International Journal of Health Sciences and Research
Vol.10; Issue: 12; December 2020
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Efficacy of Activation of Gluteus Maximus versus Transversus Abdominis in Patients with Mechanical Low Back Pain: A Randomized Controlled Trial

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ABSTRACT

Background: The existing research on Mechanical Low Back Pain has either focused on the conventional protocols or the core muscles as a whole; only a small number of studies have proposed new interventions for MLBP. There is lack of the studies which have used the concept of regional interdependence in cases of MLBP and concentrated over Gluteus Maximus (GM).
Design: A Randomized controlled trial
Participants: 120 subjects (aged between 30 to 50 years) with MLBP were included in the study on the basis of inclusion criteria.
Methodology: The subjects were randomly allocated into three groups. Groups A and B were experimental groups receiving Transversus Abdominis (TrA) activation and GM activation respectively along with Interferential Therapy (IFT) (Thrice a week for six weeks). Group C was the conventional group receiving conventional Flexion/Extension exercises and IFT (Thrice a week for six weeks). The outcome measures were Pain (Visual Analog Scale) and disability (Modified Oswestry Disability Index). The activation capacities of TrA & GM were measured using Chattanooga Pressure Biofeedback Unit (PBU).
Results: The mean difference of pre & post VAS and MODI was significant within Group A, B & C (paired t test). The comparison of three groups revealed more significant improvements in terms of pain and disability in group B (GM activation+ IFT)
Conclusion: GM activation was proven to be more beneficial than TrA activation & conventional protocol in reducing pain & disability of MLBP patients.

Keywords: Mechanical Low Back Pain, Gluteus Maximus, Transversus Abdominis, Pressure biofeedback

INTRODUCTION

Low back pain (LBP) is one of the most common conditions in modern society; it burdens the society in aspects of health and significantly contributes to disability.[1] LBP can be specified as 'pain which is localized between 12th rib and inferior gluteal folds that may or may not be accompanied by the leg pain.'[2] There is a 'diagnostic triage' developed by the health care professionals for low back pain; the triage includes structural spinal pathology, nerve root involvements and non-specific low back pain.[0] Some studies have termed the 'Non-specific low back pain'(NSLBP) as 'Mechanical low back pain (MLBP)'.[3]

Mechanical low back pain (MLBP) can be grossly defined as low back pain without a significant known cause.[1] Factors such as frequent lifting of loads, repeated and long term static posture, some psychological aspects like depression and anxiety and low socioeconomic status may have some correlation with MLBP but

accurate risk factors are yet to be analyzed; Prevalence of MLBP in Indian population varies from 6.2% to 92%. [4] Most Patients with the LBP of mechanical origin lack in having significant changes on radiographs (No degenerative changes or intervertebral disc herniation) and they do not have any significant structural cause that can be detected as source of pain. [3]

Out of all the structures the lumbar spine contains (such as bone, cartilage, nerve, muscles, fascia and ligaments) muscles have crucial role in providing stability to spine besides; The range of motion necessary for the achievement of various functional tasks is also provided by the muscles, Muscles protect the underlying structures from axial loads. [5] Role of muscles in MLBP has been widely studied and there are number of theories which have been proposed. [6] However, the available literature revolves around two basic and important theories i.e. Pain-Spasm-Pain model and Pain Adaptation model**.**

Pain-Spasm-Pain model implies that changes occurring in the muscle activity are ultimately responsible for the pain production; While Pain Adaptation model proposed that changes in the normal functioning of the muscles will have an impact on spinal mobility. [6] Although with the different mechanisms but both of these theories highlight the crucial role of muscles in low back pain cases. Hence, from the above discussion it is crystal clear that whichever may be the mechanism but the muscles around the spine are most important and they should seriously be taken into consideration for the management of MLBP patients.

The stabilization of the lumbar spine is achieved with the two types of muscles Deep or local stabilizers and superficial or global stabilizers cumulatively called as core muscles. The deep stabilizers are Transversus Abdominis (TrA), Multifidus (Mf) and Internal Oblique while the superficial stabilizers are Erector Spinae, Rectus Abdominis and External Oblique. [7]

Ample studies have focused on weakness and deconditioning of TrA in low back pain population. One of the possible root causes that can trigger the MLBP can be muscle imbalance (more precisely the imbalance between the abdominal muscles and extensor muscles of the trunk). Out of the deep stabilizers the TrA contracts faster and is majorly engaged in providing stability. [7]

According to the study the activity of TrA is constant and independent of the direction of movement. [8] The deep stabilizing muscles function in feed forward mechanism and can generate significant amount of torque. The TrA prevents the overloading of spine by contracting just prior to the movement besides, in normal physiologic conditions the local stabilizers contract prior to the global stabilizers. [8] One of the studies explained that the increased intersegemental stability after the activation of TrA is the root cause of pain relief. Hence it is wise to focus on this local stabilizer while treating low back pain cases.

Initially, MLBP was treated with the interventions limited to lumbar region only but, In some years there have been studies which are concentrating on the concept of 'Regional Interdependence' ("the concept that seemingly unrelated impairments in a remote anatomical region may contribute to, or be associated with the patient's primary complaint.") [9] and focusing on the mechanism in which hip muscles influence the lumbar region.

Out of all the muscles around the hip joint the Gluteus Maximus (GM) has various anatomical peculiarities. According to the electromyography analysis the cranial portion of the muscle is mainly involved in controlling flexion and rotation of the trunk on the femur. [10] The GM (with its ability to produce significant amount of torque) is actively involved in resisting Forces and momentum generated by the weight and movements of the trunk, limbs and hand held loads. [10] The base of support necessary for the core is provided by the

large muscles of the hip; mainly the GM. [11] The muscle has got the large physiologic cross sectional area to act as a major stabilizer (Stabilizes the trunk over the planted feet) and along with this it can also generate a large amount of force. Hence because of its tight coupling with the thoracolumbar fascia GM plays an important role in stabilizing trunk. [11] From the above discussion it is clear that the GM certainly plays a role in low back pain scenario hence in our study we have taken this muscle into consideration.

In this study we have focused on one of the local stabilizers (Transversus Abdominis) and one of the global mobilizer (Gluteus Maximus) of the spine and we wish to evaluate how it affects the pain and functional status in patients with the mechanical low back pain.

MATERIALS AND METHODS

A randomized control trial was conducted in physiotherapy OPD of Mahatma Gandhi Mission's Medical College and Hospital, Aurangabad. The Institutional research Ethical Committee approved this study prior to subject enrolment.

The inclusion criteria were as follows: 1) An episode of sub acute mechanical low back pain (6 weeks-3months). 2) Patients aged between 30-50 years (Both males and females). 3) Patients whose visual analogue scale [7] is 5 or higher. 4) Patients having Modified Oswestry Disability Index [7] 20% or higher. 5) Medically diagnosed cases of Mechanical low back pain.

The exclusion criteria were as follows: 1) Radiating pain (Lumbar radiculopathy, Sciatica). 2) Lumbar Spondylolisthesis, Lumbar Spondylosis. 3) History of previous lumbar surgeries and spinal deformities. [7]

Total 132 subjects were screened, out of which only 120 completed the study. (7 patients did not meet the inclusion criteria and remaining 5 patients lost to follow up). The written informed consent of the subjects was obtained prior to baseline examination. The baseline assessment included visual analogue scale [12,13,14] and modified Oswestry disability index.[15,16,17] The primary outcome measure was pain intensity. An unmarked visual analogue scale of 100 mm, anchored with 'no pain' at one end and 'most severe pain' on other, was used. The participants were asked to register the worst pain intensity that perceived in a day. The secondary outcome measure was functional status which was measured using modified oswestry disability index score, in this score the sum totals of activities of daily living are used, resulting in maximum possible score 50 points. After baseline assessment the patients were randomized into two interventional groups and one control group using simple random sampling.

The group A (40 Patients) received Transversus Abdominis activation exercise [18] and Interferential therapy, group B (40 Patients) received Gluteus Maximus activation exercise [7,19] and Interferential therapy [20]; while group C (40 Patients) which is control group received conventional flexion/extension exercises and Interferential therapy. Intervention in group A, B and C were given thrice a week for six weeks. The activation capacities of TrA & GM were measured at pre post treatment with Chattanooga Pressure Biofeedback Unit. [21] Outcome measures were assessed at baseline assessment i.e. before the intervention and reassessed after treatment i.e. after 6 weeks [7]

STATISTICAL ANALYSIS

Data was entered in Microsoft Excel and analyzed using SPSS version 24.0th. Normality of data was assessed for quantitative variables and the data was found to be normally distributed. So mean and standard deviation were calculated for quantitative variables and proportions were calculated for categorical variables. Also data was represented in form of visual impressions like bar diagram and tables etc. For comparison of three groups ANOVA

(Analysis of Variance) was applied; for comparison of two groups Scheffe Post Hoc test was used. Paired t test was used to check significant difference between pre and post treatment in each group. P value < 0.05 was considered statistically significant.

RESULTS

Table 1: Comparison of mean difference VAS between Pre & Post treatment in Groups [Paired t-test]

VAS	Mean Difference	t-value	P-value
Pre T/t Vs Post T/t Group A	1.53(23.83%)	13.90	P<0.00001 S
Pre T/t Vs Post T/t Group B	3.17(49.69%)	17.20	P<0.00001 S
Pre T/t Vs Post T/t Group C	2.76(42.53%)	24.58	P<0.00001 S

Table 2: Comparison of mean difference MODI between Pre & Post treatment in Groups [Paired t-test]

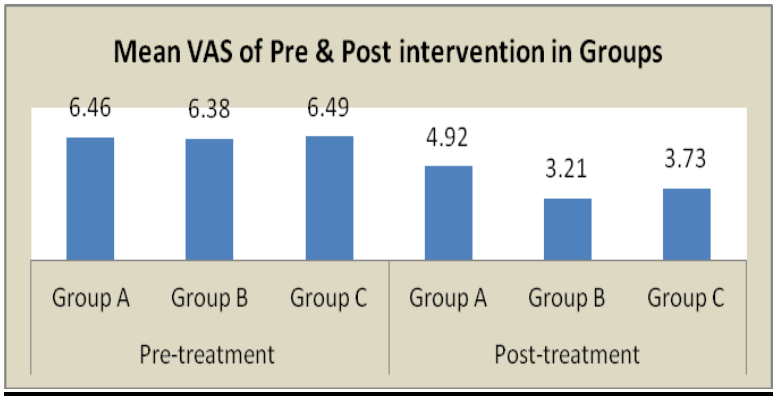
MODI	Mean Difference	t-value	P-value
PreT/tVsPostT/tGroupA	3.45 (12.95%)	16.07	P<0.00001 S
PreT/tVsPostT/t Group B	10.92 (42.38%)	16.97	P<0.00001 S
PreT/tVs PostT/tGroup C	2.40 (9.47%)	8.89	P<0.00001 S

Table 3: Comparison of mean PBU (mm/Hg) of Pre & Post treatment in Group A & Group B [Unpaired t-test]

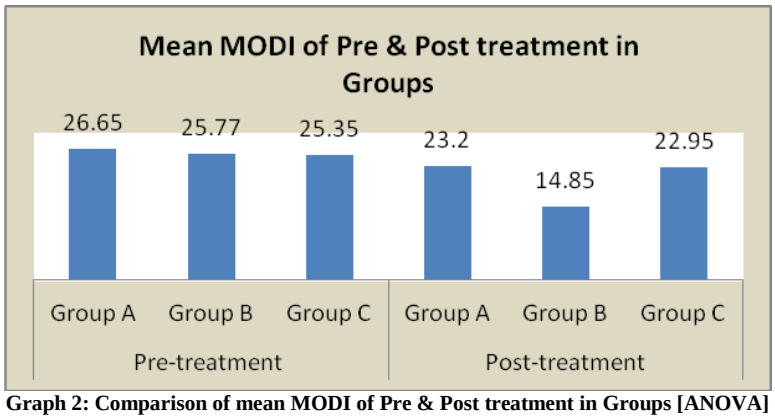
			95%ConfidenceInterval		t-value	P-value
			Lower Bound	Upper Bound		
Pre T/t	GroupA	8.52±2.26	7.80	9.24	1.59	P=0.207 NS
	GroupB	9.77±3.86	7.86	10.33		
Post T/t	GroupA	15.87±2.4	14.93	16.81	73.06	P<0.0001S
	GroupB	19.97±5.45	18.23	21.72		

Table 4: Comparison of mean difference of Pre & Post treatment of PBU (mm/Hg) between two groups of [Paired test]

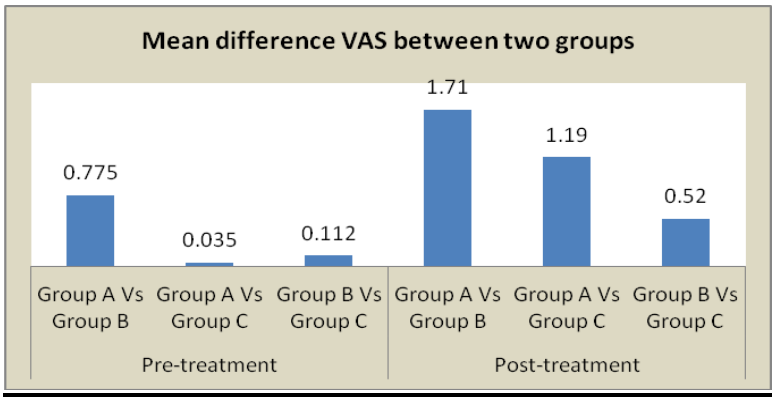
PBU (mm/Hg)	Mean Difference	t-value	P-value
PreT/tVsPostT/tGroupA	7.35 (86.26%)	20.08	P<0.00001 S
PreT/tVsPostT/tGroupB	10.87 (104.40%)	21.52	P<0.00001 S



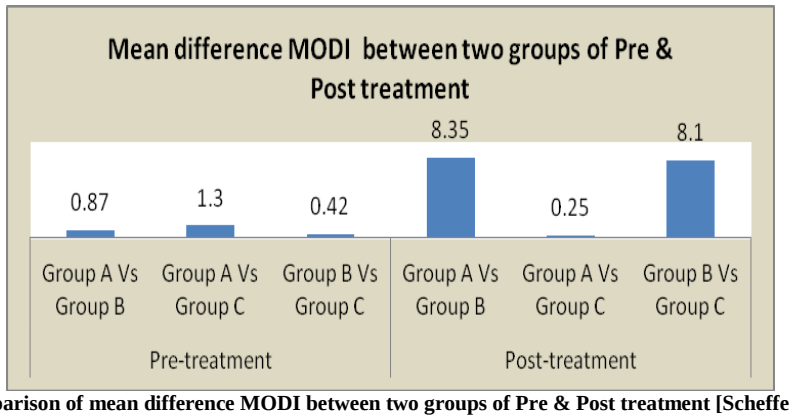
Graph 1: Mean VAS at Pre & Post intervention in Groups [ANOVA]



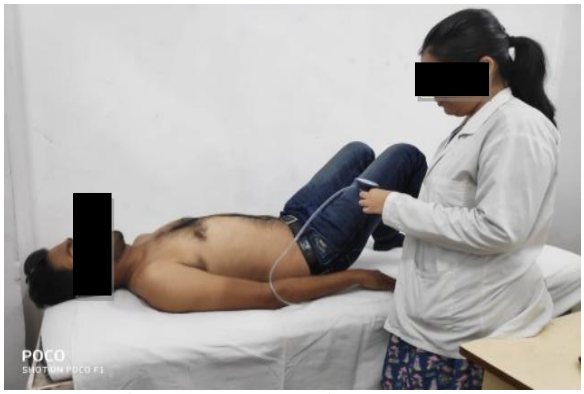
Graph 2: Comparison of mean MODI of Pre & Post treatment in Groups [ANOVA]



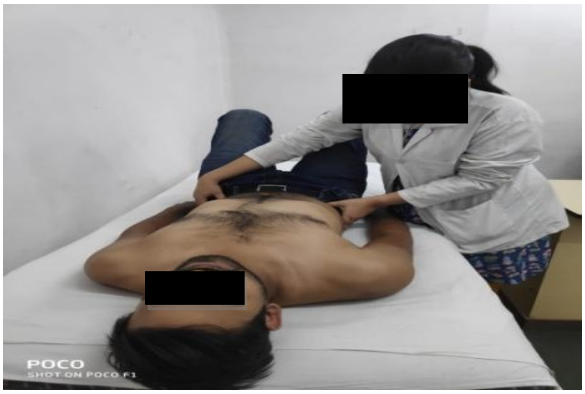
Graph 3: Comparison of mean difference VAS between two groups of Pre & Post treatment [Scheffe Post Hoc test]



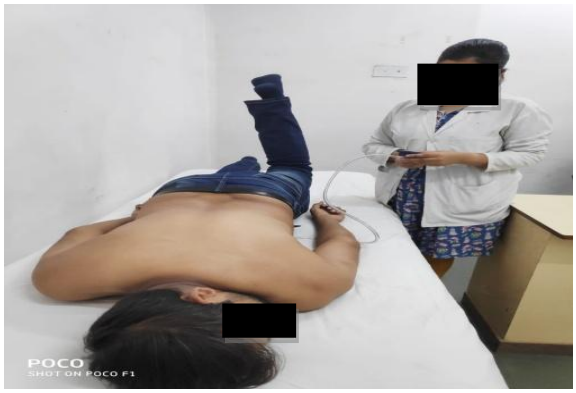
Graph 4: Comparison of mean difference MODI between two groups of Pre & Post treatment [Scheffe Post Hoc test]



Assessment of activation capacity of Transversus abdominis with pressure biofeedback unit



Patient performing the 'abdominal hollowing in maneuver

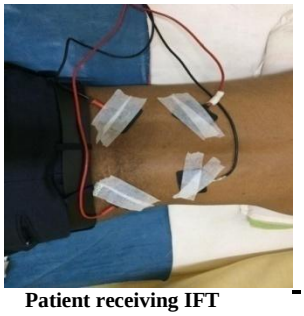


Assessment of activation capacity of Gluteus maximus using pressure biofeedback unit

Patient performing Gluteus maximus activation exercise

Patient performing the Gluteus maximus activation exercise

Patient performing the Gluteus maximus activation exercise



Patient receiving IFT

Chattanooga Pressure Biofeedback unit

Comparison of mean of VAS (at Pre & post intervention in groups) & MODI (Pre & post treatment in groups) has been done using ANOVA in (Graph 1 & 2 respectively). Comparison of mean differences VAS (between two groups of Pre & Post treatment) & MODI (between two groups of Pre & Post treatment) has been done using Scheffe Post Hoc test in (Graph 3 & 4 respectively). Comparison of mean difference VAS (Pre & Post treatment) & mean difference MODI (Pre & Post treatment) has been done using Paired t-test in (table 1 & 2 respectively) ($p<0.00001$). Comparison of mean PBU (mm/Hg) (Pre & Post treatment in Group A & B has been done in table 3 (Unpaired t-test).Comparison of mean difference of Pre & Post treatment of PBU (mm/Hg) between two groups has been done in table 4 (Paired t-test).

DISCUSSION

In the present study we got marked percentage improvement in pain and reduced disability as a result of activation of GM. Ui-Cheol Jeong compared the effects of strengthening of gluteus muscle ((gluteus maximus and medius were focused) and lumbar stabilization exercises on lumbar muscle strength and balance in patients with chronic low back pain. Oswestry Disability Index was the resembling outcome with the present study. The results of this study are consistent with the results of present study. The segmental stabilization+gluteus muscle strengthening group showed significant reduction in disability and an increase in lumbar muscle strength and balance. According to author, the possible mechanism for this improvement could be biodynamic relationship between the low back, hip joint and hip muscles. The author has also stated that the weakness of hip muscles and restricted range of motion at hip may be the potential contributors to the low back pain.[7]

Sang wk Lee (2015) demonstrated the significantly reduced hip range of motion in patients with lumbar instability. According to this study the possible mechanism of this finding could be the progressive decrease in the hip range of motion along with an increase in low back pain intensity. This study positively supports the present study; as it is based on the concept of 'regional interdependence'

and is also focusing on vital role of hip muscles in low back pain cases. [22]

In addition to this one more author, compared the activity of GM, biceps femoris and lumbar paraspinals in 19 patients with chronic low back pain and 19 healthy subjects & demonstrated the marked reduction in the activity of GM during trunk flexion and extension and hence the study recommended taking the GM into consideration while treating the low back pain cases. [23] Result of one more study stated that; in low back pain developers the GM shows delayed activation during extension from trunk flexion. [24]

Numbers of authors have focused on the vital role of TrA in different low back conditions

Rasmussen-Barr E in 2009 performed a randomized controlled trial on 71 patients with recurrent low back pain. The experimental group received the specific TrA activation and multifidus activation exercises with assistance of pressure biofeedback unit while the control group received a 45 minutes walking protocol. The outcome measures resemble the outcome parameters of present study i.e. pain (VAS) and disability (MODI). The authors concluded that, lumbar stabilizing exercises have similar effects with those of 45 minutes of walking on pain and disability in patients with recurrent low back pain.[25]

One of the studies explained about the changes in TrA recruitment and its correlation with disability in patients with chronic low back pain. The authors postulated that motor exercises lead to significant improvements in recruitment of TrA (7.8%) than general exercises (4.9%) and spinal manipulative therapy (3.7%). Hence the conclusion of this study is consistent with the result of present study that pain relieving effect of TrA activation is greater in subjects who possess the poor ability to recruit this muscle at baseline. [26]
Another study, postulated that, The TrA is the primary muscle affected by low back pain. The pain causes significant reduction in anticipatory function of the local stabilizer; hence TrA is unable to recruit to its maximum and thereby is unable to fulfill the demand of segmental protection. Hence with the correct activation of TrA it is possible to achieve reduction in pain status of patients with LBP. [27]

The local muscles provide segmental stability and they also contribute to segmental translation. The activation of TrA is irrespective of the direction of the movement that means it is the first muscle to contract in physiologic situation. They prevent the spine from overloading by contracting prior to the movement. The pain inhibits these vital functions of TrA. [9] This explains the significant improvement in pain and disability status of the patients in present study after TrA activation.

However, The GM activation group showed more significant improvements in pain and disability status of the patients when compared with the TrA activation group.

The possible explanation of this result lies in the specific peculiarities of GM muscle. This muscle in humans has got much thicker cranial portion, large cross sectional area (which is not present in any other primates) these specifications help this antigravity muscle to control the movements of trunk and hind limbs also it can stabilize the trunk over pelvis during different functional activities. This muscle is able of producing a considerable amount of torque to resist the forces generated by weight and movements of trunk, hind limbs and hand held loads.[11] The numbers of studies have reported the delayed activation of hip extensors in chronic low back pain patients.[24]

Also, for better stability of the spine, the ability to actively control the muscles of hip must be taken into consideration. The GM muscle plays a key role in delivering loads from sacroiliac joint to lower extrimities. [7] In addition to this GM is a global mobilizer. The stability of the lumbar spine cannot be achieved without consideration of Global Mobilizers. [9] The GM by coupling tightly with the

thoracolumbar fascia actively braces the lumbar spine and hence is vital in force transmission as well as maintaining erect spine posture. [23] This explanation justifies the results of present study; the GM activation resulted in more significant improvement in pain and disability status of the patients with MLBP.

CONCLUSION

This study concluded that; all three treatment protocols i.e. GM activation, TrA activation and Interferential therapy were effective in the management of MLBP However, the GM activation demonstrated the more beneficial effects over TrA activation and Interferential therapy in reducing pain and self reported functional disability.

Clinical Implications

This study reinforces the concept of regional interdependence; and underlines the significant role of hip musculature (Precisely the GM) in MLBP. The study states that activation of one single global mobilizer can produce wonderful effects in terms of pain and disability in MLBP patients. Hence it is suggested that; the GM should be given special attention while treating the NSLBP and the activation of this global mobilizer should be added as an adjunct to conventional protocol.

Limitations

1. The occupational aspect of patients was not taken into consideration
2. The age group of 20-30 years was not taken into consideration.
3. The degenerative disc diseases were excluded from the study.

Future Scope of Study

Future studies may focus on effects of targeting GM in occupation related low back pain or in degenerative disc diseases of lumbar spine. Studies may also concentrate on combine effects of GM and TrA activation on pain and disability.

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How to cite this article: Walimbe VU, Mungikar SS, Dobhal S. Efficacy of activation of gluteus maximus versus transversus abdominis in patients with mechanical low back pain: a randomized controlled trial. Int J Health Sci Res. 2020; 10(12):141-149.

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