Mechanical Diagnosis and Therapy for Radiculopathy

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KEYWORDS

• Radiculopathy • Mechanical diagnosis and therapy
• Spinal dynamics • Low back pain • McKenzie
• Dynamic disc model

A radiculopathy is a fairly precise diagnosis compared with other painful lumbar disorders. Most low back pain is lumped into the "nonspecific" category for which no definitive diagnosis is possible. However, despite its classic clinical presentation, and even when confirmed by compatible imaging findings of a herniated disc, the radiculopathy diagnosis provides only limited assistance for making decisions about treatment. Surgery, on average, provides quite favorable and predictable relief of radicular pain in a relatively short period of time, while good long-term outcomes with nonsurgical treatment are, again on average, also achievable, with far less risk, but recovery takes much longer.

The phrase "on average" is a key point here. Most data on which clinicians depend for guidance helps with the "average" patient; but individual patients are rarely "average." So how do clinicians and their patients make decisions regarding treatment?

Given varying preferences among patients regarding surgical versus nonsurgical care, shared decision-making programs are widely advocated for assistance,[1] but are still in limited use. These programs focus on presenting a balanced view of the treatment options, with each patient's personal life situation playing an important role in their preference. But do they provide all the information patients would like and therefore should receive?

Nowhere is the high variation in this decision-making more vivid than in the 2003 Medicare data that revealed an eightfold variation in the rates of lumbar laminectomy and discectomy across geographic regions.[2] With no evidence of any variation between these regions regarding the severity of the disc pathology, the ability to make the diagnosis, and patient preferences and satisfaction, the cause of this variation has been attributed to "supply-driven care," specifically a greater supply of surgeons in high-rate areas.

In an effort to address this uncertainty in care, this article describes the management paradigm known as Mechanical Diagnosis and Therapy (MDT)[3] and its

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usefulness in decision-making for patients with lumbar radiculopathies, and reviews the relevant literature.

The MDT examination provides information about the characteristics of the pain generator unavailable from any other form of assessment, including more conventional clinical examination tests and even our most advanced forms of spinal imaging. Determining the dynamic mechanical characteristics of a symptomatic herniated lumbar disc enables a far higher level of precision and certainty in decision-making than merely determining the anatomic diagnosis.

This form of dynamic spinal assessment has relevance to both axial pain and sciatica due to its unique ability to determine the potential "reversibility" of symptoms and the substantial evidence that it is related to pain-generating disc pathologies. Such reversibility is very often detected even late in the game, after other forms of conservative treatments have failed. For many, MDT's value is best documented in studies showing that patients who do not receive this form of assessment and treatment often undergo unnecessary surgery.

OVERVIEW OF MECHANICAL DIAGNOSIS AND THERAPY

MDT, the focus of this article, was developed by Robin McKenzie, a New Zealand physiotherapist, 50 years ago. It is well described in many other publications, most notably in McKenzie's textbook.[3]

In essence, this low back management paradigm begins with a unique clinical assessment process that provides precise patient-specific information that directs treatment, which can then be customized to each individual's underlying pain generator. In such individualized care, the "average" patient becomes irrelevant. Abundant evidence makes the case that the clinical findings from this assessment provide much more precise information about the underlying pathology than can be ascertained via conventional clinical testing and our most sophisticated imaging studies.

During the assessment, the patient's history often reveals that their symptoms worsen with one direction of lumbar bending or positioning and improves with another. For example, many individuals' symptoms worsen with lumbar flexion activities such as bending, lifting, sneezing, and prolonged slouched sitting, and improve when erect, most notably while walking.

In addition to the conventional physical examination including neural evaluation, patients' low backs are then essentially taken for a mechanical test-drive by the MDT examiner to determine precisely what aggravates and what relieves their symptoms, looking for a correlation with the patient's history.

Specifically, they are directed to perform, to whatever extent their pain will allow, repeated end-range lumbar test movements and static positioning in different directions of lumbar bending to determine what effect these tests have on the location and intensity of their pain, regardless of whether it is axial pain only or pain referred away from the low back, including radicular pain to the foot (**Fig. 1**). A single direction of testing, that is, the patient's "directional preference," is often elicited that will bring a beneficial pain response in the form of either pain centralization (see later discussion) (**Fig. 2**)[3] in the case of referred or radicular pain, or pain abolition in the case of axial pain. Other directions of testing typically aggravate the pain or even cause it to move further distally, called "peripheralization."

So for those in whom a directional preference is found, the most common preferred direction is lumbar extension, with a smaller number needing laterally directed movements, and a very small group rapidly recovering with lumbar flexion end-range movements.

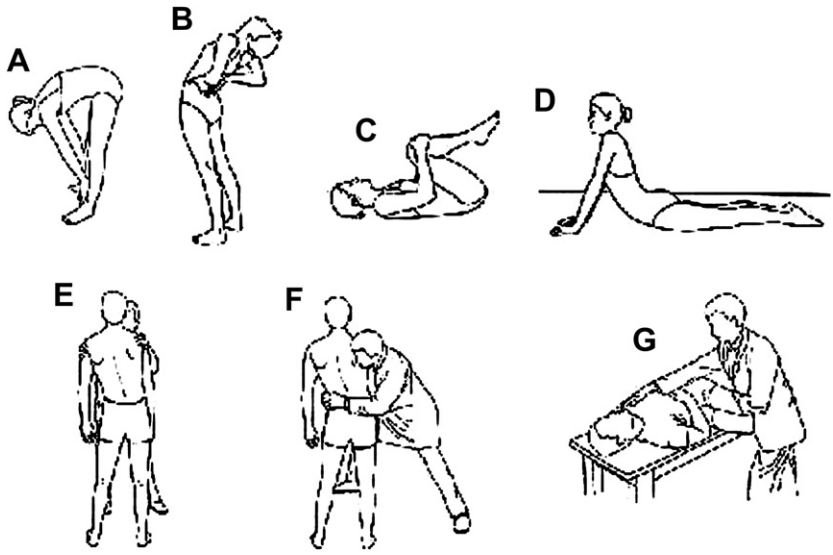

Fig. 1. MDT examination. The standardized physical portion of the MDT assessment has patients perform repeated end-range lumbar movements in both the standing and recumbent positions in lumbar flexion, extension, side-gliding, and rotation. Based on patients' feedback regarding how their pain intensity and location respond to each movement, a directional preference can frequently be identified (*A*–*G*). (*From* Donelson R. Is your client's back pain 'rapidly reversible?' Improving low back care at its foundation. Prof Case Manag 2008;13:87–96; with permission.)

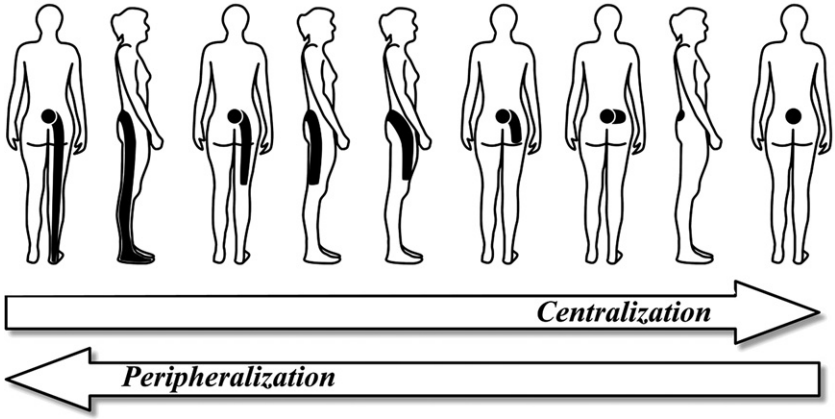

Fig. 2. Pain centralization. Pain that is referred off the lumbar midline, whether just to the paraspinal area or all the way to the foot, can be intentionally centralized back to, or toward, the lumbar midline. This change in pain location is referred to as pain centralization. This pain pattern typically occurs in response to the intentional performance of end-range movements in a single direction. Pain also often peripheralizes, or moves further away from the center of the spine, with movements or positions performed in the opposite direction to lumbar bending. (*From* Donelson R. Is your client's back pain 'rapidly reversible?' Improving low back care at its foundation. Prof Case Manag 2008;13:87–96; with permission.)

Once the patient is evaluated and classified, the MDT examiner then becomes a teacher and coach, helping each patient to learn how to self-manage his or her problem with strategic use of directional exercises every few hours performed in their single beneficial direction (**Fig. 3**). The patients quickly become enabled and empowered to eliminate and then prevent the return of their pain. In addition, they must temporarily avoid bending or positioning the spine for a few days in the opposite direction (see **Fig. 3**).

Patients quickly learn that they are in control of their own pain, by knowing how to turn it on and off, depending on what direction they move or position themselves. This knowledge provides extraordinary insight into the mechanical characteristics of their problem that enables them to either prevent, or at least promptly address, any recurrent pain in the weeks and months ahead, as well as recognize why the pain returned.

TWO INFORMATIVE CLINICAL FINDINGS

Pain centralization and directional preference are 2 clinical findings that are fascinating in large part because they are dynamic. Spine care clinicians are unfamiliar with dynamic mechanisms of pain production and relief. These findings can only be consistently elicited using this MDT dynamic examination.[3] It is also noteworthy that when patients promptly report improvements in their pain intensity and location, they also demonstrate a simultaneous improvement in their lumbar range of motion.

Both centralization and directional preference have been studied extensively for the past 20 years. These studies show that it is highly likely that the spinal loading tests that elicit centralization and directional preference do so because they mechanically influence and alter the underlying pain-generating pathology.

Pain centralization is defined as a progressive retreat of referred or radicular pain back toward or to the center or midline of the lumbar spine, usually as a result of the patient performing repeated end-range movement in a single direction (see

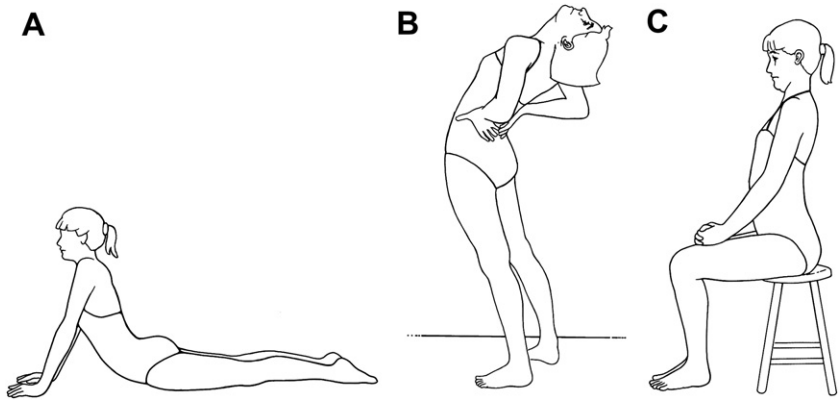

Fig. 3. Extension directional preference. The most prevalent lumbar directional preference is extension, with those same individuals being vulnerable to flexion spinal loading. Repeated press-ups (*A*) and standing backbends (*B*) performed to end-range every 2 hours are beneficial extension exercises for this large subgroup, while maintaining a lumbar lordosis while sitting (*C*) is important between exercise sessions. ((*A, B*) *From* Donelson R. Is your client's back pain 'rapidly reversible?' Improving low back care at its foundation. Prof Case Manag 2008;13:87–96; with permission; (*C*) *courtesy of* Ronald Donelson, MD.)

Fig. 2). Other directions of repeated-movement end-range testing in the same patient will not affect the pain or, much more commonly, will aggravate it in some way, such as by increasing its intensity or pushing it further away from the lumbar midline, that is, peripheralization. The single direction of testing that centralizes or often even abolishes the pain is referred to as the patient's directional preference.

RESEARCH

Studies of these two clinical findings are numerous and fall into 3 major categories: prevalence, reliability, and validity. The validity studies are of different types as well: outcome prediction, outcome efficacy, and construct validity. These studies include a wide range of lumbar patients including acute-to-chronic, axial pain only, and sciatica/radiculopathy, and come from at least 7 countries. Some studies focus specifically on radiculopathies.

Prevalence Studies

Since 1990, at least 10 studies have reported on the high prevalence of centralization and directional preference in a wide range of study populations.[4–15] Overall, the reported prevalence of these two findings has been 70% to 87% across acute low back pain studies[16] and 32% to 52% with chronic or radicular patients.[17–21]

Reliability

The value of any clinical test is fundamentally based on its interexaminer reliability. Without reliability there can be no validity, that is, the test is irrelevant. Such studies regarding centralization, directional preference, and MDT patient classification report very acceptable levels of reliability with kappa values greater than 0.6 for identifying centralization and directional preference.[20,22,23] This reliability is superior to any other form of clinical examination, including palpation and observation.[24]

Predictive Validity

Many cohort studies have investigated the impact of identifying centralization and directional preference on patient outcomes. An excellent treatment outcome routinely is reported by patients in whom a directional preference and pain centralization are found, as long as treatment is guided by the patient's directional preference findings.[4,16,22,25–28] In these same studies, outcomes were far less successful in those in whom a directional preference was not found.

But do centralization and directional preference merely identify those who have a good prognosis with most any form of treatment? There are 2 important considerations.

First, if that were the case, there should be no chronic low back pain patients with a directional preference because they would have all recovered with other forms of treatment, or with no particular treatment, long before they became chronic. But the prevalence data show that up to 50% of chronic patients still have a directional preference that, once identified, directs a specific directional exercise treatment defined by the assessment findings that leads to excellent outcomes.[17–21] These patients needed a specific form of directional end-range treatment to correct a problem that had been reversible all along, but was never given the required treatment.

Second, determining whether other treatments might also be beneficial for this large subgroup requires efficacy studies that randomize this large group of directional preference patients to different treatments.

Efficacy Validity

There are now 6 randomized clinical trials (RCTs) targeting this large subgroup of patients who demonstrated the clinical findings of pain centralization and directional preference during their baseline evaluation.[12,29–33] These 6 studies compared the standard MDT treatment of teaching directionally matching exercises and posture modifications with alternative treatments such as stabilization exercises, manual therapy, manipulation, joint mobilization, exercising in the opposite direction to the patient's preference, or guideline-based treatment.

All 6 RCTs show that treating directional preference patients with appropriate directional exercises produced significantly better outcomes compared with any of the treatment alternatives.

While none of these RCTs focused exclusively on patients with radiculopathies, 34% of the Long and colleagues[12] study sample had pain below the knee, half of whom also had neural deficits. Across all directional preference subgroups based on age, duration, and pain location, including those with a radiculopathy, all 6 clinical outcome measures were excellent when directional exercise treatment matched patients' baseline directional preference. For example, patients' self-rated improvement with matching directional exercises was 95% at just 2 weeks, far superior to either guideline-based care (42%) or exercising in the opposite direction from patients' directional preference (23%). Even for these directional preference patients, shown to have such a good prognosis in so many other studies, how they are treated makes a substantial difference. This finding was even clearer when 15% of the patients in the 2 nonmatching study groups, all of whom had a directional preference at their baseline evaluation, reported worsening.

A separately published study reported that a cross-over option was offered to those patients in this same RCT who were initially assigned to an unmatched treatment and did not do well.[27] Of the 96 patients who were then crossed over to matching exercises, 84% reported rapid recoveries after just 2 weeks, once again with significant improvement in all 6 outcome measures.

Construct Validity

There is considerable evidence that the pain-generating structure responsible for most pain centralization and directional preference is the intervertebral disc, regardless of the pain being axial or radiating fully down the leg to the foot with neural deficits.

Numerous imaging and cadaveric studies demonstrate directional mechanical characteristics of intervertebral discs and their nuclei. In normal discs, anterior or flexion loads cause the nucleus to migrate away from the load in a posterior direction, and vice versa with extension loading (**Fig. 4**).[34–40] The nucleus must change its location within the disc to enable the disc to change its shape in order for the spine to bend. The nucleus must move out of the way to enable the edges of the adjacent vertebral bodies to approximate as the spine bends.

Multiple cadaveric studies have shown that posterior disc protrusions and extrusions can be created in otherwise normal discs using either repeated or (ie, excessive) flexion loading.[34,35,37] These lesions resemble the posterior disc pathology seen so commonly in patients whose painful episodes commenced after various forms of flexion activities and postures.

One such study, after creating posterior protrusions, reversed the direction of loading or bending by repeatedly loading these discs in extension.[37] Five of the 11 protrusions then fully reduced, with the nuclei returning to their normal central position within the disc. Those reversible discs were reported to have greater disc height than

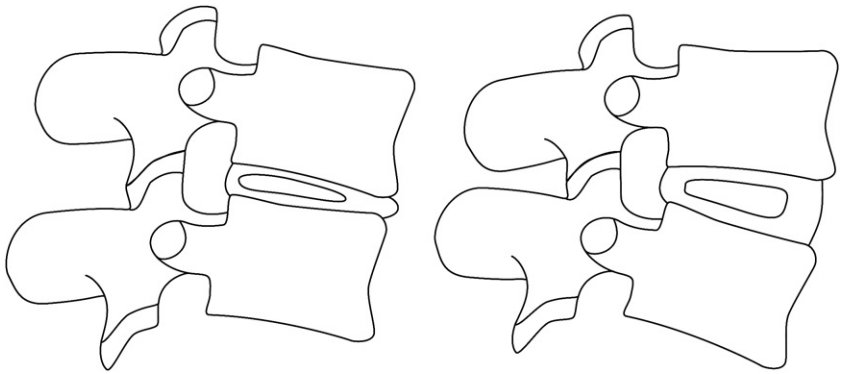

Fig. 4. Dynamic internal disc model. There is considerable evidence that loading a normal lumbar intervertebral disc anteriorly, that is, in flexion, "squeezes" or displaces the nucleus posteriorly. Similarly, when loaded posteriorly, that is, in extension, the nucleus is moved anteriorly. Problems occur when one direction dominates, usually flexion loading, to the extent that excessive displacement occurs that stimulates annular nociception, causes protrusions/herniations, and even leads to compression of an adjacent nerve root. (*Courtesy of* Ronald Donelson, MD.)

those that did not reverse, consistent with the theory that the hydrostatic mechanism within each protruded disc must be sufficiently functional for the nucleus to be reduced or reversed with the extension loading.

Given that both the posterior annulus and lumbar nerve roots are such common sources of back and radiating pain when irritated or compressed respectively by a posterior disc protrusion, it is very plausible that a reduction of the extent of that nuclear displacement, which decompresses those structures using repeated extension loading of the disc, results in both pain centralization of the sciatica and a simultaneous return of the disc's extension range of motion as the obstructing displaced nucleus returns to its normal, more central location within the disc.[3] A posteriorly displaced nucleus obstructs the adjacent vertebral bodies from approximating posteriorly with attempts at extension, until that obstruction is removed by moving it anteriorly using either repeated or sustained extension loading.

End-range repeated movement testing that comprises the MDT assessment seeks to identify the precise direction of bending that reduces the painful nuclear displacement within the symptomatic disc. Often that direction is easy and straightforward to find. Other times it is more complex and requires more than one assessment session to "get it right."[15] Of course, for other patients a directional preference cannot be identified.

Meanwhile, loading a symptomatic disc in the direction opposite to its preference apparently increases the nuclear displacement, causing the pain to either increase or peripheralize.

EVIDENCE THAT IDENTIFYING A DIRECTIONAL PREFERENCE ADDS TO THE PRECISION OF A DISC DIAGNOSIS

Two studies in particular illustrate what the MDT assessment brings to the care of radiculopathy. The first was a retrospective observational study published in 1986 that called attention to the prognostic and therapeutic value of determining whether a patient with lumbar disc prolapse and neurologic deficits exhibited a directional preference, although only the extension direction was tested.[21]

Sixty-seven military personnel with pain radiating to the calf or foot, all with at least one significant physical sign of nerve root irritation (positive straight-leg raising, motor weakness, dermatomal sensory loss, or reflex change), and all with marked reduction in extension range of motion, were hospitalized for surgical consideration because of the severity of their pain and/or failure to respond to outpatient care. All were then tested with end-range extension loading performed in the prone position (see **Fig. 1**) while their symptom response was monitored. Those whose peripheral pain did *not* worsen with this extension testing (n = 35, 52%) were then instructed to perform prone extension exercises frequently (see **Fig. 3**), but only as tolerated, over the next few days. Of these 35, 34 (97%) recovered, 33 within 5 days, and all 35 avoided surgery.

The pain of the remaining 32 (48%) patients peripheralized with their initial extension testing and was unresponsive to any subsequent form of conservative care. All underwent diagnostic imaging and 30 (91%) underwent disc surgery.

Demographic data indicated no difference between these surgical and nonsurgical groups regarding age, symptom location, or neurologic findings. The investigators postulated that this extension treatment was in keeping with a disc nuclear reversal model (just described) as well as the earlier work of Nachemson[41] characterizing the pressure within lumbar discs during extension (normalized to a standing position) as substantially lower than during a relative loss of lumbar lordosis.

Several other points are noteworthy. First and most obvious, a large percentage of patients with compelling clinical evidence of recalcitrant compressive disc disease rapidly reversed their course, even after many other failed treatments. Their effective treatment was determined by their pain response to directional lumbar testing. If not evaluated in this way most, if not all, would have otherwise undergone what this study proved would have been unnecessary disc surgery.

Second, because extension was the only direction tested, there may well have been other patients in this study who also could have avoided surgery and recovered rapidly if they had been evaluated with other directions of end-range testing (eg, lateral-left, lateral-right testing, or rotation) (see **Fig. 1**). These testing directions also elicit the same pain centralization response that enables similar rapid recoveries.[3,7]

Finally, this study illustrates that an anatomic diagnosis of a radiculopathy, normally believed to be precise, was itself completely inadequate for making good treatment decisions. However, by using the dynamic MDT evaluation, substantially more precision was added to the radiculopathy diagnosis by classifying patients into those who can still rapidly reverse and recover with no need for surgery versus those for whom surgery remains an attractive option.

The second study compared the rates of lumbar disc surgery over 10 years in one county in Denmark with those of the rest of Denmark.[42] In the first 5 years the county's rate was lower than the national rate but then was noted to move higher in the sixth year. Many of that county's doctors coincidentally attended a 2-day course on MDT about that time and decided to establish 2 spine clinics in the county to which all patients with low back pain and sciatica would be referred. MDT was a prominent part of the initial evaluation in each clinic. Over the next 4 years, the disc surgery rates in that county dropped by 50%, with initial disc surgeries decreased by two-thirds. The national rates meanwhile remained unchanged. Presumably tens of thousands of Danes in all other counties could have avoided surgery if they too had been given the opportunity to be evaluated for a directional preference.

In both of these studies the need for disc surgery dropped by 50% once patients were provided the opportunity to be evaluated and treated for directional preference. In hindsight, the underlying pathology (disc derangement?) would have been expected

to demonstrate a directional preference at the very outset of care when each patient's episode was acute. Further, the centralization prevalence data suggest that the pain generator often loses its ability to reverse over time as the disorder becomes chronic, so there is considerable benefit in assessing these patients as early as possible to reverse and teach those individuals before their underlying disc problem becomes irreversible and requires far more care and associated expense.

So those patients who escaped undergoing surgery could have also avoided most, even all, of their prior care if their directional preference had been identified at the outset of their episode. That prior care typically includes radiographs, advanced imaging, medications, prolonged physical therapy or chiropractic, and diagnostic and therapeutic injections. These interventions are routinely unnecessary in patients found to have a directional preference who are then taught how to predictably and quickly recover.[4,16,22,25–28]

THE PRECISION OF IDENTIFYING A DIRECTIONAL PREFERENCE WITH AXIAL OR REFERRED LOW BACK PAIN OR A RADICULOPATHY

Clinical information and insight gathered from patients found to have a directional preference are not only unique, but add considerable precision to the diagnosis, regardless of whether the anatomic pain source is confirmed or not. What becomes immediately clear to both the examining clinician and the patient is that the underlying pain generator can be changed for the better, even corrected, using simple exercises and posture changes, without having to know the exact tissue source. In other words, the underlying pain source can be improved and corrected without needing to identify it.

The evidence presented earlier that directional preference and pain centralization represent a reduction in painful disc nuclear displacement is compelling, yet it is not a requirement that this disc model be accurate for any single individual to enable recovery.

So, despite anyone's remaining uncertainty about the pain source, very precise information is nevertheless gleaned whenever a directional preference is found. First, the underlying problem is predominately mechanical, not inflammatory. It is also a rapidly reversible or reducible problem, likely caused by something displaced and causing pain. Further, the patient's outcome will be predictably excellent, providing appropriate standardized treatments are used that are also determined during this same assessment.

Regardless of whether the pain is otherwise labeled as radicular or nonspecific, learning a patient has a directional preference provides information that is far more precise and effectual than merely identifying the anatomic source of pain.

NOT EVERYONE HAS A DIRECTIONAL PREFERENCE

Though most do, not every patient has a directional preference. Radiculopathies are typically caused by a herniated disc first stimulating annular nerve endings and then progressing to compress an adjacent nerve root. For reduction of this displacement to occur, the disc's hydrostatic mechanism needs to be sufficiently intact for some patient-specific direction of end-range loading to squeeze the nuclear material back toward the disc's center.[3,43] This process requires the annulus to be intact and competent. However, in cases where the nucleus is extruded, or the annulus is still intact but incompetent, nuclear reduction and pain centralization are no longer achievable and these patients are unable to benefit from MDT treatment, and typically also do not benefit from any other noninvasive form of care.

It is only at this point in care that this small subgroup needs to be imaged to confirm this end-stage disc pathology. Epidural steroids are appropriate, and if there is insufficient improvement surgical excision is indicated. Such surgery can be justified, even recommended, even if the episode is still acute or subacute, due to the benefit of undertaking the surgery before the patient is too physically or psychologically debilitated or before too much work time is lost. Only a precise diagnosis enables making the decision to operate early.

Speedy recoveries, whether nonsurgical or surgical, are in everyone's best interest. The fundamental questions, however, are: who are the patients who can benefit so quickly and definitely from surgery? And who are those who cannot? The MDT assessment can identify these distinctly different subgroups of radiculopathies early, quickly, and reliably.

A 2003 article covered the best evidence at that time for how to manage symptomatic lumbar discs.[43] Considerable detail was provided regarding this dynamic disc model for changing pain location, that is, centralization, directional preference, and patient selection pathways for disc surgery.

FLOW CHART

Fig. 5 portrays the diagnostic pathways that the MDT assessment offers. The large majority of those individuals with either acute or chronic lower back pain have a derangement, that is, something seems to be displaced, causing both pain and obstruction to movement. The great majority is found to have a directional preference

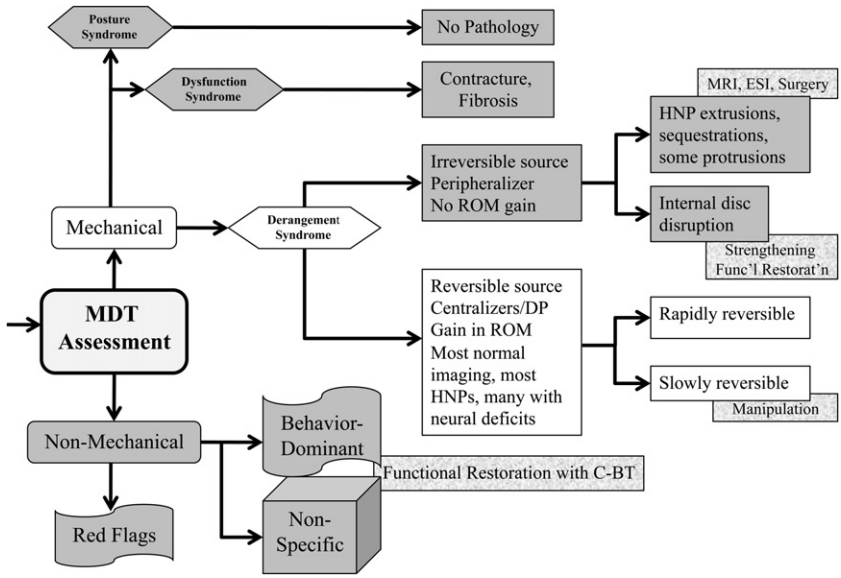

Fig. 5. MDT classification pathways. The MDT assessment can distinguish mechanical from nonmechanical disorders, derangements from nonderangements, and reducible from irreducible derangements. The great majority of patients have reversible derangements (see clear boxes) that rapidly recover if treatment matches their directional preference. C-BT, cognitive-behavioral therapy; DP, directional preference; ESI, epidural steroid injection; HNP, herniated nucleus pulposus; MRI, magnetic resonance imaging; MDT, mechanical diagnosis and therapy; ROM, range of motion. (*Courtesy of* Ronald Donelson, MD.)

that centralizes and abolishes the pain and restores movement. This very large subgroup of patients follows the shaded pathway to a reversible recovery.

The remaining derangements are irreducible. No directional preference or centralization can be found. Many in this group have positive imaging studies for extrusions, sequestrations, and often large protrusions. When a direction of testing cannot be found that centralizes the pain, particularly if every direction of testing seems to increase or peripheralize it, it is safe to conclude that the annulus is completely incompetent, and even if intact, the disc's hydrostatic mechanism is nonfunctional. These are the patients in need of imaging, epidural steroids, and possibly surgery.

Other subgroups can also be identified using the MDT evaluation. The pain of patients with nonmechanical disorders, that is, red flags and dominating psychosocial issues, does not centralize or have a directional preference. It should be noted, however, that many patients with baseline "yellow flags" are in fact centralizers with a directional preference, who recover very well with directional treatments despite their yellow flags.[12,44]

These same MDT assessment methods identify 2 other forms of mechanical back pain. Postural and so-called dysfunction pain are both minor but important syndromes, of much lower prevalence, and thus far poorly documented in the scientific literature as compared with the derangement syndrome. Considerable detail about them can be found in McKenzie's textbook.[3]

RELATIVE ROLES OF MECHANICAL AND INFLAMMATORY FACTORS IN RADICULOPATHY

In unpublished data, 32 Dutch patients with pain below the knee with neural deficits who were making insufficient progress toward recovery, including no directional preference or centralization elicited during an MDT assessment, underwent 3 epidural steroid injections (ESIs).[45] The study design required them to all undergo another MDT assessment after their injections.

Complete relief of pain after the ESIs was reported by 12.5% (n = 4). These subjects were unable to undergo their MDT examination because it requires symptoms that can be monitored.

Forty-seven percent (n = 15) remained noncentralizers with more than half (n = 8) having no pain relief. These patients elected to undergo disc surgery. The remaining noncentralizers (n = 7) had sufficient ESI relief to decide against having surgery.

The remaining 41% (n = 14) were found to now be centralizers with a directional preference. Consequently, their pain was now rapidly reversible using end-range loading that enabled all of them to fully recover. This success increased full recoveries after the ESI from 12.5% with injections alone to 53.5% when postinjection MDT was added.

These latter recoveries clearly required an initial intervention with anti-inflammatory steroids followed by mechanical end-range interventions. Was the inflammatory response to the displaced nucleus and posterior annular disruption/damage that was causing the radiculopathy somehow prohibiting the reduction of the nuclear displacement using end-range loading? Was that same reduction then enabled once the inflammation was addressed to some degree by the ESIs?

Through personal communication, (Hans van Helvoirt, personal communication, 2010) the investigators report their sample size is now more than 70 patients and the distribution of outcomes is similar to their preliminary report.

CLINICIAN AND PATIENT EDUCATION

Articles such as this and continuing medical education courses about MDT have enabled spine clinicians to learn about MDT for the past 20 years. Very few clinicians

have been adequately motivated to pursue this education, however. More recently, a book entitled *Rapidly Reversible Low Back Pain* has been well received by a broad range of clinicians who care for patients with low back pain.[46]

Patient education is also critical, ~~so they may know~~ whether they are suffering from acute or chronic, axial or referred low back pain, or radiculopathy. Given the high prevalence of centralization and directional preference, their role in informing and enabling rapid recoveries, and the lack of provision of the MDT assessment to the majority of patients with low back pain and radiculopathy, many more recoveries would no doubt occur if patients were informed of their potential to do so using MDT. A patient information book, *Solving the Mystery: The Key to Rapid Recoveries for Back and Neck Pain*, has been published with just this intent[47] as well as a classic "how-to" self-care book by McKenzie entitled *Treat Your Own Back*.[48]

Shared-decision-making (SDM) educational materials are designed to present a balanced view of patients' treatment options.[1] But how many patients now choose surgery because the outlook with further conservative care, as portrayed in current SDM content, is simply not all that attractive? Current SDM content incorrectly assumes that all available nonoperative care has been used and has failed. But what would patients' preference be if informed of a type of clinical evaluation that, despite prior unsuccessful treatments, could still identify ways that up to 50% with chronic pain could eliminate their own symptoms in a short period of time? Among the majority who had not previously been provided the opportunity to engage MDT, who would not prefer to at least try that pathway before reconsidering surgery, especially when the answer regarding directional preference is so quickly determined? While some would still end up choosing surgery if MDT or a combination of MDT and ESIs failed to help, many would be able to avoid the option of what would otherwise be unnecessary surgery.

SUMMARY

Whether axial lumbar pain, referred pain, or radiculopathy, the clinical findings of pain centralization and directional preference provide precise and highly relevant information about the characteristics of the underlying pain source. These findings are uniquely elicited during a dynamic mechanical test-drive of the lumbar spine using repeated end-range spinal loading tests, that is, the MDT form of patient evaluation as described by McKenzie. Such findings are present in the great majority of patients with acute low back pain and in as many as 50% of patients with chronic low back pain or sciatica.

When found, centralization and directional preference predict that the underlying pain source is reversible. Recovery usually takes place rapidly, using end-range directional exercises and posture modifications that match the directional preference identified during the assessment. Most patients can therefore be quickly empowered to eliminate and then also prevent the return of their own pain.

These clinical findings have been extensively studied in interexaminer reliability studies, outcome predictive and efficacy studies, and anatomic studies of the intervertebral discs. The evidence is substantially supportive in each of these research domains.

Up to 50% of patients with radiculopathies proven to be recalcitrant to other forms of treatment still have reversible disc pathology, meaning their pain can still be centralized and abolished with a single direction of loading of their painful disc. If never provided the opportunity to be adequately tested for these two findings, unnecessary spinal injections and disc surgeries are often undertaken.

Establishing that these painful disc pathologies are rapidly reversible, as well as the means of reversing them, is not possible using our conventional clinical examination or our most advanced imaging. Magnetic resonance imaging (MRI) has considerable difficulty even establishing the anatomic diagnosis of herniated nucleus pulposus independent of the presence of sciatica and neural deficits. Moreover, any MRI diagnosis of a herniated nucleus pulposus is still too imprecise to determine and predict the most effective treatment.

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