©2021 The Academy of Environmental Biology, India
Journal of Ecophysiology and Occupational Health, *Vol 21(4), DOI: 10.18311/jeoh/2021/28561, 132-141, December 2021*
ISSN (Print): 0972-4397
ISSN (Online): 0974-0805

Effectiveness of Myofascial Release, Muscle Energy Technique and Stretching of Quadrartus Lumborum Muscle in Patients with Non-Specific Low Back Pain

Siddhi V. Bhosale[1] and Mayuri Burungale[2]

[1]Intern, Krishna College of Physiotherapy, Krishna Institute of Medical Sciences "Deemed to Be" University, Karad – 415539, Maharashtra, India; bhosalesiddhi2@gmail.com

[2]Assistant Professor, Department of Neurosciences, Krishna College of Physiotherapy, Krishna Institute of Medical Sciences "Deemed to Be" University, Karad – 415539, Maharashtra, India

Abstract

Background: Low back pain is attributed to be the most commonly encountered health condition and considered to be one of the leading cause of disability. It is known to occur in all age groups in both developed as well as developing countries. About 80% of the patients have moderate to severe pain affecting their activities of daily living, with females more affected than males. Almost 90% of low back pain is of non-specific type. Quadratus lumborum is one of the deep muscles located closer to center of rotation of spinal segment having an ideal muscle length controlling motion at spine. Activities like sustained repetitive movements, twisting, bending, and sedentary posture for prolong duration, muscle imbalance, etc. leads to trigger point formation making quadratus lumborum as a common source of low back pain. **Aim**: To determine the combined effect of myofascial release therapy, muscle energy technique and stretching of Quadratus Lumborum muscle in Non-specific low back pain in a short duration span. **Methods:** In this Experimental study design, two groups were divided as Control and Experimental group with a pre and post test format for both groups. 35 participants were selected and divided into 2 groups by using the Random Sampling Technique using the inclusion and exclusion criteria. Outcome measures assessed were Numerical Pain Rating Scale (NRPS), Oswestry Disability Index (ODI) and Lumbar Range of Motion with Modified Schober's Test. A specifically designed treatment protocol for individual group was used for duration of 2 weeks. **Statiscal Analysis:** Paired and Unpaired t test were used for the analysis of the data. **Results:** The results of the study showed extremely significant difference between both the groups for NPRS and ODI with $p<0.0001$ using unpaired t test considered extremely significant. The increase in mean values is extremely significant for Lumbar ROM while comparing the pre and post-test values for mean difference of experimental group than control. The improvement in lumbar flexion, side flexion is more marked than for extension with minimal to no difference in rotation. **Conclusion:** The combined effect of Myofascial release, Muscle energy technique and stretching of Quadratus Lumborum has shown to be effective in treatment of patients with non-specific low back pain.

Keywords: Muscle Energy Technique, Myofascial Release, Non-Specific Low Back Pain, Quadratus Lumborum

1. Introduction

Low back pain is attributed to be one of the most commonly encountered health condition faced. It is considered to be the leading cause of disability affecting all age groups in both developing and developed countries. About 80% of the patients have moderate to severe pain intensity affecting their activities of daily living, with female individuals more affected than males. Almost 90% of low back pain is of non-specific type[1].

Low Back Pain can be qualified as mechanical, non-mechanical and psychogenic. Mechanical pain is further qualified as specific and non-specific. A pain arising due to unknown cause or pathology is known as non-specific low back pain. Non-specific low back pain is defined as the pain which arises due to an unknown cause or pathology. The non-specific low back pain varies with physical activity, duration and usually located to lumbosacral, buttock and thigh region with no radiating pain in leg or foot. It is localized to coastal margin, inferior gluteal folds and paraspinal region. The causes of low back pain are various such as myofascial pain or trigger points due to piriformis or quadratus lumborum, muscle spasm or strain, stiffness, altered biomechanics of the

*Author for correspondence

spine or body, limitation of movement, faulty posture, weak musculature, overuse like repetitive weight-lifting or carrying excessive weight with improper position of the body etc. Those with a higher Body Mass Index and individuals involved in sedentary work are considered at a higher risk for development of low back pain in general[2,3]. In most cases of low back pain, the initial source of pain is the soft tissue structures[3].

The prevalence of low back pain is estimated to be around 60-70% whereas almost 70-85% of people will experience low back pain at some point in their life[4]. Hoe et al., stated that among the individuals complaining of low back pain, about 85% to 95% cases there is an unknown pathoanatomical cause and thus the diagnosis conclude non-specific low back pain. Various factors are found to influence the prevalence of low back pain including age, sex, body composition, education level and occupation of an individual[5].

The musculature of the spine is divided into the global or superficial muscle system and deep or local muscle system. The superficial muscles have its attachment from the vertebrae of the spine to the ribs causing movement working together as a guy wire functioning for mobility and the deep muscles attaches one vertebra to another providing segmental stability to the vertebral column[6].

Quadratus lumborum is one of the deep muscles located closer to center of rotation of spinal segment having an ideal muscle length controlling motion at spine. Located in the posterior abdominal wall present in pair, originating at posterior border of iliac crest and inserting on inferior border of twelfth rib and transverse process of L1 to L4 vertebrae. The deep medial portion of quadratus lumborum acts as a deep segmental muscle whereas the lateral portion acts as a global muscle. The muscle functions as lateral flexor of spine contracting unilaterally, bilaterally contracts for lumbar extension, as it attaches the 12 rib and some fibers merge with diaphragm it has a significant role in respiration mainly during exhalation. It also connects the pelvis to spine acting as a primary antagonist to quadratus lumborum on other side. Hence activities like sustained repetitive movements, twisting, bending, sedentary posture for prolonged duration, muscle imbalance, etc. leads to trigger point formation making quadratus lumborum as a common source of low back pain also there are major evidences stating the same[3,6,7,17,22].

A case study conducted by Barge AS et al., stated that in most cases of low back pain may be acute or chronic the most common source of pain is missed or remains undiagnosed, very often the Quadratus Lumborum muscle compensates for weak back musculature leading to improper and powerful contractions causing painful spasms and myofascial pain syndrome in Quadratus Lumborum muscle[8]. Thus, it is necessary to take quadratus lumborum in consideration for low back pain owing to its significant role in spinal mobility as well as stability along with respiration.

A wider variety of interventions such as medical, surgical and rehabilitative have been used in management of back pain, one of which is the manual therapy techniques. A systematic review conducted by Van Middelkoop et al., suggested that exercise therapy has shown to improve various aspects of the symptoms experienced in low back pain such as pain, disability and functioning[9]. According to a study conducted by Jason Mallia et al., exercise therapy and manual therapy approaches are considered to be the first line and an integral part of management strategies in Low back pain. Also, myofascial release therapy showed to effective in reducing low back pain in about 53.3% participants of the study[10].

Myofascial release therapy is defined as the facilitation of mechanical, neural and psycho physiological adaptive potentials as interfaced via myofascial system. The role of involvement of the fascial system in non-specific low back pain is quite evident and proved by many studies. The thoracolumbar fascia has a basal tension which helps it to sense and control of underlying muscles due to presence of mechanoreceptors. With trigger point formation this tension is altered affecting the fascial model leading to dysfunction[11]. A myofascial trigger point is defined as a hard, palpable, hyperirritable area or nodule present in a tight band of muscle which often leads to pain[12]. In this technique the feedback from the patient's body is important as it acts a source of guidance for the force generation, direction, duration and taking up the slack and reaching the next barrier or restriction. It has also proved to be effective in reducing anxiety, improving sleep and tackling depression to a certain extent[13,14]. Not only the muscles, fascia and somatic dysfunction, all the fibroelastic connective tissues as well as skin, ligaments, tendon blood vessels, lymphatics are affected by myofascial release. It has shown to improve muscle length, reduce pain, improve function, improve circulation along with stimulation of mechanoreceptors, breaking adhesions, etc.[15,16].

Another manual therapy treatment approach is the Muscle Energy Technique which involves voluntary contraction of patient's muscle in a precisely controlled direction, at varying level of intensity against a distinctly executed counter force applied by therapist as stated by Chai tow. Lewit (1992) stated that in case of pain present at lumbodorsal junction use of post-Isometric relaxation techniques is beneficial to treat the involved muscles, as most of them are either shortened, overactive, sensitive on direct palpation. They become stretched and normalise post treatment so, automatically the rest of musculature functions in a normal manner[17]. MET stimulates the Golgi tendon organs within the muscle where afferent nerve impulse enters the dorsal root of spinal cord and meets with an inhibitory response. MET has been shown

effective in lengthening, strengthening of the shortened muscle, increasing the fluid mechanics, decreasing edema thus improving flexibility of the muscle[18]. A study conducted by Kumar et al., proved MET to be effective in treatment of acute low back pain patients with involvement of QL muscle[19].

The therapeutic maneuver designed to increase the extensibility of soft tissues and improving the flexibility along with range of motion by elongating structures that have adaptively shortened or became hypomobile overtime is known as Stretching. Muscular imbalances often arise due to faulty habitual postures, overuse leading to microtrauma causing chronic dysfunction. Usually, three repetitions are carried out by the participant performing stretching with a hold of 10-30 seconds during each repetition thus stimulating the stretch receptors within the muscle[6,20]. The self-static stretching involves elongation of the muscle slowly until tolerable and holding the position for a duration short of pain voluntarily by an individual. In a study conducted by Devi ZK et al., it was observed that stretching of lower back muscles had a short-term effect upon improving pain, flexibility and functional disability among occupation related chronic low back pain[21].

The previous studies showed the need for studies to be undertaken over various physiotherapy interventions focusing mainly the combined effect of manual therapy approaches adding on to scarcity in the literature. Thus, the purpose of this study is to know the combined effect of myofascial release therapy, muscle energy technique and stretching of Quadratus Lumborum muscle in Non-specific low back pain in a short duration span.

2. Materials and Methods

2.1 Participant Selection

A total of 35 participants were selected and divided in two groups i.e., Control and Experimental group with a pre and post test format for both, using Random sampling technique.

2.2 Duration and Type of Study

An experimental study was carried out in which a specifically designed treatment protocol for individual group was applied for duration of 2 weeks. Study duration was from December 2020 to May 2021.

2.3 Sampling Method

The participants were selected using the stratified sampling method, a method of simple random sampling technique according to the inclusion and exclusion criteria.

2.4 Sample size Calculation

Formula for sample size:

$$N = \frac{Z^2 pq}{L^2}$$

Z = standard normal variate at 95% confidence interval
p = estimated prevalence for migraine by using reference studies
q = 100-p = no prevalence
L = allowable error = 5%

Ref: Luomajoki HA, Beltran MB, Careddu S, Bauer CM. Effectiveness of movement control exercises on patients with non-specific low back pain and movement control impairment: a systematic review and meta-analysis, Musculoskeletal Science and Practice 2018 Aug 1; 36:1-1.

2.5 Inclusion Criteria

Subject complaining low back pain or pain after maintaining a prolonged posture

1. Low back pain for more than 3-6 weeks
2. Age group:18-40 years
3. Limitation in range of motion of lumbar spine due to tightness of the muscle, tightness of QL, hypersensitive tender points on palpation along with pain localized para spinally were selected for the study.

2.6 Exclusion Criteria

1. Individuals with a history of any spinal surgery or pathology of spine like tuberculosis, tumor, osteoporosis, etc.
2. Patients with altered sensation or spinal cord injury, any pathological condition related to hip joint.

2.7 Data Collection Procedure

In this Experimental study design, two groups were divided as Control and Experimental group with a pre and post test format for both groups. The approval for the study was obtained from the Protocol committee and the Institutional Ethical committee of the KIMSDTU. Each subject was asked to sign a written informed consent after explanation regarding the study conducted. Outcome measures assessed were Numerical Pain Rating Scale (NRPS), ODI and Lumbar Range of Motion with Modified Schober's Test[23-25]. A specifically designed treatment protocol for individual group was given for duration of 2 weeks. Pre and post test values were documented.

2.7.1 Interventions

MFR - QL is palpated in prone and side lying for trigger points. The technique is applied by the patient positioned in side lying with a pillow under waist to exaggerate stretch of the muscle. The therapist stands at level of patient's hip posterior and cross hand technique or elbow is used. The elbow of the cranial arm placed above the iliac crest and lateral to lumbar par vertebral muscles and over QL region, the caudal hand is placed on subject's thigh. Low level pressure will be applied with elbow obliquely directed towards centre of spinal column while other hand exercises gentle traction along patient's leg. This technique is applied for 7-10 minutes 14-16.

MET - Patient is in side lying with therapist standing posterior at waist level, patients upper arm extended over head to firmly grasp top end of plinth, and on inhalation abducts the uppermost leg until QL action is felt (Usually at 30 degrees) the patient holds the leg isometrically, allowing gravity to provide resistance for 10 seconds the patient allows the leg to hang slightly behind him over the back of table. The therapist straddles this and cradles the pelvis with both hands, fingers interlocked over iliac crest and leans back to take up slack and ease the pelvis away from lower ribs during exhalation. The stretch is held for 10 to 30 seconds[17].

STRETCHING - Self-stretching in standing position. For stretching the right QL the patient places the left foot in front of the right and then left laterally flexes the trunk with arm raised overhead and brought to left side[20].

3. Protocol

3.1 Outcome Measures

Numerical Pain Rating Scale (NRPS), Oswestry Disability Index (ODI) and Lumbar Range of Motion with Modified Schober's Test

A-(Control Group)

Interventions	**Dosage (3 times/per week) for 2 weeks**	**Reasoning**
Hot Moist Pack	10 mins	Relaxing soft tissue structures Increases extensibility
Transcutaneous Electrical Stimulator	10 mins	Pain relief
Exercises • Side bending • Static abdominal • Static back extensor • Side bridging • Pelvic bridging/ pelvic tilting • Cat camel	10 repetitions - 5 sec hold	For strengthening muscle

B-(Experimental Group)

Interventions	**Dosage (3 times/per week) for 2 weeks**	**Reasoning**
Hot Moist Pack	10 mins	Relaxing soft tissue structures Increases extensibility Pain relief
MFR	7 min	Target the trigger points and treating them Pain relief Improves mobility
MET	3 times	For activation of muscle fibres
Home program:		
Exercises • Side bending • Static abdominal • Static back extensor • Side bridging • Pelvic bridging/pelvic tilting	10 repetitions - 5 sec hold	For strengthening muscle
Self-Stretching	Static hold of 6 seconds 3 times.	For lengthening of shortened muscle fibres
Cryotherapy	5-10 min	Muscle relaxes and stretched muscle icing causes depression of stretch reflex Lewis hunting response

4. Results

Statistical analysis of the recorded data was done by using the software InStat version 3.2. Arithmetic mean and standard deviation were calculated for each outcome measure. Within the group comparison was done by applying 'Paired t-test' to pre and post training values of same group for all outcome measures and 'Unpaired t-test' for between the group analysis. Probability (P) was used to state the significance of the result.

Study showed extremely significant difference between both the groups for NPRS and ODI with p<0.0001 unpaired t test using considered extremely significant. The increase in mean values is extremely significant for Lumbar ROM while comparing the pre and post test values for mean difference of experimental group than control.

C-(Demographic characteristic)

Demographic characteristic	Control Group	Experimental Group
Number of subjects (n)	17	18
Age in years (mean ± SD)	26.23±4.35	26.33±3.93
Minimum Age	22	22
Maximum Age	38	36
20-30 years	14	14
30-40 years	3	4

Table1 and Figure 1 comparison of pain (NPRS) pre and post treatment using paired 't' test.

Table 1. Pre and post means of NPRS for both groups

Pain (NPRS)* cm	Pre-Mean	Post-Mean	Mean difference	Paired 't' value	p value	Significance
Control group	6.05±1.95	4.0±1.65	2.05±0.96	8.784	<0.0001	Extremely Significant
Experimental group	6.61±1.75	1.66±0.92	5.44±1.33	17.261	<0.0001	Extremely Significant

p value - <0.0001 Extremely significant (Unpaired 't' test).

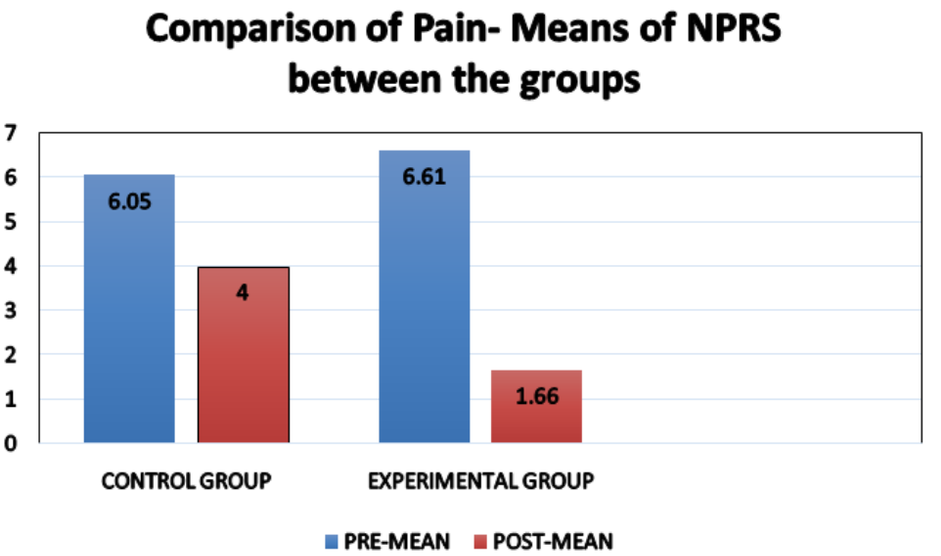


Figure 1. Pre and post mean of NPRS for both groups.

Table 2 and Figure 2 comparison of disability (ODI) pre and post treatment using paired 't' test.

Table 2. Pre and post means of ODI for both groups

Oswestry Disability Index %	Pre-Mean	Post-Mean	Mean difference	Paired 't' value	p value	Significance
Control group	38.55±9.38	23.62±8.71	14.93±3.17	19.424	<0.0001	Extremely Significant
Experimental group	41.98±6.72	9.66±2.82	32.32±7.51	18.246	<0.0001	Extremely Significant

p value - <0.0001 Extremely significant (Unpaired 't' test).

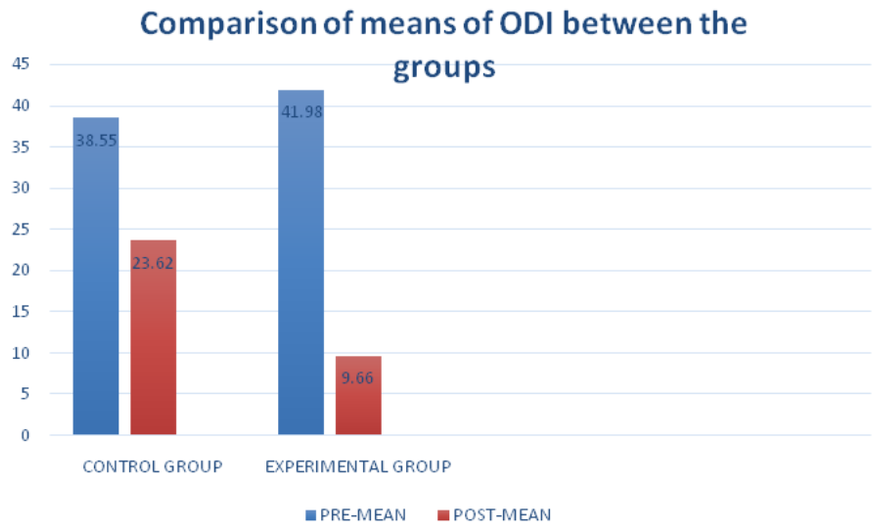
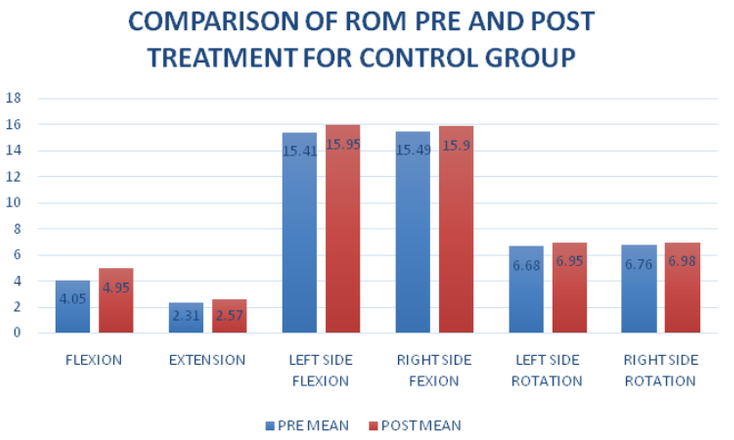


Figure 2. Pre and post means of ODI for both groups.

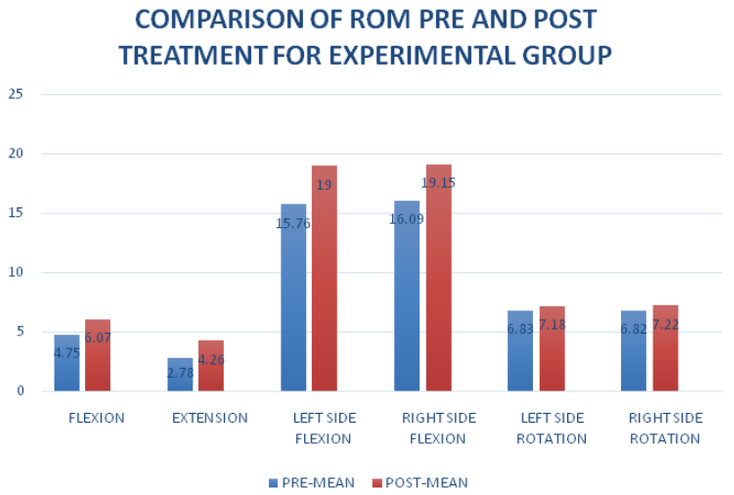
Table 3 and Figure 3 comparison of lumbar rom pre and post treatment using paired 't' test in control group.

Table 3. Pre and post means of ROM for both groups

Range of motion	Experimental Group		p value	Paired 't' test	Control Group		p value	Paired 't' test
	Pre-mean	Post-mean			Pre-mean	Post-mean		
Flexion	4.75±0.89	6.07±0.78	<0.0001	9.236	4.05±1.16	4.95±1.03	<0.0001	17.493
Extension	2.78±0.62	4.26±0.64	<0.0001	12.958	2.31±0.76	2.57±0.71	<0.0001	5.352
Left side Flexion	15.76±1.07	19.10±1.01	<0.0001	13.185	15.41±1.26	15.95±1.04	<0.0001	6.252
Right side flexion	16.09±0.87	19.15±0.91	<0.0001	11.668	15.49±1.18	15.90±1.09	<0.0001	5.895
Left rotation	6.83±0.67	7.18±0.62	0.0005	4.261	6.68±0.44	6.95±0.47	0.0019	3.699
Right rotation	6.82±0.68	7.22±0.60	0.0004	4.426	6.76±0.53	6.98±0.47	0.0060	3.167



a



b

Figure 3. a - Pre and post means of ROM for Control group; b - Pre and post means of ROM for Experimental group.

5. Discussion

Quadratus lumborum is a common source of low back pain which is often overlooked. It is necessary to take quadratus lumborum in consideration for low back pain owing to its role in spinal mobility and stability. There is limited literature regarding advanced management strategies for non-specific low back pain. Till date generic treatments are used with modest treatment effectiveness[1]. Hence proper identification of root cause through clinical reasoning opens new treatment approach to be used to treat the root cause directly targeting the source of pain and improving the condition within a shorter duration span. To our knowledge there are fewer literatures present specifically regarding the effectiveness of myofascial release therapy and muscle energy technique on quadratus lumborum in nonspecific low back pain? Few studies focus the need of research to be undertaken for proving the effect of exercise therapy approaches on specific subgroups of low back pain[1,9,10]. The previous literature has shown the effect of individual manual therapy approaches studied on patients with non-specific low back pain, this study aims at knowing the combined effectiveness of three manual therapy approaches in a short-term intervention.

The present study was an experimental carried out to know the combined effect of MFR, MET and stretching of Quadratus Lumborum muscle in patients with non-specific Low Back Pain within a short-term duration of 2 weeks. A total of 35 participants were selected for the study among which 17 were in control group and 18 were in experimental group. In Control group, 53% (9) were females whereas 47% (8) subjects were males. In Experimental group, 56% (10) were females whereas 44% (8) subjects were males. Both groups received hot moist pack prior to the treatment for 10-15 mins. Control group received TENS followed by supervised exercises. Experimental

group received MFR for 7-10 mins. followed by MET, 3-5 repetitions completing with self-stretching as a home program along with other exercises for the purpose of maintenance in improved pain, disability and functioning.

The pain assessment was carried out using the NRPS scale. For control group, the pre-test Mean and SD was 6.05±1.95 whereas the post-test values were 4.0±1.65 showing a mean difference of 2.05±0.96 with $p<0.0001$ considered extremely significance using Paired 't' test. For experimental group, the pre-test Mean and SD was 6.61±1.75 whereas the post-test values were 1.66±0.92 showing a mean difference of 5.44±1.33 with $p<0.0001$ considered extremely significance. An unpaired t test using the mean difference was used which stated the p value to be <0.0001 considered extremely significant.

The disability assessment was carried out using the ODI scoring. For control group, the pre-test Mean and SD was 38.55±9.38 whereas the post-test values were 23.62±8.71 showing a mean difference of 14.93±3.17 with $p<0.0001$ considered extremely significance using Paired 't' test. For experimental group, the pre-test Mean and SD was 41.98±6.72 whereas the post-test values were 9.66±2.82 showing a mean difference of 32.32±7.51 with $p<0.0001$ considered extremely significance. An unpaired t test using the mean difference was done stating the p value to be <0.0001 considered extremely significant.

The functional assessment was done using the Lumbar range of motion with tape method using Modified Schober's test. While comparing the differences in mean and standard deviation values for pre and post test of control and experimental group, it was observed that the experimental group had extremely significant improvement post-test in mean values for ROM of lumbar flexion (pre-test value 4.75±0.89 and post test value 6.07±0.78), extension (pre-test value 2.78±0.62 and post test value 4.26±0.64) and side flexion(left side, pre-test 15.76±1.07 and post test 19.01±1.01 for right side, pre-test value 16.09±0.87 and post test 19.15±0.91) than that of subjects in control group. Lumbar rotation was also slightly improved.

The individual application of MET, MFR and stretching for a longer duration has been shown to be effective on various parameters of low back pain such as pain, mobility and functioning by studies conducted previously focusing on Quadratus lumborum to be the source of pain[26-30]. Exercise therapy has shown to be beneficial in reducing pain and disability.[9] Bailosky et al., stated a model highlighting various potential mechanisms when use of combined treatment approaches were used in treatment of musculoskeletal disorders which supports the study where combined manual therapy techniques have shown to be effective in treatment of non-specific low back pain[31]. According to a study conducted by Chang-yu J. Hseih et al., the combined use of manual therapy approaches such as mobilization and MFR has shown to be effective in reducing low back pain and functional disability. It also suggests the need of research to be undertaken upon various manual therapy treatment approaches involved in treatment of low back pain to be compared with a specific control group to study the effectiveness of the interventions used[32]. Thus, result of the present study demonstrated that the experimental group which received combined treatment approach showed extremely significant improvement in NRPS, ODI and ROM within a short-term duration of 2 weeks compared to the control group.

6. Conclusion

The result of the study proved that there was extremely significant difference in improvement of pain, disability and functional assessment in Experimental group when compared to the Control group. Thus, to conclude the combined effect of Myofascial release, Muscle energy technique and stretching of Quadratus Lumborum has shown to be effective in treatment of patients with non-specific low back pain.

7. Ethics Approval and Patient Consent

The study was approved by the "Institutional Ethics Committee" of Krishna Institute of Medical Sciences, "Deemed to be" University, Karad, Maharashtra. The author had explained the study and the intervention to be given the participants and had taken participants consent prior to beginning of the study on every participant.

8. Acknowledgements

Author acknowledges the university, Krishna Institute of Medical sciences Deemed to be University Karad, for allowing to perform this research and providing the necessary funding. Author would acknowledge, Dr. Mayuri Burungale and Dean Dr. G. Varadharajulu for their support and guidance. The author would like to extend her sincere gratitude to the participants of the study.

9. References

1. Maher C, Underwood M, Buchbinder R. Non-specific low back pain. The Lancet. 2017 Feb 18; 389(10070):736-747. https://doi.org/10.1016/S0140-6736(16)30970-9.
2. Maleki S. Low Back Pain: A Case Study. Physical Therapy Scholarly Projects; 2015. p. 610. https://commons.und.edu/pt-grad/610/.
3. Voight M, Hoogenboom B, Prentice W. Musculoskeletal Interventions: Techniques for Therapeutic Exercise. McGraw Hill Professional; 2006 Dec 5.

4. Mooney V. Clinical Orthopaedic Rehabilitation, Steven B. Brotzman, MD, and Kevin Wilk, PT, Mosby/Elsevier, 2003. The Spine Journal. 2004 May 1; 4(3):555. https://doi.org/10.1016/j.spinee.2003.09.002.
5. Luomajoki HA, Beltran MB, Careddu S, Bauer CM. Effectiveness of movement control exercise on patients with non-specific low back pain and movement control impairment: a systematic review and meta-analysis. Musculoskeletal Science and Practice. 2018 Aug 1; 36:1-1. https://doi.org/10.1016/j.msksp.2018.03.008. PMid:29631119.
6. Kisner C, Colby LA, Borstad J. Therapeutic Exercise: Foundations and Techniques. Fa Davis; 2017 Oct 18.
7. Vohra S, Jaiswal VC. Effectiveness of strain counterstrain technique on quadratus lumborum trigger point in low back pain. IOSR J Sports Phys Educ. 2014; 1:53-58. https://doi.org/10.9790/6737-0165358.
8. Barge AS, Barge SM. Quadratus lumborum: One of the many significant causes of low back pain. Indian Journal of Pain. 2018 Sept. 1; 32(3):184.
9. Van Middelkoop M, Rubinstein SM, Kuijpers T, Verhagen AP, Ostelo R, Koes BW, van Tulder MW. A systematic review on the effectiveness of physical and rehabilitation interventions for chronic non-specific low back pain. European Spine Journal. 2011 Jan 1; 20(1):19-39. https://doi.org/10.1007/s00586-010-1518-3. PMid:20640863 PMCid:PMC3036018.
10. Mallia J. An Integrative Approach to Lower Back Pain.
11. Casato G, Stecco C, Busin R. Role of fasciae in nonspecific low back pain. European Journal of Translational Myology. 2019 Aug 2; 29(3). https://doi.org/10.4081/ejtm.2019.8330. PMid:31579477 PMCid:PMC6767839.
12. Grover C, Christoffersen K, Clark L, Close R, Layhe S. Atraumatic back pain due to quadratus lumborum spasm treated by physical therapy with manual trigger point therapy in the emergency department. Clinical Practice and Cases in Emergency Medicine. 2019 Aug; 3(3):259. https://doi.org/10.5811/cpcem.2019.4.42788. PMid:31404175 PMCid:PMC6682240.
13. Awad MA, Allah AH. Effect of Myofascial Release Technique Versus Mulligan Mobilization Technique on Post Natal Low Back Pain. The 20th International Scientific Conference Faculty of Physical Therapy Cairo, 6-7 April, 2019. 1-21.
14. Ellythy MA. Efficacy of muscle energy technique versus myofascial release on function outcome measures in patients with chronic low back pain. Bulletin of Faculty of Physical Therapy. 2012; 17(1).
15. Arguisuelas MD, Lison JF, Domenech-Fernandez J, Martinez-Hurtado I, Coloma PS, Sanchez-Zuriaga D. Effects of myofascial release in erector spinae myoelectric activity and lumbar spine kinematics in non-specific chronic low back pain: Randomized controlled trial. Clinical Biomechanics. 2019 Mar 1; 63:27-33. https://doi.org/10.1016/j.clinbiomech.2019.02.009. PMid:30784788.
16. Shah Y, Arkesteijn M, Thomas D, Whyman J, Passfield L. The acute effects of integrated myofascial techniques on lumbar paraspinal blood flow compared with kinesio-taping: A pilot study. Journal of Bodywork and Movement Therapies. 2017 Apr 1; 21(2):459-467. https://doi.org/10.1016/j.jbmt.2016.08.012. PMid:28532891.
17. Chaitow L, Crenshaw K. Muscle energy techniques. Elsevier Health Sciences; 1 Jan 2006. p. 346.
18. Wilson E, Payton O, Donegan-Shoaf L, Dec K. Muscle energy technique in patients with acute low back pain: a pilot clinical trial. Journal of Orthopaedic and Sports Physical Therapy. 2003 Sep; 33(9):502-512. https://doi.org/10.2519/jospt.2003.33.9.502. PMid:14524509.
19. Kumar VS, MK FS, Kumar S, Velmurugan A. Effects of muscle energy technique on quadratus lumborum and active posterior pelvic tilt exercises on pain and disability in acute low back pain subjects-a comparative study. Epub. 2018 Jun; 38(1):41-51. https://doi.org/10.1142/S1013702518500051.
20. Muscolino JE. The Muscle and bone palpation manual with trigger points, referral patterns and stretching. Elsevier Health Sciences. 2008 Dec 1.
21. Devi ZK, Kumar SN, Babu KB, Ayyappan RV. Effectiveness of muscle stretching in occupation related chronic mechanical low back pain in community nurses-A single blind study. International Journal of Physiotherapy and Research. 2014; 2(1):403-410.
22. Page P, Frank CC, Lardner R. Assessment and Treatment of Muscle Imbalance: The Janda Approach. Champaign, IL: Human Kinetics; 2010. https://doi.org/10.5040/9781718211445.
23. Macrae IF, Wright V. Measurement of back movement. Annals of the Rheumatic Diseases. 1969 Nov; 28(6):584. https://doi.org/10.1136/ard.28.6.584. PMid:5363241 PMCid:PMC1031291.
24. Moll JM, Wright V. Normal range of spinal mobility. An objective clinical study. Annals of the Rheumatic Diseases. 1971 Jul; 30(4):381. https://doi.org/10.1136/ard.30.4.381. PMid:5557779 PMCid:PMC1005796.
25. Johnson ME. A review of noninvasive tools used for measuring flexion of the lumbar spine. Physical Therapy Scholarly Projects; 1994. p. 238. https://core.ac.uk/download/pdf/235074274.pdf. https://commons.und.edu/pt-grad/238.
26. Tawrej P, Kaur R, Ghodey S. Immediate Effect of Muscle Energy Technique on Quadratus Lumborum Muscle in Patients with Non-Specific Low Back Pain. Indian Journal of Physiotherapy and Occupational Therapy. 2020 Jan 1; 13(1).
27. Dhargalkar P, Kulkarni A, Ghodey S. Added effect of muscle energy technique for improving functional ability in patients with chronic nonspecific low back pain. Int J Physiother Res. 2017; 5(3):2082-2087. https://doi.org/10.16965/ijpr.2017.144.
28. Rishi P, Arora B. Impact of muscle energy technique along with super-vised exercise program over muscle energy technique on quadratus lumborum and iliopsoas on pain and functional disability in chronic non specific low back pain. Int J Physiother Res. 2018; 6(3):2748-2753. https://doi.org/10.16965/ijpr.2018.129.
29. Pandey E, Kumar N, Das S. Effect of stretching on shortened quadratus lumborum muscle in non specific low back pain. Physiotherapy and Occupational Therapy Journal. 2018 April-June; 11(2). https://rfppl.co.in/subscription/upload_pdf/Ekta%20Pandey_7326.pdf. http://dx.doi.org/10.21088/potj.0974.5777.11218.5.

30. Ajimsha MS, Daniel B, Chithra S. Effectiveness of myofascial release in the management of chronic low back pain in nursing professionals. Journal of Bodywork and Movement Therapies. 2014 Apr 1; 18(2):273-281 https://doi.org/10.1016/j.jbmt.2013.05.007. PMid:24725797.
31. Masaracchio M, Cleland J, Hellman M, Hagins M. Short-term combined effects of thoracic spine thrust manipulation and cervical spine nonthrust manipulation in individuals with mechanical neck pain: a randomized clinical trial. Journal of Orthopaedic & Sports Physical Therapy. 2013 Mar; 43(3):118-127. https://doi.org/10.2519/jospt.2013.4221. PMid:23221367.
32. Hsieh CY, Adams AH, Tobis J, Hong CZ, Danielson C, Platt K, Hoehler F, Reinsch S, Rubel A. Effectiveness of four conservative treatments for subacute low back pain: A randomized clinical trial. Spine. 2002 Jun 1; 27(11):1142-1148. https://doi.org/10.1097/00007632-200206010-00003. PMid:12045509.