Original Research Article

Effects of Motor Control Exercise (MCE) and Back Endurance Exercise (BEE) for Mechanical Low Back Pain in Medical Students - A Comparative Study

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ABSTRACT

INTRODUCTION: One of the most common musculoskeletal disorders in the world is low back pain, which affects an estimated 70% to 80% of adults at some point in their lives. Low back pain occurs in the lumbosacral region of the back, between the gluteal folds and the lower margins of the 12th rib. Back endurance exercises (BEE) develop the muscular endurance of the back and abdominal extensor muscles, whereas motor control exercises (MCE) are defined as exercises that enhance pelvic, spinal, control and coordination. The aim of this study was to compare the effectiveness of MCE and BEE for mechanical low back pain in medical students.

METHODS: This study is an experimental study with 30 samples taken (aged between 18-25 years). Group A includes 15 samples for MCE exercise and Group B includes 15 samples for BEE exercise. The intervention was given for 3 sessions per week for 4 weeks at the, College of Physiotherapy, NIEPMD (D), Chennai. The pain is measured by Visual Analog Scale (VAS) and the disability level is measured by Oswestry Disability Index (ODI). The VAS and ODI questionnaire score was taken both prior to and following the 4-week exercise regimen. Both the pre and post test scores were used to help obtain the result.

RESULTS: Analysis of data indicates that both groups showed significant improvement in VAS and ODI but MCE group showed better result in improving pain whereas BEE group showed better result in improving activities of daily living. There is noticeable improvement in "within group" (p<0.001) statistical analysis for two outcome measures, but there is no significant improvement in "between group" (p>0.05).

CONCLUSION: It has been concluded that MCE is more effective in reducing pain whereas BEE improved activities of daily living in mechanical LBP patients. So, both the exercise has its own effects on outcome measures.

Keywords: Low back pain, Motor control exercise, Back endurance exercise, VAS, ODI, pain, activities of daily living.

INTRODUCTION

One of the most prevalent health issues affecting people of all ages, from young children to the elderly, is low back pain (LBP) [1,2,3]. One of the most common musculoskeletal disorders in the world is low back pain, which affects an estimated 70% to 80% of adults at some point in their lives [4,5]. Low back pain occurs in the

lumbosacral region of the back, between the gluteal folds and the lower margins of the 12th rib [6,7]. Back pain that originates naturally from the spine, intervertebral discs, or surrounding soft tissues is referred to as mechanical low back pain [8]. Age, gender, obesity, psychosocial factors (stress, anxiety, and depression), education level, occupational factors, reduced muscle flexibility and mobility, hypermobility, competitive sports, type and method of carrying and transporting weight, postural habits, degree of physical activity, smoking, and domestic factors like watching TV and playing computer games are the most significant risk factors for low back pain (LBP) [1, 9, 10].

Medical students, in particular, are at high risk for developing low back pain, to be specific due to the demanding nature of their curriculum [11,12]. Medical students endure long study hours, lectures, and complete clinical postings. This can lead to repetitive motions, awkward body positions, and prolonged sitting or standing postures. According to earlier studies, low back pain affects a significant percentage of medical students—between 30% and 75%, depending on the study population and diagnostic standards [11-15]. According to reports, the prevalence of low back pain among medical students rises as they advance academically, peaking in their final years of study [11,16,17].

Based on a review of the literature on various approaches to treating low back pain, the majority of studies do not satisfy the fundamental requirements of "evidence-based physiotherapy," which makes it very challenging to conduct a lucid and impartial evaluation of the clinical effectiveness of interventions that are frequently employed in routine practice [18].

It has also been shown that Motor control exercise (MCE) is superior to general exercise in terms of reducing pain and disability in patients with chronic low back pain (CLBP) [19-22]. Furthermore, a network meta-analysis revealed that MCE was superior to aerobic and stretching exercises for pain relief and more beneficial than stretching for improving disability [22, 23]. The current study demonstrated that endurance enhancing exercises can raise muscle endurance levels. This may improve the muscle's capacity to react to an abrupt, repeated, or prolonged load. As a result, endurance training might aid in lowering the chance of low back pain and impairment [24]. Numerous studies have demonstrated the benefits of back endurance exercises and motor control exercises (MCE), but no article has compared the two training regimens. Therefore, aim of this study was to assess the effects of back endurance exercise and motor control exercise for mechanical low back pain in medical students. Treatment for non-specific low back pain (LBP) often involves motor control exercises (MCE). MCE was created on the theory that people with low back pain (LBP) exhibit abnormalities in the control and coordination of their spinal muscles. The idea that people with low back pain (LBP) have altered spine stability and control forms the biological basis for the MCE. Therefore, the program was created to improve posture and movement control as well as the performance of particular lumbopelvic muscles [25,26]. Targeting the restoration of control and coordination in these muscles, MCE focuses on activating the deep spine muscles (transversus abdominis and multifidus) [27, 28, 29]. Patients learn how to isolate the deep spinal muscles during the intervention while continuing to breathe normally. In the advanced stage of the intervention, deep and global trunk muscles are activated through a progression toward more functional and complex tasks [27, 28, 30, 31]. 3 Back endurance exercises help patients with low back pain (LBP) by reconditioning their backs [32,33,7] and improving their ability to perform activities that were previously restricted due to low levels of muscular endurance in their abdominal and lumbar extensors [7,34]. The main point in endurance training is to increase muscle strength as well as muscle endurance and reduce the recurrence risk of injury of

intervertebral discs, facet joints and surrounding structures to minimum, by continuing the musculoligamentous control. Low back muscle endurance has been shown to be predictive of long-term back-related disabilities as well as a first episode of low back pain and CLBP [35, 36].

MATERIALS & METHODS

This study is an experimental study with 30 samples taken (aged between 18-25 years). Patient history and demographic data was collected and assessment for low back pain was done. Group A includes 15 samples for MCE exercise and Group B includes 15 samples for BEE exercise. Patient was received at the National Institute for Empowerment of Persons with Multiple Disabilities; Physiotherapy division and consent was taken from the patient. The primary outcome measures are the Visual Analog Scale (VAS), which is used to gauge pain intensity solely by patients, and the Oswestry Low Back Disability Questionnaire, which is used to assess patients' functional disability and physical functioning in relation to low back pain. Both interventions were performed for three times a week for 4 weeks with the rest period of 5 minutes. Warm up was done before starting the treatment. Patient were checked for the inclusion criteria, exclusion criteria and was assessed completely. Patient history and demographic data was collected and assessment for low back pain was done. Patient was taught and explained about the methods of intervention.

SELECTION CRITERIA:

Inclusion criteria:
- ✓ Male and female of age group 18-25 years
- ✓ Complaint of LBP experienced for at least 3months
- ✓ Patients should be college going physiotherapy students

Exclusion criteria:

- ✓ History of thoracic spine or lumbosacral spine surgery
- ✓ Any neurological findings indicating radiculopathy
- ✓ Evidence of serious spine pathology (e.g.; tumour, infection, fracture, spinal stenosis, inflammatory disease)
- ✓ Unstable or severe disabling chronic cardiovascular and pulmonary disease, current pregnancy.
- ✓ Below 18 years age group
- ✓ Spinal fractures or structural deformities such as spinal stenos, spondylolisthesis and spondylolysis

Targeting the restoration of control and coordination in these muscles, MCE focuses on activating the deep spine muscles (transversus abdominis and multifidus) [27, 28, 29]. Patients learn how to isolate the deep spinal muscles during the intervention while continuing to breathe normally while back endurance exercises help patients with low back pain (LBP) by reconditioning their backs [7] and improving their ability to perform activities that were previously restricted due to low levels of muscular endurance in their abdominal and lumbar extensors [7]. Patients were assigned at random to one of two groups:

Group A (Motor control exercise):
Group A performed MCE after warming up; which included 5mins walking and stretching exercises. MCE was given 4times a week (Figure 1-4). There were three phases to the exercise regimen: First stage (first to third sessions): 7sec hold, 10 reps (Figure 1-4) The local stability muscles (lumbar multifidus, transversus abdominis) were isometrically contracted using an abdominal drawing-in manoeuvre (ADIM) in minimally loading positions (supine lying, quadruped, sitting, and standing) while keeping the spine neutral and breathing normally [25]. Individualized instruction was given to the participants on how to activate the local stability muscles from the global muscles [25].

FIGURE. 1- ADIM IN SUPINE

FIGURE. 2- ADIM IN SITTING

FIGURE. 3- ADIM IN OUADRUPED

FIGURE. 4- ADIM IN STANDING

Second stage (fourth to ninth sessions): 4-7sec hold, 10 reps. In order to recruit a variety of trunk (local and global) muscles, additional loads were applied to the spine through different upper and lower extremity and trunk movement patterns such as heel slide (each leg), leg lift (each leg), bridging with two legs, single-leg bridge, curl-up with elbows on the table, curl-up with hands over the forehead, horizontal side support with knees bent, horizontal side support with knees straight, side lying horizontal side support, ADIM in quadruped with arm raise, leg raise, alternate arm and leg raise, which came after the participants had to have learned the ADIM.

Third stage (tenth to twelfth sessions): 5sec hold, 10 reps. Functional movement patterns like rolling from side to side (10 reps), sit-stand transfer (10 reps), wall squatting (10 reps), walking (10 minutes) are added to the training regimen during the third stage (10th to 12th sessions), which involved performing an ADIM and keeping the lumbar spine neutral [25]. Furthermore, it was stressed that the specific exercises should be regularly incorporated into everyday activities, particularly those that cause pain, by activating the local stability muscles.

At every stage of the MCE program, the treating/ therapist assessed and modified the breathing, posture, movement pattern, and recruitment of the trunk muscles. The patient's degree of fatigue, pain thresholds, or observed motor control were taken into consideration when advancing the exercises. An average MCE session lasted between twenty and thirty minutes. Cool down also included walking for 5mins and stretching exercises.

Group B (Back endurance exercise):
Following a five-minute walk and stretching exercises as part of the warm-up, Group B engaged in back endurance exercises. Three times a week, BEE was administered (Figure 5 and 6).

- **Endurance Exercise:** Douglas has utilized the following exercises as part of his endurance exercise training [7].
- **Exercise 1:** Perform 10 repetitions (reps) without experiencing any pain.
  Pelvic tilt: Transversus abdominus muscle exercise for the core spinal stabilizer
  Starting Position: Crook lying
  Instruction: The participant tightened their buttocks and pulled their belly button down. 10 repetitions (reps) through pain free range.
- **Exercise 2:** 10 repetitions, 5-10 second hold Hamstring stretch: An exercise for the hamstring muscles Starting Position: Arms by sides, supine lying.
  Instruction: The participant was instructed to raise each lower limb as high as possible while maintaining a straight knee and using both hands to support the leg. For a few seconds, the participant kept the leg in this posture.
- **Exercise 3:** 10 repetitions.
  Exercise of the abdominals: Raising your legs and arms alternately while lying down. Starting Position: Arms by sides, supine position.
  Instruction: Participant slowly lifted the left arm and the right leg simultaneously and brought them to meet in the air above the chest. Participant slowly lowered them to the original position and repeated the exercise with the other pair of limbs.
- **Exercise 4:** 10 repetitions.
  Exercise of the spinal extensor muscles: Alternate leg and arm raising in prone position Starting Position: Prone lying with arms straight in front
  Instruction: The participant should slowly raise both their right and left arms at the same time and bring them together above their chest. The exercise was repeated with the other pair of limbs after the participant carefully lowered them back to their starting position.
- **Exercise 5:** 5-10 minutes
  Cycling: Cycling is a good way to work out both legs.
  Position: Perched atop the bike

Instruction: The participant was instructed to ride the cycle ergometer with no resistance.

- **Exercise 6:** 5-10 minutes
  Brisk Walking: Walking briskly is a general-body workout.
  Instruction: The participant was instructed to walk as quickly as he could without running.

The participants spent 30 to 40 minutes performing each of the six exercises in a continuous and sequential manner. The participant was told to take a 30- to 1-minute break after completing 10 repetitions. When participants started to feel fatigued, they were told to take a break before continuing the exercise. It took five minutes to cool down, which included five minutes of walking and stretches.

FIGURE. 5- PELVIC TILT

FIGURE. 6- HAMSTRING STRECTH

OSWESTRY LOW BACK DIABILITY QUESTIONNAIRE (ODI):

For people with low back pain (LBP), one of the most widely used outcome measures is the Oswestry Disability Index (ODI). Completing the self-administered ODI questionnaire takes five minutes, and scoring it takes one minute. Scores correspond to varying degrees of disability, from bedridden to minimal. The ODI has the potential to be a useful tool in clinical practice due to its simplicity in administration, scoring, and interpretation. The ODI's psychometric qualities— validity, reliability, and responsiveness—are what ultimately determine whether the questionnaire is appropriate as a clinically meaningful tool. Reliability is the ability of a tool to be consistent, have small measurement errors, and distinguish between clients, while validity is the ability of a tool to measure what it is intended to measure. Only when an outcome measure is able to evaluate change over time (sensitivity to change) can it be considered clinically relevant. [37]

Eight of the ten sections of the ODI questionnaire are devoted to activities of daily living (ADL), and two of those sections are devoted to pain assessment. Activities like walking, sitting, standing, sleeping, traveling, lifting heavy objects, and socializing are all included in the ADL sections. The sections on pain, on the other hand, evaluate the degree of pain and how it varies over time. There are six potential responses to each ODI question, and each response is given a score between 0 and 5. Therefore, the lowest possible score is zero, and the highest possible score is fifty. A total score is then generated by adding together these individual scores. The final score can be displayed as a percentage between 0% and 100% or as a point scale between 0 and 50. The patient's functional status can be inferred from the interpretation of the ODI score. There is no disability if the score is between 0 and 4, and mild disability if it is between 5

and 14. Severe disability includes scores between 25 and 34 points, while moderate disability is between 15 and 24 points. Severe disability and suffering are indicated by a score of 35 or higher [38-42].

This questionnaire was completed both prior to and following the 4-week workout regimen. Both the pre-test and post-test scores were used to help obtain the result.

VISUAL ANALOG SCALE (VAS):

Around the world, VAS is frequently used to gauge the severity of pain. The validity and reliability of the VAS as an interval scale have been demonstrated. VAS has excellent repeatability and test-retest reliability. Known as the vertical VAS and horizontal visual analog scale, this VAS features a continuous scale made up of a horizontal and vertical line. The vertical and horizontal VAS have a strong correlation. However, the horizontal VAS score is marginally lower than the vertical VAS score. The severity or frequency of a range of clinical symptoms is measured using VAS in epidemiological and clinical research. As an outcome measure, VAS is commonly used in clinical trials and randomized controlled trials to assess treatment effectiveness. [43]

A visual analog scale (VAS) for pain intensity consists of a line, usually 100mm long, with two descriptors representing the extremes of pain intensity at each end point (e.g., no pain and extreme pain). Patients rate their pain intensity by making a mark somewhere on their body. The intensity of pain is measured by determining the distance from the end of the line where there is no pain. The researchers discovered that a system which categorized a score of 1 to 4 on a scale of 0 to 10 as mild pain, 5 to 6 as moderate pain, and 7 to 10 are severe pain offered the most effective classification among the various samples from four distinct countries [44, 45].

The VAS score was obtained both prior to and following the evaluation. To get the correct result, a score was applied.

STATISTICAL ANALYSIS AND RESULTS

All the data analysis in the present study were performed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM, Chicago, IL, USA). A sample of paired t test was performed to determine whether the mean of the goniometric measurement of External rotation & abduction and SPADI score.

Paired sample t test was used to examine the changes in outcome variables prior to and after the intervention in each group. The level of significance was set at $p < 0.05$.

For statistical analysis, paired t-test is used within the outcome measures to find out the difference between the pre and post outcome measure by using SPSS software.
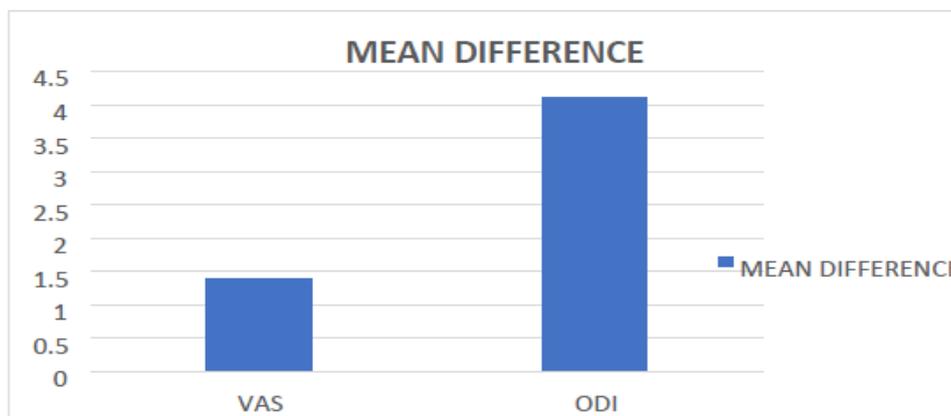
TABLE 1: ANALYSIS OF TWO OUTCOME MEASURES FOR "WITHIN AND BETWEEN GROUP A"

GROUP A					
scales	pre-test average	post-test average	mean difference	standard difference	t value	p value
VAS	4.8	3.4	1.4	0.5	10.6	<.001
ODI	19.6	15.4	4.1	2.4	6.4	<.001

Table 1 shows the value of mean difference, standard deviation, t-value, p-value of two outcome measures (VAS and ODI) and their pre-test, post-test average for Group A (15 subjects).

GRAPH 1: ANALYSIS OF TWO OUTCOME MEASURES AND THEIR MEAN DIFFERENCE FOR "WITHIN AND BETWEEN GROUP A"

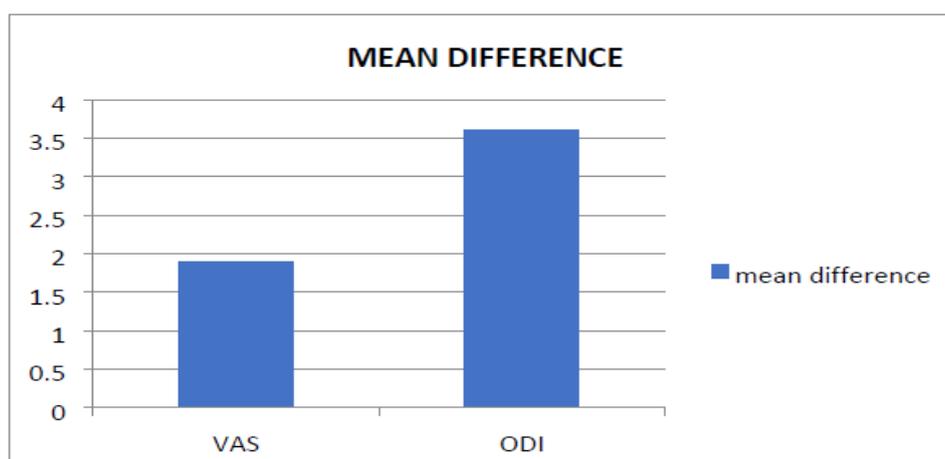Graph 1 represents the mean difference of two outcome measures: VAS and ODI. The mean difference for VAS is 1.4 whereas mean difference for ODI is 4.1 which indicates that within group A impact reflected by ODI is significantly more than that of VAS.

TABLE 2: ANALYSIS OF TWO OUTCOME MEASURES FOR "WITHIN AND BETWEEN GROUP B"

GROUP B						
scales	Pre-test average	Post-test average	Mean difference	Standard difference	t value	p value
VAS	5.1	3.2	1.9	0.8	8.4	<.001
ODI	20.6	16.9	3.6	2.0	7.0	<.001

Table 2 shows the value of mean difference, standard deviation, t-value, p-value of two outcome measures (VAS and ODI) and their pre-test, post-test average for Group B (15 subjects).

GRAPH 2: ANALYSIS OF TWO OUTCOME MEASURES AND THEIR MEAN DIFFERENCE FOR "WITHIN AND BETWEEN GROUP B"

Graph 2 represents the mean difference of two outcome measures: VAS and ODI. The mean difference for VAS is 1.9 whereas mean difference for ODI is 3.6 which indicates that within group B impact reflected by ODI is significantly more than that of VAS.

DISCUSSION

Low back pain is typically classified as mechanical or nonspecific. Mechanical low back pain might originate from the surrounding soft tissues, the intervertebral disks, or the spine itself. Clinical indicators, sometimes known as "red flags," can be used to detect nonmechanical low back pain and to guide additional testing or imaging. Progressive motor or sensory loss, new overflow or retention incontinence, a history of cancer, a recent invasive spinal treatment, and severe trauma in relation to age are all warning signs. Imaging at first presentation should only be done if there is a possibility of infection, fracture, cancer, or cauda equina syndrome. While lumbar spine plain radiography is suitable for evaluating for bone abnormalities and fractures, magnetic resonance imaging is superior for determining the origin of soft tissue or neurologic abnormalities [46]. The purpose of this study was to find out the effectiveness of intervention for mechanical low back pain to reduce pain and improve activities of daily living.

Quality of life, functional status, activity impairment, and health services are all significantly impacted by LBP, a complicated clinical and public health issue with a significant socioeconomic burden [47]. In the overall adult population, CLBP significantly affects both mental and physical health as well as health-related quality of life [48].

This study includes 30 LBP patients; in which Group A includes 15 samples for MCE exercise and Group B includes 15 samples for BEE exercise. The interventions were given for 3 sessions per week for 4 weeks. The pain is measured by visual analog scale (VAS) and the disability level is measured by Oswestry disability index (ODI).

On comparison, both groups showed significant improvement in VAS and ODI but MCE group showed better result in improving pain compared to BEE group whereas BEE group showed better result in improving activities of daily living. There is noticeable improvement in "within group" statistical analysis for two outcome measures, but there is no significant improvement in "between group".

In recent years, there has been a growing interest in motor control exercise (MCE) [22]. MCE is described as an exercise that improves pelvic and spinal control and coordination [19]. Typically, MCE decreases the overactive large external trunk muscles, like the rectus abdominal and erector spinae muscles, and increases the weak deep trunk muscles, like the transversus abdominis and multifidus [49]. Numerous meta-analyses and systematic reviews have examined the beneficial effects of MCE on LBP patients, including reductions in pain and disability. Its effectiveness is a result of several processes from the biochemistry, neuromuscular, inflammatory, and brain domains working together. MCE may improve morphological deficits, mediate the anti-inflammatory response, remap brain representation, reverse the negative brain alternation, and induce EIH to reduce pain.

Mechanically speaking, endurance is defined as either the point of dynamic fatigue, which occurs when repetitive work cannot be sustained at a particular force level, or the point of isometric fatigue, which occurs when the contraction can no longer be maintained at a particular level [50,51]. It has been demonstrated that lumbar extensor muscle endurance is reduced in patients with low back pain [50,52]. Additionally, it has been noted that individuals with low back pain have lower levels of abdominal muscular endurance than people in the general population [50,53]. Thus, these studies lend credence to the use of endurance exercises that target both the abdominal and back extensor muscles. Low back pain may be related to trunk muscle endurance. People with low back pain may not be able to handle the demands of an unexpected load if they are fatigued. Repetitive loading fatigue also impairs control and accuracy, which may make a person more susceptible to low back pain. Consequently, it has been suggested that trunk muscle endurance training raises

the fatigue threshold, enhances performance, and lessens disability.

Hence, incorporating MCE and BEE into rehabilitation programs for college student may be a valuable strategy for promoting long-term musculoskeletal health.

CONCLUSION

After following both exercise regimens, it shows that there was improvement in pain in patients with MCE than BEE while activities of daily living improved in patients with BEE than MCE. In this study VAS has shown the improvement in MCE group whereas ODI has shown improvement in BEE group.

So, after analyzing the reviewed literature related to this study it has been concluded that MCE showing more effective in reducing pain whereas BEE improved activities of daily living in mechanical LBP patients.

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