JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Efficacy of Dynamic Muscle Stabilization Technique vs. Muscle Energy Technique on Pain And Functional Disability In Chronic Mechanical Low Back Pain

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Abstract : This study compares the efficacy of Dynamic Muscle Stabilization Technique (DMST) vs. Muscle Energy Technique (MET) on pain and functional disability in Chronic mechanical low back pain (CMLBP). A major global health concern that affects people of all ages and demographics, low back pain (LBP) places a heavy burden on healthcare systems around the globe. A total of 30 subjects were randomly allocated in two groups ie. Group A and Group B. Subjects demographic data was recorded and they were asked to rate their pain on VAS and fill out the Oswestry Low Back Disability Questionnaire prior to beginning the treatment. Group A received Dynamic Muscle Stabilization Exercises in addition to conventional treatment. Group B received Isotonic Concentric Strengthening Technique of Muscle Energy Technique in addition to conventional treatment. This technique was applied to quadratus lumborum, hip adductors, rectus femoris, hamstrings, hip flexors, hip extensors, and hip abductors. At the end of the 4 week protocol with 3 sessions per week, the results showed that both the techniques were effective in the management of CMLBP, but Isotonic concentric strengthening technique of MET was more effective. Our research offers strong evidence that isotonic concentric strengthening of the MET is a more effective treatment for CMLBP than DMST. Our findings highlight the significance of customized exercise programs in the treatment of this common illness by providing superior outcomes in pain reduction and functional improvement.

Index Terms **-** Dynamic muscle stabilization, muscle energy technique, low back pain, functional disability, pain, conventional.

I. INTRODUCTION

Low back pain (LBP) represents a significant global health challenge, affecting individuals of all ages and demographics and presenting a substantial burden on healthcare systems worldwide. Approximately 60% of individuals in India experience severe back pain at some point in their lives. Between 15% and 45% of adults experience low back pain annually, and 5% of patients check into hospitals for a new episode.

The primary function of the lumbar region is to support the weight of the upper part of the body in static and dynamic situations and also withstand the tremendous compressive loads produced by muscle contraction, anterior shear forces, and ground reaction forces. Therefore the lumbar region is constantly subjected to stress making it vulnerable to injury.[1]

Mechanical low back pain can be defined as any sort of back pain caused by inserting abnormal stress and strain on muscles of the backbone. Typically, mechanical pain results from dangerous habits, like poor posture, static work posture, poorly designed seating, incorrect bending and lifting motions, repetitive movements, sudden or excessive stress, improper body mechanics, reduced trunk extensor strength, endurance and flexibility, and improper alignment or weakness of hip and pelvis musculature. Thus mechanical low back pain is a vital health drawback and a serious explanation for incapacity within the operating age.[2]

Chronic mechanical low back pain (CMLBP) leads individuals to avoid activities or movements that are associated with pain and over time avoidance behaviour can result in deconditioning, muscle weakness, and reduced flexibility adding to further limitations. Persistent pain leads to decreased physical activity and functional capacity.

Physiotherapeutic options for treating CMLBP encompass a wide variety of interventions aimed at reducing pain and promoting functional independence. Providing patients with education about their condition, posture, ergonomics, and self-management strategies can empower them to play an active role in the recovery process and prevent recurrences.

One of the techniques used to manage CMLBP is the Dynamic muscle stabilization technique (DMST). In DMST, the "neutral zone" of the joint is stabilized and excessive deflection is prevented by muscles that have a direct link to the lumbar spinal segment. By using DMST, it is possible to have sufficient dynamic control over the stresses in the lumbar spine, which lowers the risk of recurrent damage to the structures of the spinal segments and associated structures. Specific stabilizing exercises include co-

contraction of deep abdominals (transversus abdominis) and lumbar multifidus muscles to enhance the spinal segmental support and control.[3] The lumbar multifidus muscle is the most essential spine stabilizer and studies have shown that there is atrophy along with fatty infiltration in cases of chronic low back pain so a technique that focuses on the rehabilitation of this muscle is the need of the hour.[4]

Another effective technique employed for the management of chronic low back pain is Muscle Energy Technique (MET). MET is a form of soft tissue, or joint manipulation or mobilization, deriving from osteopathic medicine, employed in the treatment of musculoskeletal dysfunction. MET focuses on seven different techniques for treating musculoskeletal dysfunction of which Isotonic Concentric Contraction can be used for toning or rehabilitating a weakened musculature .The contraction starting point is a mid-range easy position. The affected muscle is allowed to contract, with some (constant) resistance from the practitioner/therapist. The patient's effort overcomes that of the practitioner/therapist since the patient's force is greater than the practitioner's/therapist's resistance. The patient uses the maximal effort available, but the force is built slowly, not via sudden effort. The practitioner/therapist maintains a constant degree of resistance. This technique is observed to be highly effective for rehabilitation.[5] This technique is applied to quadratus lumborum, hip flexors, hip extensors, hip adductors, hip abductors, hamstrings, and rectus femoris muscle which play an important role in maintaining hip and pelvis alignment and therefore are crucial spine stabilizers

II. Materials & Methods

This is an experimental study design, a total of 30 subjects were approached via convenient sampling. The subjects were explained about the nature, purpose and procedure of the study and written consent was taken from the subjects who fulfill the inclusion criteria. Patients who gave consent were randomly allocated in two groups, Group A and Group B.

Subjects demographic data was recorded and the patients were asked to rate their pain on VAS and fill out the Oswestry Low Back Disability Questionnaire prior to beginning the treatment.

Conventional Treatment included pelvic bridging, prone on elbows, prone on hands. Initially beginning with 10 seconds hold for 5 repetitions and later progressed to 10 seconds hold for 10 repetitions.

Group A received Dynamic Muscle Stabilization Exercises and Conventional treatment- 4 weeks protocol, 3 sessions per week

Exercises were given in 4 stages in the following order:

(i)First week: Isolation and facilitation of target muscles. Verbal instruction such as drawing in and hollowing the lower abdomen, drawing the navel up and in towards the spine, or feeling the muscle tighten at the waist. From the beginning, the patient learns to breathe normally while activating or holding the muscular contraction. The patient is in a supine hook-lying position and instructed to perform abdominal hollowing (in which the patient is instructed to make the lower abdomen cave in) or abdominal bracing (in which the patient is instructed to contract the abdominals by actively flaring out laterally in the region of the waist just above the iliac crest).

(ii)Second week: Training of trunk stabilization under static conditions of increased load. The patient's position and concentration pattern is the same as the first week; the individual is then asked to hold the position while the load is added via the weight of the lower limbs being moved passively into a loaded position.

(iii)Third week: Development of trunk stabilization during slow controlled movement of the lumbar spine. Once stability is trained through the static procedure, the movement of the trunk will optimize the activation of the supporting muscle. The first step is to produce and explore lumbopelvic movement and learn abdominal hollowing or bracing in a variety of positions: sitting, quadruped, standing, supine, kneeling, and inclination by the degree to control loading.

(iv)Fourth week: Lumbar stabilization during high-speed and skilled movement. High- speed phasic exercises are recommended to the patient along with abdominal hollowing or bracing in a variety of positions.

Group B received Isotonic Concentric Strengthening Technique of Muscle Energy Technique and Conventional treatment - 4 weeks protocol, 3 sessions per week

Repetitions: Repeat 4-7 times or more if appropriate. Contractions that occur against a resistance that is then overcome, allow toning and strengthening of the muscles involved in the contraction.

The practitioner positions the limb, so that a muscle group will be at a comfortable resting length, and thus will develop a strong contraction. The practitioner explains the direction of movement required, as well as the intensity and duration of that effort. The patient contracts the muscle with the objective of moving the muscle through a complete range, rapidly (in about 2 seconds). The practitioner offers counterforce that is slightly less than that of the patient's contraction, and maintains this throughout the contraction. This is repeated several times, with a progressive increase in the practitioner's counterforce (the patient's effort in the strengthening mode builds towards maximal).

Where weak muscles are being toned using these isotonic methods, the practitioner allows the concentric contraction of the muscles (i.e. offers only partial resistance to the contractile effort). Such exercises should always involve practitioner effort which is less than that applied by the patient. The subsequent isotonic concentric contraction of the weakened muscles should allow approximation of the origins and insertions to be achieved under some degree of control by the practitioner. Isotonic concentric efforts are usually suggested as being of short duration, ultimately employing maximal effort on the part of the patient.

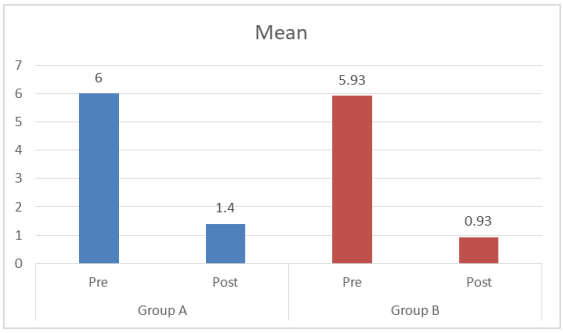
Applied to quadratus lumborum, hip adductors, rectus femoris, hamstrings, and hip extensors, and hip abductors.

Patients were assessed after the treatment for the outcome measures of pain by using VAS and functional disability by using the Oswestry low back disability questionnaire.

III. Results

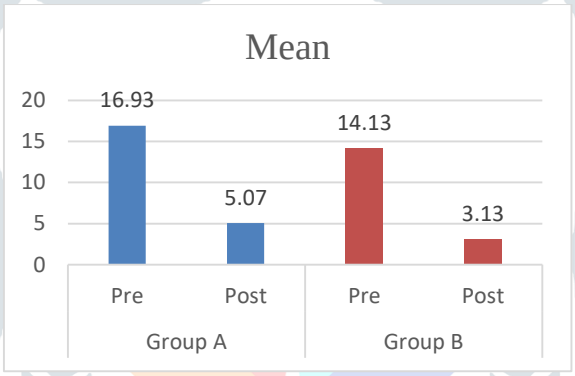
Data is normally distributed as all the variables have indicated p-value greater than 0.05 in the observation. The researcher shall use parametric test for data analysis purpose in the following sections.

Graph 1: Comparison of pre-test and post-test scores of VAS in two Groups by paired sample t test



Interpretation: The mean value for pain in Group A indicated changes post-treatment (1.40) and lower values were recorded as compared to pre-treatment (6.00). The mean value for pain in Group B indicated changes post-treatment (0.93) and lower values were recorded as compared to pre-treatment (5.93).

Graph 2: Comparison of pre-test and post-test scores of Functional Disability Score in two Groups by paired sample t test



Interpretation: The mean value for functional disability in Group A indicated changes post treatment (5.07) and lower values were recorded as compared to pretreatment (16.93). The mean value for functional disability in Group B indicated changes post-treatment (3.13) and lower values are recorded as compared to pre-treatment (14.13).

Table 1:Pre-treatment and Post-treatment comparison of Group A and Group B

Variable	Time	Group	Mean	SD	t-value	p-value
VAS	Pre	Group A	6.00	1.20	0.151	0.881
		Group B	5.93	1.22		
	Post	Group A	1.40	1.06	1.313	0.200
		Group B	0.93	0.88		
Functional Disability Score	Pre	Group A	16.93	7.65	1.105	0.279
		Group B	14.13	6.15		
	Post	Group A	5.07	4.38	1.389	0.176
		Group B	3.13	3.14		

Interpretation: For between group analysis the p value is not significant, thus the comparison is made on effect size.

Table 2: Between the groups comparison based on effect size

Variable	Effect size of Group A	Effect size of Group B	Remarks
VAS	4.67	6.61	Group B is better
Functional Disability Score	2.86	2.91	Group B is better

Interpretation: The effect size for Group A for VAS is (4.67) and for functional disability is (2.86). The effect size for Group B for pain is (6.61) and for functional disability is (2.91). Thus for the present study Group B has shown higher effect size indicating better improvements than Group A

IV. Discussion

In this study, we embark on a journey to delve deeper into the intricacies of mechanical low back pain by employing the Dynamic muscle stabilization technique and Isotonic concentric strengthening technique of Muscle energy technique and studying their effectiveness on chronic mechanical low back pain in reducing pain and improving functional disability.

The result of the study shows that there is a statistically significant improvement in pain and functional disability after 4 weeks of protocol in both groups.

The mean value for pain in Group A indicated changes post-treatment 1.40 and lower values were recorded as compared to pretreatment 6.00. The effect size or Cohen's D indicated 4.67 value which is assumed to be very high in effect size as per the standard parameters of reference and the following could be the reason as both the groups received conventional treatment which included back extension exercises like pelvic bridging, prone on elbows and prone on hands. Back extension exercises target the muscles of the lower back, including the erector spinae muscles which play a role in stabilizing the spine and reducing the load on other structures such as the intervertebral discs and facet joints thus reducing pain.[6] Controlled movement and exercise stimulate blood flow to the injured and inflamed tissues in the lower back, promoting the delivery of oxygen and nutrients necessary for repair and also washes away the pain exudates, thus facilitating the healing process and reducing inflammation, leading to pain relief. Along with these improved posture and increased flexibility of muscles alleviates the tension on the spinal structures and reduces strain on the spine leading to pain relief.

The mean value for pain in Group B indicated changes post-treatment 0.93 and lower values were recorded as compared to pretreatment 5.93. The effect size or Cohen's D indicated 6.61 value which is assumed to be very high in effect size as per the standard parameters of reference as Group B received Isotonic concentric strengthening technique of MET along with conventional treatment.

During MET the rhythmic muscle contractions increase muscle blood and lymph flow rates also the mechanical forces acting on the tissues have the potential to change interstitial pressures and increase transcapillary blood flow. This facilitates the natural tissue response to inflammation. MET may support these processes by reducing the concentration of pro-inflammatory cytokines which results in decreased sensitization of peripheral nociceptors. Rhythmic muscle contraction activates the low threshold mechanoreceptors from joints and muscles which project to the periaqueductal grey in the midbrain and results in sympathoexcitation and localized activation of the lateral and dorsolateral PAG also activation of non opioid descending inhibitory pathways (serotonergic and noradrenergic) plays an important role in modulating pain.[5]

The mean value for functional disability in group A indicated changes post treatment 5.07 and lower values were recorded as compared to pretreatment 16.93. The effect size or Cohen's D indicated 2.86 value which is assumed to be very high in effect size as per the standard parameters of reference and the following could be the reason,

Dynamic muscle stabilization exercises focus on enhancing the coordination, strength, and endurance of the deep stabilizing muscles of the spine and pelvis, which play a crucial role in maintaining spinal stability and supporting optimal movement patterns. In DMST muscles with direct attachment to the lumbar spinal segment stabilize the joints in neutral zone and prevent excessive deflection. DMST targets the deep core muscles, including the transversus abdominis and multifidus. By engaging these muscles in dynamic movements, individuals can enhance their ability to stabilize the spine and pelvis during functional activities, such as bending, lifting, and twisting. By activating these deep stabilizers, DMST helps establish a solid foundation for optimal movement patterns and reduces reliance on compensatory strategies.[3]

1)Neuromuscular control; DMST involves coordinated activation of multiple muscle groups, promoting improved neuromuscular control and proprioception. DMST requires coordinated activation and timing of multiple muscle groups to maintain spinal stability while performing dynamic movements. By challenging the body to stabilize the spine in various planes of motion and under different loading conditions these exercises promote improved neuromuscular coordination and control.

2)Sensorimotor integration; DMST improves the integration of sensory information from proprioceptors with motor commands from the central nervous system, thus it also plays a role in enhancing sensorimotor integration.

Pain modulation; In CMLBP individuals experience altered pain pathways, where there is increased sensitivity to pain stimuli and abnormal amplification of pain signals, so with the enhancement of sensorimotor integration these altered pain pathways and corrected and response to stimuli normalized

3)Versatility and Progression; Dynamic muscle stabilization exercises can be tailored to individual needs and fitness levels, making them suitable for individuals at various stages of rehabilitation or fitness. These exercises can be modified in terms of intensity, range of motion, and resistance to accommodate different levels of ability and ensure on going progression and adaptation.

4)Integration with functional movements; DMST can often be integrated with functional movements that mimic activities of daily living. By integrating them into dynamic activities, individuals learn to stabilize their spine while performing everyday tasks and this helps translate stability gains into improved functional strength and performance.

5)Promotion of motor learning and adaptation; through repetition and progressive overload DMST promotes motor learning and adaptation, as the challenge level increases the neuromuscular system learns to adapt and refine movement patterns to meet the demands of the exercise. This reinforces proper movement mechanics and encourages the recruitment of deep stabilizing muscles during functional activities.

The mean value for functional disability in group B indicated changes post-treatment 3.13 and lower values are recorded as compared to pre-treatment 14.13. The effect size or Cohen's D indicated 2.91 value which is assumed to be very high in effect size as per the standard parameters of reference and the following could be the reason, isotonic concentric strengthening is a type of muscle contraction that occurs when a muscle shortens against a constant load or resistance, resulting in movement at a joint.

1)Muscle fiber recruitment; During isotonic concentric contractions, motor units within the muscle are activated in a coordinated manner to generate force. Initially, smaller motor units are recruited, followed by larger ones as the demand for force increases. This recruitment pattern ensures that the muscle generates the necessary force to overcome the resistance.[8]

2)Actin-myosin cross bridges; Within the muscle fibers, myosin (thick) filaments and actin (thin) filaments interact to produce muscle contraction. During concentric contractions, cross-bridges form between the actin and myosin filaments, causing them to slide past each other and the muscles to shorten. This sliding filament theory of muscle contraction explains the mechanical basis of muscle shortening during isotonic concentric contractions.[1]

3)Neuromuscular adaptations; Regular isotonic concentric strengthening exercises lead to neuromuscular adaptations that enhance muscle performance. These adaptations include increased motor unit recruitment, improved synchronization of motor unit firing, and enhanced coordination of muscle fibers. Over time, these changes contribute to greater strength, power, and endurance in the trained muscles.[8]

4)Central nervous system adaptations; Strength training with isotonic concentric contractions can induce adaptations within the central nervous system, including changes in motor neuron excitability, synaptic efficacy, and cortical representations of the trained muscles. These neural adaptations contribute to improvements in muscle strength, coordination, and skill acquisition.[8]

It is observed that between-groups analysis is not significant for VAS and Functional Disability Score pre-time frame at 5% level significance as the p-value is more than 5%. It shows non-significant differences between the groups, therefore the comparison is based on the effect size, The greater the effect size greater the clinical improvement, thus for the present study group B has shown a higher effect size indicating better improvements than group A

Both isotonic concentric strengthening using Muscle Energy Technique (MET) and Dynamic Muscle Stabilization Technique (DMST) techniques can be effective in the treatment of chronic mechanical low back pain, but their efficacy may depend on various factors including the individual's specific condition, underlying biomechanical issues, and personal preferences. However, in certain cases, isotonic concentric strengthening using MET may be preferred over DMST for the following reasons:

1)Targeted Muscle Activation: Isotonic concentric strengthening with MET focuses on activating specific muscles through resistance training, aiming to improve their strength and endurance. This targeted approach can be particularly beneficial for individuals with identified muscle weakness or imbalances contributing to low back pain. By strengthening these muscles, isotonic exercises can help improve spinal stability and reduce strain on the lower back structures.

2)Progressive Resistance: MET allows for progressive resistance training, meaning that the resistance can be gradually increased as the individual's strength improves over time. This progressive nature of isotonic exercises enables tailored treatment programs that can be adjusted based on the individual's response to treatment and ongoing progress.

3)Patient Engagement and Compliance: Some individuals may find isotonic concentric strengthening exercises with MET more engaging and enjoyable compared to static stabilization exercises commonly used in DMS techniques. The dynamic nature of isotonic exercises may enhance patient compliance and adherence to the prescribed exercise program, leading to better long-term outcomes.

4)Evidence Base: While both isotonic concentric strengthening with MET and DMS techniques have been studied in the management of chronic low back pain, there may be a larger body of evidence supporting the effectiveness of resistance training for improving strength, function, and pain relief in individuals with mechanical low back pain.

V.Conclusion

Our research offers strong evidence that isotonic concentric strengthening of the musclE energy technique (MET) is a more effective treatment for chronic mechanical low back pain than dynamic muscle stabilization technique. Our findings highlight the significance of customized exercise programs in the treatment of this common illness by providing superior outcomes in pain reduction and functional improvement. These findings have important ramifications for clinical practice, indicating that when developing treatment plans for patients with persistent low back pain, medical professionals should give isotonic concentric strengthening of MET priority.

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