance

A successful prevention of injury program can improve productivity, save money, and improve work place attitudes.

Conclusions

This prevention program was highly effective in reducing low back injuries on the oil and gas platform with the positive effects lasting for at least 3 years post intervention.

Discussion

Physiotherapists are ideally placed to implement prevention of low back injury programs across the oil and gas industry, improving productivity, creating positive work place attitudes and effectively decreasing the costs associated with injured workers. Physiotherapy prevention programs are a positive intervention to address the cost of low back injury in our society and should be embraced by the physiotherapy profession.

IMPLEMENTATION OF ORGANIZATIONAL GUIDELINES FOR LBP IN DANISH PRIMARY CARE. HOW TO GET 'START'ED?

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Introduction

Research in the field of LBP has increased but the burden of low back pain has not decreased. Though guidelines based on research results have been suggested, clinical routines are hard to change leaving implementation processes slow and rigid. Clinicians are often unaware of research results and proposed guidelines and researchers do not fell responsible for implementation. This leaves a vacuum between research and clinic. Challenges and pathways of how to translate research into daily clinical practice are rarely described.

Purpose/Aim

The aim of this project was to implement the recommended bio-psycho-social approach in management of complex low back patients, from the organizational guidelines of the Region of Southern Denmark, into primary care.

Materials and Methods

The need to re-think the management of LBP patients created a political interest in the STarT Back Tool (SBT) model of risk stratification and targeted treatment. Organizational guidelines including the integration of SBT into primary care was developed by the Region of Southern Denmark. An educational program on SBT classification was conducted for GPs through out the region. Physiotherapists from the Spine Centre of Southern Denmark participated in the educational program tailored to managing complex low back pain patients at Keele University, UK. The aim for participating in the program was to develop skills in using the SBT, but also to extend the knowledge on identifying and managing complex patients in order to educate other health professionals. The Danish version of the intro course was a 3 days program. To mirror clinical setting the content of the course was mainly a 'hands on' approach. The participants were physiotherapists and chiropractors employed in community health centres or in private practice. The course was organized by the Region of Southern Denmark and was free of charge for the participants.

Results

80 clinicians have attended the intro course representing a wide variety of private practitioners and employees from primary care through out the Region of Southern Denmark. The overall regional cost was €335 per educated clinician. The clinicians were positive and indicated that the risk stratification and targeted treatment was easy to apply to their clinic. The SBT approach was also introduced to secondary care and investigations of whether this model is useful in secondary care are performed.

Conclusions

The overall implementation indicates promising results, because of enthusiastic scientific and clinical health professionals, political and economic goodwill in a coordinated process.

Discussion

Implementation requires continuously hard work by teachers, clinicians and politicians. Ongoing commitment is fundamental. Funding for education of clinicians is required and so is ongoing education of the teaching staff.

Relevance/Implications

The implementation of SBT creates a common understanding for managing LBP across health professionals. This process is to major benefit for patients. SBT advocates a simple and understandable approach for patients and has shown to be beneficial for quality of treatment and for health economy.

Keywords

SBT, Implementation, Political interest

ARE THE BACK EDUCATIONAL INTERVENTIONS EFFECTIVE FOR PREVENTING LOW BACK PAIN?

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Introduction

Educational programs mainly or exclusively based on proper care of the back (e.g., maintaining the natural lordosis and keeping a load against the trunk while carrying, avoiding the stooping technique while lifting, pivoting instead of twisting) are commonly used in the general population and in workers to limit low back pain (LBP) occurrence. Some reviews concerning back pain prevention have questioned the benefits of such programs. However, most of the reviews did not focus specifically on the preventive back educational programs.

Purpose/Aim

A systematic search was conducted to study the efficiency of preventive educational interventions mainly focused on a biomechanical/biomedical model. In order to interpret properly the trials included in the present work, we also investigated their methodological quality according to the recommendations of the Cochrane Back Review Group.

Materials and Methods

The Pubmed electronic database and the Cochrane Library were searched based on a combination of keywords related to LBP and posture education. We only included randomized controlled trial (RCT) studying the efficiency on outcomes directly related to LBP of a preventive intervention program mainly based on education of proper care of the back for subjects not seeking treatment. References of the articles meeting these inclusion criteria were also checked to identify other potential citations.

Two of the authors scored the methodological quality (based on twelve criteria) of the included RCTs.

Results

Nine studies, all conducted at the workplace, were included in this review. Their mean quality level was low (5.1/12) and among the four studies with a huge sample size (n > 400 subjects), only one had an acceptable methodological quality score (6/12). The educational interventions differed widely from one study to another. No significant differences between the control and education groups were found at the follow-up in eight out of the nine studies on the incidence of back pain, disability and sick leave.

Conclusions

The results of the RCTs included in this review suggest that educational interventions mainly focused on a biomechanical/biomedical model are not effective in preventing LBP.

Discussion

However, considering the low number of RCTs included in this review, their methodological quality level and the very short and heterogeneous interventions often proposed, one should not draw a strong conclusion concerning their efficiency.

Implications

This review points out the need to conduct additional high quality studies with a longer education period to conclude that such interventions are inefficient. Comparing such educational interventions to psychosocial information programs based on a biopsychosocial model would also be particularly relevant.

Keywords

Prevention; education; low back pain; review; back school

COST BURDEN OF LOW BACK PAIN IN NIGERIA: A PILOT STUDY

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Introduction

Back pain is a major health and socioeconomic problem in Western society, it presents with large and growing economic burden with attendant disability in its sufferers. Low back pain (LBP) is one of the top ten reasons patients seek care from family physicians.

Purpose and Aim

Estimation of cost burden of a disease condition is a very significant part of health care policy making worldwide. Up till date, such documents are nonexistent especially on non-communicable diseases like LBP in the health policy making process in Nigeria. This article therefore attempts to report the results of a prospective cross-sectional study on the cost burden of LBP in Nigeria. It estimates the direct health care cost for a minimum period of 2weeks and maximum of 20weeks for the management of this musculoskeletal disease.

Materials and Methods

Study Design/ Settings- It was a collaborative cross-sectional study amongst four health facilities in Nigeria. It involved an Oil and Gas Company hospital, two Government tertiary hospitals, and a Private Specialist hospital all in Nigeria.

Medical records of two hundred and twenty (220) patients with LBP managed within the last six years (2005-2011) were randomly selected from the medical record departments of the study centers. They were patients diagnosed and admitted for LBP management in the four health facilities, in the South-South zone of Nigeria. Files of the patients whose age ranged between 34 and 62years and were admitted during acute care period (without discharge against medical advice) and were followed on out-patient basis without default within the study period were purposively utilized. The files were then assessed for the various investigations and treatment interventions of acute and long term care and the costs thereof. Ethical approval to access patients' case files was granted by the Research Ethics Committee of the different study centers.

Results

The results revealed that it requires an average of N75,070: 00 ($478 =€373.56) and N400,100: 00 ($4860=€1990. 95) in a government and a private hospital, respectively to access care within 20weeks of post hospital presentation of a LBP case in Nigeria.

Relevance

The study suggests that managing LBP constitutes a huge direct cost burden unaffordable by an average Nigerian back pain sufferer.

Conclusion

The consequence is low quality of life of citizens in a country where majority live on a per capital income of less than $2.00 per day.

Implications

Disability-adjusted life year may be the consequence of unaffordable cost of care amongst sufferers. Health policies on health education on preventive measures could go a long way in reducing this cost burden.

Keywords

Low back pain, cost burden, Nigeria

EFFECT OF STRONTIUM RANELATE ON VERTEBRAL PAIN SYNDROME AND FUNCTIONAL ABILITIES IN POSTMENOPAUSAL WOMEN WITH SYSTEMIC OSTEOPOROSIS

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Aim

To evaluate the effect of strontium ranelate in treatment of systemic osteoporosis in postmenopausal women.

Materials and Methods

There were examined 894 postmenopausal women with systemic osteoporosis (average age 59,97±10,57 years, average height 161,82±7,09 cm, average weight 71,32±13,44 kg). Evaluation of pain syndrome and level of physical activity was carried out with visual analogue scale (VAS). Examination was performed before onset of treatment and after a four, eight and twelve month treatment course. Strontium ranelate (Bivalos, «Servier») was taken in a dose of one 2 g sachet as a suspension in water once a day and 1 tablet of Calcemin-advance (Calcium – 500 mg, Vit. D – 400 IU) 2 times a day during 12 months.

Results

The patients had the risk factors of osteoporosis: 28 % of patients had osteoporotic fractures in their anamnesis; 17% – hip fractures in mother or father of patients, 12% – smoking, y 8% – alcohol abuse, 27% of patients have taken corticosteroid tablets for more than 3 month. We observed a reliable decrease of vertebral pain syndrome (after treatment – 2.97±0.77, after four months – 2.24±0.85, after eight months – 1.61±0.94; after twelve months – 1.24±1.04; $p<0.00001$) and increase of functional abilities of patients (after treatment – 1.50±0.67, after four months – 2.08±0.52, after eight months – 2.67±0.53; after twelve months – 2.88±0.63; $p<0.00001$).

Conclusion

It has been demonstrated that strontium ranelate treatment significantly decreases pronounced vertebral pain syndrome and improves functional abilities of patients in the postmenopausal women.

EFFECT OF A MULTIDISCIPLINARY PREVENTION PROGRAM IN HOSPITAL EMPLOYEES AT RISK FOR DEVELOPING LOW BACK PAIN

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Introduction

There is a lack of experimental studies evaluating the prevention possibilities of work-related low back pain (LBP) in health care workers such as nurses and hospital workers, despite the high prevalence and incidence of LBP in this population. Monodisciplinary programs have been found ineffective in nurses or in other populations at risk for developing LBP. The multifactorial aetiology of LBP suggest that multidisciplinary prevention programs should be recommended above monodisciplinary interventions.

Purpose/Aim

The purpose of this study is to evaluate the effect of a multidisciplinary prevention program for LBP, focusing on a client-centred approach, on healthy workers which are at risk for developing LBP.

Materials and Methods

Hospital employees in physically demanding jobs were recruited from two hospitals. They were randomly allocated to a control group (no intervention) or to an experimental intervention (i.e. multidisciplinary prevention program). The experimental intervention consisted of four components: 1) intervention at hospital policy level, 2) exercise and nutritional intervention, 3) ergonomics and 4) psychological intervention, reflecting the biopsychosocial nature of LBP. Sixty-nine workers were randomly assigned to the experimental or control group. Participants were tested prior to the intervention and after a six months follow-up period. Primary outcome measures included work absenteeism, incidence of LBP and quality of life. Secondary outcomes included daily physical activity, job satisfaction and coping strategies.

Results

No significant differences were observed between groups for work absenteeism, incidence of LBP, quality of life or job satisfaction ($p>0,05$). A significant time effect was demonstrated for the daily physical activity and passive coping reaction pattern, but no between groups differences were observed implying that a similar evolution occurred in both groups ($p>0,05$).

Conclusions

This multidisciplinary prevention program fitting into a biopsychocial context has no effect on work absenteeism, incidence of LBP or quality of life compared to a control group receiving no intervention at six months follow up.

Discussion

Our multidisciplinary prevention program included decisive and receptive factors for developing LBP, but we cannot exclude that other factors have played a role. For example, fear-avoidance beliefs and pain catastrophizing are primary psychosocial factors in the development and maintenance of LBP. Preliminary evidence suggest that interventions addressing beliefs and attitudes should be the priority in the treatment of subjects with LBP. Information oriented toward promoting activity and improving coping may promote a positive shift in beliefs. However this evidence is still insufficient to recommend for or against psychosocial information delivered at the worksite.

Implications

Further research should determine whether prevention of LBP is possible in caregiving personnel.

Keywords

Prevention, multidisciplinary intervention program, occupational disability, behavioural change, biopsychosocial

LOW BACK PAIN AMONG CAREGIVERS OF CHILDREN WITH CEREBRAL PALSY

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Introduction

Single Event Multilevel surgery (SEMLS) is increasingly being performed to effectively rehabilitate children with cerebral palsy (CP). During the postoperative period, caregivers had to transfer the child from bed to wheel chair, carry the child to the rehabilitation centre, on the staircase and at home till he/she was able to walk independently. Musculoskeletal pain especially involving the lower back was common among caregivers during the non-ambulatory phase of the post-operative rehabilitation of their children. There is a paucity of research reporting the epidemiology and risk factors of low back pain in caregivers of children with CP.

Aim

To identify the prevalence and risk factors of low back pain among the caregivers of children with CP following a multilevel surgery.

Materials and Methods

A case control study where the study group comprised of 257 (mean age: 35.4 + 6.73 years) caregivers of children with CP who underwent multilevel surgery. The control group comprised of 117 (mean age: 39.28 + 9.25 years) caregivers of ambulatory children with CP. The study was conducted in a tertiary level rehabilitation hospital over a period of 3 years (2008-2011). The study utilised a closed ended self-administered questionnaire. The level of physical exertion during lifting/carrying child and fatigue were measured using Borg CR-10 scale and the Modified Caregiver Strain Index (CSI).

Results

The participants were predominantly females in both the study and control groups (63.4% and 69.3% respectively). Lower back pain was the commonest reported symptom in both the study and control groups (56% and 36% respectively). The majority of cases of low back pain was found to be of myofascial origin. Though low back pain was common in both the groups, the prevalence was more significant in the study group. CSI did not show any significant difference between the groups.

Conclusions

The results indicated a significant prevalence of low back pain among caregivers of children with CP, with a higher risk for parents of children with older age, more severe disabilities, uncooperativeness and higher body mass index. Early identification of the cause of pain and treatment of the same is essential to prevent them from becoming severe cases and hampering the child’s rehabilitation.

Discussion

The results indicated a significant prevalence of low back pain among the caregivers of children with CP during the non-ambulatory phase of rehabilitation. Most of the caregivers held their child in an upright position, directly against the chest in the centre. Carrying a child in this position created postural imbalances that could lead to low back pain and other musculoskeletal disorders over time.

Implications

Routine training in safe transferring, lifting and carrying techniques, usage of assistive devices, psychological counseling, stress management and sleep hygiene training are the possible ways to prevent low back pain in caregivers of children with CP.

Keywords

Low Back Pain, Caregivers, Cerebral Palsy

PREVALENCE AND RISK FACTORS OF LOW BACK PAIN AMONG INDIAN PHYSIOTHERAPISTS

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Introduction

Published literature has revealed that physiotherapists are prone to various work related musculoskeletal disorders (MSD), involving the lower back, neck, shoulder and hand. Identification of risk factors and prevalence of low back pain (LBP) in physiotherapists has not been reported in India.

Aim

The aim of the study was to evaluate the prevalence and risk factors of LBP among physiotherapists in India.

Materials and Methods

A prospective survey study was conducted in which 140 (male 88, female 52) physiotherapists from various parts of India participated. The participants were asked to fill in a structured questionnaire which included details of demography such as age, sex, height, weight etc, total work experience, number of working hours in a day, type or department of work, questions related to regular exercise, physical risk factors associated with working condition, present health status, Nordic Musculoskeletal Questionnaire, and the short form of Workstyle Questionnaire. The data were analysed statistically.

Results

The mean age of the subjects was 26.4 ± 2.96 years. The mean height, weight and BMI of the subjects were 163 ± 9.6 cm, 63.81 ± 13.85 kg and 23.70 ± 3.99 kg/m2 respectively. The average years of experience of the subjects were 3.21 ± 2.90 years. On an average the subjects worked for 9.29 ± 1.08 hours per day for 6 days a week. Only 23.4% of the subjects exercised regularly. 81.25% of the subjects complained of pain or discomfort within the past one year. Pain was most commonly reported in the neck (56.25%), upper back (56.25%) and lower back (50.07%). Analysis of short form of workstyle questionnaire revealed that 67.18% of the subjects were under adverse workstyle risk (total score >28). Risk factors identified for LBP included prolonged duration of standing, frequent bending or twisting of upper body, working in awkward postures, prolonged period of static posture and lifting or carrying heavy weights (especially the patients).

Conclusions

The present study revealed that the physiotherapists were prone to develop LBP as they were exposed to various risk factors at the workplace. Further research is needed to clearly understand the causes and prevention of LBP in Physiotherapists.

Discussion

The present study revealed that the physiotherapist were prone to develop MSD as several risk factors were present in the workplace.

Implications

Eliminating all the risk factors associated with the development of LBP in Physiotherapists may not be possible due to the nature of the job, but based on the number of prevention techniques being suggested, it is possible to reduce the risk factors leading to LBP.

Keywords

Low Back Pain, Risk factors, Physiotherapist

ACHONDROPLASIA: THORACOLUMBAR KYPHOSIS IN A FEMALE CHILD MEXICAN CASE

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Introduction

The Achondroplasia is the most common non-lethal skeletal dysplasia. The existence of this kind of dwarfism documented since ancient Egypt (2000-100 BC). Is an autosomal dominant trait, a majority of cases are spontaneous mutations (90%). The prevalence 1: 10,000 to 1:50,000 births worldwide. The Achondroplasia is an endochondral bone formation disturbance, which results of short-limb dwarfism characterized by: short stature, short-trunked (rhizomelic shortening of the limbs); large head; characteristic facies with frontal bossing and midface hypoplasia; limitation of elbow extension, genu varum, and trident; thoracolumbar gibbus presents at birth and after could become on lumbar lordosis. In this study, clinical and radiological outcomes were assessed in a child with angular thoracolumbar kyphosis (TLK) in achondroplasia, without history of cervicomedullary compression.

Material and methods

The proposita 6 year-old, was the product of the IV pregnancy, of non-consaguineus parents. The mother referred slow intrauterine development after the 29 weeks of pregnancy. Was born a term by caesarean. At birth: weight 2725 gr, height 48.5 cm, OFC 37cm; arm spam 42cm. The present physical examination showed facial and clinical features indicating achondroplasia and disproporcionate short stature. Weight 16.800 Kg, Height 90 cm, OFC 56 cm; arm spam 85 cm. At 4 years-old was under surgery by vertebral fusion (L1-L2) without compression symptoms. Radiological findings revealed small cuboid-shaped vertebral bodies with short pedicles and progressive narrowing of lumbar interpedicular distance, thoracolumbar kyphosis with anterior beaking of T10 to L2 vertebra, and degenerative spondylosis.

Discussion

The thoracolumbar kyphosis is an entity that presents 10-15% of acondroplastics, seen in most infants, but it resolves when the child begins to walk. In children this is initially a persuits, however in more than 10% of children is detected and become a fixed TLK deformity. As the reports in the literature the symptomatic TLK and spinal stenosis occurs at all spinal levels due to the abnormally narrow bone canal. Avoidance of pitfalls in the management of these patients is still discussed for both pediatric and adult patients. The purpose of this case is report a 6 year-old child who presents angular TLK on T10 to L2 vertebral bodies, without cervicomedullary compression, to choose the better Medical and surgical option for her best quality of life. The knowledge of evolution and management in TLK in Achondroplasia, should give the best multidisciplinary health team care, and will prevent features findings and complications in patients with Achondroplasia.

IS MALARIA IMPLICATED IN ACUTE PAIN EXACEBATION IN PATIENTS WITH CHRONIC LOW BACK PAIN IN NIGERIA?

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Introduction

Back pain affects an estimated 80% of the population, it is responsible for one third of all disability costs in the USA. Indirect costs resulting from lost work productivity represent a majority of overall costs associated with exacerbation of low back pain (LBP).

Purpose and Aim

Malaria is found in most tropical and subtropical regions of the world, it is endemic in Nigeria and believed to be responsible for 60% of outpatient visits and 30% of hospitalizations. Patients who undergo physiotherapy (PT) for chronic LBP (CLBP) often complain of exacerbation after recording significant improvement in their pain severity (PS) and appear to regain pain relief after malaria chemotherapy. This study aims at examining if malaria infection significantly exacerbates PS in patients with LBP.

Materials and Methods

Twenty (20) patients whose age ranged between 25- 57 years who had severe CLBP and were managed with PT were purposively recruited into the study. They were those whose back pain resulted from spondylotic changes (arthritis) of the lumbosacral spine. Participants were also not on any analgesic medication during the period of management. Their PS was assessed using numerical pain rating scale before PT intervention, reassessed weekly during PT sessions which included when they reported exacerbation. They were then referred to their physicians for malaria attack investigation. Those who tested positive were treated while off PT and PS was rated when they visit for PT. Data were analysed using descriptive statistics as well as one-way ANOVA to test the strength of changes in the PS between the periods.

Results

The result revealed that PT resulted in a significant reduction in the PS of patients with LBP ($p=0.695$). However, the increase in PS caused by malaria infestation descriptively increased the PS of the patients, the increase in PS was not statistically significant ($p= 0.023$). The PS remained significantly reduced after malaria treatment ($p=0.926$).

Relevance

Malaria complicating LBP which is already a major health challenge could be a double barrel burden for people living in malaria endemic regions like Nigeria.

Conclusion

The study shows descriptive significance in PS for malaria positive persons, which is in agreement with the fact that joint and back pain are some of the symptoms of malaria, it therefore calls to attention the impact of malaria in the holistic management of LBP. However, the non statistically significant of the exacerbation of pain thought to be due to the small sample size in this pilot study requires further investigation.

Implication

This should add to the importance of research for the malaria vaccine which has been on in the last three decades.

THE VALUE OF IONM IN SPINE SURGERY

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Intraoperative Neurophysiologic Monitoring (IONM) is the application of a variety of electrophysiological and vascular monitoring procedures during surgery to allow early warning and avoidance of injury to nervous system structures.

The purpose of IONM is to reduce the incidence of iatrogenic (e.g., arising from medical treatment) and randomly induced neurological injuries to patients during surgical procedures. IONM consequently confers possible benefits at many levels including:

- Improved patient care
- Reduced patient neurological deficits
- Improved surgical morbidity and mortality
- Reduced hospital stay and medical costs
- Reduced overall insurance burden

The efficacy of IONM has been best studied in spinal surgery where significant benefits occur including reduction in quadriplegia and death. IONM is becoming a standard of care in many spine surgeries. Several surgical events need Intra-operative Monitoring, to avoid possible post-operative neurological deficits:

Deformity correction / cord compression

- Patient positioning
- Nerve roots manipulation
- Pedicale screws fixation
- Hypotention

IONM is now recognized and remunerated by most insurers in the USA. Numerous types of surgeries benefit from and thus utilize IONM. These can be generally classified by surgical specialty into orthopedic, neurosurgical, cardiac, otolaryngological, plastic (peripheral nerve), and urologic. IONM is now considered a standard of care in this group and is likely to remain so for the foreseeable future.

THE NORWEGIAN ASSOCIATION FOR WOMEN WITH PGP

Sol-Hege N.K., Torgersen Lunestad A.

LKB - the Norwegian Association for Women with Pelvic Girdle Pain, Norway

The Norwegian Association for Women with PGP (in Norwegian: Landsforeningen for Kvinner med Bekkenløsningsplager - LKB) is a special interest group that looks after the interests of women in Norway who suffer from pelvic girdle pain (PGP). We are working to create a fuller understanding of this condition in order to achieve an optimum combination of treatment, relief in everyday life, aids and equipment, and social security entitlements. LKB was founded in 1987 and has 1,000 members. It is affiliated to the Norwegian Association for the Disabled (NHF). In 1990, LKB was among the driving forces behind the 1st International Conference on Pelvic Girdle Pain in Tromsø, Norway. LKB focuses on prevention, and wishes to help women to cope with this condition and enjoy life.

We have information brochures and a website (www.lkb.no) and we organise conferences and courses to spread correct and up-to-date information about our diagnosis. Our information is based on documented research and our own experience of what helps in practice.

LKB provides a peer counselling service that women who suffer from PGP can contact for support and help. Peer counsellors are trained contact persons who you can call to talk and receive advice and tips. They are not professionals, but people with experience of PGP. LKB's peer counsellors are women with knowledge and understanding who share their experience in confidence. Our peer counsellors are bound by a duty of confidentiality. To talk to women in the same situation might improve their quality of life.

LKB sees it as important that patients with PGP receive optimal and individually adapted treatment. In our experience, alternating between activity and rest tends to relieve the pain. The pelvic girdle with joints, ligaments and muscles is a stable structure, but pain must be taken seriously in order to prevent sensitization to pain.

We are grateful that research is being conducted into PGP, and we think it's of big importance to spread the results of this research. The more people who receive correct and up-to-date information, the more women will receive the proper help in time. This means a lot to the quality of life of those affected and their families, and it is also important in socioeconomic terms.

OSTEOPATHIC PREVENTION STUDY IN ACHIEVEMENT-ORIENTED YOUNG SOCCER PLAYERS

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Introduction

I would like to examine, whether one-sided sportive training leads to typical sport specific dysfunctions of joints and muscles and whether it is possible to eliminate them in the long run through regular exercises adapted to the reversible functional disorders.

Purpose

Is it possible to take soccer as an example of the kind of sport to assess typical patterns of dysfunctions at the lumbosacral transition including functional muscle shortenings of the lower limbs with osteopathic examinations?

If so, is it possible to eliminate these dysfunction in the long run by a specifically designed stretching and strengthening program which is based on osteopathic biomechanical principles?

Materials and Methods

In the framework of a sports medical examination of young soccer players from the national association training centre 33 juvenile soccer players aged between 11 and 13 years were examined.

The examination looked at dysfunctions at the lumbosacral transition and at functional shortening of the muscles of the lower limbs. Based on the findings of the examination, a training program in line with osteopathic biomechanical principles was compiled.This program was carried out twice a week over a period of 4 months with each session lasting for 45 minutes. After four months, a control examination directed at the above mentioned criteria was done.

Inclusion Criteria

Participation on the national association training centre. Regular soccer training at least twice a week over a period of at least two years. Regular participation in the practice at the national association training centre. Regular participation in the stretching and strengthening program. No absences due to injury of more than four weeks. No problems passing the medical admission examination and the control examination. Aged between 11 and 13 years.

Results

45 per cent of the athletes examined displayed a dysfunction of the sacroiliac joint and 81 per cent were diagnosed with having functional muscle shortenings on the lower limbs. The dysfunctions were exclusively torqued sacra on the standing leg. The functional muscle shortenings reflect a typical (sport specific) pattern: The muscles mostly affected were hamstrings (63 %), followed by m. piriformis (51%) and m. quadriceps (36 %). It was striking to see that with all torqued sacrum dysfunctions, a functional muscle shortening of the contralateral m. piriformis was diagnosed.

Through the control examination, only three per cent of the soccer players were diagnosed with a dysfunction of the sacroiliac joint. From the statistical point of view the result is highly significant. $P < 0,03$. Only 18 per cent of the soccer players exhibited functional muscle shortenings on the lower limbs during the control examination. Here, too, the result is highly significant from the statistical point of view. $P < 0,03$.

Relevance

It is of prime importance for an osteopathic basic treatment to treat. But even more important is to use our osteopathic knowledge to develop a stretching and strengthening program in line with osteopathic biomechanical principles to prevent dysfunctions and functional muscle shortenings.

Conclusions

One-sided sportive training leads to typical pattern of dysfunctions of joints and functional muscle shortenings. Regularly performed exercises within a stretching and strengthening program based on osteopathic biomechanical considerations can prevent sport specific dysfunctions and functional muscle shortenings in the long term.

Keywords

prevention, osteopathy, achievement- oriented young soccer players, typical patterns of dysfunctions, functional muscle shortenings, training program in line with osteopathic biomechanical principles

EVALUATING A DYNAMIC ELASTOMERIC FABRIC ORTHOSIS (DEFO) DEVELOPED TO AID IN THE MANAGEMENT OF ATHLETIC PELVIC PAIN

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Introduction

Athletic pelvic pain is a common but difficult phenomena to manage; often because of more than one site of injury(1). Transverse pelvic belts have been used to improve pain and function with athletes with adduction-related pain(2), and diagonal belt configurations have also been shown to be effective(3). However belts are often not appropriate for performance-wear, so the results of the latter pelvic belt study have been used to develop an alternative; a DEFO in the form of bespoke shorts.

Purpose

To evaluate the effect of a bespoke DEFO upon pain and function in athletes with pelvic pain.

Materials and Methods

A series of eight single case studies, with randomised onset of intervention, were undertaken with athletes confirmed through clinical screening, as presenting with pain affecting the pelvic girdle. Daily assessments were undertaken over 15 days, where during the intervention period the athletes wore a bespoke DEFO (in the form of shorts). Outcome measures were: force produced on bilateral resisted hip adduction, and self-scored pain (using a numerical rating scale 0-10) at rest and on completing an active straight leg raise (ASLR) and a broad jump. A follow up session was undertaken after 1 month, and a questionnaire on DEFO usage was administered on completing the study.

Results

Visual analysis of trend, level and slope demonstrated athletes responded differently, but all but one case showed significant improvements on at least one measure. One case demonstrated very little pain during testing, despite meeting the inclusion criteria; possibly indicative of an inflammatory condition.

Questionnaire responses indicated that all athletes would continue to wear this DEFO. Subjective responses indicated that participants felt that the DEFO was tight, was limited in colour range, but was felt to improve balance, posture and power.

Relevance

A patient profile is developing as to who responds with significant improvements when wearing this DEFO.

Conclusions

This DEFO may support the physiotherapeutic management of athletic pelvic pain.

Discussions

A patient profile is developing which indicates that those with a low force output on the squeeze test (<2N/kg body weight), and/or those with a very asymmetric ASLR in terms of pain, respond with significant improvements to wearing this bespoke DEFO.

Future work will look to build on this profile, and to attempt to quantify the subjective improvements (dynamic balance and power) disclosed.

Implications

A bespoke DEFO may be an appropriate adjunct to the physiotherapeutic management of athletic pelvic pain, particularly when improvements are sought in clinical measures such as the ASLR and squeeze test.

Keywords

Athletes, pelvic pain, orthosis

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THE CHARACTARISTICS OF TRUNK ISOKINETIC STRENGTHS IN COLLEGE AMERICAN FOOTBALL PLAYERS

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Introduction

American football players need great strength and agility to do specific performance with contact-collision such as hard tackling and blocking. They regularly train muscle strengths of neck, trunk, upper and lower extremity to enhance physical performance, and to prevent football-related injuries. When there is a weakness of muscle, especially trunk muscle, they can have lower movement ability, and expose a risk of injury. It suggests that the trunk muscle strength and stability are important for athlete's performance, because many studies have reported improvements in physical performance by trunk strength training. In spite of this clinical importance, athlete's standard trunk muscle strength or characteristics have not been shown. In American football, the relationships of physical performance and trunk muscle strength, or the positional characteristics of trunk muscle strength are not still well known.

Purpose

The purpose of this study was to determine the positional features of trunk isokinetic strength in college American football players.

Methods

Seventy-three American football players who belong to division I of Kantoh Collegiate American Football Association participated in this study. Subject's positions are categorized as follows; offensive line (OL), wide receiver (WR), running back (RB), defensive line (DL), linebacker (LB), defensive back (DB). Trunk flexion and extension isokinetic strengths at 60 degrees/sec, 90 degrees/sec and 120 degrees/sec were measured by using CON-TREX TP (CMV AG inc, Switzerland). With the absolute and relative trunk isokinetic strengths as dependent variables, Games-Howell's multiple comparison was used to identify the presence of any significant differences between positions.

Results

In absolute isokinetic strengths, OL was significantly greater than DB at all absolute strengths and LB at 90 degrees/sec of extension. In relative isokinetic strengths, WR was significantly greater than OL at 60 degrees/sec of extension, and DL at 60 and 90 degrees of flexion and extension, and 120 degrees of flexion. There were no significant differences between other positions.

Discussion

OL had greater absolute trunk strength than DB or LB, and WR had greater relative trunk strength than OL or DL. OL players need high power and quickness to cover Quarter back or RB from defensive team. WR players need high speed, quickness and body balance to follow through DB and to catch a ball. It thought that the results of this study reflect these positional features.

Keywords
American football, trunk isokinetic strength, positional feature

CONSERVATIVE CARE OF SKELETALLY IMMATURE DANCERS WITH INTRA-ARTICULAR, PRE-ARTHRITIC HIP DISORDERS: A CASE SERIES

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Introduction

Dancers are at risk for developing pelvic girdle and hip pain associated with acetabular labral tears, femoroacetabular impingement (FAI) and developmental hip dysplasia (DDH). Surgical management has been described but the specifics of conservative management have not been determined. There are no descriptions of conservative care in this high risk population of skeletally-immature dancers.

Purpose/Aim

The purpose of this case series is to describe the presentation and conservative care of 3 dancers with pre-arthritic hip disorders.

Materials and Methods

Charts of 3 adolescent dancers with pre-arthritic hip pain successfully treated conservatively were reviewed. The presentation, physical examination, and imaging results were described. Individualized conservative treatment programs, improvement in pain and ability to return to dance were reported.

Results

One male (14 yo) and 2 female dancers (15 and 13yo) presented with complaints of anterior groin or lateral hip pain preventing dance participation. The male dancer attended an international school of ballet and the female dancers were competition dancers averaging of 16 hours of dance per week. Their visual analog scale on presentation ranged from 3 to 8 out of 10. Two of the 3 dancers had prior physical therapy without improvement. At presentation all had positive anterior impingement tests, anterior femoral glide and 2 had positive FABER tests. Imaging findings included: Dancer 1 with combined cam and pincer FAI and fraying of the labrum: Dancer 2 acetabular labral tear: Dancer 3 with mild DDH, an acetabular labral tear and a partial ligamentum teres tear. Treatment included medications, activity modification to avoid symptom provocation and physical therapy. Therapy focused on correction of muscle length and strength imbalances at the pelvis, neuromuscular re-education to reduce anterior femoral glide and modification of specific dance movements. The number of physical therapy session ranged from 6-8. All dancers returned to their prior level of dance with minimal pain and no restrictions in dance participation.

Relevance

This is the first specific description of the conservative treatment of skeletally immature dancers with intra-articular, pre-arthritic hip disorders.

Conclusions

At risk skeletally immature dancers with pre-arthritic hip disorders can be successfully treated without surgery and return to dance.

Discussion

The dancers presented represent a spectrum of pre-arthritic hip disorder. All 3 dancers had underlying osseous or soft tissue abnormalities and presented with anterior glide of the femoral head with respect to the acetabulum. Reducing this aberrant motion was likely an important factor in successful return to dance.

Implications

A detailed description of the conservative treatment of adolescent dancers with intra-articular, pre-arthritic hip disorders will provide assistance to clinicians in managing patients with similar conditions.

Keywords

Femoroacetabular impingement, Developmental hip dysplasia, Hip pain, Labral tears, Dancer

IRRITABLE BOWEL SYNDROME CAUSED BY SACROILIAC JOINT HYPERMOBILITY AND PELVIC GIRDLE PARASYMPATHETIC IMPINGEMENT WITH AUTONOMIC DYSREGULATION

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Introduction
There is an emerging epidemic of Irritable Bowel Syndrome (IBS) amongst young males, for which the cause is unknown. IBS was noted in young males during clinical evaluation for sacroiliac joint (SIJ) disorder. Extreme sports participation was common in patients with both these conditions.

Purpose/Aim
To develop a unifying pathophysiological model explanatory how biomechanical injury to a unilateral SIJ can lead to IBS.

Materials and Methods
Case histories of 20 males meeting criteria for IBS. Inclusionary criteria were complaint of chronic low back pain and extreme sports participation, or significant lifting injury, or mechanical fall, or motor vehicle accident. Extreme sports were defined as any sport-like activity where persons ride upon unstable platforms. Patients were physically examined for a unilateral sacroiliac joint disorder and had at least three SIJ provocation maneuvers positive. In order to be included in the study, each participant had to have either a positive Badgley Book Sign (counternutation and a Short Leg Sign) or a positive Fulcrum Sign (nutation and a Long Leg Sign). A previous study has reported significant correlation between positive Badgley Book and/or Fulcrum Signs and a positive fluoroscopic-guided diagnostic block of an injured hypermobile SIJ.1

Results
Each patient had a unilateral SIJ hypermobility disorder and IBS. Sixteen study participants reported biomechanical injuries to their low back and pelvic girdle regions from falling off unstable platforms. The skateboard was the most common unstable platform reported (N=9).

Relevance
In that there is no known cause for IBS, clinicians need a pathophysiological model to aid development of rational therapeutic solutions.

Conclusions
IBS can develop in young males who incur biomechanical injury to an SIJ. Clinical data suggests a pathologic biophysical mechanism for IBS in young males.

Discussions
IBS is a functional disorder suggesting involvement of a neurophysiological mechanism. Examination of anatomical relationship of the SIJ and pelvic parasympathetic nerves suggests that abnormal pelvic girdle biomovements might stimulate pelvic parasympathetic efferents causing autonomic dysregulation of colon function and symptoms of IBS.

Implications

The importance of this study is that it presents a pathophysiologic model for development of IBS in young males; providing basis for other studies to discover preventative information and rational medical/surgical treatments for IBS.

Keywords

Counternutation, Irritable Bowel Syndrome, Long Leg Sign, Nutation, Sacroiliac joint, Short Leg Sign, Skateboarding

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