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# Indian Journal of Physical Therapy

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# Editor's Desk

Dear Physios,

Greetings of the day.

It gives us immense pleasure to publish this issue of Indian Journal of Physical Therapy. With the support of all of you, journal has completed three years and six months successfully. As the time pass, we are glad to have many new numbers of subscriptions from physios. On behalf of core committee of Indian Journal of Physical Therapy, I promise readers to provide evidence based research on all possible aspects of Physiotherapy. Here we are also in effort of promoting research by motivating research scholar those are doing PhD in physiotherapy. Use of articles published is guiding students pursuing MPT for their dissertation. Hoping positive response and suggestions from readers for improving our content.

Dr Dinesh M Sorani
Editor
Indian Journal of Physical Therapy

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# EFFECTIVENESS OF FOAM ROLLING VERSUS STATIC STRETCHING ON FLEXIBILITY OF HAMSTRING MUSCLE GROUP

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***ABSTRACT***

***Background: Foam rolling is a relatively new technique in improving flexibility of muscle so its effectiveness has to be studied.***

***Study Design: Experimental Random Control Trial***

***Level of evidence: Therapy, level 2a***

***Objectives: To assess & compare the pre and post interventional results of a 6 weeks Static Stretching programme in one group versus Foam Rolling programme in other group on Hamstring muscle length.***

***Methods: Fifty female subjects were enrolled in study out of which forty female subjects (age group 19-25 years) having hamstring tightness defined by active knee extension test to be less than 80 degrees were included and randomly assigned to foam rolling and static stretching groups (20each)***

***Active knee extension measurements pre, mid and post-intervention were taken.***

***Foam rolling: Subject did continuous rolling of hamstring muscle on the foam roller, from the ischial tuberosity to the posterior knee for 1minute.***

***Static stretches: Subject placed their leg on elevated surface with knee extended and ankle neutral. Subject leaned forward from hip, with spine in neutral until a stretch was felt in the posterior thigh***

***Results: A repeated measures ANOVA of variance for week wise analysis of each group revealed significant difference in pre and post-measurements (p=0.00).Unpaired t-test for comparison of week 6 findings of both static stretching and foam rolling group showed significant changes with p=0.00, there is significant variation in mean observed for static stretching and foam rolling, i.e. 79 degrees and 86.52 degrees respectively at week 6***

***Conclusion: This study revealed that both foam rolling and Static stretching were effective techniques for increasing hamstring muscle flexibility showing improvement in ROM which were highly significant on analysis but Foam rolling produced more significant results as compared to static stretching group over a 6 weeks intervention plan***

***KEYWORDS: Myofascial release; active knee extension; autogenic inhibition; Foam Rolling; Static Stretching***

## INTRODUCTION

Flexibility is considered to be one of the essential component of injury prevention and rehabilitation[1]. Muscle "tightness" is a result of an increase in the tension from active or passive mechanisms. Passively, through postural adaptation or scarring the muscles can become shortened; actively, through spasm or contraction muscles can become shortened. Regardless of the cause, this tightness limits range of motion and may create a muscular imbalance in an individual[2].

Hamstring is considered to be a 'Mobilizer' Muscle of the hip and knee joint, and is one of the most common muscle to get shortened in muscle length. A tight hamstring can cause a lot of biomechanical and postural changes and can adversely affect function and increase the risk of injury, and hence stretching interventions become an integral component of individualized rehabilitation programme.

Stretching is used to increase the extensibility of soft tissues, thereby improving flexibility of muscles by elongating the structures that have adaptively shortened and have become hypo mobile over a period of time[3]. Stretching is a common activity practiced by athletes, older adults, rehabilitation patients, and anyone participating in a fitness programme.

Several researchers have investigated different muscle stretching techniques on subjects with tight hamstrings. Several modalities or physical agents have been used in conjunction with stretching to enhance further increases in range of motion[2] thereby improving the flexibility.

Foam rolling is quickly becoming a staple in training programmes worldwide. From elite athletes to weekend warriors, one can walk into many training facilities and see people using a foam roller as part of their exercise regimen. Despite the world wide popularity of this tool there have not been enough studies to endorse the benefits accompanied with its use. Our effort in

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this study was to explore and get some more objective data on a smaller scale though and to question its effectiveness.

***AIM***

To find the effectiveness of Foam rolling versus Static Stretches on flexibility in Hamstring muscle group.

***OBJECTIVES***

- To assess the pre and post Interventional results of a 6 weeks Static stretching programme on hamstring muscle length.
- To assess the pre and post Interventional results of a 6 weeks foam rolling programme on hamstring muscle length.
- To compare the effectiveness of Foam rolling versus Static Stretching in increasing the Hamstring muscle flexibility.

# METHOD

## SUBJECTS

Fifty healthy college female students were randomly enrolled in study by Simple Random Sampling using chit method, out of which 7 were excluded from the study and 3 declined participation. Forty healthy college female students within age group of 19-25 years (Age 21.7 years ± 1.79 SD ) having hamstring tightness defined by active knee extension test less than 80 degrees participated in this study. Subjects having recent hamstring injuries in last 6 months, recent upper limb, Lower limb or spinal musculoskeletal injuries in last 6 months, & any previous experience with foam rolling technique were excluded. An ethical clearance was obtained from institution's ethical committee. All subjects read and signed the informed consent form (as per guidelines of Helsinki Declaration). Subjects who met the inclusion criteria were randomly assigned to treatment groups. Forty subjects were assigned to the treatment group, out of which twenty were assigned to Foam rolling group and remaining twenty to Static stretching group.

## PRE-PARTICIPATION SCREENING

Active Knee Extension Test was done. This procedure was repeated three times and the average was used in the statistical analysis after six weeks.

***ACTIVE KNEE EXTENSION TEST PROCEDURE***

The fibular head and the lateral malleolus were marked and a marking was made from greater trochanter towards lateral femoral epicondyle using a tape measure (cm). The goniometer was placed with fulcrum on the lateral femoral epicondyle and stationary arm parallel to line joining greater trochanter and lateral femoral epicondyle and the moving arm parallel to a line joining the fibular head and lateral malleolus. Active knee extension (AKE) measurements were taken with the subject starting in supine with the test hip at 90 degrees of flexion measured using a goniometer and 90 degrees of knee flexion measured using a goniometer, while the other leg was resting flat on the treatment table[4].

## MID AND POST TESTING MEASUREMENTS

Midway through the protocol period i.e. at 3 weeks experimental measurements of this test were taken using the same procedure performed during the pre-test. Post-test measurements were taken following the sixth week using the identical Active Knee Extension testing procedures

As mentioned in Table 1, it gives a brief idea of the total protocol of foam rolling and static stretching for a 6 weeks' time frame

**TABLE 1: PROTOCOL**

| | Stretching | Foam Rolling |
|---|---|---|
| Duration | 30 secs x 3 reps | 1 Min x 3 reps |
| Frequency | 3 times/week | 3 times/week |
| Feel | Until a stretch is felt in the thigh but not pain | To stay in the painful spot for 20 sec and then find another painful spot or else keep rolling for 1 min |
| Rest period | 60 sec in between reps | 60 sec in between reps |
| Protocol Period | 6 weeks | 6 weeks |

## FOAM ROLLING TECHNIQUE

The subjects received visual and verbal instructions on how to properly perform the foam rolling technique. Each repetition of foam rolling consisted of staying on the painful spot for 20 seconds and then find another painful spot or else keep rolling for 1 min on the foam roller, from the ischial tuberosity to the posterior knee. During foam rolling the subject sustained terminal knee extension of the foam rolling leg and used arms for support as shown in figure 1 and 2. They were encouraged to use their body weight to maintain pressure on the foam roller. The foam roller's dimensions were 36 inches in length and 4 inches width. Stop watches were used to time each stretching and resting bout[1].

**FOAM ROLLING FOR HAMSTRING MUSCLE**

**FIGURE 1: STARTING POSITION**

FIGURE 2: END POSITION

**THE STATIC STRETCHING GROUP**

For the static stretch the subjects placed their leg on an elevated surface with their knee extended and their ankle neutral. Subjects were then instructed to lean forward from the hip, with their spine in neutral until a stretch was felt in the posterior thigh as shown in figure 3 and 4. This position was held for 30 seconds, and then repeated 3 times[5].

**STATIC STRETCHING FOR HAMSTRING MUSCLE**

FIGURE 3: STARTING POSITION

**FIGURE 4: END POSITION**

## RESULTS

A repeated measure ANOVA of variance for week wise analysis from week 1 to week 3 to week 6 revealed significant difference with p= 0.00 in both static stretching and foam rolling group.

The mean observed for static stretching from week 1 to week 6 was 66.65 degrees and 79 degrees respectively and that for foam rolling was 68.47 degrees and 86.52 degrees respectively as shown in table 2, 3 and 4.

**TABLE 2: STATIC STRETCHING ON ACTIVE KNEE EXTENSION TEST**

| | WEEK 1 | WEEK 3 | WEEK 6 |
|---|---|---|---|
| MEAN (DEGREES) | 66.65 | 71.55 | 79 |
| SD | 5.94956876 | 5.44324787 | 5.28154682 |
| RANGE | 57-78 | 65-85 | 70-90 |

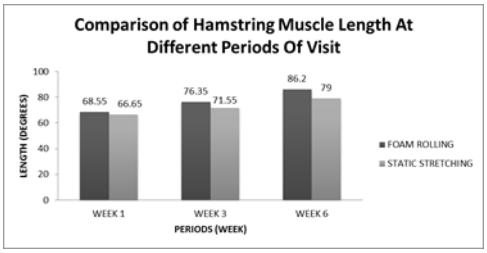
**TABLE 3: FOAM ROLLING ON ACTIVE KNEE EXTENSION TEST**

| | WEEK 1 | WEEK 3 | WEEK 6 |
|---|---|---|---|
| MEAN (DEGREES) | 68.55 | 76.35 | 86.2 |
| SD | 4.3585971 | 3.46827729 | 3.7919582 |
| RANGE | 60-80 | 70-83 | 80-90 |

**TABLE 4: ACTIVE KNEE EXTENSION TEST WEEK WISE COMPARISON BETWEEN FOAM ROLLING AND STATIC STRETCHING**

| | FOAM ROLLINGLLING (DEGREES) | STATIC STRETCHING (DEGREES) |
|---|---|---|
| WEEK 1 | 68.55 | 66.65 |
| WEEK 3 | 76.35 | 71.55 |
| WEEK 6 | 86.2 | 79 |

As shown in graph it depicts a gradual significant increase in difference of the Active Knee Range of Motion measurement from start of the study and by end of 6 weeks of Intervention.




**GRAPH 1: COMPARISON OF HAMSTRING MUSCLE LENGTH AT DIFFERENT PERIODS OF VISIT**

The unpaired t-test for week 6 findings between static stretching and foam rolling group showed significant change with p=0.00

## DISCUSSION

The study was done to find the effectiveness of this new emerging tool foam roller in improving flexibility of hamstring muscle in healthy young females. Foam rolling & Static stretching showed significant increase in ranges from week 1 to 6. The variation in results of foam rolling and static stretching is possibly due to the mechanism of foam rolling which targets all the components of kinetic chain.

Foam rolling aptly being called "partner free, hands free" technique is also known as 'self-myofascial release[1,6] which works on the principle known as autogenic inhibition. The source of the pressure when using foam rollers is the individual's body weight. The Golgi Tendon Organ (GTO) is a special mechanoreceptor found at the musculotendonious junction. It detects change in tension in the muscle and works as a safety mechanism by increasing muscle tension when the force becomes too great to potentially cause an injury to the muscle. When we apply a force or a pressure to the muscle via a foam roller it actually adds muscle tension, thereby causing the Golgi Tendon Organ to relax the muscle hence improving the flexibility of muscle[1]. This phenomenon is called as Autogenic Inhibition because the contracting agonist is inhibited by its own receptors. This reduction in soft-tissue tension decreases pain, restores normal muscle length-tension relationships and improves function[2].

In a study done by Miller & Rockey, it showed foam rollers show no increase in hamstring muscle flexibility, this is possibly because they had a small sample population & they did not emphasize on maintaining pressure on painful spots. In our study it was emphasized on maintaining the pressure on "the spot" where there was maximum tenderness for a period of 20-30 sec. Resting on foam roller for 20-30 seconds on the painful areas of muscles stimulates the GTO and autogenically inhibit the muscle spindles; reducing muscular tension and thereby help regulate fascial receptors6. A recent study highlighted that an acute bout of Self Myofascial Release of the quadriceps was an effective treatment to acutely enhance knee joint range of motion without a concomitant deficit in muscle performance by 10 %[7].

Foam rollers are growing in popularity in recent times. Despite the extensive use of foam rolling, there is dearth of literature supporting the value of this tool. This study has shown significant increase in ranges with foam roller but faster when compared to static stretching group.

Static stretching technique is an extremely effective and popular method of stretching[5]. Static stretching showed gradual gains in ranges at week 1, 3 and 6 respectively.

The possible reason for this is static stretch of a muscle causes stimulation of a Golgi Tendon Organs, located in the same muscle, resulting in decreased tension. Thus, the muscle is permitted to be stretched to a greater length thereby increasing the muscle length and range of motion[8]. There have been several theories to explain this physiology. One of them suggests structural changes including decreased stiffness in the muscle tendon unit and also phenomenon of passive resistive force during static stretching. There is tissue plasticity observed which results in irreversible elongation. Other Schools have hypothesized that there is no actual change in the structure but a sensitization or tolerance to the stretch sensation might lead to increase Range of Motion[9,10].

A lot of studies have been done on different stretching techniques with variation in frequency and repetitions but for a general fitness program, the American College of Sports Medicine recommends static stretching for most individuals at least 2 to 3 days per week[8]. Each stretch should be held 15-30 seconds and repeated 2 to 4 times. Also there is strong evidence to suggest that a 6 to 8 weeks of static stretching programme is sufficient to increase hamstring muscle length[7,11,12].

This study has used standard principles of stretching with maintenance of Static stretch for 30 sec for 3 times in a week protocol and has shown positive gains in range of motion post study stating from week 1 to week 6 there was significant mean difference of 66.65 degrees and 79 degrees respectively.

A few alterations in the experimental design could have enhanced this research study. Generally before stretching 10-15 minutes of warm up session is suggested. Our subjects did not perform warm up prior to the start of each stretching session.

Whereas, Static stretching technique causes transient increase in muscle length, Foam roller works at local myofascial tightness areas

present in the entire muscle and thereby foam rolling offers benefits similar to static stretching with addition to breakdown of soft-tissue adhesions and scar tissue.

## CONCLUSION

This study revealed that both foam rolling and Static stretching were effective techniques for increasing hamstring muscle flexibility over a six week time period.

Both the Interventions showed gains in ROM which were highly significant when analyzed but Foam rolling produced more significant results as compared to static stretching group over 6 weeks intervention plan.

## CLINICAL IMPLICATION

Foam roller is rapidly becoming staple throughout globe but lacking a strong research background. It shows quick and effective results as compared to the traditional stretching techniques used by many physical therapist.

## ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to all those who have helped us to give our abstract thoughts a perceivable form.

We wish to acknowledge with gratitude, Dr. Rachana Nikam Dabadghav for her valuable time and wherever we felt short of help, solving our amateur queries, giving valuable advice through this voyage.

We acknowledge all the patients for their valuable time and participation in this study.

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# CURRENT PRACTICE AND CONCEPT OF VOLUNTARY CONTROL AND ITS CLINICAL APPLICATION AMONG PHYSICAL THERAPIST

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***ABSTRACT***

***Introduction: Stroke is a sudden abrupt onset of neurological deficit. Voluntary control scale was developed based on Brunnstorm stages of recovery. This scale is primarily used to measure the level of motor control. However, there is widespread variation in opinion and need of usage in this scale across India. There is need to know whether this scale has excellent or poor prevalence among physical therapist.***

***Objective: To find out current knowledge and concept of voluntary control among the physical therapist.***

***Methodology: A review based online survey was created on Google e-doc, once created the survey was send via email to physical therapist. The responses were then descriptively analyzed.***

***Inclusion criteria: Clinical therapist, Student enrolled in post-graduation studies, Interns.***

***Exclusion criteria: People not graduated from recognized BPTh course.***

***Result: The subjects that found this scale ineffective was 66% Also 45% believed that stroke recovery did not follow the pattern described by the stages of voluntary control and 67% of the therapist did not use this scale for treatment and evaluation.***

***Conclusion: It was found that there is poor knowledge and the voluntary control scale was underutilized by physical therapist across India.***

***KEYWORDS: Voluntary control scale; Stroke; India; Physiotherapist; Brunnstorm; Outcome measure for stroke in India.***

## INTRODUCTION

A stroke or cerebrovascular accident is defined by the abrupt onset of a neurological deficit that is attributable to a focal vascular cause[1]. In India there high rate of mortality and morbidity following a stroke[2]. The concept of Voluntary control scale was put forth by Signe Brunnstorm, a Swedish therapist. She subscribed that the CNS has undergone an evolution in reverse and regressed to phylogenetically older patterns of movement. This phenomenon gives rise to synergistic movements. Brunnstorm believed that the synergies constituted a necessary intermediate stage for further recovery[4]. This gave rise to Stages of motor recovery. This scale defines motor stages from Grade 1 to Grade 6 [4]. Many clinical practitioners must have the parallel capability to judge the stage of recovery and thus apply appropriate rehabilitation technique[4].There is poor awareness of stroke in various regions of India[2].Moreover, there is high incidence of variation in assessment techniques. Very few outcome measures reveal the specific joint motion control with exception to the Fugl – Meyer Assessment scale[5].

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### AIMS AND OBJECTIVES

#### *AIM*

To find out about the current knowledge and perception of the concept of voluntary control among clinical therapist.

#### *OBJECTIVE*

To find out the knowledge about voluntary control concept by Signe Brunnstorm among clinician therapist in different places (urban and rural), to understand to what extent they are applied in clinical practice and to find out whether the scale has poor or excellent prevalence.

## METHODOLOGY

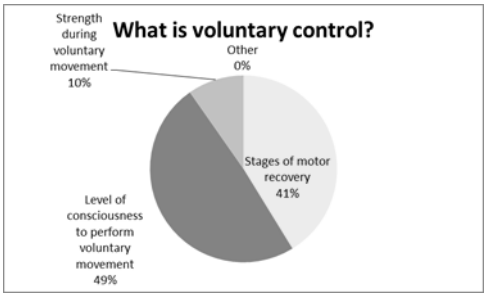
Sample size: The form was emailed to 1236 subjects however, response rate was 34.76. Hence final sample size of 430 was included in the study.

Study design: Questionnaire based study

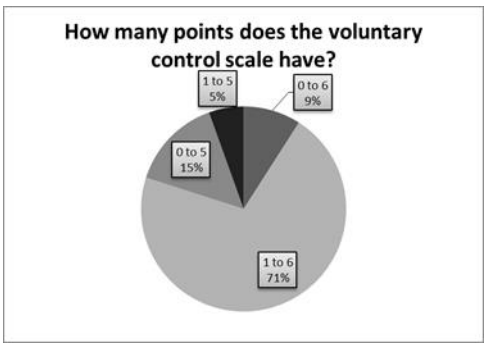
Inclusion criteria: Practicing clinical therapist, student undergoing post graduate studies, and interns.

Study design and technique- A review based form was created on google e-doc, once created the form was email to physical therapist. On reception they were descriptively analyzed.

## RESULTS




**GRAPH 1**

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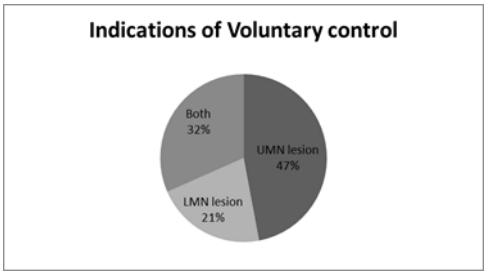


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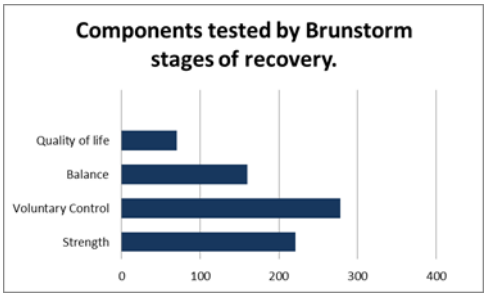


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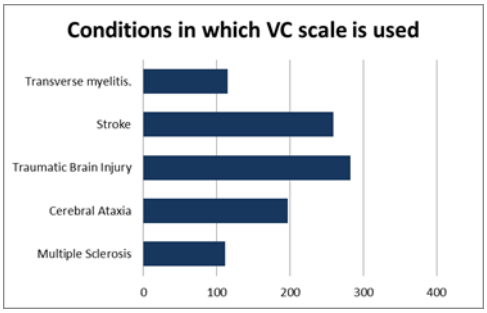


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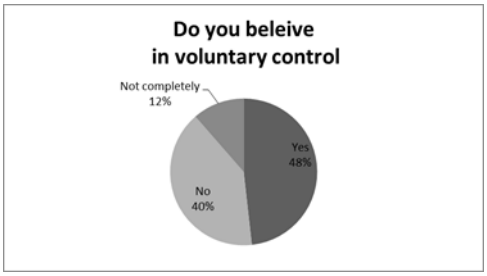


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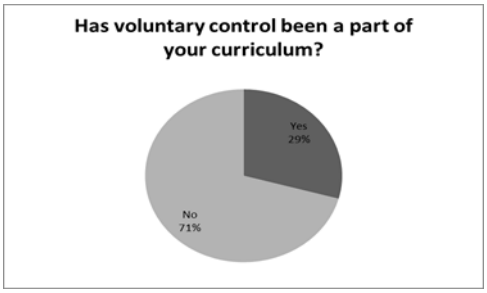
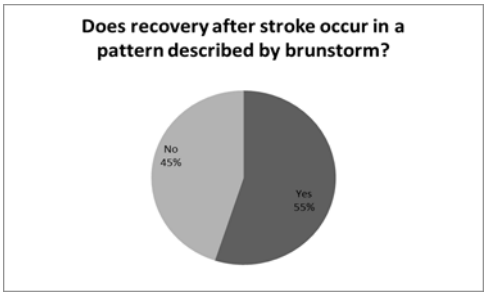



**GRAPH 7**

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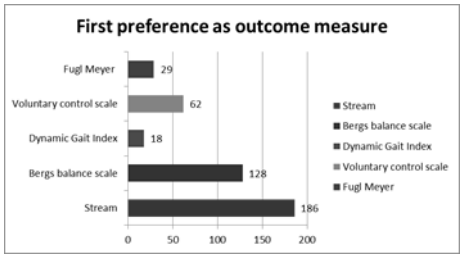


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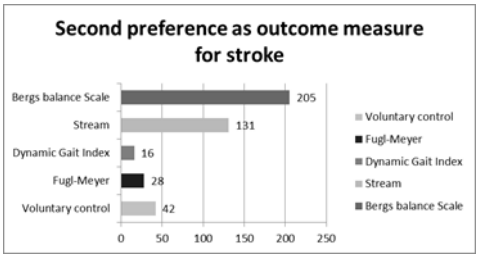


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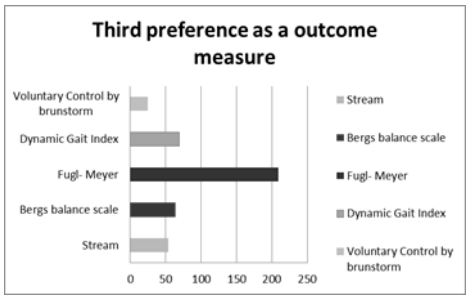


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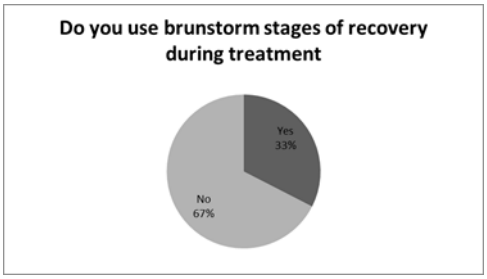


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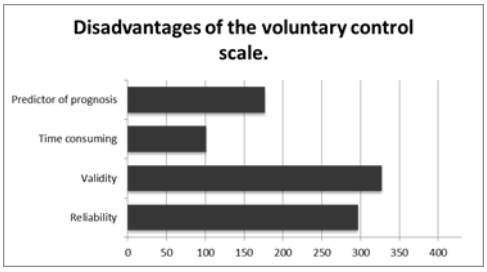


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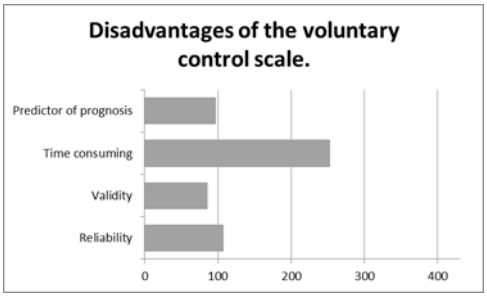
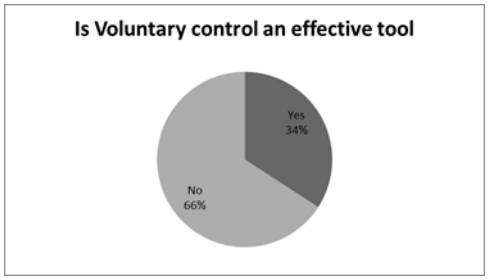



**GRAPH 14**




**GRAPH 15**

## DISCUSSION

On analyzing the questions based on knowledge, 49 % of the subjects incorrectly answered that voluntary control is level of consciousness required to perform voluntary movements, 41% answered correctly stating that it is the stages of recovery after stroke, 10% answer that is the strength during voluntary movements. This demonstrates that there is disparity in knowledge about, what is voluntary control scale among therapist, which is the one of the pre requisite for understanding voluntary control. Majority amounting to 69% answered correctly to the question which was, what were the number of grades in the voluntary control scale that is stages 1 to stage 6. The rest of the 31% have answered incorrectly to the question. It is noteworthy that 31% of the population has answered this question incorrectly indicating insufficient knowledge among the population. According to Brunnstorm UMN lesion was the major indication for usage of the voluntary control scale, only 47% of subjects chose the correct answer whereas 63% chose the incorrect answer to this question. This shows that 63% have inconsistent knowledge about the voluntary control scale. Traumatic brain injury and stroke with 66 % and 60% were chosen as the conditions that used the voluntary control scale as an outcome measure, whereas, cerebral ataxia, multiple sclerosis and transverse myelitis were the other options with 46%, 26% and 27% consensus. Since cerebral ataxia is clearly, a wrong answer chosen by a significant population indicating major fallacy in the understanding among the physical therapist chose. Most of the subjects answered voluntary control is the most important component tested by Brunnstorm (65%) among the other components Strength was 51%, Balance was 37% and quality of life was 16%. It is difficult to find and understand the cause of large number of the population choosing Balance as a vital component tested by the voluntary control scale because the scale has no mention of balance or components related to balance, same stands for the quality of life component. Even though most questions have been answered correctly, the alarming concern is about the significant

percentage of subjects that have chosen the incorrect options. Most of the subjects have mutable and unclear knowledge about the voluntary control scale designed to evaluate patient of stroke.

Questions that were aimed at investigating the use of the scale revealed that 47% of the subjects did believe in voluntary control scale whereas 40 % did not believe and 11% did not believe completely in voluntary control scale. This shows poor confidence among the physical therapist in the scale. 66% of the subjects believe that scale is ineffective, this proves that the therapist believe that the scale does not serve its purpose. Thirty three percent of the subjects did not use Brunnstorm for treatment and evaluation of stroke. 71 % admitted that it exist in their syllabus whereas 29% said it was not a part of their curriculum. This could indicate that universities are now considering the effectiveness of voluntary control scale and are maybe not including them in the curriculum, it could also indicate that maybe teachers and practitioners are not teaching them or are not paying regard to the concepts. Fifty five percent of the subjects admitted that the patient after a stroke undergoes recovery as described by Brunnstorm whereas 45 % denied and said recovery after stroke did not undergo through stages of Brunnstorm. This large mid line disagreement seriously puts the original concept of Brunnstorm at doubt. Forty four percent of the subjects chose stream as the first preferred outcome measure for treatment of stroke, whereas bergs balance scale at 48% was second preferred outcome measure for stroke and 39 % chose Fugl Meyer scale of motor assessment as the third preferred outcome measure for stroke. Even though this scale has moderate validity[6], the Voluntary control scale was chosen as the fourth outcome measure preferred for evaluation of stroke patients. Dynamic Gait Index was chosen as the fifth outcome measure for evaluation of stroke patients. Fugl - Meyer scale of motor assessment is the single most and significantly effective evaluation tool that encompasses all necessary components that need to be tested in a patient of stroke. Fugl Meyer scale also has excellent reliability and validity[5]. Perception of Validity and reliability were the major disadvantages of the scales, this could be because of the dynamic nature of the changing pattern that is seen during the recovery of patients with stroke, whereas time saving was the most advantageous component of the scale because the scale is short and quick to run through.

## CONCLUSION

The study demonstrated that there is variability in opinion and incongruence about the current concepts and use of the voluntary control scale. Due to its poor perception of reliability and validity, it is less preferred compared to other available outcome measures. There is need for studying the reliability and validity of the scale.

## ACKNOWLEDGEMENT

We are thankful to all our subjects who willingly participated and gave their valuable time for my study.

## CLINICAL APPLICATION

Although Voluntary control is widely practiced there is variation in its application. Its use should be given a second thought Knowledge about the concept and use of voluntary control scale is helpful in revising strategies used for the evaluation and treatment Stroke. This could improve the quality of treatment and care administered by physical therapist to the patients.

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# CARE GIVERS THINKING AND OPINION ABOUT TREATMENT STRATEGY AMONG CEREBRAL PALSY CHILDREN

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***ABSTRACT***

***Introduction: Cerebral palsy is considered a neurological disorder caused by a non-progressive brain injury or malformation that occurs while the child's brain is under development. In India, it is 3.8% of the population. Nearly 15-20% of the total physically handicapped children's suffering from Cerebral Palsy (CP). For India, the estimated incidence is around 3/1000 live births; however, being a developing country, the expected actual figure may be much higher.***

***Objectives: The following survey-based study was designed to obtain parental perspectives on key issues related to the perceived quality of educational services and communication with school personnel.***

***Method: The thirty (32) item open ended questionnaire which included combination of Likert-scale and narrative responses, which identify the probe parents' perceptions of the various therapeutic interventions and treatment strategy that the student would need to successfully complete his or her school experience.***

***Participants: The number of participants which included in the descriptive study eleven (11) female and five 5 male caregivers of the parents. The participated Children which covers ranged in age from 5 to 21. Fifteen (94 percent) of the children were South Indian and one (6 percent) was north Indian.***

***Results: Overall, general satisfaction rates with school- based services were quite high. Fifty percent of caregivers reported that they were very satisfied with the provisions of their child's school program. Thirty-one percent of caregivers reported that they were satisfied and twelve percent reported that they were dissatisfied with the provisions of their child's school program. School nurse services were rated most favorable outcome. Among the participants 69% of students receiving regular school nurse treatment services, 91% of caregivers reported that they were satisfied with those acquired treatment services.***

***Conclusion: The Overall estimated accomplishment state that the respondents expressed less satisfaction with each of above mentioned channels of communication than they did with overall treatment services. Caregivers expressed even less confidence in the communication between school and outside health care providers and communication among school personnel. In the former area, only one sub discipline of neuro rehabilitation, especially functional rehabilitation treatment approach, clinically marked mean ratings in the good accomplishment.***

***KEYWORDS: CP; Spastic; Athetoid; Ataxic; Rigid and Mixed***

## INTRODUCTION

Cerebral palsy is considered a neurological disorder caused by a non-progressive brain injury or malformation that occurs while the child's brain is under development. Cerebral palsy primarily affects body movement and muscle coordination. Though cerebral palsy can be defined, having cerebral palsy does not define the person that has the condition.

According to World Health Organization (WHO) estimation, 10% of the global population has some form of disability due to different causes; in India, it is 3.8% of the population. Nearly 15-20% of the total physically handicapped children suffer from Cerebral Palsy (CP). For India, the estimated incidence is around 3/1000 live births; however, being a developing country, the expected actual figure may be much higher[15]. Despite the advancement in modern technology and improved neonatal care, stagnant or increasing incidence of CP has been observed, which is of great concern[14]. As far as management or preventive aspect is concerned, no satisfactory criteria have been developed to date[13].

Disabled children are of great concern to a family as well as to the society. When disability is discussed, particularly in children, about a quarter of chronic childhood problems are neurological in origin. Cerebral palsy (CP) is the leading cause of chronic disability in children making them physically and mentally handicapped and socially aloof. The worldwide incidence of CP is approximately 2 to 2.5 cases per 1000 live births[2]. In India, it is estimated at around 3 cases per 1000 live births; however, being a developing country the actual figure may be much higher than probable figures. There are about 25 lakh CP children in India as per the last statistical information[3].

### PSYCHOEDUCATIONAL NEEDS

Research studies suggest a wide range of symptomology with direct implications for psychoeducational interventions for students with CP disorders. These include impaired oculomotor function[10] slowing of information processing and speech production, increased simple visual and auditory reaction time1, decreased sustained attention, variable memory performance[7], pain and fatigue[14]. While those involved with special

education servicing may be familiar with addressing the majority of the aforementioned needs, fatigue and pain management strategies are less familiar territory for schools. In a study of the unmet needs of young disabled clients with CPs, symptom management (e.g., pain) was ranked among the top three of unmet needs (along with physical mobility and psychological needs) by the clients as well as the physicians and staff who served them[9].

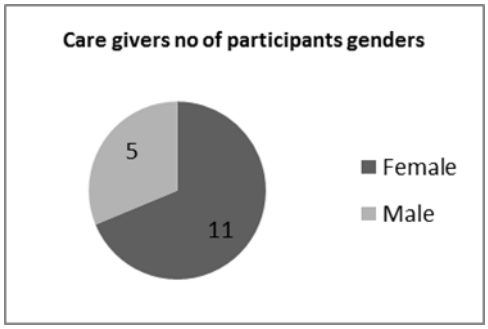
Although the physical symptoms are serious, the social and emotional ramifications may also have debilitating affects on children and their families[12]. Twenty to thirty percent of children with chronic illness or disability will experience significant behavioral or psychological problems, a rate twice that of non-afflicted peers. The psychosocial needs profile for individuals with neuromuscular disorders includes depression, negative body image, social isolation and inhibition, anger, anxiety, and feelings of helplessness and hopelessness. Caregivers, also, are at increased risk for poorer psychological adjustment marked by higher stress, less family support, greater intra familial conflict, feelings of isolation and extended bereavement from multiple losses[8].

One of the most the most significant changes in the reauthorization of the Individuals with cerebral palsy organization was the requirement of collaboration between schools and parents[11]. Two other mandates of the pertaining CP include the requirement that children must be evaluated in all areas related to their suspected disability and that collaboration activities extend to coordination of services across agencies, when necessary, to attenuate the affect of the identified disability on the child's educational functioning.

## METHOD

The thirty (32) item survey, a combination of Likert-scale and narrative responses, examined parents' perceptions of the various interventions and treatment strategy that the student would need to successfully complete his or her school experience. Those areas included: a) general satisfaction with educational services, b) assessments of the child's present levels of educational performance and evaluation of need for assistive technology, c) school personnel's understanding of the child's disorder d) timeliness of response to the child's changing needs, and e) communication with family, health care providers and other school personnel. Discipline-specific information was collected for the following nine school professions: 1) CSE administrator, 2) school principal, 3) occupational therapy, 4) physical therapy, 5) speech/language therapy, 6) school psychology and counseling, 7) school nurse, 8) general education teacher and 9) special education services. Eighty surveys were sent to families of children with cerebral palsy (CP). Twenty percent (N=16) were returned.

### PARTICIPANTS




**GRAPH 1: PARTICIPANTS**

The surveys were completed by 11 female and 5 male caregivers. Children ranged in age from 5 to 21. Fifteen (94 percent) of the children were South Indian and one (6 percent) was north Indian. Caregivers listed their child's impairment as moderate to severe in 63% of the cases. Estimated reported included spastic, athetoid, ataxic, rigid and mixed type of cerebral palsy. Brief descriptions follow below. Accompanying conditions reported were in 63 % of the cases. These included CTEV, mental retardation, scoliosis, chronic lung problems, learning disabilities, anxiety, obsessive compulsive disorder, attention deficit hyperactivity disorder, behavior problems, central auditory processing problems, and hearing impairments.

### TYPES OF CP

Ataxic/ataxia: Ataxic cerebral palsy affects coordinated movements. Balance and posture are involved. Walking gait is often very wide and sometimes irregular. Control of eye movements and depth perception can be impaired. Often, fine motor skills requiring coordination of the eyes and hands, such as writing, are difficult.

Dyskinetic: Dyskinetic cerebral palsy is separated further into two different groups; athetoid and dystonic[10].

Athetoid cerebral palsy includes cases with involuntary movement, especially in the arms, legs, and hands[10].

Dystonia/Dystonic cerebral palsy encompasses cases that affect the trunk muscles more than the limbs and results in fixed, twisted posture[9].

Because non-spastic cerebral palsy is predominantly associated with involuntary movements, some may classify cerebral palsy by the specific movement dysfunction, such as:

Athetosis — slow, writhing movements that are often repetitive, sinuous, and rhythmic

Chorea — irregular movements that are not repetitive or rhythmic, and tend to be more jerky and shaky[8].

Choreoathetoid — a combination of chorea and athetosis; movements are irregular, but twisting and curving[7].

Dystonia — involuntary movements accompanied by an abnormal, sustained posture 5

Ataxia/Ataxic — does not produce involuntary movements, but instead indicates impaired balance and coordination[6].

Mixed: A child's impairments can fall into categories, spastic and non-spastic, referred to as mixed cerebral palsy. The most common form of mixed cerebral palsy involves some limbs affected by spasticity and others by athetosis[4].

## RESULTS

Overall, general satisfaction rates with school- based services were quite high. Fifty percent of caregivers reported that they were very satisfied with the provisions of their child's school program. Thirty-one percent of caregivers reported that they were satisfied and twelve percent reported that they were dissatisfied with the provisions of their child's school program. Discipline-specific service ratings indicated slightly more variability. School nurse services were rated most favorably. Of the 69% of students receiving regular school nurse services, 91% of caregivers reported that they were satisfied with those services.

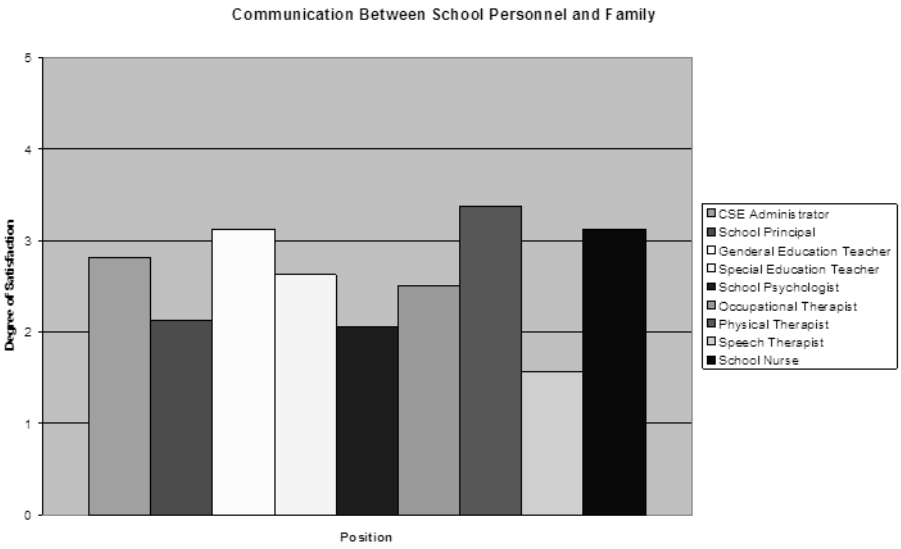
**TABLE 1: CAREGIVER SATISFACTION WITH SERVICE AREA**

| Service | Receiving Service | Satisfied |
|---|---|---|
| Special Education | 44% | 86% |
| Counseling | 56% | 78% |
| School Nurse | 69% | 91% |
| Occupational Therapy | 81% | 85% |
| Physical Therapy | 93% | 80% |
| Speech Therapy | 94% | 80% |

Counseling services were rated least favorably among caregivers, regardless of their child's special education classification status. Of those responding to specific questions about their child's socio-emotional needs, only 60% reported agreement with the school in addressing those needs. Thirty percent of students were reported to be receiving mandated counseling per IEPs. While this is nearly congruent with base-rate estimates of need, one-third (1/3) of caregivers of these students reported being unclear about counseling goals and objectives. Moreover, 44% of caregivers reported that their children did not receive evaluation for counseling services.

From this preliminary study, it appears that school-based needs-assessment, in general, may be problematic for students with CP. However, 75% of the time symptoms were not recognized. When school-based assessments were conducted, they failed to identify concerns in 94% of these cases. Because diagnosis of progressive motor skills degeneration is beyond the expertise of many school personnel it is essential that schools make referrals if they are able to address parental concerns. Schools need to offer professional development in these areas to assist teachers and other school-based personnel to identify physical changes or weaknesses in students. Unfortunately, only 19% of caregivers reported that when aspects of their child needs extended beyond the expertise of school staff, adequate provisions for outside assessments were not made. Even after formal diagnosis and inception of specialized programming, a significant percentage (44%) of caregivers reported lack of confidence that options in assistive technology were fully explored.

In both its original state and throughout reauthorizations, the Individuals with Disabilities Act had increasingly emphasized collaboration as a fundamental tool in meeting the educational needs of children with disabilities. Although no one model of collaboration is specifically asserted, best-practice presupposes that collaboration between school and families, among school personnel (e.g., within and between general and special education service areas), and with outside healthcare providers is necessary to support children with serious health related conditions such as CP. Given that the primary goal of school-based collaboration is coordination of services and dissemination of information, the preliminary marker of success for school personnel is likely to be the perception of established lines of communication. Overall, respondents expressed less satisfaction with each of aforementioned channels of communication than they did with overall services. For example, given the range of 1 to 5 on satisfaction with communication between school personnel and the family, only three professions; physical therapy, school nurse, and general education achieved a mean rating of 3 (moderate satisfaction) or higher. Caregivers expressed even less confidence in the communication between school and outside health care providers and communication among school personnel. In the former area, only one discipline, physical therapy, achieved mean ratings in the satisfactory range. In the latter, only general education and physical therapy were rated satisfactory.




**GRAPH 2: COMMUNICATION BETWEEN SCHOOL PERSONNEL AND FAMILY**

**TABLE 2: MEAN SATISFACTION RATINGS:- AGREEMENT WITH SCHOOL IN ADDRESSING CHILD'S NEEDS**

| | Agreement | Clarity of IEP | Usefulness of Reports |
|---|---|---|---|
| Education | 3.13 | 3.44 | 3.00 |
| Psychology/Counseling | 1.06** | 1.31** | 0.75* |
| Occupational Therapy | 2.44 | 3.00 | 2.56 |
| Physical Therapy | 1.19* | 1.50* | 2.94 |
| Speech Therapy | 3.50 | 3.56 | 1.25 |

Note. * Mean difference with one or more other areas significant at $p < 0.005$.
** Mean difference with one or more other areas significant at $p < 0.001$.

In an effort to discriminate factors that influenced perceptions of quality of service and collaboration, caregivers were also asked to evaluate school personnel on five key domains. The first three included issues general to all families whose children receive special education services. Agreement with school in addressing my child's needs was assessed to determine the level of differing expectations in interpersonal exchanges between home and school (see Table 2). Usefulness of progress reports and Clarity of goals and objectives were evaluated as markers of standard special education communication and reporting systems (see Table 3). The latter two, Range of understanding of my child's disorder and Timeliness of response to my child's changing needs were assessed as other potential sources of frustration in or barriers to the unique needs of CP home/school partnerships. As one might anticipate, the service areas rated highest in overall satisfaction and collaborative communication were also rated highest on other satisfaction measures (i.e., special education, physical therapy, occupational therapy). The two service areas ranked lowest in overall satisfaction (i.e., counseling, school psychology and speech therapy) were perceived by caregivers as weakest in communication, general special education dynamics, and specific issues related to CP.

**TABLE 3: MEAN RATINGS: -TIMELINESS OF RESPONSE TO CHILD'S CHANGING NEEDS, - RANGE OF UNDERSTANDING CHILD'S DISORDER**

| | Timeliness | Understanding |
|---|---|---|
| CSE Administrator | 2.44 | 2.19 |
| School Principal | 1.94 | 1.56* |
| General Ed. Teacher | 2.38 | 2.69 |
| Special Ed. Teacher | 2.44 | 2.00 |
| Psychologist/Counselor | 1.75 | 1.81** |
| Occupational Therapist | 2.31 | 2.88 |
| Physical Therapist | 1.00** | 1.00** |
| Speech Therapist | 2.94 | 3.63 |
| School Nurse | 2.25 | 2.56 |

Note. * Mean difference with one or more other areas significant at $p < 0.005$.
** Mean difference with one or more other areas significant at $p < 0.001$.

## DISCUSSION

The limitations of this study are similar to those evidenced across the research pertaining to the socio-emotional well being of patients with CP in that the sample size is small and is without control group. However, one must consider that CP s are low incident occurrence in schools and despite the fact that the sample size was small the respondent group was a focal representation of the CPs and comorbid conditions likely to be encountered by school personnel. Additionally, because this was designed as a pilot study, the interpretations are based solely on caregiver perceptions, excluding potentially helpful perceptions of the students and school personnel. Future studies should examine larger sample size and evaluate the effectiveness of survey among

western population. Nevertheless, some significant themes did emerge[13]. The progressive degeneration of CP s leads to considerable and unique stress for students and their families.

Therefore, students with CPs and their families have a heightened need for a flexible educational environment, integrated multi-disciplinary teaming, and the attention of experienced, sensitive teachers and support staff. Consistent with best-practice treatments for other developmental issues, timely interventions that are closely monitored for efficacy and adjusted accordingly are associated with better outcomes.

## CONCLUSION

The Overall estimated accomplishment state that the respondents expressed less satisfaction with each of above mentioned channels of communication than they did with overall treatment services. For example, given the range of 1 to 5 on satisfaction with communication between school personnel and the family, only three delivering a treatment which consists of physical therapy, school nurse, and general education which significantly achieved a mean rating of 3 (moderate satisfaction) or higher. Caregivers expressed even less confidence in the communication between school and outside health care providers and communication among school personnel. In the former area, only one sub discipline of neuro rehabilitation, especially functional treatment approach, significantly marked mean ratings in the satisfactory outcome. In the latter, only general education and physical therapy treatment which provide clinically satisfactory outcome.

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# TO STUDY THE IMMEDIATE EFFECT OF TAPING ON PAIN AND DISABILITY IN RECURRENT LOW BACK PATIENTS WITH ANTERIOR PELVIC TILT

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***ABSTRACT***

***The pelvis is the connecting link between the spine and the lower extremities which causes motion at the hip and the lumbar spine. To prevent excessive pelvic motion when moving the femur at the hip joint, the pelvis must be stabilized by the abdominals, erector spinae, multifidus, and quadratus lumborum muscles. Incorrect biomechanics leads to compensation which causes imbalance in the muscles, muscle spasm, nerve irritation which causes changes in the position of the spinal column straining ligaments and muscles, and indirectly affects the curvature of the lumbar spine, leading to pain and disability. In many studies, the relationship between changes in lumbar lordosis and back pain has been investigated. Kinesiology taping (KT) technique can help to reduce the pelvic tilt. Uses of KT are; reduce pain and inflammation, improve circulation, relax support over-used, tired, injured muscles and provide structural support to joints and muscle movement, assist in healing and provide support to the injury site allowing full range of movement. KT creates a neuromuscular feedback that inhibits or facilitates the firing of stronger muscles or tendons. The aim of this study was to study the immediate effect of taping on pain and disability in recurrent lower back pain patients with anterior pelvic tilt with objectives' of assessing and comparing the intensity of pain using Visual Analogue Scale (VAS) pre, post and post 24 hours using anterior pelvic tilt taping technique and also assessing and comparing the disability using Oswestry Low Back Pain Disability Questionnaire pre and post 24 hours of anterior pelvic tilt taping technique.***

***Study design: Quasi experimental trial***

***Method: A total of 40 subjects with anterior pelvic tilt were taken in this study. The anterior pelvic tilt was assessed and K tape was applied using the muscle technique. Pain was recorded using the visual analogue scale (VAS): pre taping, immediately after taping and post 24 hours after taping. Disability was measured using the Oswestry lower back pain disability questionnaire. The disability questionnaire was given before applying KT and post 24 hours after applying KT.***

***Results: The results of this study indicated that the subjects have shown significant improvements on VAS (p=0.00) and Oswestry disability questionnaire scoring after application of K tape (p = 0.00).***

***Conclusion: This study showed that kinesiotaping with anterior pelvic tilt correction technique had a significant positive effect on pain reduction and pain related disability on Oswestry disability questionnaire in-patient with anterior pelvic tilt.***

***KEYWORDS: Anterior pelvic tilt; K tape; VAS; Oswestry lower back pain disability questionnaire***

## INTRODUCTION

The pelvis is the connecting link between the spine and the lower extremities. Movement of the pelvis causes motion at the hip and the lumbar spine. To prevent excessive pelvic motion while moving the femur at the hip joint, the pelvis must be stabilized by the abdominals, erector spinae, multifidus, and quadratus lumborum muscles[1].

The anterior superior iliac spines of the pelvis move anteriorly and inferiorly and thus closer to the anterior aspect of the femur as the pelvis rotates forward around the transverse axis of the hip joints. This results in hip flexion and increased lumbar spine extension[2,3]. During standing the line of gravity of the trunk falls anterior to the axis of the hip joints; the effect is an anterior tilt moment. Stability is provided by abdominal muscles and the hip extensor muscles[2,3].

Incorrect biomechanics leads to compensation which causes imbalance in the muscles leading to muscle spasm, nerve irritation further causing changes in the position of the spinal column which strain the ligaments and muscles, and indirectly affects the curvature of the lumbar spine, leading to pain and disability causing lumbar lordosis[3,4,5]. Kinesiology taping (KT) technique can help to reduce the pelvic tilt[4,6]. Studies have shown that application of KT stimulates the mechanoreceptors, strengthens the

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weakened muscles thus assisting the postural alignment to prevent pelvic inclination and also creates a neuromuscular feedback that inhibits or facilitates the firing of stronger muscles or tendons[7,8].

Kinesiology taping originates in the science of kinesiology, based on the belief that the body's muscles are responsible for the movements of and in the body as well as being in control of other elements, such as circulation of the blood and body temperature[4]. As a result of this, when muscles fail or are impaired other parts of the body are affected. The principle of kinesiology is to treat the muscles to help the body heal itself naturally. Kinesiology tape is 100% cotton; hypoallergenic, latex free, non-restrictive elastic adhesive tape having the same amount of stretch as human skin[11]. Uses of KT are; reduce pain and inflammation, improve circulation, relax and support over-used, tired, injured muscles, providing structural support to joints and muscle movement, assist in healing and provide support to the injury site allowing full range of movement[4].

However, few studies have been done to study the repositioning of the pelvic inclination using KT. Thus, the purpose of this study was to investigate the effect of taping on pain and disability in recurrent lower back pain patients with anterior pelvic tilt.

## METHOD AND METHODOLOGY

### STUDY PROCEDURE

The subjects included in this study were explained about the research and a written informed consent was taken. A total of 40 subjects were taken in this study using a goniometer the anterior pelvic tilt was assessed by drawing a line joining the ASIS and PSIS and drawing a horizontal line from the ASIS. Patients having anterior pelvic tilt more than 15 degrees were included in this study. The muscle technique of KT was used to activate the Rectus Abdominis and inhibit the Erector Spinae. To activate the Rectus Abdominis muscle, the anchor of the tape was applied at the pubic symphysis. Then, rectus abdominis muscle was stretched by asking the patient to extend and rotate to the opposite side. The tape was applied giving a 35 to 50% stretch and was applied till the xiphisternum. For inhibition of the Erector Spinae muscle, the tape was applied from the PSIS to the spinous process of T7 vertebrae after stretching the erector spinae muscle by asking the subject to do forward flexion. A 15 to 25% stretch was applied. Pain was recorded using the visual analogue scale (VAS): pre taping, immediately after taping and post 24 hours after taping. Disability was measured using the Oswestry lower back pain disability questionnaire[10]. The disability questionnaire was given before applying KT and post 24 hours after applying KT.

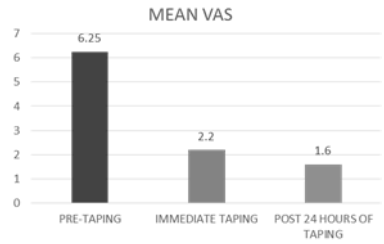
## RESULTS AND ANALYSIS

Wilcoxon test was used to analyze pre and post scores for VAS and Oswestry scores. p value was set at less than or equal to 0.05. Pain intensity was reduced after application of KT immediately (0.00) and after 24 hrs (0.00).

Disability was measured using the Oswestry lower back pain disability questionnaire. There was statistically significant reduction on Oswestry scores post 24 hrs of KT application. (p= 0.00)

**TABLE 1: COMPARISON BETWEEN PRE & POST TAPING (IMMEDIATE) AND CORRELATION BETWEEN IMMEDIATE AND POST TAPING 24 HOURS EFFECT ON PAIN**

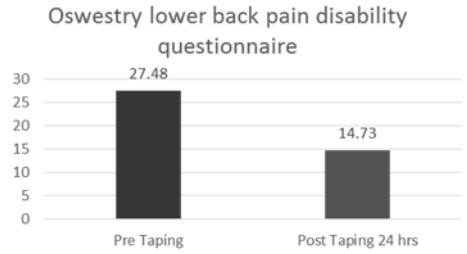
| | pre taping | post taping (immediate) | Post taping 24 hrs |
|---|---|---|---|
| mean ± SD | 6.25±1.10 | 2.20±1.38 | 1.6±1.56 |




**GRAPH 1: MEAN OF VAS IN ALL THE GROUPS**

**TABLE 2: COMPARISON OF OSWESTERY QUESTIONNAIRE BETWEEN PRE TAPING AND POST 24 HOUR TAPING.**

| | Pre taping | Post 24 hr taping |
|---|---|---|
| Mean ± SD | 27.48±7.58 | 14.73±8.94 |




**GRAPH 2: COMPARISON OF OSWESTERY QUESTIONNAIRE BETWEEN PRE TAPING AND POST 24 HOUR TAPING**

## DISCUSSION

Chronic low back pain produces mobility restriction, long-term disability and quality of life impairment and is one of the main causes of absenteeism[1]. Incorrect biomechanics of lumbar spine leads to compensations and imbalance in the muscles leading to muscle spasm, nerve irritation further causing changes in the position of the spinal column which strain the ligaments and muscles, and indirectly affects the curvature of the lumbar spine, leading to pain and disability with increased lumbar lordosis[3,4,5]. In the present study, an effort was made to find the effect of corrective K taping for anterior pelvic tilt on pain and disability caused due to chronic low back pain. This study indicated that there was a significant improvement in VAS pre, immediate and post 24 hours KT for anterior pelvic tilt (p=0.00).

DeLeo (2006), Paolini et al (2011) observed similar outcomes in pain and disability with application of corrective anterior pelvic tilt taping for one week. Authors of the study hypothesized that the improvement could be attributed to the cutaneous stretch stimulation provided by KT which might have interfered with transmission of painful stimuli (pain gate mechanism) and by delivering the efferent stimuli that facilitate descending pain inhibitory mechanisms and thus reducing pain[6,7,8,11]. It is proposed that the blood and lymph circulation at the site of application of KT is enhanced and thus the muscular and myofascial functions at those sites may be improved further reducing pain[1]. Further, the application of KT to the skin may stimulate cutaneous mechanoreceptors recruiting the weakened muscles through greater proprioceptive awareness, assisting the postural alignment[7]. A study has shown that people with chronic non-specific low back pain reported less pain and disability when kinesio tape was applied for a week. The mechanism by which one week of taping would cause long lasting reduction in pain is not clear but could be attributed to increased sense of confidence during sustained postures as well as transfers and minimal increment in endurance of the back muscles which was found during the study[1]. Being a short duration study training effect and confidence improvement would have contributed minimally in pain reduction in the present study. However pain gate mechanism, improvement in proprioception, muscle recruitment and improved posture could be responsible factors for pain reduction in 24 hrs of KT application.

Castro-Sanchez et al has done a randomized trial to study the effect of Kinesio Taping on disability and pain slightly in chronic non-specific low back pain. The results showed that there was considerable change in the post 24 hours KT in the pain intensity, sitting and standing components in the Oswestry questionnaire as compared to the pre KT[12]. These results were similar to present study. Since reduced pain, improved posture, improved back muscle recruitment patients might have reported less pain and pain related disability during sitting and standing postures which was reflected in reduction of total disability score on Oswestry questionnaire even after short term (24 hr application of KT).

## STUDY LIMITATION

- Intervention period was short.
- Anterior pelvic tilt angle was not assessed post 24 hours.

## CONCLUSION

This study showed that kinesiotaping with anterior pelvic tilt correction technique had a significant positive effect on pain reduction and pain related disability on Oswestry disability questionnaire in-patient with anterior pelvic tilt.

## ACKNOWLEDGEMENT

We take this opportunity to thank Dr. Mrs Savita Rairikar for her support.

Lastly, I extend my warm gratitude to all the people who have participated in this project.

## CLINICAL APPLICATION

KT can be incorporated as an integral part of treatment in patients with chronic low back pain along with stretching and strengthening exercises.

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# WORK RELATED MUSCULOSKELETAL DISORDERS AMONG INDIAN PHYSIOTHERAPISTS

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***ABSTRACT***

***Introduction: Physiotherapists are known to be prone to Work- related musculoskeletal disorders (WRMDs) but its prevalence among physiotherapists in India has not been reported. This study investigated the prevalence; identify the risk factors and coping strategies for WRMDs among physiotherapists of India.***

***Study Design: Questionnaire based Cross-sectional study***

***Method: A Questionnaire was prepared with items adopted and modified from questionnaires for similar studies conducted around the world and distributed amongst the participants via Google forms. Their response on the questionnaire was analyzed using the Microsoft Excel 2010.***

***Results: The questionnaire was filled by 487 physiotherapists, giving a response rate of 48.7%. Reported 12- month prevalence of WRMDs among Indian physiotherapists was 69.8%. Prevalence of WRMDs was significantly higher in female physiotherapists 82% and those with higher body mass index (overweight) 85%. The low back (66.9%) was the most commonly affected body part, followed by the neck (51.7%). Treating large number of patients in a day was the most important work factor for their WRMDs. The most commonly adopted coping strategy identified was for the therapists to modify their position and/or the patient's position. Majority of the respondents (93.2%) did not leave the profession but many (62.1%) changed and/or modified their treatment because of their WRMDs.***

***Conclusion: The study reveals that WRMDs is prevalent within the physiotherapy professional in India. People of younger age, Higher BMI, Female gender and more no. of work hours/day made the highest number of people who had WRMDs. The most common risk factors mentioned were – treating large no. of patients in a day, lifting or transferring dependent patients, performing manual Orthopaedic techniques (joint or soft tissue mobilizations). Most frequently adopted coping strategies were – Modify their position and/or the patient' position, selecting techniques that will not aggravate or provoke discomfort, use electrotherapy instead of manual therapy. These factors and strategies directly affect patient results and physiotherapy as a profession.***

***KEYWORDS: work-related musculoskeletal disorders; Indian Physiotherapists***

## INTRODUCTION

Physiotherapy is a health care profession primarily concerned with the remediation of impairments and disabilities and the promotion of mobility, functional ability, quality of life and movement potential through examination, evaluation, diagnosis and physical interventions[1]. Musculoskeletal disorders (MSDs) can affect the body's muscles, joints, tendons, ligaments and nerves. Most work-related MSDs develop over time and are caused either by the work itself or by the employees' working environment[2]. Elements of physiotherapy practice which have been suggested as risk factors include: treatments which demand repetitive movements or continuous bending, lifting/transferring dependent patients, responding to unanticipated or sudden movements by patients, performing manual therapy, restricted work place, understaffing, age and sex. These work tasks put therapists at risk for both acute and chronic WRMDs[3].Other studies into the occupational health issues affecting physiotherapists in India and abroad have identified a number of key areas of concern. For instance, Cromie et al[4] from a survey physiotherapist in the state of Victoria, Australia, found that work-related pain or discomfort had been experienced by 91% of respondents, while Bork et al[5] identified an incidence of 61% of work-related musculoskeletal disorders among physical therapy graduates from the University of Iowa, USA. However, not much information is available about the occupational hazards of physiotherapy practice in India. Hence we designed this study to investigate the prevalence, to identify various risk factors and coping strategies adapted for work-related musculoskeletal disorders among physiotherapists in an underserved health system as India to observe the difference from what we've learnt about from the advanced countries around the world. This study therefore

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investigated the prevalence and work factors of WRMDs among physiotherapists in India.

The objective of this study is to determine the prevalence, identify the risk factors coping strategies, influence of factors such as gender, body mass index, number of years of practice, hours of practice in a day and clinical specialty for WRMDs among physiotherapists in India.

## METHOD AND METHODOLOGY

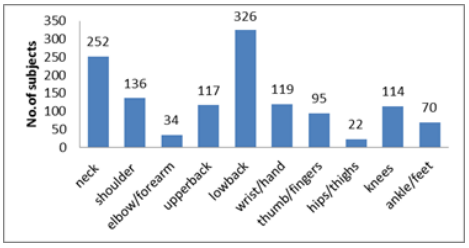
Study Design: Questionnaire based Cross-sectional study

Method: A Questionnaire was prepared with items adopted and modified from questionnaires for similar studies conducted around the world and distributed amongst the participants via Google forms and on paper. It was sent to more 1000 physiotherapists practicing in various parts of India. The questionnaire consisted of demographic information including age, BMI, years of clinical experience, hours of practice in a day; self-reports of work related musculoskeletal injuries, perceived job related risk factors and strategies adopted to cope. Their response on the questionnaire was analyzed using the Microsoft Excel 2010. Inclusion Criteria was people practicing physiotherapy since more than a year from different parts of India and Exclusion Criteria were Physiotherapists having known neurovascular dysfunction, any pain related to trauma and who have discontinued practice since more than a year.

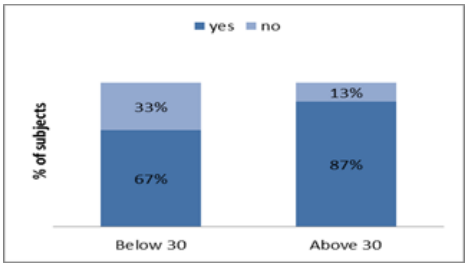
## RESULTS

**TABLE 1: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS**

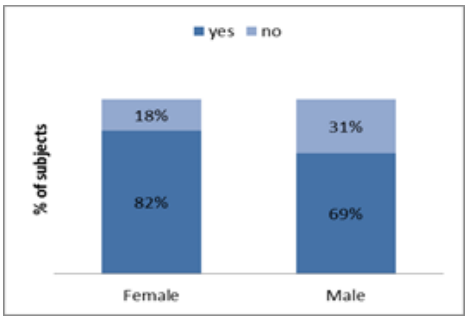
| | Characteristics | Results |
|---|---|---|
| Age (yr) | Mean (SD)<br>Range | 26.1 (4.3)<br>22-44 |
| Height (m) (n = 487) | Mean (SD)<br>Range | 1.65 (0.08)<br>1.5-1.9 |
| Weight (Kg) (n = 487) | Mean (SD)<br>Range | 64.8 (11.66)<br>44-100 |
| BMI (n = 487) | Mean (SD)<br>Range | 25.2 (2.1)<br>18.23-43.61 |
| Gender | Male<br>Female | 169 (34%)<br>318 (66%) |
| Post Graduate Training | Yes<br>No | 171 (35%)<br>316 (66%) |
| Years of PT experience | 1-5 yrs<br>5-10 yrs<br>10-15 yrs<br>>15 yrs | 411 (84.3%)<br>36 (7.3%)<br>28 (5.7%)<br>12 (2.4%) |
| Hours of Work/Week | 14-20<br>20-40<br>40-50<br>>50 | 114 (23.4%)<br>149 (30.6%)<br>154 (31.6%)<br>70 (14.4%) |
| Ergonomic Training | Yes<br>No<br>No Response | 275 (56.4%)<br>198 (198%)<br>14 (2.8%) |



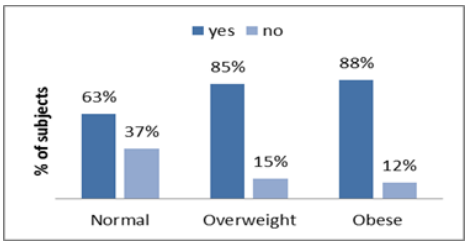

**GRAPH 1: PREVALENCE OF WRMDS BY BODY PARTS**



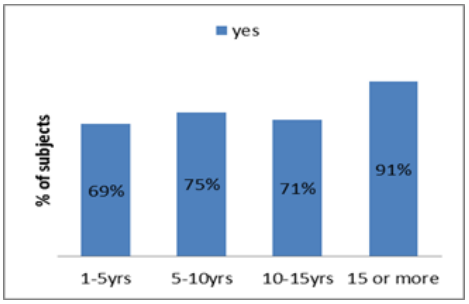

**GRAPH 2: PREVALENCE OF WRMDS ACCORDING TO AGE**




**GRAPH 3: PREVALENCE OF WRMDS ACCORDING TO GENDER**




**GRAPH 4: PREVALENCE OF WRMDS ACCORDING TO BMI**



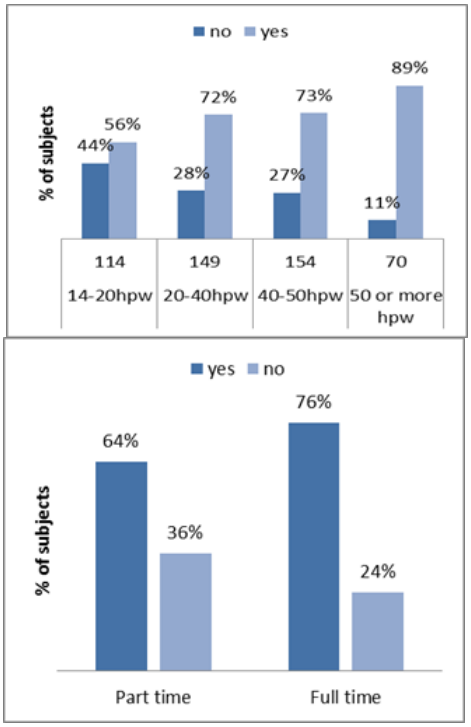

**GRAPH 5: PREVALENCE OF WRMDS ACCORDING TO ONSET OF DISORDER**

### EFFECTS OF WRMDS

62.6% of the physiotherapists have changed/modified their treatment for the patients as a result of WRMDs, but 88.4% did not change their area of practice and 87% did not leave the profession due to their WRMDs. (Data not shown).

### WORK FACTORS

The two most important work factors commonly identified by physiotherapists were treating large number of patients in a day (83.5%), and working in the same position for long (71.3%). Reaching or working away from the body (17.4%) was cited as the most unimportant work factors. (Data not shown)




**GRAPH 6 AND 7: PREVALENCE OF WRMDS ACCORDING TO HOURS OF WORK PER WEEK**

### COPING STRATEGIES

The two most commonly adopted coping strategies were therapists modifying their positions or the positions of their patients (64.3%) and selecting techniques that will not aggravate or provoke their discomfort (47.0%). The two least adopted coping strategies were the use of electrotherapy instead of manual therapy (9.6%) and warming up and stretching before performing manual technique (5.2%). (Data not shown)

## DISCUSSION

The aim of this study was to investigate the prevalence and work factors of work related musculoskeletal disorders among physiotherapists in India. The percentage response for this study was 48.7% which is consistent with responses in studies from Turkey[6] (59%) and Australia[7] (53%) but lower than the 74% reported by Glover et al[8] in the United Kingdom and the 80% by Bork et al[5] in the United States of America (USA). Our finding that there were more female than male physiotherapists in the survey is a reflection of the population from which our sample was drawn.

We observed a significantly higher prevalence of WRMDs among female physiotherapists with all the female physiotherapists in comparison to 82% of the males reporting WRMDs. Our finding is consistent with findings from previous related studies[3,5,6,8]. Borke et al[3,5] implicated the female gender as a potential risk factor for the occurrence of WRMDs while Glover et al[3,8] reported a higher prevalence of work related low back pain, neck pain, shoulder pain and wrist/hand pain among female physiotherapists. It has been suggested that the usually higher prevalence of WRMDs in female physiotherapists may be related to their height and body weight which put them at a disadvantage during patients' treatment and/or transfer[3,5]. Also, women do have a higher prevalence than men for many upper extremity musculoskeletal disorders, even after controlling for cofounders such as age or work factors[3,9].

The prevalence of WRMDs among Indian physiotherapists was found to be 69.8%. This prevalence is higher than the 12-month prevalence of 58% reported by Glover et al[8], 40% by West and Gardner[7], 61% by Bork et al[5] and 62.5% by Cromie et al[4]. The higher 12-month prevalence found in our study suggests that physiotherapy practice in India highly predisposes to WRMDs. This may be a reflection of the conditions under which physiotherapists practice in India. Physiotherapy practice in India, like in many other developing countries is largely bedeviled by unwholesome work settings, understaffing and lack of appropriate equipment including those as basic as standard plinths.

In this study, the low back was reported as the most common site of WRMDs among Indian physiotherapists, with a prevalence of 66.9%. Internationally, the prevalence of work-related low back pain ranged between 22% and 74%[3,4,8]. Our finding is consistent with those of previous studies that have overwhelmingly implicated low back as the body part most commonly affected by WRMDs among physiotherapists[3-8,10-12].

The work factors commonly identified by physiotherapists in this study as contributing to the occurrence of their WRMDs in decreasing order of importance were: treating a large number of patients in one day, working in the same position for long and lifting or transferring dependent patients, and performing manual therapy techniques. Previous studies have similarly identified treating large number of patients in a day and working in the same position for long periods of time[4,5,7], lifting or transferring dependent patients[4,6,12,13] and performing manual therapy techniques[7] as the work factors most commonly found to cause WRMDs among physiotherapists. In our study, physiotherapists selected reaching or working away from the body as the least important work factors to the occurrence of their WRMDs. Thus, mobilization and manipulation have been identified as work factors to the occurrence of upper limb, neck, and upper back pain[3,4], while performing the same task over and over[3,8] and lifting and transferring dependent patients[3,7] have been reported to be related to the occurrence of low back symptoms.

The most commonly adopted coping strategies among physiotherapists in our study were therapists modifying their position or the position of their patients, therapists selecting techniques that will not aggravate or provoke their discomfort, and therapists adjusting bed or plinth height. This finding is similar to that of Glover et al[3,8], which reported the four most important preventive strategies commonly adopted by physiotherapists in response to sustaining musculoskeletal disorder at work as: therapists adjusting plinth or bed height, therapists modifying their position or the position of their patients, obtaining assistance when handling heavy patients, and ceasing a patient's treatment if such treatment aggravates or provokes their symptoms.

Despite the high prevalence of WRMDs among Indian physiotherapists, we found that the majority of the physiotherapists did not leave the profession and only a few changed their area of practice/specialty. Our finding is consistent with those of majority of studies that found that few physiotherapists will change their areas of practice[3,4,6,8] and majority will not leave the profession[3,4, 5,7,8,10] as a result of WRMDs.

## STUDY LIMITATION

This study is limited by the sampling technique employed, as the non-probability sampling employed in our study may prevent generalization of our results. Like all other cross-sectional studies involving recall, our respondents might have given vague answers to questions asked in this study as they might not have remembered the information requested of them easily. In an attempt to curtail the influence of this in our study, we restricted our survey to a 12-month prevalence which would have tasked the participants' memory lesser than the conventional lifetime and career prevalence

## CONCLUSION

This study reveals that the prevalence of WRMDs among physiotherapists in India is higher than most values reported for their counterparts around the world, but reflected similar work risk factors and coping strategies. Further studies on the consequences of WRMDs and why Indian physiotherapists remain in the profession despite the inherent high prevalence of WRMDs are imperative and hence suggested.

## ACKNOWLEDGEMENT

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Lastly, we extend our warm gratitude to all the people who have participated in this project.

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# A SYSTEMATIC REVIEW ON EFFICACY OF INTRAOPERATIVE NEUROMONITORING (IONM) ON REDUCING NEUROLOGICAL COMPLICATIONS OCCURING DURING SPINAL SURGERY

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***ABSTRACT***

***BACKGROUND: Intraoperative spinal cord monitoring consists of a subcontinuous evaluation of spinal cord sensory - motor functions and allows the reduction the incidence of neurological complications resulting from spinal surgery. A combination of techniques is used: SomatoSensory Evoked Potentials (SSEP), SomatoMotor Evoked Potential (SMEP), Electromyography (EMG), Transcranial Motor Evoked Potentials (tcMEPs).Aim of the study is to conduct a systematic review on efficacy of Intraoperative neuromonitoring (IONM) in spinal surgery.***

***METHOD: A systematic review of the English language literatures was undertaken for articles published between February 2003 and October 2013. MEDLINE, PUBMED, and journal of bone and joint surgery databases was searched the use of IONM in spine surgery. Studies were selected on based of inclusion criteria. Two independent reviewers screened 71 search results, identifying 17 suitable studies and assessed methodological quality and risk of bias using a modified PEDro scale.***

***RESULTS: Study quality ranged from 7 to 13 out of 14 points of modified PEDro scale. Intraoperative neuromonitoring is used to reduce postoperative neurological complications during spinal surgeries like correction of spinal deformity, craniocervical instability, and excision of spinal tumour and more.***

***CONCLUSION: Based on strong evidences Intraoperative neuromonitoring is reliable and safer to reduce neurological complication that occurs during spinal cord surgery, with high sensitivity and specificity.***

***KEYWORDS: Intraoperative neuromonitoring; spinal cord surgery; spinal deformity***

## INTRODUCTION

New onset of paralysis that occurs during surgeries remains one of the most feared complications of spinal surgery. Cramer DE et al (2009) concluded that 57.1 % of cases associated with significantly higher risk of new onset of major neurological deficits immediately after spinal surgery[1].

Intraoperative neuromonitoring (IONM) consist of a subcontinuous evaluation of spinal cord sensory - motor functions by using electrophysiological methods such as Electromyography (EMG), Evoked Potentials[Somatosensory Evoked Potentials (SSEP), Motor Evoked Potentials (MEP)], Transcranial Motor Evoked Potential (tcMEPs).

IONM is used:

- To localise neural structures
- To test function of structures
- For early detection of intraoperative injury allowing for immediate corrective measure.

During surgery on any spinal column, there is some risk to spinal cord. Evoke potential can use to monitored spinal cord function by stimulating a nerve distal to surgery and recording from the cerebral cortex or other locations rostral to the surgery[2].

These all allow the reduction the incidence of neurological complications like paraplegia, brachial plexus injury, lumbosacral plexus injury during spinal cord surgery. The EMG assesses the integrity of cranial/spinal nerve roots and indirectly peripheral nerves from the site of stimulation to the muscle. SSEPs monitor the integrity of sensory pathways from peripheral nerves to the sensory cortex. Disruption along any part of this pathway may disrupt normal SSEP responses. MEPs involve transcranial motor cortex stimulation to elicit a response from muscles and thereby assess the integrity of motor pathways[3]. tcMEP used to evaluate pyramidal motor pathways by stimulate motor cortex and descending motor axons and get response in both hand and legs[4].

There was limited evidenced and randomized control trials on IONM used during spinal cord surgeries. None of systematic review conducted methodological quality assessment of studies which are and evaluate efficacy of IONM during spinal cord surgeries. So, the need of study is to conduct a systematic review on efficacy of IONM spinal cord surgeries.

## AIM AND OBJECTIVES

The aim of this systematic review was to provide an updated evidence synthesis that includes all published trials to date but with particular criteria for inclusion. A systematic review on efficacy of Intraoperative

neuromonitoring (IONM) to evaluate reduction in post neurological complication in spinal surgery.

## METHOD

Eligibility criteria: Studies eligible for inclusion were RCTs evaluating efficacy of SSEP, SMEP, EMG, TcMEP, monitoring while spinal surgery. These parameters are used for early detection of Intraoperative injury, like iatrogenic paraplegia, brachial plexus injury, lumbosacral plexus injury which allowing for immediate corrective measure.

Identification of studies: A comprehensive search strategies was developed using the US national library of medicine and national institute of health, Scoliosis research society, Journal of bone and joint surgery, Journal of neurosurgery, European review for medical and pharmacological science, Indian Journal of Orthopaedic, Journal of Clinical Monitoring and Computing, The spine journal: official journal of the North American Spine Society, Clinical evidence databases were searched from February 2003 to October 2013 .Titles, abstracts and full text articles, where necessary were screened for eligibility by two independent reviewers.

**Methodological quality assessment**: A modified version of physiotherapy evidence database [Modified PEDro] scale was used to assess the methodological quality of included studies. One point was awarded for each criterion that was clearly satisfied according to prespecified guidelines, and the 14 items summed to give a total methodological quality score out of 14. Two reviewers completed formal training for using the PEDro scale and independently rated each eligible study[5].

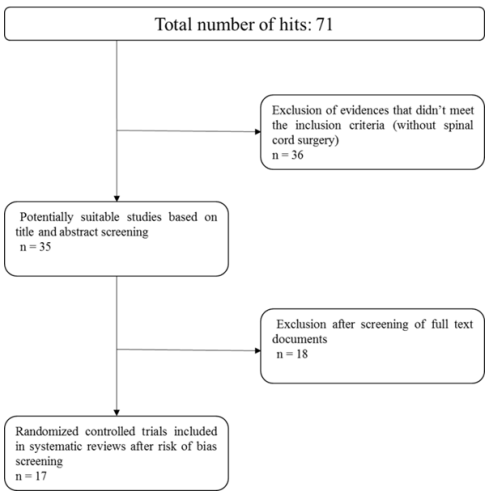
**TABLE: QUALITY RATINGS USING THE MODIFIED PEDRO SCALE OF REVIEWED STUDIES (N= 18)**

| Author | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. Gavareta, J. et al(2013)[6] | √ | √ | | √ | √ | | | √ | √ | | √ | | √ | √ | 9 |
| Akash J. Patel, et al (2013)[7] | √ | √ | √ | √ | √ | | | √ | √ | √ | √ | √ | √ | √ | 12 |
| Parthasarathy D. Thirumala, et al (2013)[8] | √ | √ | √ | √ | √ | | | √ | √ | √ | √ | √ | √ | √ | 12 |
| Vishal K Kundnani, et al(2010)[4] | √ | √ | √ | √ | √ | | | √ | √ | √ | √ | √ | √ | √ | 12 |
| David L. Skaggs, et al (2009)[9] | √ | √ | √ | √ | √ | | | √ | √ | | √ | | √ | √ | 10 |
| Indukchung et al.(2009)[10] | √ | √ | √ | √ | | | | √ | √ | √ | √ | √ | √ | √ | 11 |
| Michael O Kelleher, et al (2008)[11] | √ | √ | | √ | √ | | | √ | √ | √ | √ | √ | √ | √ | 11 |
| Andrew at al.(2008)[12] | √ | √ | √ | | √ | | | √ | √ | √ | √ | √ | √ | √ | 11 |
| Daniel M. Schwartzet, et al (2007)[13] | √ | √ | √ | √ | | | | √ | √ | √ | √ | √ | √ | √ | 11 |
| Franz J., et al (2007)[14] | √ | √ | √ | √ | √ | | | √ | √ | √ | √ | √ | √ | √ | 12 |
| Martin Shutter, et al (2007)[15] | | √ | | √ | √ | | | √ | √ | | √ | √ | | √ | 8 |
| Francesco et al.(2006)[16] | √ | √ | √ | √ | | | | √ | √ | √ | √ | √ | √ | √ | 11 |
| Accadbled, et al (2006)[17] | | √ | √ | √ | √ | | | √ | √ | √ | √ | √ | √ | √ | 11 |
| Lieberman, Jeremy A., et al (2006)[18] | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | 13 |
| Thomas O., et al (2005)[19] | √ | √ | | √ | | | | √ | √ | | √ | √ | | √ | 8 |
| Dr H.L.Journee, et al (2004)[20] | | √ | | √ | √ | | | √ | √ | | √ | | | √ | 7 |
| David B MacDonald, et al (2003)[21] | √ | √ | | √ | √ | | | √ | √ | √ | √ | √ | √ | √ | 11 |

## DATA EXTRACTION AND ANALYSIS

Data extraction performed by authors and included characteristic of surgery and outcome measures. For the studies that included spinal surgery only for correction of spinal deformity, Vertical Expandable Prosthetic Titanium Rib surgery, Vertebral column resection and the initial implantation of expandable spinal rods for early-onset spinal deformity, other than spinal surgery data were extracted. For studies that utilized more than one outcome measure for neuromonitoring techniques were SSEP, SMEP, EMG, tcMEP, other than these were extracted.

## METHODOLOGICAL QUALITY



## RESULT

In this study Out of 71 articles 17 articles are selected and their results show that IONM is used to reduce postoperative neurological complications during spinal surgeries.

### METHODOLOGICAL QUALITY:

Quality assessment scores ranged between 7 and 13 out of a maximum of 14. Criteria that met least number of studies were blinding of therapist who administers the treatment and blinding of all assessors who measured one key outcome.

### OUTCOME MEASURE:

Four different outcome measures of neuromonitoring technique reported in 17 studies were Somatosensory Evoked Potentials (SSEP), Somatomotor Evoked Potential (SMEP), Electromyography (EMG), Transcranial Motor Evoked Potentials (tcMEPs). 78.68% articles had included SSEP and MEP, 21.05% had included EMG, 10.52% had included TENS and 5.26% had included tcMEP.

**EVIDENCE FOR INTRAOPERATIVE NEUROMONITORING**

| Author | Sample Size | Outcome Measures | Conclusion |
|---|---|---|---|
| M. Gavareta, J. et al(2013)[6] | 300 | SSEP | IONM can be performed in children younger than 4 years and allows real-time assessment of spinal functional integrity. |
| Akash J. Patel, et al (2013)[7] | 6 | SSEP, MEPs | IONM during neurosurgical procedures (cranio-cervical instability) in children with Down syndrome may be reliably and safely implemented. |
| Parthasarathy D. Thirumala, et al (2013)[8] | 447 | SSEP, MEP | SSEP monitoring alone during idiopathic scoliosis continues to be a highly reliable method for the detection and prevention of iatrogenic injury. Result shows high sensitivity and specificity of SSEP monitoring |
| Vishal K Kundnani, et al(2010)[4] | 354 | SSEP, NMEP | The sensitivity and specificity of combined IONM may reach up to 100%. Multimodality monitoring with SSEP + NMEP should be the standard of care in order to indentifying spinal cord injury. |
| David L. Skaggs, et al (2009)[9] | 1736 | SSEP | As IONM didn't demonstrate any changes in children without a previous vertical expandable prosthetic titanium rib related monitoring change and there were no neurologic injuries during more than 1000 VEPTR-lengthening procedures, IONM may not be necessary during those procedures in children without a history of a neurologic deficit during VEPTR surgery. |
| Indukchung et al.(2009)10 | 229 | SSEP, EMG | The present study demonstrates that upper-limb SSEP monitoring could detect position-related ulnar neuropathy in 5.2% of the patients undergoing lumbosacral spine surgery. |
| Michael O Kelleher, et al (2008)[11] | 1055 | SSEP, EMG, MEP | Combined neurophysiological IONM with EMG and SSEP recording and the selective use of MEPs are helpful for predicting and possibly preventing neurological injury during cervical spine surgery. |
| Andrew at al.(2008)[12] | 144 | MEP, CMAP | The monitoring criteria are sufficiently strict to achieve a sensitivity of 1.0 and a specificity of 0.97. Monitoring of CMAPs alone has been adequate to avoid clinical neurological deficits. |
| Daniel M. Schwartzet, et al (2007)[13] | 1121 | SSEP, MEP | Changes in transcranial electric motor evoked potentials are detected earlier than are changes in SSEP, thereby facilitating more rapid identification of impending spinal cord injury. |
| Franz J., et al (2007)[14] | 134 | MEP, TENS | Combining spatial facilitation with a TENS protocol improved monitoring of corticospinal motor pathways during spinal surgery in children. |
| Martin Shutter, et al (2007)[15] | 109 | SSEP, MEP, EMG, tcMEP | IONM is an effective method of monitoring the spinal cord and nerve root function during surgical approach of spinal tumours and consequently can reduce or prevent the occurrence of postoperative neurological deficit. |
| Francesco et al.(2006)[16] | 50 | SSEP, MEP, D-WAVE | The applied MEPs methods seem to improve long-term motor outcome significantly after spinal cord surgery. |
| Accadbled, et al (2006)[17] | 191 | SSEP,MEP | The use of a single epidural electrode allowing SSEP recording and spinal cord stimulation alternately is a safe and valid method of IONM. |
| Lieberman, Jeremy A., et al (2006)[18] | 56 | MEP | Younger age was associated with an increase in the threshold voltage needed to elicit a sufficient MEP response after spinal cord surgery. |
| Thomas O., et al (2005)[19] | 1 | MEP | In young children, sophisticated electrophysiological techniques combined with a ketamine-based anesthesia may be necessary to achieve reliable MEPs during spinal cord surgery. |
| Dr H.L.Journee, et al (2004)[20] | 63 | MEP, TENS | It was concluded that double-train TENS stimulation can markedly facilitate responses to a single stimulus train during spinal cord surgery. |
| David B MacDonald, et al (2003)[21] | 33 | SSEP, MEP | In neurologically normal patients, the combined methods are safe and rapid, and could improve the sensitivity and specificity of scoliosis monitoring. |

SSEP: Somato-Sensory Evoke Potential MEP: Motor Evoke Potential CEP: Cranial Evoke Potential ES: Electrical Stimulation TENS: Transcutaneous Electrical Nerve Stimulation NMEP: Neurogenic Motor Evoke Potential

## DISCUSSION

Intraoperative neuromonitoring is reliable, safer and valid for use during spinal surgery to reduce postoperative neurological complication. As an outcome measures SSEP, MEP, TcMEP and EMG can be used. This systemic review shows that IONM can be used during spinal surgeries like correction of spinal

deformity, Vertical Expandable Prosthetic Titanium Rib surgery, Vertebral column resection and the initial implantation of expandable spinal rods (growing rods) for early-onset spinal deformity.

In 1992, the Scoliosis Research Society issued a position statement regarding the use of neurophysiologic monitoring during spinal surgery and concluded that neurophysiologic monitoring can assist in the early detection of complications, and can possibly prevent postoperative morbidity in patients undergoing operations on the spine. The Scoliosis Research Society considers neurophysiologic monitoring a viable alternative, as well as an adjunct, to the use of the wake-up test during spinal surgery. The goal of neurophysiologic monitoring is rapid detection of any neurological insult that can result in neurological deterioration during surgical intervention on the spine and prompt early intervention to systematic thus reversing the insult and avoiding adverse sequels[4].

Though there are many conditions in which IONM cannot be used or used with precaution. Like SSEPs and tcMEPs may not be attainable in ages below 18 months and SSEP may not be obtainable below age 6 months. As normal neural pathways develop steadily during the first approximately 18 months of age. Progressive myelinisation occurs during this period and in part determines responsiveness to externally delivered stimuli.

Surgery for paediatric spinal deformity is often required for patients with abnormal nervous systems. As the use of tcMEP has become common place in patients with neurologic disorders, there have not been reports of adverse effects in seizure patients, and it has become routine to attempt tcMEP in patients with seizure disorders.

Hydrocephalus commonly accompanies these diagnoses and may depress cortical signals and response to stimulation. In patients with partial lower-extremity paralysis, lower-extremity SSEP and tcMEP often are not obtainable, even though clinical motor and sensory function is paralysis, lower-extremity SSEP and tcMEP often are not obtainable, even though clinical motor and sensory function is present. This disparity can be attributed to anatomic abnormality in the dysplastic spinal cord.

IONM is an essential component of contemporary deformity surgery. Paediatric deformity surgery, with its wide range of aetiologies, present special challenges for IONM.Surgeons should be familiar preoperatively with strategies for intraoperative change in IONM[9].

There are certain limitations those must be acknowledged. Only English studies were included, meaning that potentially relevant papers may have been excluded on the bases of publication language. Reviewers who rated the studies on the modified PEDro scales were not blinded to author, institution and journals, which may have introduce study biases.

For further recommendation all type of surgeries includes to evaluate the efficacy of intraoperative neuromonitoring to reduce neurological complications that occurs during surgeries.

## CONCLUSION

These different studies support the uses of IONM during surgeries. It is reliable, safer and valid with high specificity and sensitivity to reduce complications that occurs during spinal surgeries.

## CONFLICT OF INTEREST

There was no personal or institutional conflict of interest for this study.

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# A STUDY TO FIND OUT RELATION BETWEEN HAMSTRINGS FLEXIBILITY AND BACK EXTENSORS ENDURANCE IN HEALTHY FEMALE PHYSIOTHERAPY STUDENTS: AN OBSERVATIONAL STUDY

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***ABSTRACT***

***Background: Work-related musculoskeletal disorders (WMD) in health professionals especially physiotherapist are more common. They are exposed to many of the some occupation related risk factors leading to WMD, especially with regard to the low back. Hamstring tightness causes many abnormalities in human body e.g. anterior knee pain, increase in lumbar lordosis and lower cross syndrome. Its tightness causes alteration in pelvic tilt, which can affect back muscle is moment arm. As there is lack of research in this aspect, the aim of this study is to correlates the relationship in between hamstrings flexibility and back extensors endurance.***

***Purpose: Purpose of this study is to determine the relationship between hamstring flexibility and back extensors endurance.***

***Study design: A cross-sectional observational Study***

***Material and Methods: A cross-sectional observational study was conducted on 50 healthy female physiotherapy students (Age:-18-24 years). Hamstrings flexibility was measured by modified sit and reach test with the subjects in long sitting position foot against wooden flexometer. Subjects were supposed to lean forward with fingertip slides on its top, score was recorded (i.e. stretch difference). Back extensors endurance was measured by Beiring Sorenson test performed by subjects in the prone position. They were asked to hold the test position while time recorded.***

***Result: The Pearson's correlation coefficient test was applied. The result showed moderately positive correlation (r = 0.07411) between hamstrings flexibility and back extensors endurance.***

***Conclusion: This study shows moderately positive association between hamstring flexibility and back extensor muscle endurance, which may lead to Low Back Pain.***

***KEYWORDS: Healthy Female Physiotherapy Students; Back Extensors Endurance; Hamstrings Flexibility; Low Back Pain (LBP); Beiring Sorenson test; modified sit and reach test***

## INTRODUCTION

Work-related musculoskeletal disorders (WMD) are common among health care workers[1]. The relationship of the disorder with employment can be complex: individuals may experience impairment or disability at work because of back disorders whether the later was directly caused by job-related factors or not. The degree to which ability to work is impaired that often dependent on the physical demands of the job. Furthermore, when an individual experiences a back disorder at work, it may be a new occurrence or an exacerbation of an existing condition[2].

Physiotherapists are also exposed to some occupational risk factors leading to WMD, especially with regard to the low back. Byron E. Bork reported that about 2.8% of physiotherapists unable to practice due to low back pain during 12 month period[1].

McKenzie (1981) found changes in body alignment (static posture) and alteration of movement sequencing (dynamic posture) are considered to be common risk factors for low back pain. Alteration in movement patterns could lead to excessive loading of lumbar tissues predisposing the subject to LBP[3].

Low back pain is defined as a pain or discomfort localized below the costal margin and above the inferior gluteal fold with or without referred leg pain[4]. It is among the most prevalent musculoskeletal disorders affecting a large proportion of the population with prevalence rate 60–85%[5].

Previous episodes of LBP, health and lifestyle, physical attributes, lifting technique, psychosocial state, and work environment are the risk factors of the low back pain[6]. Jensen et al (2012) found that the risk of developing LBP is greatest among the newly educated health care workers[7]. Physical attributes those have been implicated are erector spinae muscular endurance, quadriceps strength and endurance, abdominal muscle endurance and hamstring flexibility.

Goel et al, (1993) showed the back muscles reduce load on passive structures and maintain the erect posture of the spine throughout the day and active during many manual handling procedures including lifting and load carrying[8]. A

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reduction in back extensors endurance has been found to be significantly predictive for new episodes of LBP[8].

Muscle tightness is caused by a decrease in the ability of the muscle to deform. It could make the musculotendinous units more susceptible to injury and increased resistance to various anatomical structures which may lead to overuse syndrome. Some pathological conditions at the joint on which the muscle acts especially, muscles like the hamstrings which pass over two joints[9].

Hamstring tightness generates posterior pelvic tilt and decreases lumbar lordosis, due to the attachments of it to the ischial tuberosity which puts the spine at a disadvantage when it comes to the ability to hold body upright against gravity. According to isometric length-tension relationship, when a muscle fiber is lengthened beyond optimal length, its ability to generate amount of active tension reduces[10]. Due to attachment of back extensor muscles on the pelvis, the posterior pelvic tilt may put these muscles in to lengthen position. So, Back extensors have to work harder.

If the constant pulling of the shortened muscles happens for a prolonged time, the muscles in the low back become weak and start to get tired sooner[11]. Back extensor muscle with reduced endurance may over load the soft tissue and passive structure of spine may cause LBP[12].

### NEED OF THE STUDY

LBP is the most prevalent musculoskeletal disorders affecting a large proportion of the population prevalence rate 60–85%. A reduction in back muscle endurance has been found to be significantly predictive for new episodes of LBP[7], but there is less studies available shows correlation between back extensors endurance and hamstring flexibility. So the need of this study is to find out relation between hamstring flexibility and back extensors endurance in healthy female physiotherapy students.

## AIMS OF STUDY

To find out relation between hamstrings flexibility and back extensors endurance in healthy female physiotherapy students.

## OBJECTIVES

- To obtain hamstring flexibility in centimeter.
- To obtain back extensors endurance in seconds.
- To correlate the hamstring flexibility and back extensor muscle endurance.

## HYPOTHESIS

Null hypothesis: There is no correlation between the hamstring flexibility and the back extensors endurance.

Experimental hypothesis: There is correlation between the hamstring flexibility and back extensors endurance

## METHODOLOGY

### MATERIAL

**FIGURE 1: MATERIAL (Pen, Paper, Stopwatch, Two stabilizing belts, Scale, Custom made wooden flexometer)**

Study population: healthy female physiotherapy students
Sample size: 50 Healthy female physiotherapy students.
Source of data: Shri K.K. Sheth, Physiotherapy College, Rajkot.
Study design: Cross-sectional observational study
Method of sampling: Purposive sampling

***INCLUSION CRITERIA***

- Age group: 18 to 24 years
- Gender : Female
- Volunteered to participate

***EXCLUSION CRITERIA***

- Professional sports players
- History of Low Back Pain
- Previous fractures or surgery to their back, pelvis, hips or knees.
- During menstruation
- Unwillingness to perform the test

### MEASUREMENT PROCEDURE

50 healthy female physiotherapy students, age-18-25 (mean=20.48). Who all fulfill the inclusion criteria was selected. All individuals were provided informed consent and agreed to participate in the study. Age was recorded prior to the testing and oriented to the study. After the hamstring flexibility was checked through custom made wooden flexometer, the subjects were asked to performed Beiring Sorenson test. Then, the correlation had established between hamstrings flexibility and back extensors endurance.

### MODIFIED SIT AND REACH TEST

**FIGURE 2: MODIFIED SIT AND REACH TEST (START)**

Subjects were asked to take a long sitting position with back and head against a wall. Then, a flexometer was placed against the subjects' feet while keeping the back straightened (fig. 2)

**FIGURE 3: MODIFIED SIT AND REACH TEST (END)**

Subjects were instructed not to jerk or bounce to reach further. Adjust the sliding ruler so that the zero mark is at subject's fingertips. Ask the subject to place her hands side by side, and lean forward slowly as far as possible (head and shoulders can come away from the wall) keeping the fingertips level with each other and the legs flat (fig 3). Hold the full reach position for two seconds, and score (i.e. reach distance) was recorded. Score was recorded to nearest[13].

### BEIRING-SORENSEN TEST

The test was performed for assessment of trunk extensor endurance. The subjects lied in the prone position on the examining table with the upper edge of the iliac crests positioned on the upper edge of the table. The knees and ankles were fixed to the table by two stabilizing belts and arms were bent across the chest. The subjects were asked to isometrically maintain the upper body in a horizontal position (fig. 4). A chair was provided for safety purpose. The time during which the patient keeps the upper body straight and horizontal was recorded by stopwatch[14].

**FIGURE 4: BEIRING SORENSON TEST**

### STATISTICAL ANALYSIS

Data from sample of 50 healthy female physiotherapy students was taken and Correlation was done between hamstring flexibility and back extensor endurance by using Pearson's correlation co-efficient test by software SPSS 14.0 version.

## RESULTS

Hamstring flexibility and back extensor muscle endurance shows moderately positive correlation (r= 0.0741) at 95% confidence interval (-0.2086 to 0.3454) with two tailed p-value (t=0.60). Results of this study were not statistically significant.

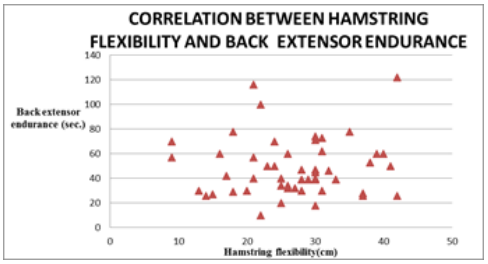


**FIGURE 5: CORRELATION BETWEEN HAMSTRING FLEXIBILITY AND BACK EXTENSION ENDURANCE**

## DISCUSSION

This study was designed to correlate between hamstring flexibility and back extensors endurance in healthy female physiotherapy students. Results showed the moderate positive correlation between hamstring flexibility and back extensors endurance. However, the results were not found statically significant.

C. M. Morris studied on 29 students participating in sport activities. No association was found between hamstring muscle length and total angle of pelvic tilt in people with extensibility of the hamstrings within normal limits[14]. Mohammad Reza Nourbakhsh et al, (2002) studied on symptomatic LBP and asymptomatic 600 subjects on relationship between mechanical factor and incidence of LBP

and found moderate correlation between hamstring length and pelvic tilt[12].

O'Sullivan et al., (2002) studied on Poor back muscle endurance and correlated to increased periods of sitting and lower physical activity. That is shown a relationship between passive slumped sitting postures and reduced back muscle activity. The findings of this study suggest that the measure of an individual's 'usual' spinal posture relative to their end of range may be a more significant factor than simply comparing spinal flexibility (back extensor endurance) or posture[8]. Kendall et al, (1993) theoretically explained the relation between hamstring flexibility and back extensors endurance. Because the hamstring muscles attach to the ischial tuberosity, it is hypothesized that tightness of these muscles may induce posterior pelvic tilt, resulting in a flat back and LBP[14].

However, this study shows moderately positive relation in between two variables. First reason is hamstring length, if it influences on pelvic tilt, only one of many factors that may lead to LBP as seen as lower cross syndrome.

Second possible reason, the line of action of the hamstrings is almost vertical and the attachment to the ischial tuberosity is only slightly posterior to the femoral head. This minimal posterior force tends to rotate the pelvis posteriorly. This is likely to be outweighed by activity of the hip flexors which will rotate the pelvis anteriorly. Therefore, any change in the length of the hamstrings may not alter the total range of pelvic tilt[14].

So, the length tension relationship does not alter as there is no change in the sagittal plane motion of the pelvis during normal standing position. Ultimately there is no or moderate reduction in back extensor muscle endurance.

## LIMITATIONS

- The person with less physical fitness cannot perform back extensor endurance test effectively though the hamstrings are not tight.
- Obesity may affect the back extensor endurance, but Body Mass Index is not taken into consideration in this study.
- Person with thoraco-lumbar fascia tightness may not perform the modified sit and reach test effectively.

## FURTHER STUDY

- This correlation between hamstrings flexibility and back extensor endurance should be established for different age group and for male population.
- Retrospective analysis can be done for back extensors endurance in LBP patient.
- Effect of BMI on back extensor endurance can be done. Studies over the abdominals strength and hip flexor tightness are recommended.
- The study can be done with active knee extension angle, as it is more specific for hamstrings flexibility.

## CLINICAL IMPLICATION

There is moderately positive correlation between hamstring flexibility and back muscles endurance .So, the hamstring tightness may alter the back extensors endurance. This may lead to LBP.

## CONCLUSION

The prevalence of WMD among physical therapy students was higher in the low back. Several studies were shown that decreased back extensor muscle endurance is an important factor in chronic LBP. This study shows that there is moderate association between hamstring flexibility and back extensor endurance. So, hamstring flexibility may affect back extensor endurance, hence low back pain.

## CONFLICT OF INTEREST

There was no personal or institutional conflict of interest for this study.

## ACKNOWLEDGMENT

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# EFFICACY OF THERAPEUTIC ELECTRICAL MUSCLE STIMULATION TREATING HAMSTRINGS MUSCLES STRAIN BY FUNCTIONAL SPORTS REHABILITATION PRESCRIBED PROTOCOLS

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***ABSTRACT***

***Electrical neuromuscular stimulation (ES) was first described over 35 years ago. Application of an electrical current to the skin stimulates lower motor nerves and muscle fibres resulting in improved contractility and greater muscle bulk. The aim of this study was to investigate the effects of EMS training on hamstring muscle strength. The study utilized a quantitative experimental research design. The intervention was assessed using a Humac Norm 7000 Dynamometer. A Chattanooga Intelect Mobile Combo muscle stimulator was used for the 4-week EMS training based on the 10-50-10 or "Russian Protocol". Inclusion criteria: The were being free of any specific injury, a body mass index (BMI) of less than 30 kg/m2, active individuals (trained three or more days per week for at least 30 minutes per day), aged between 18 and 25 years and who had a hamstring to quadriceps ratio (H/Q) of less than 60% at an isokinetic testing velocity of 60°/s. Descriptive statistics were performed and pre- to post-test changes were analyzed using dependant t-tests. Statistical significance was set at p≤0.05. The Following 4-weeks' intensive EMS training there were statistically significant increases in both the PTQ and work performed during concentric isokinetic knee flexion at 60°/s. There was also a 21.4% increase in the H/Q ratio following the EMS training.***

***KEYWORDS: EMS, the H/Q ratio.***

## INTRODUCTION

Neuro muscular Electrical stimulation originated in ancient Greece thousands of years ago. Aetius, a Greek physician, allegedly prescribed gout treatment in the form of shocks from an electric fish[6]. Early attempts to treat muscle paralysis with electricity have a history that spans over 2000 years[5]. The nineteenth century Duchenne had expanded the technique to using surface electrodes placed over nerve trunks and motor points. He also discovered that electrical stimulation could relax spastic muscles.

In 1971, the interest of US scientists in EMS grew following reports by from the then USSR that EMS training resulted in strength increases of 20% to 40% in already highly trained athletes. Historically, most research studies involving EMS training have focused on isometric training of the quadriceps femoris muscle group in both patient and healthy populations[2].

More recently, the effects of EMS alone or in combination with voluntary exercise training have been studied in a variety of patient populations which included patients recovering from total knee replacement, anterior cruciate reconstruction, knee osteoarthritis and stroke patients[1].

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Currently, there is no consensus regarding the therapeutic effectiveness of EMS in a wide variety of patient populations[7]. However, evidence from several randomized clinical trials have demonstrated that EMS combined with voluntary exercise is effective in strengthening the quadriceps femoris muscle group during the rehabilitation of anterior cruciate reconstructions[8]. There are also promising trends emerging for the inclusion of EMS during rehabilitation (especially when combined with voluntary exercise), but more randomized clinical trials are needed to make accurate conclusions on its effectiveness[2].

In healthy populations, most of the researchers conducting EMS studies have focused on the quadriceps femoris muscle group[9]. Other muscle groups that have been studied include the abdominal muscles, the elbow muscles, and the ankle plantar flexors[10]. Varying results have also been reported in healthy populations using EMS training as a strengthening modality[3]. While some researchers reported no or a very small increase in muscle strength following EMS training, others found significant increases in muscle strength[11].

Compared to the studies using EMS training for the quadriceps, there is little information available regarding the effect of EMS strength training on the hamstring muscle group[12]. Thus, the aim of this study was to investigate the effects of EMS training on hamstring muscle strength[4].

# METHODOLOGY

## RESEARCH DESIGN

The study utilized an experimental research design.

## PARTICIPANTS

Inclusion criteria were being free of any injury, a body mass index (BMI) of less than 30 kg/m$^2$, active individuals (trained three or more days per week for at least 30 minutes per day), aged between 18 and 25 years and who had a hamstring to quadriceps ratio (H/Q) of less than 60% at an isokinetic testing velocity of 60°/s. Fourteen participants did not meet the inclusion criteria at the start of the study or withdrew from the study during the four weeks of intervention. Eight participants were included into the experimental group (EG) (3 men and 5 women) and eight participants were allocated to the control group (CG) (1 man and 7 women).

Each participant signed an informed consent approval form and ethical clearance was obtained from the Institute of Review board. Height and weight were measured using a calibrated scale and a standard wall stadio meter. BMI (kg/m2) was calculated by dividing the body mass in kilogrammes (kg) with the height in metres (m) squared.

If one leg had an H/Q ratio less than 60% and the other did not, EMS training was only conducted on the leg with the H/Q ratio lower than 60%. Therefore, we obtained two sets of subject data from each participant if both legs' H/Q ratios were lower than 60% and thus, both hamstring muscle groups needed to be trained with EMS. Both the left and right legs of each participant in the CG were tested, thus obtaining 16 different values.

## ISOKINETIC TESTING

Participants warmed up prior to the isokinetic testing by cycling easy for 5 minutes (men cycled at 50 Watts and women at 25 Watts). Positioning was according to the standardized protocol described with the exception that hip flexion was at an angle of 120° instead of 90°[13]. This was done to allow for full knee extension from a seated position. Isokinetic testing was performed using a calibrated Humac Norm 7000 Isokinetic Dynometer[14]. The results were corrected for the effects of gravity using the customized Humac software. The range of motion was set between 90° knee flexion and 10° (0°: full knee extension). Each participant completed five reciprocal (knee extension and flexion) familiarization repetitions; two repetitions at 50%, two repetitions at 75% and one repetition at 100% of voluntary effort. A 10-second rest period was followed by five maximum effort repetitions. Participants received verbal encouragement to give their maximum effort and were also allowed visual feedback during the test. The highest of the five repetitions was used for the analysis. Variables used for analysis included peak torque (PTQ-Nm), work (J) and H/Q ratio (%)[15].

Participants from the CG and EG underwent exactly the same testing than at pre-test, following the 4-week EMS intervention period of the EG.

## INTERVENTION

Each intervention session was started with a 5-minute cycle (25/50 Watts) to warm up. A Chattanooga Intelect Mobile Combo muscle stimulator (Chattanooga Group International, Tennessee, USA) was used for the EMS training. The electrical stimulator delivered a constant current symmetrical biphasic waveform with a pulse duration of 100 µs and a frequency of 50 Hz. A 2-second ramp and fall time was utilized. Commercially available adhesive electrodes (Multistik 5cm round) were used. Each EG participant was allocated his/her own electrodes to avoid any chance of contamination. The participants lay prone on a plinth, with the knee joint flexed at 90°, during the EMS training.

Prior to placing the electrodes, the skin was prepared by rubbing it with alcohol swabs to remove any oil or cream that could hinder the conduction of the electrical current. The positive electrode was placed just distally to the origin of the hamstrings (ischial tuberosity) and the negative electrode was placed on the middle of the posterior thigh between the muscle bellies of the semitendinosus and long head of biceps femoris.

Each EMS session consisted of 10 muscle contractions. Each contraction lasted 10 seconds and a rest interval of 50 seconds was observed between each contraction (10-50-10 or "Russian Protocol"). The EMS intensity (mA) was set according to each participant's tolerance level. The participant's lower leg was held still at 90° of flexion by the researcher to prevent uncontrolled movements in the knee joint. Participants were encouraged to increase the EMS intensity for every session. Participants were monitored for pain and discomfort during and after the EMS session; if needed the intensity was adjusted downwards. After each session the researcher stretched the participant's hamstring muscle group for one minute.

The EMS intervention lasted for four weeks and each EG participant received at least 10 EMS sessions. The maximum amount of EMS sessions to talled 12 sessions. At least one day's rest was observed between successive EMS training sessions to prevent undue fatigue and to

allow for strength adaptations to take place. Participants were encouraged to continue with their normal everyday activities during the intervention period. On completion of the EMS intervention, at least two days' rest were observed before post testing occurred in order to allow for complete recovery following the last EMS training session.

Descriptive statistics was used and pre- to post-test changes were analyzed using dependent t-tests. Statistical significance was set at $p \leq 0.05$.

## RESULTS

Thirty students volunteered for the study, but only eight complied with all the EMS inclusion criteria and they were allocated to the EG. From the remaining 22 student volunteers, eight randomly selected students were assigned to the CG (Table 1).

The CG's knee flexion PTQ at pre-test was 73.15 Nm (±36.95) and 71.08 Nm (±30.63) at post-test. Thus, there was a non-significant difference of -1.14% (p=0.47) in the CG. The EG participants had a pre-test mean knee flexion PTQ of 65.00 Nm (±28.36) and at the post-test, following the 4-weeks of EMS intervention, the knee flexion PTQ increased significantly with 14.40% (p=0.001) to 73.70 Nm (±30.63) (Table 2 and 3; Figure 1 and 2).

**TABLE 1: PARTICIPANT CHARACTERISTICS BETWEEN THE CONTROL GROUP (CG) AND THE EXPERIMENTAL GROUP (EG)**

| Variable | Mean (±SD) | | Minimum | | Maximum | |
|---|---|---|---|---|---|---|
| | CG | EG | CG | EG | CG | EG |
| Gender | 1M & 7F | 3M & 5F | | | | |
| Age (years) | 22.88 ŧ (±1.81) | 19.80 (±0.92) | 20.00 | 19.00 | 26.00 | 22.00 |
| Height (m) | 1.628 (±0.099) | 1.647 (±0.066) | 1.490 | 1.580 | 1.820 | 1.770 |
| Weight (kg) | 55.50 (±11.45) | 58.90 (±13.73) | 43.00 | 47.00 | 81.00 | 86.00 |
| BMI ($kg/m^2$) | 20.78 (±2.20) | 21.46 (±3.11) | 17.001 | 18.83 | 24.450 | 27.45 |

SD: standard deviation; ŧ Significant difference between the CG and the EG ($p \leq 0.05$)

In terms of knee flexion work, there was a significant increase (p=0.002) from 68.30 J (±37.17) at pre-test to 81.30 J (±33.54) at post-test (i.e. a 26.51% increase), following the 4-weeks of EMS intervention. There was no significant change in knee extension PTQ or work done from pre- to post-test. The EG H/Q PTQ ratio was 48.08% (±6.08) at pre-test, but it increased significantly (p=0.001) with 21.14% to 58.12% (±10.15) at post-test. The EG's H/Q work ratio also increased significantly (p=0.003) by 26.84% from 46.11% (±8.51) at pre-test, to 58.22% (±12.33) at post-test. There were no significant changes in either the H/Q PTQ or H/Q work ratio of the CG (Table 2 and 3; Figure 1 and 2).

**TABLE 2: PRE- AND POST-TEST ISOKINETIC RESULTS FOR THE CONTROL GROUP (CG) AND THE EXPERIMENTAL GROUP (EG)**

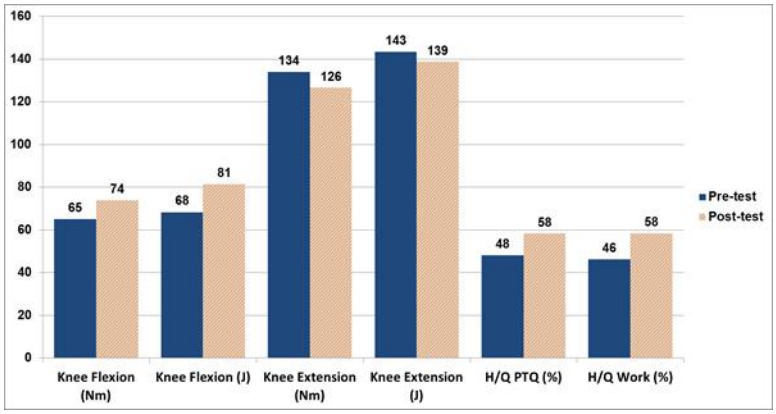
| Variable | Pre-Test Mean (SD) | | Post-Test Mean (SD) | | % Change | | p-value | |
|---|---|---|---|---|---|---|---|---|
| | CG | EG | CG | EG | CG | EG | CG | EG |
| Knee Flexion | | | | | | | | |
| PTQ (Nm) | 73.15 (36.95) | 65.00 (28.36) | 71.08 (33.11) | 73.70 (30.63) | -1.14 | 14.40 | 0.47 | 0.001* |
| Work (J) | 84.46 (50.67) | 68.30 (37.17) | 82.77 (39.72) | 81.30 (33.54) | 4.48 | 26.51 | 0.76 | 0.002* |
| Knee Extension | | | | | | | | |
| PTQ (Nm) | 112.69 (52.26) | 133.90 (49.96) | 110.62 (45.01) | 126.40 (50.10) | 1.12 | -3.58 | 0.74 | 0.375 |
| Work (J) | 119.69 (50.67) | 143.30 (59.23) | 120.15 (39.72) | 138.60 (45.84) | 4.66 | 0.68 | 0.95 | 0.581 |
| H/Q ratios | | | | | | | | |
| H/Q PTQ ratio (%) | 64.80 (10.68) | 48.08 (±6.08) | 63.87 (12.56) | 58.12 (10.15) | -0.96 | 21.14 | 0.71 | 0.002* |
| H/Q Work ratio (%) | 69.08 (11.03) | 46.11 (±8.51) | 68.74 (12.54) | 58.22 (12.33) | 0.37 | 26.84 | 0.90 | 0.003* |

SD: standard deviation; PTQ: peak torque; H/Q: knee flexion/extension; * Significant difference between Pre- and Post-test ($p \leq 0.05$)

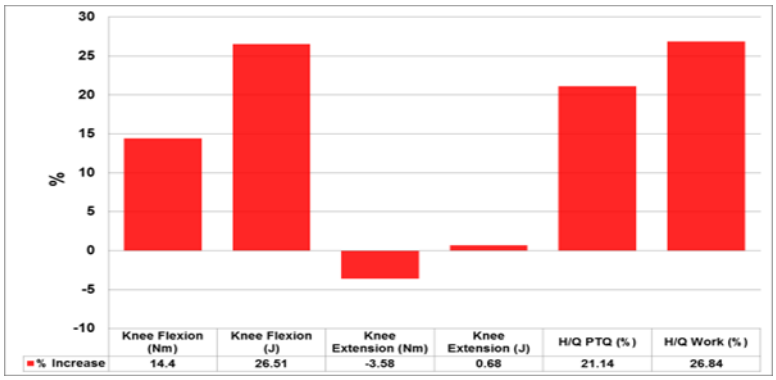
**TABLE 3: INTRA-GROUP (PRE-TEST VS. POST-TEST) AND INTER-GROUP (CG VS. EG) DIFFERENCES**

| | p-value | | p-value | p-value |
|---|---|---|---|---|
| | CG | EG | Pre-Test | Post-Test |
| Knee Flexion | | | | |
| PTQ (Nm) | 0.47 | 0.001* | 0.556 | 0.846 |
| Work (J) | 0.76 | 0.002* | 0.388 | 0.924 |
| Knee Extension | | | | |
| PTQ (Nm) | 0.74 | 0.375 | 0.335 | 0.444 |
| Work (J) | 0.95 | 0.581 | 0.358 | 0.381 |
| H/Q ratios | | | | |
| H/Q PTQ ratio (%) | 0.71 | 0.002* | 0.000 ŧ | 0.238 |
| H/Q Work ratio (%) | 0.90 | 0.003* | 0.000 ŧ | 0.058 |

PTQ: peak torque; H/Q: knee flexion/extension; * Significant difference between Pre- and Post-test ($p \leq 0.05$); ŧ Significant difference between the CG and the EG ($p \leq 0.05$)




**GRAPH 1: PRE- AND POST-TEST ISOKINETIC VALUES FOR THE EG**




**GRAPH 2: PERCENTAGE INCREASES FOLLOWING FOUR WEEKS OF EMS TRAINING IN THE EG.**

## DISCUSSION

Previous research on EMS mostly reported on training of the quadriceps muscle group reported an increase of 21.2% in isometric knee extension PTQ, 21.7% in isokinetic knee extension PTQ at 60°/s and a 15.6% increase at 180°/s after four weeks of isometric EMS training of the quadriceps femoris[16]. The present study also reported significant increases of between 13.2% and 20.7%in both isometric and isokinetic PTQ of the quadriceps femoris muscle following 10 EMS training sessions. Thus, there seems to be general consensus that EMS alone or in combination with voluntary exercise is an effective mode of muscle strengthening[17]. Since very few researchers have used EMS on the hamstrings, the aim of the present study was to investigate whether EMS training would be effective in strengthening the hamstring muscles.

The present study utilized four weeks' EMS strength training of the hamstring muscle group in participants who demonstrated less than "ideal" H/Q ratios (<60%). The results were extremely favorable. Following the EMS training, there was a 14.4% increase in isokinetic knee flexion PTQ (Nm) and a 26.51% increase in isokinetic work (J) performed by the hamstrings. The EG's H/Q ratio increased by 21.14% (from 48.08% at pre-test to 58.12% at post-test). Thus, four weeks of EMS training was effective in strengthening of the hamstring muscle group.

A low H/Q ratio may to increase the risk for knee injuries, especially in athletes who are involved in sports that require sprinting, cutting, landing and rapid changes in direction like rugby, football, basketball and netball. Since isokinetic testing provides information on muscle performance during open-chain-kinetic contractions, some researchers may question the transferability of isokinetic strength gains to functional performance. However, the significant increases in functional performance after EMS training[18]. He showed that four weeks of EMS training resulted in an increase of 27.3% in one repetition maximum calf raises and 20.5% increase in leg power determined by the Margaria-Kalamen method[19].

The effectiveness of EMS on hamstring muscle strength training in the present study may provide athletes with an additional mode for correcting low H/Q ratios. Clinicians may utilize EMS to increase hamstring muscle strength especially during the early phases of musculo-skeletal rehabilitation. Future research should investigate the effects of EMS training in larger and varied samples and also on other muscle groups.

## CONCLUSION

Following 4-weeks' intensive EMS training there were statistically significant increases in both the PTQ and work performed during concentric isokinetic knee flexion at 60°/s. There was also a 21.4% increase in the H/Q ratio following the EMS training. Future research may be conducted on larger samples to verify these findings. Considering the results of the present study and those of previous research, both the quadriceps and hamstring muscle groups are responsive to EMS strength training.

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# NORMATIVE VALUES FOR ACTIVE LUMBAR RANGE OF MOTION IN CHILDREN AND CONFOUNDING FACTORS THAT AFFECTS THE ACTIVE LUMBAR RANGE OF MOTION

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***ABSTRACT***

***Purpose: The purpose of this study was to establish normative values for active lumbar movement in children five, seven, nine, and 11 years of age and to find the confounding factors that affect the lumbar range.***

***Methods: End range active flexion, extension, and right- and left-side bending of the lumbar spine were measured for 400 normally developing children (200 girls, 200 boys) using dual inclinometric technique. Means were determined for each motion by age and sex. Group relationships were explored.***

***Results: Normative values for lumbar spine cardinal plane movements were identified. Reduced lumbar movement was found in the 11-year-old group compared with the 5-year-old group in both girls and boys. Flexibility levels were defined using percentiles as poor (<25th), moderate (between 25th and 75th), good (between 75th and 95th), and very good (>95th) respectively. The mean value for forward flexion, extension right and left lateral flexion for all participants was 55.9±17, 21.8±6, 15.2±5.1 and 14.9±5.***

***Conclusion: Normative data for cardinal plane movements of the lumbar spine provide therapists with a baseline for assessing spinal mobility of children of these ages.***

***KEYWORDS: Child; Spinal flexibility; dual inclinometer; normative data.***

## INTRODUCTION

Adequate range of motion (ROM) is necessary for maintenance of normal spinal movement patterns in the developing child[1]. During the growth and maturation process, there forces that contribute to the shape of the individual vertebra which leads to changes in the posture and mobility of the mature spine[2]. Patterns of change across the adult life span[3,4] and the proposed reasons for these changes provide a valuable perspective for beginning exploration of spinal mobility in children[3,5,6]. Quantifying spinal mobility is an important component of the physical therapy examination process for both adults and children who experience limited spinal mobility as the result of spinal disorders or injury[3,4,11].

Two important developmental milestones in the lumbar vertebrae are achieved between seven and 11 years of age. First, the lumbar spine completes primary ossification between approximately seven and nine years[12,13]. As the percentage of bone increases relative to the percentage of cartilage, the bone becomes less malleable in response to both external and internal forces. Second, the lumbar facet joints change from a relatively frontal to a sagittal plane, and the shape changes from relatively flat at birth to curved by approximately 11 years of age[14]. This change in lumbar facet orientation is thought to play a role in the quantity and direction of lumbar movement[5].

The confounding factors that affects the spinal mobility involves not only the ROM of a joint or series of joints but it is also affected by internal influences such as the type of joints, the elasticity of muscle tissues, tendon, ligaments, and length of musculature and also by external influences such as age, gender, height, weight[3,9].

Lumbar range in children is important because spinal mobility in the developing child may be affected by diseases, disorders and/or injuries of the neuromuscular or musculoskeletal systems. Abnormal spinal mobility may develop in response to a variety of factors, such as, weakness and abnormal positioning and movement patterns in neuromuscular diseases[1,2,10].

Numerous techniques have been developed to assess spinal flexibility such as visual estimation[11,12], finger-to floor distance[13], sit-and-reach measurements[14,15], standard or modified Schober's methods[13], subjective reports through questionnaires[16] and the use of devices such as flexicurves[17], protractors and goniometers and inclinometers[18,19]. The preference of technique of spinal ROM evaluation in routine clinical practice is often based on its reliability, validity, simplicity, cost, level of invasiveness and technicality[11,12]. Establishment of reference norms for spinal flexibility requires assessment techniques with high level of validity and reliability. In light of this, the inclinometric

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technique has been found to be valid and reliable[19] and has been recommended as a valuable tool in routine clinical for assessment of spinal ROM. It is believed that the inclinometric technique could measure and differentiate movements of the hip from those of the lumbar spine[20] and could be learned quickly within a short period of time[19]. Normative values of spine range of motion (ROM) are essential for proper diagnosis of spinal impairments and in the monitoring of effect of treatment and patient's recovery[21,22].

Normative values are also useful for physical therapists to estimate the active end-range spinal position achieved in each cardinal plane motion as they do not have direct access to radiographs as physicians quantify spinal mobility using radiographs[23].

They are also essential for proper diagnosis of spinal impairments. Early identification and management of abnormal lumbar spinal mobility is essential to prevent further deformity. Normative data and confounding factors that affects lumbar range is a valuable component in prevention of deformities[11,23].

Adult lumbar spine mobility is frequently addressed in the literature[3,4,6] and normative values for adult spinal mobility have been established using a variety of measurement devices[11] little information is available regarding normal lumbar spine mobility for children 5 to 11 years of age. The purposes of this study were to establish normative values for active lumbar flexion, extension, side bending in children five, seven, nine, and 11 years of age; to find the confounding factors that affect the lumbar range.

## MATERIALS AND METHODS

Four hundred healthy children participated in this study. Children who were 5, 7, 9 and 11 years of age were included in this study. Exclusion criteria included a history of disorders or activities that may affect spinal posture and mobility, such as back pain or injury, scoliosis, musculoskeletal disease, neuromuscular disease[1,2,11]. Parental assent was filled and need of the study was well explained to parents and children. Permission from Institutional Ethical Committee (IEC) was taken (Ref: SKNCOPT Academic/2014/IEC/205).

Materials- 2 bubble inclinometer, measuring tape, weighing scale, stadiometer, sit and reach box, pen and paper

### MEASURMENTS

Anthropometric measurements included height, weight, body mass index (BMI), limb length (LL), trunk length (TL) and hamstring flexibility.

1. Height was measured using a stadiometer. The subject stood barefooted on the platform of the scale looking straight ahead while the horizontal bar attached to the height meter was adjusted to touch the vertex of the head.
2. Weight was measured on weighing scale standing in an erect posture looking straight ahead.
3. LL was measured by taking the distance between the anterior superior iliac spine and the sole of the foot with the participant in a supine position.
4. TL was measured by taking the distance from the anterior superior iliac spine to the acromion process with the participant in an erect position sitting on stool.
5. Hamstring flexibility - The participants sat at the sit and reach box and fully extended both legs so that the sole of the feet were flat against the end of the box. The hands were put on top of each other with their palms down. The participants slowly reached forward while sliding their hands along the box scale as far as possible. Reading of the distance reached along the scale after the subject held the position for 2 s was recorded to the nearest centimeter. Average of three trials on each limb was recorded for analysis. The order of doing the test was in a uniform sequence. During the testing, verbal commands like "bend as far as you can" were given to the subject in order to gain a maximal effort.

### PROCEDURE FOR MEASURING LUMBAR RANGES USING DUAL INCLINOMETER

Dual inclinometric technique was used to assess spinal ROM in flexion, extension, right and left lateral flexion. The assessment procedure for spinal ROM was explained and demonstrated to each consecutive participant at inclusion. Prior to the test, the participants were required to warm up with back stretches and a 5-minute walk at self-determined pace around the research venue. Measurements were carried out with the universal inclinometer based on guidelines provided in the American Medical Association (AMA) Guides (1993). The mean of three consecutive movements was used in the final analysis to determine spinal ROM.

***For flexion and extension-***

The upper edge of the sacrum (S1 vertebra) and the lower edge of the T12 vertebra was palpated in the participant in a standing position. The middle of the platform of the first inclinometer was put on the sagittal plane of the spinous process of T12, and the second inclinometer was set on the sagittal plane of the spinous process of S1.

In the neutral position, the participant was asked to stand erect with their hands hanging without any effort toward the ground. From this position, the participant was then asked to flex forward as far as possible with their knees straight. Readings were taken.

To get the true lumbar ROM, the readings of the lower inclinometer was subtracted from those of the upper inclinometer. The flexion protocol was repeated for extension having the participants extend back for full extension instead of flexing forward.

***Lateral Flexion Measurement-***

The inclinometers was placed on the frontal planes of the both the S1 and T12 vertebrae so that the bases of the inclinometers line up with the lines drawn at this planes. The two inclinometers was held upside down and not pressed against the back, so that the gravity dependent pendulum swung freely. The participants were then asked to stand erect against a wall with nose nearly touching the wall. This position kept the participants from bending forward during lateral flexion measurements. The participants were asked to laterally flex to the right by running their right hands down the lateral thigh towards the right knee. The readings were then taken from the two inclinometers. The difference between the T12 and the S1 inclinometers gave the true right lateral flexion value. The right lateral flexion procedure was repeated for left lateral flexion the participants had to bend to the left instead of bending to the right.

**FIGURE 1: MEASURING WEIGHT ON WEIGHING SCALE**

**FIGURE 2: MEASURING HEIGHT ON STADIOMETER**

**FIGURE 3: MEASURING TRUNK LENGTH**

**FIGURE 4: MEASURING LIMB LENGTH**

**FIGURE 5: MEASURING HAMSTRING FLEXIBILITY**

**FIGURE 6: MEASURING EXTENSION**

**FIGURE 7: MEASURING LATERAL FLEXION**

**FIGURE 8: MEASURING FLEXION**

# RESULTS

**TABLE 1: DESCRIPTIVE STATISTICS OF MEAN AND STANDARD DEVIATION**

| | Mean | SD | Skewness |
|---|---|---|---|
| Age | 8 | 2.239 | .000 |
| BMI | 17.62 | 3.254 | 0.984 |
| TL | 66.69 | 6.124 | -135 |
| LL | 69.14 | 9.571 | -268 |
| Hams flexibility | 24.54 | 6.609 | 1.204 |
| Flexion | 55.92 | 17.11 | 0.049 |
| Extension | 21.8 | 6.122 | 0.496 |
| Rt.Flexion | 15.21 | 5.119 | 0.597 |
| Lt.Flexion | 14.93 | 5.08 | 0.664 |

**TABLE 2: INDEPENDENT F TEST - DIFFERENCE BETWEEN MALES AND FEMALES**

| | Male | Female | F | P value |
|---|---|---|---|---|
| Age | 8± 2 | 8±2 | .000 | 1.000 |
| BMI | 17.8± 3 | 17.47± 3 | 1.184 | 0.277 |
| TL | 66± 6 | 67± 5 | 6.508 | 0.011 |
| LL | 68± 10 | 70± 8.9 | 2.919 | 0.089 |
| Hams flexi | 25± 6 | 23.9± 6 | 0.123 | 0.726 |
| Flexion | 57± 15 | 54.5± 18.6 | 7.508 | 0.006 |
| Extension | 21.9± 6.5 | 21.6± 5.6 | 7.172 | 0.008 |
| Rt.Flexion | 15.2± 4.8 | 15± 5.3 | 1.541 | 0.215 |
| Lt.Flexion | 14.9± 4.8 | 14.9± 5.2 | 1.875 | 0.172 |

**TABLE 3: ANALYSIS OF VARIANCE (ANOVA) – TO COMPARE GENERAL CHARACTERISTICS AND SPINAL FLEXIBILITY VALUES ACROSS DIFFERENT AGE GROUPS**

| | X±SD | X±SD | X±SD | X±SD | F-ratio | p |
|---|---|---|---|---|---|---|
| Age | 5±.000 | 7±.000 | 9±.000 | 11±.000 | | |
| BMI | 17.7±3.36 | 16.3±2.1 | 18.0±3.3 | 18.2±3.6 | 7.224 | .000 |
| TL | 59.9±3.86 | 65.1±3.8 | 68.6±3.0 | 72.9±3.8 | 207.521 | .000 |
| LL | 56.7±4.51 | 65.6±3.7 | 75.4±3.9 | 78.7±4.2 | 585.729 | .000 |
| Hams flexi | 18.6±3.1 | 22.3±7.6 | 29.2±3.4 | 27.8±4.7 | 95.646 | .000 |
| Flexion | 36.8±10.7 | 68.4±13.6 | 61.1±13.6 | 57.3±11.2 | 118.279 | .000 |
| Extension | 18.8±5.11 | 24.6±6.2 | 23.9±6.1 | 19.8±4.8 | 26.186 | .000 |
| Rt.Flex | 12.9±3.3 | 18.5±4.9 | 14.6±4.9 | 14.7±5.3 | 24.992 | .000 |
| Lt.Flex | 12.9±3.3 | 18.4±4.8 | 14.3±5.0 | 14±5.1 | 26.399 | .000 |

**TABLE 4: PEARSON CORRELATION ANALYSIS - TO DETERMINE THE RELATIONSHIP BETWEEN SPINAL FLEXIBILITY AND EACH OF AGE, BMI, TL, LL AND HAMSTRING FLEXIBILITY**

| | Age | BMI | TL | LL | Hams |
|---|---|---|---|---|---|
| Age r-val | 1 | | | | |
| p-val | | | | | |
| BMI r-val | .108* | 1 | | | |
| p-val | 0.03 | | | | |
| TL r-val | .780** | .182** | 1 | | |
| p-val | .000 | .000 | | | |
| LL r-val | .888** | .181** | .861** | 1 | |
| p-val | .000 | .000 | .000 | | |
| Hams r-val | .586** | .162** | .414** | .553* | 1 |
| p-val | .000 | 0.001 | .000 | .000 | |
| Flex r-val | .354** | -0.041 | .313** | .361** | .235** |
| p-val | .000 | 0.417 | .000 | .000 | .000 |
| Ext r-val | 0.42 | 0.08 | 0.008 | 0.079 | 0.126 |
| p-val | 0.402 | 0.724 | 0.103 | 0.116 | 0.012 |
| Rt.flex r-val | 0.032 | -0.086 | 0.009 | 0.018 | 0.024 |
| p-val | 0.519 | 0.087 | 0.861 | 0.717 | 0.635 |
| Lt.flex r-val | -0.02 | -0.077 | -0.018 | -0.022 | -0.015 |
| p-val | 0.693 | 0.126 | 0.719 | 0.654 | 0.767 |

**TABLE 5: MEAN SCORE AND PERCENTILE DATA OF SPINAL FLEXIBILITY (VALUES IN DEGREE)**

| Variable | Age | Sex/No. | X±SD | Min | Median | 25th | 75th | 95th | Max |
|---|---|---|---|---|---|---|---|---|---|
| Forward Flexion | 5 | F – 50 | 32.2±7.8 | 20 | 30 | 28.75 | 40 | 45 | 45 |
| | | M – 50 | 34±7.8 | 20 | 30 | 30 | 40 | 47.2 | 50 |
| | 7 | F – 50 | 68±13.7 | 40 | 70 | 60 | 76.2 | 92.2 | 100 |
| | | M – 50 | 68.9±13.6 | 40 | 62.5 | 60 | 80 | 100 | 100 |
| | 9 | F - 50 | 63.5±13.9 | 30 | 62.5 | 58.7 | 75 | 84.5 | 90 |
| | | M - 50 | 58.7±13.7 | 35 | 60 | 50 | 70 | 80 | 90 |
| | 11 | F - 50 | 56.5±11.4 | 40 | 57.5 | 48.7 | 65 | 77.2 | 80 |
| | | M - 50 | 58.1±11 | 40 | 60 | 50 | 66.2 | 77.2 | 80 |
| Extensin | 5 | F - 50 | 19.4±4.1 | 10 | 20 | 20 | 20 | 30 | 30 |
| | | M – 50 | 18.7±5.5 | 10 | 20 | 15 | 20 | 30 | 30 |
| | 7 | F – 50 | 23.9±6.4 | 15 | 25 | 20 | 30 | 35 | 40 |
| | | M – 50 | 25.3±6 | 10 | 30 | 20 | 30 | 35 | 35 |
| | 9 | F – 50 | 23.3±4.9 | 10 | 20 | 20 | 30 | 30 | 30 |
| | | M – 50 | 24.5±7.1 | 10 | 20 | 20 | 30 | 40 | 40 |
| | 11 | F – 50 | 19.3±5.1 | 10 | 20 | 15 | 20 | 30 | 30 |
| | | M – 50 | 20.4±4.4 | 10 | 20 | 20 | 20 | 30 | 30 |
| Rt Flexion | 5 | F – 50 | 12.2±2.8 | 10 | 10 | 10 | 15 | 17.2 | 20 |
| | | M – 50 | 13.1±3.3 | 10 | 15 | 10 | 15 | 20 | 20 |
| | 7 | F – 50 | 18.7±5 | 10 | 20 | 15 | 25 | 25 | 25 |
| | | M – 50 | 18.3±4.8 | 10 | 20 | 18.7 | 20 | 27.2 | 30 |
| | 9 | F – 50 | 14.5±4.8 | 10 | 15 | 10 | 20 | 25 | 25 |
| | | M – 50 | 14.7±5 | 10 | 15 | 10 | 15 | 25 | 25 |
| | 11 | F – 50 | 13.1±4 | 10 | 10 | 10 | 15 | 20 | 25 |
| | | M – 50 | 16.4±6 | 10 | 15 | 10 | 15 | 27.2 | 35 |
| Lt Flexion | 5 | F – 50 | 12.2±2.8 | 10 | 10 | 10 | 15 | 17.2 | 20 |
| | | M – 50 | 13.1±3.3 | 10 | 15 | 10 | 15 | 20 | 20 |
| | 7 | F – 50 | 18.5±4.9 | 10 | 20 | 15 | 20 | 25 | 25 |
| | | M – 50 | 18.3±4.8 | 10 | 20 | 30 | 20 | 27.2 | 30 |
| | 9 | F – 50 | 14.4±4.9 | 10 | 15 | 10 | 20 | 25 | 25 |
| | | M – 50 | 14.3±5.1 | 10 | 10 | 10 | 20 | 25 | 25 |
| | 11 | F – 50 | 12.9±4 | 10 | 10 | 10 | 15 | 20 | 25 |
| | | M – 50 | 15.1±5.9 | 10 | 15 | 10 | 15 | 25 | 35 |

The study was carried in Sinhgad Spring Dale School, Pune among 400 students between 5-11 years of age. Descriptive statistics of mean and standard deviation, in which mean age was 8±2, mean BMI was 17.62±3, mean trunk length was 66.69±6, mean limb length was 69.14±9.5, mean hamstring flexibility was 24.54±6.6, mean flexion was 55.9±17, mean extension was 21.8±6, mean right flexion was 15, mean left flexion was 14.9±5 is shown in table 1. The physical characteristics of all participants in both males and females show that limb length is more in males than in females. Active lumbar flexion was more in females than in males. Active lumbar extension was more in males than in females. Limb Length

in males is more than female is shown in table 2. Comparison of general characteristics and spinal flexibility values across different age groups show significant difference across different age groups which is shown in table 3. Correlation which determined the relationship between spinal flexibility and age, BMI, trunk length, limb length and hamstring flexibility shows significant correlation. Significant correlations were found between trunk length and age (r=0.780; p=0.000), trunk length and BMI (r=0.182; p=0.000), limb length and age (r=0.888; p=0.000), limb length and BMI (r=0.181; p=0.000), limb length and trunk length (r=0.861; p=0.000), hamstring flexibility and age (r=0.586; p=0.000), hamstring flexibility and BMI (r=0.162; p=0.001); hamstring flexibility and trunk length (r=0.414; p=0.000), hamstring flexibility and limb length (r=0.553; p=0.000),flexion and age(r=0.354; p=0.000), flexion and trunk length(r=0.313; p=0.000), flexion and limb length(r=0.361; p=0.000), flexion and hamstring flexibility(r=0.235; p=0.000) which is shown in table 4. Mean, standard deviation, range and 25th, 75th and 95th percentile scores and were determined for four age categories and both genders for spinal flexibility of all participants. Flexibility levels were defined using percentiles as poor (<25th), moderate (between 25th and 75th), good (between 75th and 95th), and very good (>95th) respectively which is shown table 5.

## DISCUSSION

This study established the normative data and correlates of spinal flexibility in children using the dual inclinometer. Normative values for each cardinal plane movement of the lumbar spine were identified. Participants in this study were children with the mean age of 8+2.23 years.

A statistically significant difference in lumbar ranges was seen in both genders & was found in children between 5 and 11 years of age, with older subjects demonstrating reduced movements. Some authors[3,5] propose that an age related decline in ligamentous and muscle fiber elasticity results in soft-tissue limitation of lumbar flexion. Extension, which may be limited by bony approximation[5,7] has little variability within age groups or between sexes, and decreases in small amounts with increasing age[3,8].

The male participants had significantly higher limb length than female participants. Literature is replete on the gender dependent differences in body segment proportions between male and female[11].

Active lumbar flexion was more in females than males in our study, which may be related to earlier maturation in females than in males[24-27] and these results corroborates with previous studies that suggest that females are more flexible than males[26,28].

In addition to structural differences, males appear to have greater stiffness and decreased segmental motion in the lumbar spine compared to females[25], however, Mellin and Poussa (1992)[29] who found no significant differences in forward flexion of the lumbar spine between male and female our study found there is a difference in forward flexion between male and female. Although conclusive evidence is lacking, several factors, including anatomical and physiological differences, may account for the difference in flexibility between the sexes. Additional factors could be smaller muscle mass, joint geometry, and gender-specific collagenous muscle structure[25,26,28]. Active lumbar extension was more in males than females in our study.

Reduced lumbar side bending was seen in both genders when comparing 11 year old children to five year old children, this correlates with two important skeletal maturation milestones that are achieved during the same time period. Primary ossification of the lumbar spine is completed between seven and nine years of age and mature lumbar facet orientation is achieved by approximately 11 years of age[7,9-11]. Side bending was greatest in the five-year-old group in this study, which coincides with a more frontal plane orientation of facets. The 11-year-old children had the least side bending, which correlates with achieving a relatively sagittal plane orientation. It has been reported that sagittal orientation of the lumbar facet joints may play a role in constraining and/or directing movement within the adult lumbar spine, specifically limiting a lesser degree side bending[8,9,11]. Conversely, a more frontal plane orientation may allow greater rotation and side bending[8,,11]. It is possible that normal developmental changes in Lumbar facet orientation[1,9] may play a role in the decline in side bending that is observed in this sample of children.

In our study there is significant relationship between flexion and age, trunk length, limb length and hamstring flexibility. Esola et al. found that Forward Bending motion occurs mainly at the hips, with a 2:1 ratio of lumbar spine to hip motion between 0° and 30°, building to a 1:2 ratio between 60° and 90° 28,30. This means it is likely that hamstring is most influential when approaching the end of pelvic rotation range and decrease hamstring flexibility will limit the movement at lumbar spine[28].

Although it is not possible to directly compare the data from this study to other study results because of the differences in measurement methods and age groups studied, close examination of patterns within the data reveals similarities. First, spinal mobility varied in this

sample of children, as well as in other studies of children[14] and adults[3,4,13-16], which suggests that variability may be the norm. Flexion was more variable than any other spinal motion in both boys and girls, a pattern that was also observed in other studies of both children[9] and adults[4,16]. Flexion was found to be less in the subjects 11 years of age as compared with the five-year-old subjects in this sample of children. This finding was greater in girls than boys[8]. Normal developmental changes in ligament and muscle fiber elasticity across these age groups[11] may contribute to greater "stiffness" of the soft tissues and increased resistance to lumbar flexion.

Our findings of normative data are in similar with the previous study that was done in 2007 in Michigan[11].

## LIMITATIONS

Rotations were not measured.

## FUTURE SCOPE OF THE STUDY

Rotations can be measured. Comparing the results of this study to a sample of children who have been diagnosed with a neuromuscular or musculoskeletal disorder would test difference of spinal mobility of individuals in these populations & normally developing children.

## CONCLUSION

Normative values of lumbar spine mobility of children 5, 7, 9, and 11 years of age can be used as a baseline for comparing spinal mobility that may be in question and for monitoring progress during periods of physical therapy intervention. This study established a set of normal values for lumbar spinal ranges in children between 5-11 years of age. Increasing age was associated with decreasing spinal flexibility without gender bias. These values can be used in clinical practice. This study also established confounding factors that are age, trunk length, limb length and hamstring flexibility affect active lumbar flexion range of motion.

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# IMMEDIATE EFFECT OF MULLIGAN BENT LEG RAISE TECHNIQUE VERSUS SELF MYOFACIAL RELEASE ON HAMSTRING TIGHTNESS IN YOUNG ADULTS-A RANDOMIZED CONTROL TRIAL

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***ABSTRACT***

***Background: Muscular flexibility is an important aspect of normal human function. Limited flexibility has been shown to predispose a person to several musculoskeletal overuse injuries and significantly affect a person's level of function. The objective of our study was to find out the effect of mulligan BLR on hamstring tightness, to find out the effect of self MFR on hamstring tightness & Comparison of Mulligan BLR & self MFR on hamstring. Procedure: 40 normal healthy subjects (20 in each group) fitting in inclusion criteria. They were divided in 2 groups by simple randomization method. Group A received single session of mulligan BLR Technique and Group B received single session of self MFR technique for hamstring tightness. Sit and reach flexibility tests were measured pre intervention and post intervention. Data was analyzed using paired and unpaired t-test. Result: Shows that hamstring flexibility in mulligan BLR (17.2850) and self MFR (11.0492) increased immediately post-intervention y within the group but there was no significant (0.5877) difference on comparison between two groups. Conclusion: The single intervention of Mulligan BLR and self MFR technique is equally effective in improving flexibility of hamstring.***

***KEYWORDS: Hamstring tightness; Mulligan Bent Leg Raise; Self Myofascial release***

## INTRODUCTION

Muscular flexibility is an important aspect of normal human function. Limited flexibility has been shown to predispose a person to several musculoskeletal overuse injuries and significantly affect a person's level of function[1]. Muscular tightness is frequently postulated as an intrinsic risk factor for the development of a muscle injury. Lack of flexibility has been suggested as a predisposing factor to hamstring strains[2].

Decreased hamstring flexibility is suggested to be one of the predisposing factors for hamstring strains. Hamstring stretches are routinely used as part of a pre-exercise routine, usually after an aerobic warm-up[3]. A theoretical model for hamstring strains, suggesting that they result from a complex interaction of four etiologic factors: warm-up, strength, fatigue, and flexibility. Reasons for stretching relate to beliefs that stretching exercises will increase flexibility and decrease muscle stiffness. For maintaining normal muscle length requires regular stretching to prevent muscle stiffness, decreases risk of musculoskeletal injuries and enhance physical performance. The flexibility of hamstring muscle is important for general and athletic population and of almost importance for health care professionals, to achieve this goal one needs to know the most effective and efficient technique to gain hamstring flexibility[1].

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There are various treatment for the hamstring stretching like active release technique[1], passive stretching, static stretching[4], PNF Stretching Techniques[5,6], eccentric stretching exercises[7] for improving hamstring flexibility.

The Mulligan concept is now an integral component of many manual physiotherapists' clinical practice[8]. Brian Mulligan pioneered the techniques of this concept in New Zealand in the 1970s. The concept has its foundation built on Kaltenborn's (1989) principles of restoring the accessory component of physiological joint movement. Mulligan proposed that injuries or sprains might result in a minor positional fault to a joint thus causing restrictions in physiological movement[9].

Mulligan bent leg raise is a painless technique and can be applied on any patient with low back pain who has limited or painful straight leg raising (SLR).It can be tried with patients who has a gross bilateral limitation of straight leg raise (SLR). If the bent leg raise (BLR) cannot be executed without pain then it is not to be used[10].

Myofascial release is a collection of techniques used for the purpose of relieving soft tissue from an abnormal hold of a tight fascia[11].The physiology behind this technique involves the golgi tendon organ[12]. The pressure associated with myofascial release causes the Golgi tendon organ to sense a change of tension in the muscle and responds to this high or prolonged tension by inducing relaxation of the muscle spindles[12]. The source of the pressure when using foam rollers is the individual's body weight[12].

Self myofascial release is a type of self-massage in which the practitioner utilizes their body weight and implements such as foam rollers to apply pressure and stretch to problematic areas of the body in an attempt to improve tissue quality. The theory behind this practice centers on the fascia, which is a normally gelatinous tissue that envelopes the musculature in the human body. When exposed to injury, inflammation, inactivity, or other forms of trauma, the fascia achieves a more solid state and forms adhesions with the underlying musculature[13,14]. These adhesions create tension and pain that resonates throughout the body thereby limiting range of motion (ROM) and facilitating dysfunctional movement patterns. It is proposed that the proper application of pressure and stretch can release these adhesions, eliminate pain, and restore a healthy ROM[13,14].

Hence this study was undertaken to compare the immediate effect of mulligan Bent Leg Raise technique versus self Myofacial Release technique on hamstring tightness.

## MATERIAL AND METHOD

Ethics Approval: The Ethical clearance was obtained for the study from Institutional Ethical Committee of PDVVPF, COPT, Ahmednagar .Written informed consent was obtained from all the subject fitting in inclusion criteria i.e. both genders with age 18- 24 and willing to participate in the study.

In this randomized control trial, 40 subjects were divided in two groups i.e. Experimental Group n=20 (mulligan BLR) and Control Group n=20 (Self MFR) using lottery method of allocation.

Initially the demographic data that is Name, Age, Gender, Height, Weight & BMI was assessed. Then the variable of the study that is back sever sit and reach test was assessed before and immediately after the intervention for each subject & score was noted down.

### BACK SAVER SIT TO REACH TEST

The back-saver sit and reach is very similar to the traditional sit and reach except that the measurement is performed on one side at a time. By testing one leg at a time a determination can be made of any asymmetry in hamstring flexibility, and hyperextension of both knees is avoided. The sit and reach measures predominantly the flexibility of the hamstring muscles. Normal hamstring flexibility allows rotation of the pelvis in forward bending movements and posterior tilting of the pelvis for proper sitting. The back-saver sit and reach has been shown to provide extremely consistent scores when administered under standardized conditions. The back-saver sit and reach has also been shown to be a reasonably accurate measure of hamstring flexibility. This test involved sitting on the floor without shoes with legs stretched out straight ahead. The soles of the feet were placed flat against a custom made sit and reach box. Both knees were locked and pressed flat to the floor. With the palms facing downwards, and the hands on top of each other, the participant reached forward along the measuring line as far as possible ensuring that the hands remain at the same level, not one reaching further forward than the other. The participant reached out and held that position for one-two seconds while the distance was recorded. It was instructed and made sure that there are no jerky movements. The score was recorded to the nearest centimeter as the distance reached by the hand.

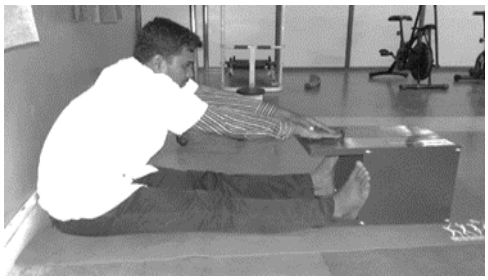

**FIGURE 1: BACK SAVER SIT TO REACH TEST**

### BENT LEG RAISE (BLR) TECHNIQUE

BLR technique consist of gentle isometrics stretching of hamstring in specific directions in progressively greater positions of hip flexion, the expecting results are increased flexibility of hamstring muscle with increased ROM of active knee extension. The procedure for performing BLR was as follows: Participant was in supine lying on a high couch with the investigator in walk stand position lateral to the leg, which was being stretched. Hip and Knee of the side to be stretched was bent at 900- 900. Investigator placed participant's flexed knee over his shoulder, the popliteal fossa of the knee resting on his shoulder. A distraction (longitudinal traction force along the long axis of femur) was applied at the lower end of femur and the participant was asked to push the investigator's shoulder with his or her leg followed by voluntary relaxation. At this point of relaxation, the investigator pushed the bent knee up as far as possible in the direction of the shoulder on the same side in a pain free range. This stretch was sustained for 5-10 seconds and then relaxed. If the pain or restriction eased, the hip was taken further in to flexion. It was ensured that there was no pain during the procedure, if it was painful the direction of the leg raise was altered medially or laterally. The process was repeated till the knee of the participant was beyond the shoulder of

therapist. The contra lateral leg was kept relaxed and allowed to move as it goes. At the end of the range, the position was held for 10 seconds and limb brought back to the neutral position. The traction was maintained throughout the technique.

**FIGURE 2: MULLGAN BENT LEG RAISE TECHNIQUE**

### SELF MYOFACIAL RELEASE (MFR)

Myofascial Release Technique involves applying sustained pressure onto myofascial tissue restrictions. The sustained pressure diminishes associated pain, increases circulation and increases motion by rousing the stretch reflex of the muscles and overlying fascia. In Self MFR, subjects were asked to place hamstrings on the roll with hips unsupported. Legs are kept straight on and asked to Roll from knee toward posterior hip while keeping quadriceps tightened. Procedure is repeated for 1-2 min on each side. Subjects were asked to keep the abdominal muscles tight to provide stability.

**FIGURE 3: SELF MYOFACIAL RELEASE TECHNIQUE**

## RESULT

**TABLE1: COMPARISON OF PRE AND POST SIT TO REACH TEST VALUES IN BLR GROUP**

| Group | Mean± SD | T Value | P value |
|---|---|---|---|
| Pre Intervention | 20.12 ±3.67 | 17.2850 | <0.0001 |
| Post Intervention | 22.5±3.500 | | |

Table no 1 shows that on Comparison of Pre and Post Sit to reach test values in BLR group using paired t test t value is 17.2850 and p value <0.0001 it indicated statistically significant.

**TABLE NO 2: COMPARISON OF PRE AND POST SIT TO REACH TEST VALUES IN SELF MFR GROUP**

| Group | Mean ±SD | t value | P value |
|---|---|---|---|
| Pre Intervention | 20.575±3.764 | 11.0492 | < 0.0001 Extremely statistically significant. |
| Post Intervention | 21.842±3.815 | | |

Table no 2 shows that on Comparison of Pre and Post Sit to reach test values in self MFR group using paired t test t value is 11.0492 and p value <0.0001 it indicated statistically significant

**TABLE NO 3: COMPARISON OF POST VALUE OF SIT AND REACH TEST AFTER THE MULLIGAN BLR AND SELF MFR**

| Group | Mean ±SD | t value | p value |
|---|---|---|---|
| Post intervention (mulligan BLR) | 22.475 ±3.408 | 0.5469 | 0.5877 Statistically not significant |
| Post intervention (self MFR) | 21.842 ±3.815 | | |

Table no 3 shows that on comparison of post value of sit and reach test after the mulligan BLR and self MFR using unpaired t test t value is 0.5469 and p value is 0.5877 it indicated not statistically significant.

## DISCUSSION

The result of the present study demonstrated that mulligan BLR and self MFR increases immediate post-intervention hamstring flexibility within the group but there was no significant difference on comparison between two groups.

As per our knowledge this study was the first which compared the self MFR and Mulligan bent leg raise in healthy subjects with hamstring tightness with the single intervention. Self MFR and Mulligan bent leg raise technique releases the scar tissue adhesions to allow full lengthening of the muscle and to regain flexibility for functional use.

The present study compared the effectiveness of mulligan BLR & self MFR on hamstring tightness, Even though BLR produced a change of 2 to 3 centimeters difference in pre and posttest measures when observed within groups, a comparison between groups failed to produce significant differences which shows that BLR does not have any clinical advantage than self MFR in improving hamstring flexibility. Result of our study are supported by Oves Patni et al which concluded that the BLR produced a change of 3.7 and 4 centimeters difference in pre and posttest measures when observed within groups, a comparison between groups failed to produce significant differences which shows that BLR does not have any clinical advantage than

passive stretching in improving hamstring flexibility[15].

Toby Hall et al concluded that after a single intervention of Mulligan's BLR technique, immediate improvement were not observed but the technique was effective in improving the range of SLR after 24 hours. They also added that BLR technique was no better than placebo[10].

Improvement of SLR range, by the BLR technique, might be due to mobilization of the painful, sensitized, nerve tissues, similar to the ‘‘slider’’ effects[16,17]. However, it is unlikely that this is the main treatment benefit; in a comparable LBP sample with SLR limitation, only one third of the subjects had signs of sensitized neural tissue[18]. Another beneficial effect of the BLR technique might be a change in stretch tolerance of the hamstrings. Goeken and Hof demonstrated that the increased range of SLR, following stretching, is mediated via an increase in hip flexion and hamstring length, and not related to increased hamstring viscoelastic properties[19]. Since studies on BLR are scarce and highly variable, the results of our study can be of significance in setting a baseline for further future studies.

From our study we conclude that the self MFR produced a change of 1 and 1.5 centimeters difference in pre and post sit and reach test measures when observed within groups, a comparison between groups failed to produce significant differences which shows that self MFR does not have any clinical advantage than BLR in improving hamstring flexibility. Previous studies by Graham MacDonald et al concluded that there was a significant increase in knee joint ROM at 2 min post- (12.7%) , Foam rolling for two minutes increased knee joint ROM by approximately 11° and 9° at 2 and 10 minutes, respectively[20].

One potential theory to explain the increase in ROM following foam rolling is a change in the thixotropic property (fluid like form) of the fascia encasing the muscle[21]. Fascia is made of colloidal substances and when it is disturbed, via heat and/or mechanical stress, it softens and takes on a more gel-like state, but when left undisturbed it thickens and becomes more viscous, taking on a more solid state[22]. Repeated stress placed on the soft-tissue of the body due to overuse or inactivity may cause abnormal cross-links and scar tissue to form in the fascia. Subsequently, these abnormal cross-links and scar tissue may inhibit proper biomechanics and reduce joint ROM. SMR may mechanically shear out these cross-links and breakdown scar tissue, remobilizing the fascia back to its gel-like state[23]. Once the fascia is in a more gel-like state, soft-tissue compliance increases allowing for greater range of motion[24]. The reference literature on MFR, and assert that foam rolling causes neuro-myofascial inhibition, which decreases the stiffness of the muscle and increases its compliance[25]. That is of concern because multiple advocates suggest foam rolling prior to exercise, which may negatively affect performance by causing latency in neuromuscular responses to exercise or physical activity[26-29].

## CONCLUSION

We conclude that single intervention of Mulligan BLR and self MFR techniques are equally effective in improving hamstring flexibility.

## CONFLICT OF INTEREST

None

## FUNDING

None

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# A STUDY TO DETERMINE THE ELECTROMYOGRAPHIC ACTIVITY OF SHOULDER MUSCLES DURING UN-WEIGHTED AND WEIGHTED PENDULUM EXERCISE IN FROZEN SHOULDER PATIENTS

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***ABSTRACT***

***Aim: The aim of this study is to determine the shoulder muscles activity during un-weighted and weighted Codman's pendulum exercises.***

***Methods: 40 participants with FS, with age ranging from 50-60 years, who fulfilled the inclusion and exclusion criteria were recruited. MVIC was recorded for Deltoid, Supraspinatus, Trapezius, Infraspinatus, Triceps LH, Biceps LH from unaffected shoulder. 4 variations of Codman's exercise (with and without weight) were performed with affected shoulder and EMG activity of all these muscles was recorded.***

***Results: The pairwise comparison using repeated measure ANOVA with Bonferroni Correction revealed that there is a significant increase in muscle activity in all the muscles on addition of weight i.e. a significant difference was found in un-weighted and weighted (dumbbell, hand held ball weight and suspended ball weight) Codman's pendulum exercises ($p<0.05$) but there was no significant difference found between hand held ball weight and suspended ball weight variants for all the muscles ($p>0.05$).***

***Conclusion: The study concluded that addition of weight to Codman's exercise gives distracting force as well increases the muscle activation and hence can be used as a progression to shoulder rehabilitation program.***

***KEYWORDS: Frozen shoulder; Codman's pendulum exercise; EMG***

## INTRODUCTION

Frozen shoulder (FS) also called frozen shoulder syndrome, adhesive capsulitis or periarthritis, is characterized by the development of dense adhesions, capsular thickening, and capsular restrictions, especially in the dependent folds of the capsule, rather than arthritic changes in the cartilage and bone, as seen with rheumatoid arthritis or osteoarthritis[1]. Patients with adhesive capsulitis have a painful restriction of both active and passive GH joint motion in all planes, or a global loss of GH joint motion[2].

Subjectively, the patient complains of a vague, dull pain over the deltoid that increases with motion and disturbs sleep. Functionally, the patient will be unable to sleep on the affected side, hook a brassiere in the back, comb the hair, or reach for a wallet in a back pocket[3].

Early joint mobilization plays an important role in the rehabilitation of the shoulder for the return of normal kinematics and shoulder function[4]. The goal of an early rehabilitation protocol is to provide motion at the glenohumeral joint, while maintaining relative inactivity of the affected muscles and tendons.

Exercise is the most useful treatment in FS. In the acute stage all active treatment is contraindicated. Treatment in this stage should be directed at pain relief. Rest, ice, and TENS are helpful at this time. In the sub-acute stage, both active and passive exercises may be cautiously initiated, but the patient's reaction must be constantly monitored.

Active exercises are essential in maintaining the capsular extensibility obtained through manipulation. They are best performed in a pain-free range to prevent any inflammatory reaction by forcing joint movement[3].

Codman or pendulum exercises performed with gravity are usually pain free. With the patient bent at the waist and extremity dangling, the weight of the extremity produces joint separation and eliminates a fulcrum at the glenoid or acromion with movement. The objective is to have the patient increase the arc of movement within a painful ROM[3].

Very few studies have been conducted regarding this frequently used shoulder exercise during the shoulder rehabilitation. It is essential to know whether this exercise remains passive in patients with shoulder pathology and also on addition of weight in order to provide distraction.

Thus the purpose of this study is to determine the shoulder muscles activity without weight and with weight to Codman's pendulum exercises in patients with frozen shoulder. Additionally, it also examined the activity of the shoulder musculature with various methods of performing Codman's exercises.

## METHODOLOGY

Study design: Cross sectional observational study

Sampling technique: Purposive

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Study setting: Various physiotherapy centers in Rajkot city

Sample size: 40 subjects

***INCLUSION CRITERIA***

- Age group: 50-60 years
- Gender: Male and female patients
- Patients with unilateral frozen shoulder
- Patients with diagnosis of idiopathic frozen shoulder
  - Acute or sub-acute phase (1 week to 6 months)
  - Capsular pattern of restriction present

***EXCLUSION CRITERIA***

- Patients with traumatic injury to shoulder
- Patients with rotator cuff tear
- Patients with impingement syndrome
- Patients with vertigo or giddiness
- Patients with cervical or upper limb injury
- Post traumatic frozen shoulder
- Patients with back pain
- Uncooperative patients

**PROCEDURE**

The proposed title and procedure was being approved by ethical committee members. 40 participants who fulfilled the inclusion and exclusion criteria were selected. Prior to measurement all the sites of electrode placements were abraded with sand paper cleaned with alcohol to minimize the skin impedence[5]. Surface electrodes applied with electrode gel were positioned on the target muscle (viz. anterior deltoid, biceps long head, triceps long head, supraspinatus, infraspinatus and upper trapezius).

The maximum voluntary isometric contraction (MVIC) was taken from the unaffected shoulder with the patient positioned in the standard manual muscle testing position for the best isolation of the targeted muscle[6].

Participants were then positioned with the non-tested arm resting on a table and the upper extremity to be tested hanging down for free movement. Trunk flexion at the hips was kept at a 90° angle from the upright vertical position.

The "pendulum" or swinging motion was initiated by having the participant move their trunk slightly back and forth until motions of external circumduction were achieved. Participants were asked to perform four variations of the Codman's exercise:

- Without any weight held in hand or suspended.
- With dumbbell held in hand with a cylindrical grasp.
- With a ball weight held in hand with a hook grasp.
- With a ball weight tied and suspended from the wrist.

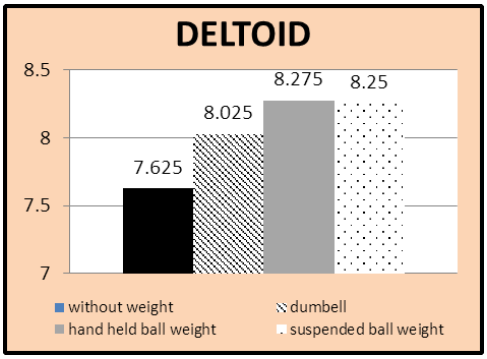
Three trials for each variant were performed to allow participants to become comfortable with the motion and the testing procedure. The third trial was used for the data collection. The entire testing procedure was done on the same day in a single session. The EMG signals were acquired and analyzed using the RMS EMG PK M-II software.

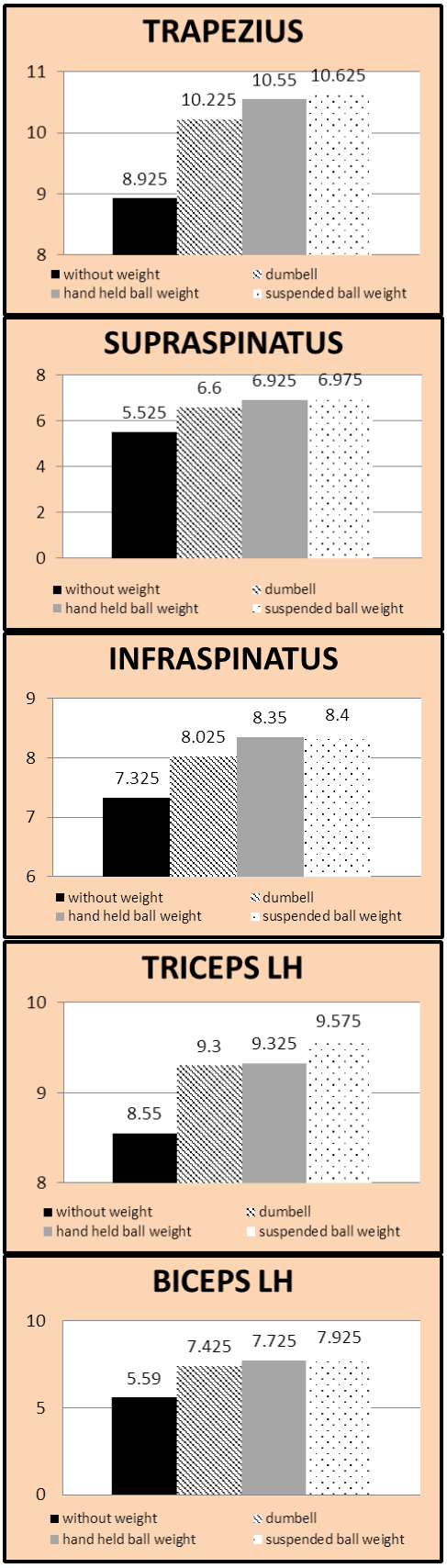
## RESULTS

All Statistical analysis was done by software SPSS 14.0 version. Means and Standard Deviation (SD) were calculated as a measure of central tendency and measure of dispersion respectively. The effect of the different types of Codman's exercises on muscle activity was examined using a repeated measure Analysis of Variance (ANOVA) with Bonferroni corrections for pair-wise comparisons.

Repeated measure ANOVA with Bonferroni corrections is used for pairwise comparison of activity of each muscle during all the variants of Codman's exercise. The results indicate that a significant increase is found in muscle activity in Deltoid muscle with weight compared to without weight ($p<0.05$). Similar results are found for all the other muscles. It has been identified that muscle activity significantly increases in pendulum exercises with hand held ball weight and suspended ball weight compared to dumbbell for all the muscles ($p<0.05$) except for Triceps LH in which no significant difference is found with any of the weighted pendulum exercise variants ($p>0.05$) and for Biceps LH in which significant increase in activity is found only in suspended ball weight compared to dumbbell ($p>0.05$). However no significant difference is found between hand held ball weight and suspended ball weight variants in all the muscles ($p>0.05$).

The graphs show the mean %MVIC of different muscles during various Codman's exercises.






## DISCUSSION

The results of the present study supports the experimental hypothesis which shows the significant difference between the shoulder muscles EMG activity during un-weighted and weighted pendulum exercise in Frozen Shoulder (FS) patients.

The increase in muscle activity with addition of weight is mainly because of the difficulty in relaxing the muscles completely due to altered scapulohumeral rhythm. Though there is a significant increase in muscle activity on addition of weight, the percentage of muscle activity is found below 15% for all types of exercise for all the Codman's exercise variants. That is the reason that majority of the Codman's pendulum exercise fell below the optimal value. The categories of the muscle activity are: 1) Minimal- if <20% MVIC activity 2) Moderate- if 20%-50% MVIC activity and 3) Maximal- if >50% MVIC activity is recorded as identified by McCann et al[4].

Other reason which is associated is the arc of pendulum which affects the muscle activity, if the exercise is performed in different arcs. The patients sometimes mistakenly make this an active exercise, performing it incorrectly by using their shoulder muscles to swing the arm rather than simply allowing it to hang in a relaxed state. In one such study Joy L Long et al found that incorrect and correct large pendulums elicited more than 15% maximum voluntary isometric contraction in the supraspinatus and infraspinatus[7].

The hand grip force also plays role in increasing the muscle activity. The grip force affect the shoulder muscle activation and with the increase in load the shoulder muscles may have to work more to stabilize the extremity. This is supported by Sporrong H et al who found that high static handgrip force, particularly in elevated arm positions, increases the load on some shoulder muscles. The stabilizing muscles i.e. the rotator cuff muscles were more influenced than the motor muscles by hand activity[8,9].

Also the type of exercise i.e. closed kinematic or open kinematic, may have effect on muscle activity. The muscle activity may have increased due to the increase in load in open chain which led the muscles to work more to stabilize the arm against distracting forces at the GH joint. It has been found that by varying the amount of arm support and force, different demands are imposed on the shoulder musculature[10,11,12].

It has been suggested that gentle therapy such as painfree pendulums and active exercises is better than the intensive therapy such as passive stretching and manipulation in treatment of adhesive capsulitis or frozen shoulder[12]. Yet as the activity for all the muscle remains minimal making it a suitable exercise not only in FS but also in early rehabilitation period as it provides greater distraction and increasing the muscle

activity but within minimal levels and in a painfree range.

Codman's exercises are usually pain free. With traction at the joint, the patient usually finds the exercises more comfortable. For additional traction, the patient can grasp a light weight, such as a dumbbell. The objective is to have the patient increase the arc of movement within a pain free ROM.

From the results of this study it can be concluded that addition of weight not only provides traction but also increases the muscle activity within pain limits. Thus weighted pendulum exercises can be prescribed as a progression in shoulder rehabilitation.

## LIMITATIONS

- The sample size is relatively small.
- The arc of the pendulums performed is not controlled for muscle activity. It varied with the patients.
- In regards to the use of surface EMG to measure muscle activity; the possibility of cross talk between muscles exists.

## FURTHER RECOMMENDATIONS

- Large sample size.
- Activity of other shoulder and scapular muscles can also be studied.
- Study can be done with varying amounts of weights.

## CONCLUSION

It can be concluded from the study that addition of weight to Codman's exercise gives distracting force as well as increases the muscle activation and hence can be used as a progression to shoulder rehabilitation program.

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# A STUDY TO COMPARE THE EFFECT OF FLOW ORIENTED SPIROMETER (FIS) WITH VOLUME ORIENTED SPIROMETER (VIS) ON PULMONARY VENTILATION AFTER UPPER ABDOMINAL SURGERY

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***ABSTRACT***

***Aim: To compare the effect of flow oriented spirometer (FIS) with volume oriented spirometer (VIS) on pulmonary ventilation after upper abdominal surgery.***

***Methods: 50 subjects who fulfilled the inclusion and exclusion criteria were selected for the study with age group 30-40 years. All the subjects were assigned into 2 groups as per order of appearance, Group A (Volume oriented spirometer), Group B (Flow oriented spirometer) with 25 patients in each group. Group A was given volume oriented incentive spirometry (VIS) treatment and Group B had given flow oriented incentive spirometry (FIS) treatment. Pre and post test evaluation of FEV1, FVC and MVV were taken on 1st post operative day and on 7th day of the intervention.***

***Results: The result revealed that Group A showed improvement in terms of FEV1 (t=14.894; p< 0.05), FVC (t=13.89, p<0.05) and MVV (t=9.50; p<0.05) and Group B showed improvement in FEV1 (t=39.072; p< 0.05), FVC (t=21.978, p<0.05) and MVV (t=14.382; p<0.05). But there was more significant improvement in Group A for FEV1 (t=2.309; p<0.05), FVC (t=2.384; p<0.05) and MVV (t=2.517; p<0.05) compared to Group B.***

***Conclusion: Both VIS and FIS improves pulmonary ventilation after upper abdominal surgery. But VIS showed better results in terms of FVC, FEV1, and MVV than FIS. Thus volume oriented incentive spirometer is better option in improving pulmonary ventilation after upper abdominal surgery.***

***KEYWORDS: Upper Abdominal Surgery; Volume Oriented Spirometer; Flow Oriented Spirometer; FVC; FEV1; MVV***

## INTRODUCTION

Postoperative pulmonary complications (PPCs) are a major problem after upper abdominal or thoraco-abdominal surgery. They lead to a prolonged intensive care unit (ICU) stay as well as increased costs and are one of the main causes of early postoperative mortality[1]. The common complications after surgery are incisional hernia, wound infection, wound dehiscence, limb edema, pain, drowsiness, depression and aspiration[2,3]. Pulmonary complications occur more frequently than cardiac complications and may arise from pneumonia, atelectasis, respiratory failure, bronchospasm and exacerbation of underlying chronic lung disease. Recumbent positioning and decreased mobility leads to further regional hypoventilation[4].

The basic mechanism of post pulmonary complications is a lack of lung inflation which occurs because of change in breathing pattern to a shallow, monotonous breathing without periodic sighs, prolonged recumbent position, temporary diaphragmatic dysfunctions, mucocilliary clearance which is impaired post-operatively along with decreased cough reflex. It is due to residual effect of anesthesia and analgesics increase risk associated with retained pulmonary secretions[5].

Midline and transverse (including oblique) incisions are the two commonest forms of incision used. A number of postoperative interventions have been recommended to decrease the risk of postoperative pulmonary complications with main aims to reverse atelectasis and secretions retention, and include deep breathing exercises, positioning, airways clearance techniques and mobilization. Intermittent, deep, prolonged inspiration efforts are thought to re-inflate collapsed alveoli, increased pulmonary compliance and reduce regional ventilation-perfusion inequalities[6].

Incentive spirometer is used clinically as a part of routine prophylactic and therapeutic regimen in postoperative respiratory care. It is a device that encourages through visual and auditory feedback as well as the performance of reproducible sustained maximal inspiration. It allows greater sustained inspiration and enables the patient to inspire with very little additionally imposed work of inspiration, thereby helping to improve lung expansion in those at a risk of postoperative pulmonary complication[7].

The incentive spirometer has a wide application for the treatment of postoperative atelectasis in abdominal, thoracic, and neurosurgical patients. Benefits attributed to incentive spirometry include the amelioration of

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atelectasis, and improved coughing mechanism due to improved inspiratory capacity, and a strengthening of the diaphragm. Also one of proposed benefits for incentive spirometer is that patient can assume responsibility for their own treatment, thus reducing the amount of direct patient contact time with the therapist[8].

There are two types of Incentive spirometers available in routine clinical practice flow oriented incentive spirometer (FIS) and volumetric-oriented incentive spirometer (VIS). Flow oriented spirometer are flow dependent.

Despite the widespread use of incentive spirometer (IS), recent systematic reviews suggested, based on the questionable methodological quality of previous trials, that their benefits are controversial. So, purpose of the study is to compare the effect of flow oriented spirometer (FIS) with volume oriented spirometer (VIS) on pulmonary ventilation after upper abdominal surgery.

Pulmonary function test performed at the bedside to provide immediate information about the need for respiratory therapy and its effectiveness. It includes measurement of the lung volumes and capacities (tidal volume, inspiratory capacity etc.), ventilation, pulmonary mechanics and diffusion, expiratory flows (forced expiratory capacity, forced expiratory flow in 1 second etc.). Primary purpose of pulmonary function test is to identify pulmonary impairment and to quantify the severity of pulmonary impairment[9].

Forced vital capacity (FVC) is the maximum volume of gas the patient can exhale as forcefully as possible. Forced expiratory volume in 1 second (FEV1) is the maximum volume of gas a patient can exhale in the first second during FVC maneuver. Maximum voluntary ventilation is the maximum volume of gas a patient can move during 1 minute[9].

So the purpose of the study is to compare the effect of flow oriented spirometer (FIS) with volume oriented spirometer (VIS) on pulmonary ventilation after upper abdominal surgery.

## METHODOLOGY

Study design: Comparative study
Sampling technique: Purposive sampling Technique
Study setting: Civil Hospital, Rajkot. Subjects underwent upper abdominal surgery via transverse, midline and paramedian incision.

### SAMPLE SELECTION

50 subjects who underwent upper abdominal surgery with age group of 30-40 years (35.36±3.56 (SD)), who fulfilled the inclusion and exclusion criteria were selected for the study. The subjects were selected by purposive sampling and assigned to group A and group B according to their order of appearance. The study was approved by the members of ethical committee.

GROUP A: 25 subjects who received the exercise in form of flow oriented spirometer training.

GROUP B: 25 subjects who received the exercise in form of volume oriented spirometer training.

Study Duration: 10 breaths 5 times a day for 7 days

***INCLUSION CRITERIA:*** [10,11]

- Age group: 30-40 years
- Both male and female patients were included.
- Patients who underwent upper abdominal surgery (midline, transverse and paramedian incision)

***EXCLUSION CRITERIA:*** [10,12]

- Patient underwent abdominal surgery in the past
- Smokers and ex-smokers
- Uncooperative subjects
- Patients having any chest or cardiovascular diseases
- Patients having any neurological disorders and orthopaedic disorder

### MEASUREMENT PROCEDURE:

PFT (Pulmonary Function Test):

Pulmonary function test was taken pre and post training as per the standards outlined by American Thoracic Society[12].

Position of the subject:

Patients were asked to sit in comfortably sitting position and were made fully relaxed prior the pulmonary function test. (Figure 1)

**FIGURE 1: PFT MEASUREMENT**

For performing the pulmonary function tests subjects were given a comfortable starting position as described above, a soft nose clip was placed to prevent air escaping from nose and test was performed.

For FVC and FEV1 subjects were asked to take the deepest breath as much as possible than place the mouthpiece in mouth with lips sealing it and immediately exhale hard and fast for as long as possible, preferably at least 6 seconds followed by a rapid inspiration from the mouthpiece.

For MVV subjects were asked to do deep inspiration and expiration for 1 minute.

Three trials were given for each procedure and best trial was selected. The trial was considered "unacceptable" if it showed evidence of cough, early termination of expiration or inconsistent effort.

After calculation the machine showed the results in form of printed graphs showing one of the 4 patterns: Normal, obstructive, restrictive or combined[12].

Treatment by (FlS) Mediciser and (VIS) Voldyne spirometer.

Patients were asked to take half lying position and hold the volume oriented incentive spirometer in an upright position and cover the stitches with pillow.

They were asked to exhale normally then place lips tightly around the mouthpiece and seal the mouthpiece with lips.

For group A patient were asked to place lips tightly around the mouthpiece and seal the mouthpiece with lips and inhale slowly to raise the ball in the chamber as high as patient can.

For group B they were asked to then inhale slowly to raise the bellow in the chamber and continue inhaling and try to raise the piston as high as patient can.

When patient could not inhale any larger, the mouthpiece was removed and breath held for 10 seconds or as long they could.

Then they were asked to exhale normally.

The exercise was repeated 10 breaths 5 times a day for 7 days[10,13].

**FIGURE 2: TREATMENT WITH VOLUME ORIENTED SPIROMETER**

**FIGURE 3: TREATMENT WITH FLOW ORIENTED SPIROMETER**

## STATISTICAL ANALYSIS

Study design: Interventional study.

Test: The collected data were analyzed by using paired t-test to compare the result for single position pre & post values and unpaired t-test was used to compare the result between two positions at 0.05 level of significant with 95% of confidence interval.

Statistical software: The statistical software named SPSS 14.00 was used for data analysis. Microsoft Excel and Word were used to generate graphs and tables.

### TABLES

**TABLE 1: INTRA GROUP COMPARISON OF FEV1, FVC AND MVV FOR FLOW ORIENTED SPIROMETER (FIS) FOR THE STUDY**

| Parameters | Mean ± Std. Deviation | | t | p | Result |
|---|---|---|---|---|---|
| | Pre | Post | | | |
| FEV1(L) | 0.71 ± 0.18 | 1.18 ± 0.17 | 39.07 | <0.05 | S |
| FVC(L) | 0.93 ± 0.22 | 1.50 ± 0.21 | 21.97 | | |
| MVV(L/min) | 21.76± 3.87 | 28.44± 4.18 | 14.38 | | |

Where, S = significant, NS-not significant.

Interpretation: The result shows significant difference for pre and post FEV1 (t=39.072, p<0.05) FVC (t= 21.978, p<0.05) and MVV (t = 14.18, p<0.05) of flow oriented spirometer (FIS).

**TABLE 2: INTRA GROUP COMPARISON OF FEV1, FVC AND MVV FOR VOLUME ORIENTED SPIROMETER (VIS) FOR THE STUDY**

| Parameters | Mean ± Std. Deviation | | t | p | Result |
|---|---|---|---|---|---|
| | Pre | Post | | | |
| FEV1(L) | 0.75 ± 0.23 | 1.31 ± 0.27 | 14.894 | <0.05 | S |
| FVC(L) | 1.10 ± 0.41 | 1.79 ±0.33 | 13.89 | | |
| MVV(L/min) | 25.32± 8.20 | 34.76±10.54 | 9.50 | | |

Where, S = significant, NS-not significant.

Interpretation: The result shows significant difference for pre and post FEV1 (t=14.894, p<0.05), FVC (t=13.89, p<0.05) and MVV (t=9.50, p<0.05) of volume oriented spirometer (VIS).

**TABLE 3: BETWEEN GROUP COMPARISON OF FEV1, FVC AND MVV VALUES FOR VOLUME AND FLOW ORIENTED SPIROMETER FOR THE STUDY**

| Parameters | Mean ± Std. Deviation | | t | p | Result |
|---|---|---|---|---|---|
| | Flow oriented | Volume oriented | | | |
| FEV1(L) | 0.47 ± 0.060 | 0.56 ± 0.18 | 2.309 | <0.05 | S |
| FVC(L) | 0.57 ± 0.13 | 0.69 ± 0.23 | 2.384 | | |
| MVV(L/min) | 6.68 ± 2.32 | 9.44 ± 4.96 | 2.517 | | |

Where, S = significant, NS-not significant.

Interpretation: The above table shows a significant difference in the FEV1 (t=2.309, p<0.05), FVC (t=2.384, p<0.05) and MVV (t=2.517, p<0.05) score in both the groups but more significant improvement was found in FEV1, FVC, and MVV, in group B patients compared to group A. The result shows volume oriented spirometer is more effective.

## DISCUSSION

This study was conducted to determine the efficacy of flow-oriented incentive spirometer versus volume-oriented spirometer training in

management of pulmonary complications after upper abdominal surgery. It included 50 patients who underwent upper abdominal surgery with ages 30-40 years mean ± SD (35.36±3.56), the patients were equally assigned into two equal groups: Group (A), 25 patients received flow-oriented incentive spirometer training. Group (B), 25 patients received volume oriented incentive spirometer training.

The presence of preoperative respiratory symptoms and impaired spirometric parameters as forced vital capacity (FVC) and forced expiratory volume in 1st second (FEV1) were the most valuable risk factors for early prediction of post-operative pulmonary complications[14].

The result of the present study supports the Experimental hypothesis which stated that there is a significant difference in the FEV1 ($t=2.309$, $p<0.05$), FVC ($t=2.384$, $p<0.05$) and MVV ($t=2.517$, $p<0.05$) score in both the groups but more significant improvement was found in FEV1, FVC, and MVV, in group B patients compared to group A.

There is a significant increase in FEV1 ($t=2.309$, $p<0.05$) score in both the groups but more significant improvement was found in FEV1 in patients doing exercise with volume oriented incentive spirometer compared to FEV1 for flow oriented incentive spirometer. The result of the present study was supported by the study of Gopala Krishna Alaparthi et al., (2013) compared the effect of flow and volume oriented Incentive spirometry on lung function and diaphragm movement after laparoscopic abdominal surgery and found that volume oriented incentive spirometry contributed towards early recovery of pulmonary functional diaphragm movement among patients who had undergone laparoscopic abdominal surgery due to the fact the inspiratory volume indicated on volume oriented incentive spirometer is determined by the volume inspired. Patients may adjust their inspiratory flow rate and inspiratory time to inflate their high time constant alveolar units[15].

There is a significant increase in FVC ($t=2.384$, $p<0.05$) score in both the groups but more significant improvement was found in FVC in patients doing exercise with volume oriented incentive spirometer compared to mean value of FVC for flow oriented incentive spirometer. Illia ndf lima et al., (2013) studied acute effects of volume-oriented incentive spirometry on chest wall volumes in patients after stroke and found that is promotes an increased expansion in all compartments of the chest wall and reduces the asymmetric expansion between right and left pulmonary rib cage due to the fact that incentive spirometry induce similar increases in chest wall expansions and reduce asymmetry of the two pulmonary rib cage expansion supported the result of present study[16].

Paula Agostini et al., (2008) reported that use of flow oriented incentive spirometer may be less appropriate for high postoperative risk patients given the increased work of breathing and upper chest motion associated with the device and there may be some advantages in using volume oriented incentive spirometer, such as improved diaphragmatic activity and decreased work of breathing[17].

Mang et al., (1989) tested different volume and flow-oriented spirometers in the laboratory[7] and reported significant differences in the WBimp between different incentive spirometers and postulated a potential clinically relevant effect on incentive spirometry primarily in patients at risk for inspiratory muscle fatigue[8].

Postoperative hypoxemia reduced by IS due to its ability to encourage long, slow, sustained deep inspiration which leads to achieve maximal inflating pressure in the alveoli and maximal inhaled volume. It also maintains the patency of the smaller airways, improve inspiratory muscle performance and stimulate normal patterns of pulmonary hyperinflation[18].

## LIMITATIONS OF THE STUDY

- Sample size was relatively small.
- Study duration of the treatment protocol was short.
- A control group was not taken for the study.
- The pain was the confounding factor to interfere with the ability to produce a sustained maximum inspiration of interventional program.
- Anesthesia may hamper performance of patient was not taken into consideration.

## CONCLUSION

Volume oriented incentive spirometer (VIS) and flow oriented spirometer (FIS) have found to be effective in improving pulmonary ventilation after upper abdominal surgery. The subjects who received volume oriented incentive spirometer (VIS) showed better results in terms of FVC, FEV1, and MVV compared to flow oriented spirometer (FIS) which showed additional work of breathing and increased accessory respiratory muscle activity in flow oriented spirometer.

Hence it can be concluded that volume oriented incentive spirometer is better option in improving pulmonary ventilation after upper abdominal surgery.

## FURTHER RECOMMENDATIONS

- Study can be done with larger sample size.
- Study can be done by addition of deep breathing exercise to both the groups.

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# EFFECTS OF SLUMP STRETCHING TECHNIQUE ON GRADE I HAMSTRING STRAIN

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***Abstract***

***Aim and Objectives: To compare the recovery period of slump positive grade I hamstring injured cricket players being treated with: a) traditional treatment, with slump stretching; to b) traditional treatment.***

***Intervention and Outcomes: Of the 9 association approached, only 6 agreed to participate in the survey. Of the 6 associations involved in the study, three did not use slump as treatment technique, but treated along traditional lines, which enabled these to be used as controls. The remaining three associations used slump stretch in addition to the traditional treatment methods. Pain response is established following each component of the test. The recovery period was defined as the number of matches missed between injury and one complete pain free match. The number of matches missed was chosen because clinically, the players and coaches are only concerned with this aspect of the injury.***

***Results: The number of games missed through this injury was then analyzed between the two groups. This result is displayed as a frequency histogram. Due to the askew shape of the distribution, the normality of variance assumption required by the t-test was violated. By collapsing the data into a 2 x 2 contingency table, chi-square statistical analysis was used. The difference between the two groups was found to be statistically significant ($p<0.001$).***

***Conclusion: This study has demonstrated that the slump stretching technique, combined with traditional modalities, is a more effective treatment regime for managing grade I hamstring strain in patients who demonstrate a positive slump test.***

***KEYWORDS: Slump test; Grade I hamstring strain***

## INTRODUCTION

Hamstring strain has been described as being among one of the most difficult and refractory conditions to treat in sports medicine[20]. Grade I hamstring strains can be vague and varied, ranging from "hamstring pull" to "minor tear". The criteria being used for diagnosis of muscle injuries, we define Grade I hamstring injuries as follows:

- pain and tenderness in the hamstring muscles,
- pain and decreased strength on isometric contraction, and
- decreased length of the hamstring [as measured by straight leg raise (SLR) test].

These criteria may not be as definitive as they seem, as pain and tenderness within the muscle may be due to referred pain from lumbar pathology[1,5,14,19,22] and/or abnormal tension within the nerve roots or dura[5,8,10,23]. Clinical tests for determining hamstring strength and length also have their pitfalls. It is difficult to differentiate muscle weakness due to pain inhibition from actual muscle pathology. There is no objective method of measuring the strength of muscles that will determine whether they exhibit a weakness due to intramuscular trauma or whether they exhibit weakness due to reflex pain inhibition.

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Cibulka et al.[4], in a study of subjects with hamstring strains, were able to demonstrate a significant increase in hamstrings peak torque for the group which received sacroiliac joint manipulation, as compared to a non-manipulated group. They claimed a relationship between sacroiliac joint dysfunction and hamstring torque.

However it could be argued that it was the sacroiliac joint dysfunction, and its referred pain, which resulted in the initial apparent reduction in hamstrings torque.

Traditionally, the SLR test has been used to measure hamstring length[12,13,21] but it is also used as a test to measure abnormal neural tension in lumbar pathology[2,3,5,7,8,10,23]. This dual function of the SLR renders it dubious as a differentiation test between hamstring muscle strain and abnormal neural tension.

Gajdosik et al.[9], using ankle dorsiflexion in an attempt to sensitize the SLR as a test of neural tension, could not discount the tension of the posterior structures of the knees as a limiting factor to the test. Brieg and Troup[2] used cervical flexion and medial rotation in their attempt to sensitize the SLR test. In their cadaver studies, they were able to show that medial hip rotation in the SLR position involves medially rotating the tibia (biceps femoris being a lateral rotator of the tibia).

Maitland[17] advocated the use of the "slump test" to measure the tension of the "pain sensitive structures within the vertebral canal or intervertebral foramina" (p.215). He claimed that

this test, combining vertebral flexion, SLR, and ankle dorsiflexion, was more sensitive than the existing tension tests. This was supported, in a clinical study, by Massey[18]. In her study of 50 patients with low back pain, she found the slump test to be more sensitive in reproducing the patients' symptoms than any of the traditional tension tests. Therefore, the slump test could be used to differentiate limitation of the SLR due to hamstring length from limitation due to neural/dural tension.

The need for a differentiation test was highlighted in Kornberg's investigation15. His double blind study showed a high incident of positive slump test in grade I hamstring injured football players, compared to a control group. He defined a positive response to the slump test as reproduction of the patient's symptoms in full slump position, with alleviation of symptoms with release of cervical flexion.

Since the slump test is a spinal test which is aimed at determining the relationship between the mobility of the pain sensitive structures in the vertebral canal and/or intervertebral foramen6, in Kornberg's study indicated that abnormal neural tension was responsible for symptoms mimicking hamstring strain and/or that abnormal neural tension predisposed to hamstring muscle pathology. However, if local muscle pathology could irritate the nerve endings, and it is these irritated the nerve endings which are responsible for the presentation of symptoms, then it is feasible that stretching these neural structures may reproduce the symptoms.

In view of this, it was decided to compare the recovery period of slump positive grade I hamstring injured cricket players being treated with: a) traditional treatment, with slump stretching; to b) traditional treatment. If symptoms were caused by muscle pathology, however indirectly, then stretching neural structures would have no beneficial effect on recovery time.

## METHODS

A double blind survey was set up in 9 professional crickets Associations, using the association Physiotherapist as the assessor. Of the 9 association approached, only 6 agreed to participate in the survey. Recording sheets were then distributed to the participating clubs. The subjects for this study had to satisfy the following criteria:

- Play cricket professionally
- Be aged between 17 to 35 years
- Be able to fulfill the criteria for grade I hamstring strain, as described previously.
- Have no diagnosed lumbar pathology, with or without distal symptoms.
- Have a positive response to the slump test, as defined by Kornberg[15].

Of the 6 associations involved in the study, three did not use slump as treatment technique, but treated along traditional lines, which enabled these to be used as controls. The remaining three associations used slump stretch (FIGURE 1) in addition to the traditional treatment methods. Other than slump stretching technique, there was no apparent difference in the other treatment received.

**FIGURE 1**

Prior to data collection, to ensure consistency of assessment of the slump test, a practical demonstration was held, with the observers present to demonstrate the procedure. The procedure for examining the slump test was as follows, assuming that the left leg was being tested. Pain response is established following each component of the test.

- Player seated at the edge of the couch, with knees flexed to 900, popliteal surface of the knee in contact with the couch, and posterior aspect of the thighs fully supported by the couch (FIGURE 2)
- Player instructed to slump his back, by the therapist standing on his left (FIGURE 3)
- Maximum slump of the back was maintained by the therapist bearing down with his /her axilla and forearm on the shoulders of the player (FIGURE 4).
- Maintaining that pressure, the player was instructed to bend his head down to his chest. The therapist, using his/her chin, increased the neck flexion to the end of range (FIGURE 5).
- The player then was instructed to "straighten your knees as far as you can" (FIGURE 6).
- The player then was asked to "bring your foot and toes back as far as you can" (FIGURE 7).
- Using his/her left hand, the therapist pulled the player's foot into maximum dorsiflexion and knee extension (FIGURE 8).
- In full slump position, the player was asked to "tilt your head back and try to straighten the knee further" (FIGURE 8).
- The test was then repeated for the right leg and results recorded on the assessment sheet.

**FIGURE 2**

**FIGURE 3**

**FIGURE 4**

**FIGURE 5**

**FIGURE 6**

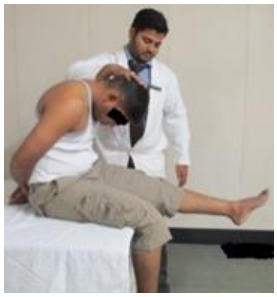

**FIGURE 7**

**FIGURE 8**

The recovery period was defined as the number of matches missed between injury and one complete pain free match. The number of matches missed was chosen because clinically, the players and coaches are only concerned with this aspect of the injury. One full, pain free match was then used as measure of full recovery, as this representative of the player's functional level.

Thirty seven recording sheets were returned for analysis. Of these, 28 players demonstrated positive slump test. Sixteen of the 28 players had been treated in the traditional manner. The remaining 12 were treated in the same manner, with the addition of slump stretching technique. Since it was double blind survey, the therapists chose whether to use slump stretching or not. All physiotherapists should have had full confidence in the treatment they chose, thus eliminating negative bias.

## RESULTS

The number of games missed through this injury was then analyzed between the two groups. This result is displayed as a frequency histogram. Due to the askew shape of the distribution, the normality of variance assumption required by the t-test was violated. By collapsing the data into a 2 x 2 contingency table, chi-square statistical analysis was used (Table 1).

Of the 12 players managed with traditional treatment and slump stretching technique, only 1 player missed more than one match. However, all 16 players treated in the traditional manner missed one or more matches.

The difference between the two groups was found to be statistically significant ($p<0.001$).

This indicates that the slump stretch, combined with traditional modalities, is more effective treatment for cricket players with grade I hamstring strain, exhibiting a positive slump test.

**TABLE 1: 2 X 2 CONTINGENCY TABLE SUMMARIZING DATA FROM THE EXPERIMENTAL AND CONTROL GROUPS OF SUBJECTS**

| | 0 Games Missed | 1+ Games Missesd |
|---|---|---|
| Experimental | 11 (4.71) | 1 (7.29) |
| Control | 0 (6.29) | 16 (9.71) |
| ($x2 = 20.47$; $df = 1$; $p< 0.001$) | | |

## DISCUSSION

Clinically, grade II and III hamstring strains can be identified by signs of bleeding and bruising. However, grade I injuries lack this clinical sign, and hence, are more difficult to differentiate from referred pain. Previous authors have associated lumbar pathology with hamstring strain11, whereas other authors identified lumbar pathology with referred as a syndrome that mimicked hamstring strain[20].

It can be argued that increased tension in the neural structures may elevate the resting tone of the hamstrings, thus predisposing them to intrinsic muscular pathology. Assuming muscular pathology was present in this group of slump positive grade I hamstring injured cricketers, it is difficult to explain how neural stretching technique could alter physiological healing time. If this assumption is held correct, then there should be no significant difference demonstrated between the experimental and control groups.

However, this study has demonstrated a significant ($p < 0.001$) difference between the two treatment regimes. Therefore, it is more logical to argue that it was abnormal neural tension which produced symptoms that mimicked hamstring injury. This may give some explanation as to why some hamstring injuries become recurrent, as traditional treatment may not have attended to the neural structures adequately.

It would be interesting to compare experimental (slump stretch and traditional) and control (traditional) treatments for cricketers, with grade I hamstring strains, exhibiting a negative slump test. If the slump test is definitive test, there should not be a significant difference between these treatments for the negative slump group. However, this study design allowed the therapist to choose the treatment regime. No therapist chose to use slump stretch technique on those cricketers exhibiting a negative slump test. Therefore, a different experimental design is necessary to adequately address this issue.

## CONCLUSION

This study has demonstrated that the slump stretching technique, combined with traditional modalities, is a more effective treatment regime for managing grade I hamstring strain in patients who demonstrate a positive slump test. Therefore, the slump test could be used as differentiation test in the assessment of hamstring strain, so that the most effective treatment regime may be implemented.

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# EFFECT OF CAPSULAR STRETCHING AND MAITLAND MOBILIZATION IN ADHESIVE CAPSULITIS – A COMPARATIVE STUDY

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***ABSTRACT***

***Introduction- The term "capsulitis" or "frozen shoulder" refers to a common shoulder condition characterized by the global restriction in the shoulder range of motion in a capsular pattern. Capsular stretching and Maitland mobilization is one of the treatment used to reduce pain, increase glenohumeral mobility and reduce disability. The aim of the present study was to find out the effect of capsular stretching and Maitland mobilization in adhesive capsulitis.***

***Methodology- A comparative study was carried on 30 subjects who were divided into two groups by convenient sampling method.***

***Procedure- subjects were divided into Group A (Capsular Stretching) and Group B (Maitland mobilization), 15 subjects in each group by convenient sampling method. Patient consent was taken and assessment was done on the basis of 3 outcome measures [VAS, ROM (external rotation, abduction, internal rotation), and SPADI] Capsular stretching and Maitland mobilization was given for 5 days period in 30 patients. Post test assessment was done on 5th day.***

***Results- Capsular stretching and Maitland mobilization were effective among which Maitland mobilization was significantly effective in reducing pain on VAS (mean=3.336 and p=0.005, significant improvement in ROM of external rotation (mean=7.666 and p=0.000), abduction (mean 27.166 and p=0.000), internal rotation (mean=9.333 p=0.001) and significant reducing in disability on SPADI (mean=31.73 p=0.000).***

***Conclusion- Maitland mobilization was significantly effective in reducing pain on VAS, improving glenohumeral mobility and disability.***

***KEYWORDS: Adhesive capsulitis; capsular stretching; Maitland mobilization; Visual Analogue Scale; Range Of Motion; Shoulder Pain and Disability index Scale.***

## INTRODUCTION

The term "capsulitis" or "frozen shoulder" refers to a common shoulder condition characterized by the global restriction in the shoulder range of motion in a capsular pattern. Capsular pattern in the shoulder is characterized by most limitation of passive lateral rotation and abduction[1]. In adhesive capsulitis, there is a lack of synovial fluid, which generally helps the shoulder joint, which is a ball, and socket joint, is moved by lubricating the gap between the humerus (upper arm bone) and the socket in the shoulder blade. The shoulder capsule get thickens, swells, and tightens due to bands of scar tissue (adhesion) that have formed inside the capsule. Due to this condition, there is less space in the joint for the humerus, which makes movement of the shoulder stiff and painful. The condition rarely appears in people under 40 years old, at least in its idiopathic form, which is much more common in women than in men (70% of patients are women aged 40–60)[3]. Frozen shoulder in diabetic patients is thought to be a more troublesome condition than in the non-diabetic population, and the recovery is longer. People complain that the stiffness and pain get worsens at night. Pain due to frozen shoulder is usually dull or aching and can get worsened with attempted motion[2]. The traditional principles of treatment of adhesive capsulitis are pain relief, maintain range of motion, and ultimately to restore function. Treatment of adhesive capsulitis by means of physiotherapy all along consists of different modalities (e.g., exercises, electrotherapy or massage) which may be applied side by side. The natural course of the condition is longer than generally stated and not always complete, that is, not all get fully recovered. Although adhesive capsulitis is generally considered to be a self-limiting condition that can be treated with physical therapy, to regain the normal extensibility of the shoulder capsule. Passive stretching of shoulder capsule in all planes of motion by means of mobilization techniques has been recommended.

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Grades I and II of Maitland mobilization techniques are primarily used for treating joints limited by pain. Oscillations may have an inhibitory effect on the perception of painful stimuli by repetitively stimulating mechanoreceptors that block nociceptive pathways at the spinal cord or brain stem levels. These nonstretch motions help to move synovial fluid to improve nutrition to the cartilage whereas Grades III and IV are primarily used as stretching maneuver[1]. Shoulder stretches helps to maintain balance among the muscles around the shoulders and upper back as well as help in loosening the tightness. Capsular stretches such as posterior capsule, inferior capsule, and anterior capsule stretch helps to loosen the tight capsule, improve ROM. In this present work, the purpose is to compare the efficacy between Maitland mobilization and capsular stretch in the rehabilitation of the adhesive capsulitis.

### AIM

To find out the most effective technique between capsular stretching and Maitland mobilization in adhesive capsulitis.

### OBJECTIVES

- To study the effectiveness of capsular stretching in adhesive capsulitis.
- To study the effect of Maitland's mobilization in adhesive capsulitis.
- To compare the effect of capsular stretching and Maitland's mobilization in adhesive capsulitis.

## METHODOLOGY

The study was approved by the ethical committee & faculty of physiotherapy department, Tilak Maharashtra Vidyapeeth Pune. The study was done in Military Hospital, Khadki, Pune. A total of 30 subjects diagnosed with adhesive capsulitis stage 2 & 3 between age group 40-60 yrs both male and female were included. Subjects with additional shoulder joint pathology, History of humerus fracture and dislocation and Subjects with medical co-morbidities such as uncontrolled HTN was exclusion criteria.

Methods: This study was pre & post test experimental study Capsular stretching and Maitland mobilization was given for 20 minutes for 5 consecutive days period in 30 patients. They were divided into Group A (Capsular Stretching) (15 subjects) and Group B (Maitland mobilization) (15 subjects) by convenient sampling method. Patient consent was taken and assessment was done on the basis of 3 outcome measures [VAS, ROM (external rotation, abduction, internal rotation), and SPADI] and were reassessed on the 5th day.

Group A was given capsular stretching 5 sessions for a period of 1 successive week.

- ANTERIOR CAPSULAR STRETCH
- POSTERIOR CAPSULE STRETCH
- INFERIOR CAPSULE STRETCH

Group B was given Maitland's mobilization.

- ANTERIOR GLIDE
- POSTERIOR GLIDE
- INFERIOR GLIDE

### OUTCOME MEASURES

- Visual Analogue Scale (VAS)
- ROM (External Rotation, Abduction and Medial Rotation)
- Shoulder Pain And Disability Index Scale.

### STATISTICAL ANALYSIS

Statistical analysis was done using SPSS software version 20.

In which Wilcoxon Signed Rank Test was used to analyze within group variables and Mann Whitney U Test was used to analyze between group variables.

## RESULTS

**TABLE 1: MEAN OF AGE BETWEEN GROUP A (CAPSULAR STRETCHING) AND GROUP B (MAITLAND MOBILIZATION).**

| | Mean | SD | P | 95% Confidence Interval of the difference | | Significance |
|---|---|---|---|---|---|---|
| Group A | 48.93 | 5.59 | 0.409 | Lower | Upper | Significant |
| Group B | 51.26 | 6.34 | | 2.48 | 7.15 | Significant |

**TABLE 2: PERCENTAGE OF GENDER AFFECTED BY ADHESIVE CAPSULITIS.**

| Gender | N |
|---|---|
| Male | 10 |
| Female | 20 |

**TABLE 3: AFFECTED SIDE**

| Side | N |
|---|---|
| Left Hand | 10 |
| Right Hand | 20 |

**TABLE 4: DIFFERENCE OF VAS BETWEEN GROUP A (CAPSULAR STRETCHING) AND GROUP B (MAITLAND'S MOBILIZATION)**

| Mean | S D | Mann Whitney U test | 2 – tailed test | 95% Confidence Interval Of The Difference | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| 3.336 | 0.999 | 50.50 | 0.005 | -1.592 | -0.407 |

**TABLE 5: DIFFERENCE OF EXTERNAL ROTATION BETWEEN GROUP A (CAPSULAR STRETCHING) AND GROUP B (MAITLAND'S MOBILIZATION).**

| Mean | SD | Mann Whitney U test | 2 – tailed test | 95% Confidence Interval Of The Difference | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| 7.666 | 4.3018 | 37.50 | 0.000 | -6.878 | -2.454 |

**TABLE 6: DIFFERENCE OF ABDUCTION BETWEEN GROUP A (CAPSULAR STRETCHING) AND GROUP B (MAITLAND'S MOBILIZATION).**

| Mean | SD | Mann Whitney U test | 2 – tailed test | 95% Confidence Interval Of The Difference | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| 27.166 | 15.181 | 17.00 | 0.000 | -30.660 | -11.339 |

**TABLE 7: DIFFERENCE OF INTERNAL ROTATION BETWEEN GROUP A (CAPSULAR STRETCHING) AND GROUP B (MAITLAND MOBILIZATION)**

| Mean | SD | Mann Whitney U test | 2 – tailed test | 95% Confidence Interval Of The Difference | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| 9.333 | 5.208 | 11.00 | 0.001 | -10.842 | -5.842 |

**TABLE 8: DIFFERENCE OF SPADI SCALE BETWEEN GROUP A (CAPSULAR STRETCHING) AND GROUP B (MAITLAND'S MOBILIZATION).**

| Mean | SD | Mann Whitney U test | 2 – tailed test | 95% Confidence Interval Of The Difference | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| 31.73 | 7.371 | 23.00 | 0.000 | -13.85097 | -4.28236 |

## DISCUSSION

Adhesive capsulitis refers to a common shoulder condition characterized by the global restriction in the shoulder range of motion in a capsular pattern. The annual incidences of adhesive capsulitis are 3-5 % in general population and up to 20% in people with diabetes. It commonly affects women aged between 40 and 60 years. In our study the mean of age was 50.10 and p=< 0.0001 which was significantly effective. There were less evidence for comparison between effect of capsular stretching and Maitland Mobilization in adhesive capsulitis so; this topic has been selected to find which technique is most effective between capsular stretching and Maitland mobilization.

Adhesive capsulitis was more prevalent in females compare to male which is represented by table and no 2.This findings are in accordance with the study done by Neviaser RJ; Neviaser TJ in which they concluded that adhesive capsulitis condition is more prevalent in Women[3].

Capsular Stretching and Maitland mobilization techniques were effective in reducing pain on VAS while Maitland mobilization was significantly effective in reducing pain on VAS which is represented by Table No 4 which shows difference of VAS between Group A (Capsular Stretching) and Group B (Maitland Mobilization) in which Mann Whitney U Test was 50.50, p value was 0.005 which was statistically significant.

There was improvement in increasing glenohumeral end range motion such as external rotation, abduction and internal rotation with both capsular stretching and Maitland mobilization amongst which Maitland mobilization was more significantly effective in increasing glenohumeral end range motion represented by Table No 5 which shows difference of external rotation between Group A (Capsular Stretching) and Group B (Maitland Mobilization) in which Mann Whitney U Test was 37.50, P value was 0.000. Table 6 represents difference of abduction between Group A (Capsular Stretching) and Group B (Maitland Mobilization) in which Mann Whitney U Test was 17.00, p value was 0.000; Table No 7 represents difference of internal rotation between Group A (Capsular Stretching) and Group B (Maitland Mobilization) in which Mann Whitney U Test was 11, p value was 0.001, which was also statistically significant. This was found in accordance with Johnson AJ et. al. who found that Posterior Mobilization techniques are superior to Anterior Mobilization techniques for increasing glenohumeral End Range motion[5]. May S.F. Leung et.al. also found that addition of deep heating to stretching exercises produced a greater improvement in pain relief, which resulted in better performance in the activities of daily living and in range of motion than did superficial heating.

On pre-assessment we found that there was significant disability in right handed women on SPADI scale and there was greater restriction during ADLs which was significantly improved with Maitland Mobilization which is represented by Table No 8 showing difference of Shoulder Pain And Disability Index Scale between Group A (Capsular Stretching) and Group B (Maitland Mobilization) in which Mann Whitney U Test was 23.00, p value 0.000 which was statistically significant.

It can be commented that by giving Maitland Mobilization to male and females with disabilities and restrictions in ADLs can be improved to a significant value and their daily activities can be made easy to have good quality of life. From the study we can suggest that Maitland mobilization as an effective measure in treatment of adhesive capsulitis.

## LIMITATIONS AND RECOMMENDATION

- The study was conducted on small sample size. The study can be done with large sample size for more accuracy & better results.
- Treatment duration was for five days, which can be increased for longer duration to find out sustained effects.
- Study was done on population who were having primary adhesive capsulitis; same study can be performed on population with secondary adhesive capsulitis.

## CONCLUSION

The study concluded that Capsular Stretching and Maitland Mobilization are effective in reducing pain on VAS, improving ROM and disability on SPADI in adhesive capsulitis. However, Maitland Mobilization appears to be more effective in improving glenohumeral mobility and reducing pain on VAS and improving disability as compared to Capsular Stretching.

## ACKNOWLEDGEMENT

We would like to thank Military Hospital kirkee Pune for allowing to conduct the study. We extend our gratitude towards the patients for the consent and cooperation for the study.

## CLINICAL APPLICATION

Adhesive capsulitis is a most common condition affecting most of the population which needs effective physiotherapy techniques for its treatment. From this study it can be suggested that Maitland mobilization can be effectively used to reduce pain, improve mobility and improve functional abilities.

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# EFFICACY OF MECHANICAL VIBRATION CHEST PHYSIOTHERAPY INTERVENTION TO IMPROVE EXPECTORATION OF AIRWAY SECRETIONS AND PREVENT LUNG COLLAPSE IN VENTILATED ICU PATIENTS

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***ABSTRACT***

***Introduction: Almost 80% of patients in the intensive care unit are intubated and on mechanical ventilation. Thus, their airway clearance ability is compromised and their risk of lung collapse increased. A variety of interventions are used to enhance airway clearance with the goal of preventing atelectasis and infection. It is hypothesized that mechanical vibrators may help in improving the quality & frequency of chest physiotherapy in these groups of patients.***

***Aims & Objectives: To evaluate the comparison effects of manual and mechanical CPT techniques, such as manual technique percussion and vibration along with mechanical vibrator. To evaluate the decrease in chest infection rates & mortality in ventilated patients with head & spinal cord injury who received mechanical vibrator along with chest physiotherapy.***

***Materials & Methods: A total of 578 numbers of patients were participated in the study. Number of head Injuries 234 in CG (Control Group) and 206 participants of patients in TG (Test Group). In Spinal Injuries patients number participants in CG in 74 and TG which include 64 patients. The Mean Age between CG 30.75 and TG years 31.9 years. The gender participants of Male and Female Ratio 89:13(CG), 77:13 (TG). The Mean Admission GCS 9.9(CG) and 9.9(TG).The Average Ventilator Days 7.46(CG) and 7.9(TG) days Tracheal culture positivity 9.83% (CG) and 15.18% (TG).***

***Results: The present which demonstrate the mortality was significantly lower in the test group 17.4% as compared to the control group's 27.21%.The control group mortality rate which has got 31.48% and test group mortality rate in percentage 15.84%.***

***Conclusions: The present study demonstrate that the Use of mechanical vibrators which is performed through by physiotherapist and apply specific tailored chest physiotherapy strategy can improve outcomes and reduced chest infection rates in ventilated head & spinal injury patients.***

***KEYWORDS: Airway clearance; Mechanical vibrater; Critical care; MTC and LCI***

## INTRODUCTION

Operative procedures and the care of trauma victims have been recorded for centuries, with open chest surgery performed in Galen's time[1]. As a result of advances over the past two centuries in mechanical ventilation, anesthesia, and infection control the estimated number of surgical procedures in the United States in 1979 was 23,858,000. Included in this number were 445,000 cholecystectomies, 166,000 open heart operations, and 813,000 respiratory procedures[2]. The incidence of trauma has also been increasing in the United States and, in 1979, accounted for 65,000 hospital beds, and 22,000,000 bed days[3]. Although operative procedures are vast in number, sophisticated in techniques, and remarkable in results, they continue to harbor significant risks. Respiratory failure is either a major cause or a major contributing factor in 50 percent of postoperative death[3]. Treatment to prevent or modify respiratory complications has been a major focus of care for the operative patient. The purpose of this paper is to review chest physical therapy strategy used for postoperative or traumatic injury patients. This review will define and critically review postoperative pulmonary complications (PPC), and evaluative and therapeutic procedures used for the above types of patients. Needed investigations in chest physical therapy (CPT) will be proposed[4].

Techniques of chest physical therapy have been used since the early 1900s to decrease postoperative pulmonary complications. Through investigations since the 1950s, documentation as to the efficacy of chest physical therapy in actually reducing postoperative pulmonary complications has been published. However, the careful documentation of techniques employed (such as full Trendelenburg's position versus a modified position and vibration of particular force and frequency) has not been done. Also, because of an inability to specify the risk factors of postoperative pulmonary complications occurring in particular patients or to qualitative the occurrence of these complications, it is difficult to establish what treatment is most efficacious[5].

The purpose of this paper is to review physical therapy used for postoperative or traumatic injury patients. This review will define

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and critically review postoperative pulmonary complications (PPC), and evaluative and therapeutic procedures used for the above types of patients. Needed investigations in chest physical therapy (CPT) will be proposed.

A systematic review of non pharmacologic protrusive therapies found that a combination of more than 1 chest physiotherapy procedure may help to re inflate the collapsed lobe of a lung[8]. Many studies have suggested that postural drainage combined with chest percussion, as well as lung hyperinflation plus suction, are the best ways to quickly solve lung lobe atelectasis[9,10]. However, a head-down leg-elevated position is harmful to the vital signs of unstable patients, and is therefore not recommended for the critically ill. The manual performance of chest wall percussion or the use of a hand-driven chest vibrator is labor-intensive and highly operator-dependent, with its efficacy being quite variable. Auto percussion or auto vibration (1,000–1,200 cycles/min), which can be quantified and timed, is more objective and should provide more reliable data. Some studies have shown that high frequency chest compression leads to more mucus clearance and better lung function compared with conventional chest physiotherapy.

### SUCTIONING

Respiratory therapists, physiotherapist, and family members who have been taught the procedure may use suctioning to help remove secretions from the airways. A small plastic tube is introduced through the nose and extended a few inches into the windpipe (trachea). A gentle vacuum sucks out the secretions that cannot be coughed up. Suctioning is also used to remove secretions in someone who has a tracheostomy (a surgical opening in the trachea to allow breathing) or who has a breathing tube inserted through the nose or mouth and into the trachea (endotracheal tube) while on a ventilator.

## AIMS & OBJECTIVES

The purpose of this study was to test the effectiveness of a mechanical chest vibration pad linked with repositioning every 2 hours when used on mechanically ventilated critically ill patients with the aim of improving pulmonary secretion clearance and preventing lung collapse.

## METHODOLOGY

This retro-prospective study which was carried out those who met eligibility criteria which included in all ventilated head & spinal injured patients over six months stipulated period in Neurosurgery ICU. The clinical investigation which includes (demographics, admission GCS & in hospital mortality) & microbiological data (Modified tracheal culture) was collected over the two time periods. Simple randomization was performed using a table of random numbers, and eligible patients were randomly assigned into either a control or a test study group. The institutional review board approved the study protocol and informed consent was obtained from the entire participant. Patients in the control group received routine positioning care, which included a change of position every 2 hours by those who posted in ICU physiotherapist. The position turning sequence was left lateral, supine, right lateral and supine. Patients in the experimental group received routine positioning care plus mechanical chest vibration over 72 hours. The chest vibration physiotherapy intervention included placing a mechanical chest wall vibration pad on the patient's back for 60 minutes when the patient was turned into the supine position. The chest vibration intervention was performed 6 times a day, every 4 hours over the 72 hours. The vibration pad was placed from shoulder to sacrum. The mechanical chest wall vibration used was a Niagara vibrator type H.U.75, frequency 70 Hz, 1,000–1,200 cycles/min. The vibration wave was generated from the pad (40 × 60 cm) in spiral, vertical and horizontal directions. The patients lay on the pad with a blanket covering them. The vibrator was turned on and took just over half a second to reach the maximum frequency and range of vibration. During vibration therapy, hemodynamic status and vital signs were closely monitored, and if heart beat fluctuated >20bpm, blood pressure fluctuated >20mmHg, respiration rate fluctuated > 10 bpm, or oxygen saturation dropped to lower than 95%, vibration would be stopped immediately and the study process for that Clinically, the nurse suctioned the sputum into a suction bottle, and every morning, at 7 a.m., the investigator weighed the bottle, stirred it evenly, and drew out 10 mL, which was sent to the laboratory investigation of tracheal sputum culture analysis. The weight of the dried sputum was then multiplied to give the 24-hour amount. LCI was evaluated by 1 neuro anesthetist and 1 physiotherapist practitioner independently using a 4-point scale (0 = normal expansion, 1=single lobe collapsed, 2=2 lobes collapsed, 3=multiple lobes collapsed) and based on changes in routine chest X-ray and the patients' clinical presentation every morning. If there was disagreement between the LCI readings, a face-to-face discussion was held by the physician and the physiotherapy practitioner to achieve consensus. Univariate and multivariate analyses were used to compare the variables between the 2 groups.

Multivariate longitudinal regression analyses were performed using the generalized estimating equation (GEE). Continuous variables were compared using Student's test for normally distributed variables. The $\chi 2$ test was used to compare categorical variables. Statistical significance was considered at a p value $\leq 0.05$ for all comparisons. patient ended. However, none of the participants experienced any of the above episodes in this study. The mechanical ventilator settings for both groups were adjusted by certified respiratory therapists in compliance with the prescription. Tidal volume was set based on the patient's weight (10 mL/kg). The system was in the pressure control mode, with a pressure level of 20–25cm$H_2O$, and a plus positive end expiration pressure of 10–15cm$H_2O$ as the plateau pressure for inspiration was set < 35cm$H_2O$. Every ventilator was equipped with heated-wire humidifier, with the temperature set at 37°C and the moisture at 100%. The respiratory therapist checked the ventilator's temperature and moisture every 8 hours. ICU physiotherapist assessed the patient's breath sounds and suctioned out any secretion as needed.

Demographic and clinical data were collected on enrolment and included sex, age, diagnosis on admission, medical history, number of days intubated before enrolment, and APACHE II score. Before the treatment group interventions started, the outcome variables, 24-hour Tracheal culture sputum (TCS) and lung collapse index (LCI), were evaluated. They were also measured at 24, 48 and 72 hours after the study intervention began. Twenty-four-hour TSC was calculated from the 24-hour sputum collection, which had been dried using a heater set at 80°C for another 24 hours.

***Inclusion criteria***

- The participant age between 20 and 85 years,
- Expected use of a ventilator for less than three days,
- Participants must head and spinal injury
- APACHE-II (Acute Physiology and Chronic Health Evaluation, version II) score of 15–40,
- Ability to communicate in English
- Willingness to participate in the study.

***Exclusion criteria***

- Included skin damage to an area of the back,
- Any tendency towards acute bleeding,
- Presence of a chest drainage tube, fractured ribs or percutaneous emphysema, unstable intracranial pressure and patients who signed the "do not resuscitate" instruction.

# RESULTS

**TABLE 1: SHOWS REPORT NO. OF HEAD AND SPINAL INJURY PATIENTS, MEAN AGE, MEAN GCS, AVERAGE VENTILATOR USAGE AND TREACHEAL CULTUTE SPUTUM**

| | Control group | Test group |
|---|---|---|
| No.of Head Injury | 234 | 206 |
| No.of Spinal Injury | 74 | 64 |
| Mean Age | 30.75 | 31.09 |
| Mean Male/Female ratio | 89:13 | 77:13 |
| Mean GCS | 9.9 | 9.9 |
| Average ventilator | 7.46 | 7.9 |
| Tracheal cultute | 9.83 | 15.18 |

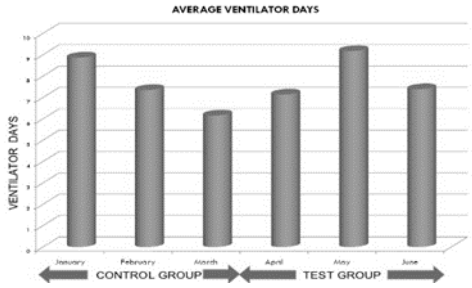


**DIAGRAM 1: AVERAGE USAGE OF VENTILATOR IN BOTH GROUP**

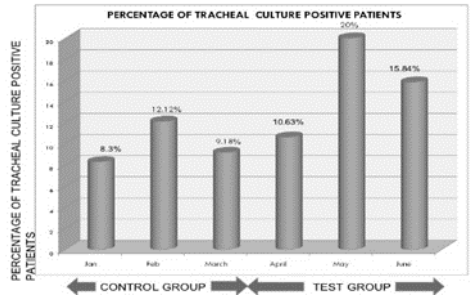


**DIAGRAM 2: PERCENTAGE OF TRACHEAL CULTURE IN SPUTUM**

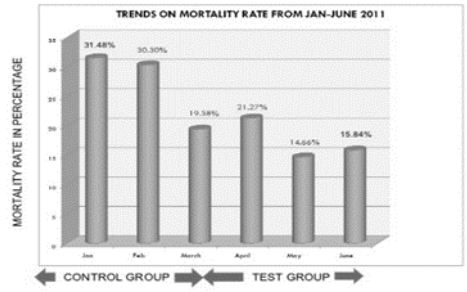


**DIAGRAM 3: SHOWING PERCENTAGE OF MORTALITY RATE**

# DISCUSSION

The performance of effective and safe pulmonary physiotherapy care always poses a challenge for physiotherapist taking care of ventilated ICU patients in light of their critically ill condition. Since manual percussion is no longer

used to help excrete sputum, the present study was conducted to provide empirical support for the effectiveness of vibration in preventing lung collapse. The results showed that for ventilated ICU patients, routine positioning care combined with 60 minutes of chest-wall deep vibration performed every 4 hours by auto vibrator at 1,000–1,200 cycles/min when patients were in supine position, plus suction if necessary, was able to achieve a significant difference in 24-hour TCS compared with a control group that received routine care only. The LCI in the experimental group also improved significantly at 48 and 72 hours compared to that in the control group. Our results are consistent with those of previous studies. A significant difference was found between the control and experimental groups at 24, 48 and 72 hours with regard to TCS after vibration, as monitored by GEE in time sequence. The predictive value for pre-test TCS was statistically significant at 24 hours after chest vibration started, but not at 48 and 72 hours. Thus, there was a significantly greater expectoration effect at 24 hours after auto chest vibration in the ventilated patients. At 48 and 72 hours, there was a continuing but only limited increase in excretion compared to the control group; however, this did not reach statistical significance.

A significant difference was also found between the control and experimental groups for LCI at 24, 48 and 72 hours after chest vibration, when monitored by GEE in time sequence. The statuses of lung collapse at the 3 time points were all able to predict pre-test LCI. We believe that chest vibration made a significant improvement to the rate of lung collapse at 24 hours for the ventilated patients with sputum retained in their airway because of the increase in sputum secretion. Later, at 48 and 72 hours, since there was no continuing increase in sputum secretion, the improvement at 24 hours remained significantly different relative to the pre-test state of lung collapse. In the regression analysis, pre-test TCS and grouping classification were the 2 significant predictors of 24-hour TCS. This result supports the idea that chest physiotherapy can have an immediate effect on the first day. In addition, the predictive factors of TCS at 48 hours included TCS at 24 hours, the postoperative status of the patient and COPD history. In other words, the TCS at 48 hours seemed to be affected by the amount of sputum excreted the day before, whether the patient had been operated on, and whether the patient had a history of COPD. The 2 most important predictors of TCS at 72 hours were the TCS at 48 hours and pre-test LCI (when patients were enrolled into the study). In summary, whether monitored at 24, 48 or 72 hours, the TCS of that day was always an important predictor of the following day's TCS. In addition, the TCS at 48 and 72 hours were affected by a previous history of pulmonary disease and pre-test lung collapse condition. Thus, it is clear that chest physiotherapy needs to be performed when patients have pulmonary morbidities or have had serious lung collapse. When monitoring LCI at 24, 48 and 72 hours, we found that the predictive factors for lung collapse at 24 hours included the pre-test status and grouping classification. This finding confirms the idea that there is an immediate effect of chest vibration on the first day of treatment. The predictive factors of LCI at 48 hours included the LCI and TCS at 24 hours, and history of cerebrovascular accident. The predictive factors of LCI at 72 hours included lung collapse status at 48 hours and grouping classification. These results indicate that, whatever the time point, the LCI of that day was always a predictor of the following day's LCI. In addition, LCI at either 24 or 72 hours was also related to chest vibration, which again confirms the effectiveness of chest vibration in these circumstances, especially for patients with serious chest morbidities or lung collapse. The chest vibration physiotherapy intervention in this study was designed to be simple and easily carried out by the physiotherapist who would perform these procedures. This is different from the study of Templeton and Palazzo, who applied very complicated chest physiotherapy to their critically-ill ventilated patients, which included inflating the lung manually, vibration, suction in a sitting position, inspiration and muscle movement, postural drainage and ventilated suction[7]. Such an approach places an extremely heavy burden on the patients and physiotherapist. In contrast, our intervention created no extra burden on either the patients or physiotherapist. Our study showed that chest vibration physiotherapy intervention is able to reduce lung collapse among critically ill and mechanically-ventilated patients and does this quickly within 24 hours; furthermore, patients' condition continues to improve with intervention up to 72 hours. One limitation of this study is that the study participants were from single units in 1 hospital, which limits the generalizability of the study to other types of units and healthcare sectors in India. Nevertheless, this study shows that chest vibration physiotherapy intervention is a safe and effective alternative method of pulmonary clearance and can be used on patients who are on ventilators in an ICU. The present study established a standardized chest vibration physiotherapy intervention based on a literature review and clinical observation. The study results confirm the feasibility of this approach in an ICU setting. The addition of this intervention to conventional positioning care appears to be better in preventing

lung collapse than conventional positioning care alone. Thus, positioning care with the use of auto vibration performed every 4 hours is an effective intervention.

## CONCLUSIONS

The present study demonstrate that the Use of mechanical vibrators which is performed through by physiotherapist and apply specific tailored chest physiotherapy strategy can improve outcomes & chest infection rates in ventilated head & spinal injury patients. The results suggest that chest vibration may contribute to expectoration and thus improve lung collapse among ventilated patients in an ICU. Chest vibration physiotherapy intervention is a safe and effective alternative pulmonary clearance method and can be used on head and spinal injury patients those who are on ventilators in ICUs.

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