Effect of Stabilization Exercise on Lumbar Multifidus Muscle Thickness in patients with non-specific Chronic Low Back Pain

Akodu Ashiyat Kehinde, PhD.[*]; Akinbo SRA, PhD.; Odebiyi DO, PhD.
College of Medicine, University of Lagos, Lagos, Nigeria

Objectives: In a single blinded randomized controlled study, we investigated the effect of stabilization exercise on lumbar multifidus muscle thickness in patients with non-specific chronic low back pain. Low Back Pain is highly prevalent and results in considerable level of disability. Many causes have been associated with weakness or injury of the soft tissues in the lumbar area.

Methods: A total of 122 individuals (44 males, 78 females) with non-specific chronic low back pain participated in this study. They were assigned to four different groups. Group 1 received stabilization exercise only. In addition to stabilization exercise, groups 2 and 3 received Transcutaneous Electrical Nerve Stimulation and massage therapy respectively and group 4 was the control group who received drug therapy only. Participants went through this protocol twice weekly for 8 consecutive weeks. Measurement of muscle thickness using Ultrasound scanning machine was done at baseline and end of 8th week. Analysis of variance was used to determine significant difference at $p < 0.05$.

Results: There was an increase in the Lumbar Multifidus muscle thickness at L4-L5 lumbar vertebra post-intervention assessment with more increment in group 2 with a mean and standard deviation of 3.28 ± 0.47, within the three groups except the control.

Discussion: The study established that stabilization exercise alone and in combination with Transcutaneous Electrical Nerve Stimulation and massage is effective in increasing the thickness of Lumbar Multifidus muscle in patients with non-specific chronic low back pain .

Keywords: Ultrasound scanning, lumbar spine rehabilitation, core stability exercise

Introduction

It has been documented that in spite of the large number of pathological conditions that can result in LBP, 85% of these are without pathoanatomical / radiological abnormalities (1). It is the Non-specific Chronic Low Back Pain (NCLBP) population which frequently develops into a chronic fluctuating problem with irregular flares (2). Skeletal muscles play a crucial role in the pathology of low back disorders. It is known clinically that undue motion outside the normal physiological limits, sometimes referred to as spinal instability, may result in chronic low back pain (3). Available facts suggest that spinal muscles provide stability and muscle recruitment patterns drastically affect loading on the inter-vertebral joints (4). The stability of the spine is determined by the osseoligamentous armour that encapsulates the spine (5). The complex loading patterns linked with activities of daily living, act on these structures and if unguarded, can expose spinal vulnerability, predisposing to musculoskeletal injuries, such as Low Back Pain (LBP) (6). Epidemiological research has concentrated primarily on the local stability system, which acts as a 'corset like' structure to squeeze the waist, when the spine is in weight bearing position (7). The correct alignment required to stabilize and

* All correspondences to: Akodu Ashiyat Kehinde, email: <akoduashiyat@gmail.com>

allow movements depends on adequate strength and endurance on abdominal musculature (8). It is the activation of the dynamic spinal support system that is exposed and which provides the basis for the concept of stabilization training (7). Basically stabilization exercise is aimed at protecting and supporting the spinal segment from re-injury by reestablishing and encouraging muscle control to substitute for any loss of muscle action caused by injury or degenerative changes (9).

There is a major fact about the role of Lumbar Multifidus (LM) muscle in the stabilization of the lumbar spine. Biomedical studies have enumerated the role of multifidus in the provision of segmental stiffness, control of the neural zone and its ability to stabilize the spine when spinal stability is affected (5). Measurement of muscle size using ultrasound scanning machine has provided correct assessment of muscle wasting in various muscles (10). In a recent study Ultrasound measurement of lumbar Multifidus muscle has been reported to be an important, quick and simple way to evaluate muscle size at different levels of lumbar vertebrae in clinical settings (11). Possible application in physiotherapy and research relate to measurement of muscle thickness and monitoring of muscle contraction while it actually occurs, which may be useful for muscle rehabilitation particularly in deep muscles which are sometimes difficult to assess (12). Measurement of muscle size using ultrasound scanning machine has provided an accurate measurement of muscle wasting in various muscles and a study was carried out in which normal reference ranges for the objective assessment of LM muscle was done (13). Also a study by Kiesel *et al* (14), hypothesized that measurement of muscle thickness changes using real time ultrasound is authentic and it is a useful method for measuring activation of lumbar multifidus muscle in an asymptomatic individual. Hence this study is designed to determine the effect of stabilization exercise on lumbar multifidus muscle thickness of patients with non-specific chronic low back pain.

Methods

Participants - A total of 135 individuals (49 males, 86 females) with Non-specific Chronic Low Back Pain (NCLBP) between 24- 67 years of age were recruited for this study. They were recruited from Orthopedic Clinic of Lagos University Teaching Hospital (LUTH), Idi- Araba, Lagos and National Orthopedic Hospital Igbobi, Lagos, Nigeria. All patients included into the study were Participants with history of non specific chronic low back pain with or without pain radiating to one or both lower limbs, and Participants whose clinical assessment indicates that he/she is suitable for stabilization exercise training. Excluded from the study were Participants confirmed to be pregnant, Participants with specific LBP, and Participants with medical or surgical conditions that might hinder exercise performance. Prior to the commencement of the study the Participants' demographic data such as age, gender, weight, height, occupation, marital status, clinical history of LBP and number of LBP episodes during 12 months were obtained from the participants and baseline assessment of lumbar multifidus muscle thickness was measured at L4-L5 lumbar vertebra. Informed written consent was obtained by providing a consent form for the Participants to fill. Ethical approval was sought and obtained from the Health Research and Ethics Committee of Lagos University Teaching Hospital, Idi-Araba, Lagos.

Of the 135 patients, seven were found ineligible for the study after screening and were therefore excluded. The eligible patients were randomly assigned to four groups using computer generated numbers. Each group had 32 patients from the 128 eligible patients. Group 1 received stabilization exercise only. In addition to stabilization exercise, Groups 2 and 3 received Transcutaneous Electrical Nerve Stimulation (TENS), and massage respectively. Group 4 was the control who received drug therapy only. However only 122 patients (44 males, 78 females) age range 25-65 years completed the study. 6 participants did not complete with reasons ranging from lack of effect, transportation problem and illness figure (1). Randomization; Group1: Stabilization exercise; Group 2: Stabilization exercise with TENS; Group3: Stabilization exercise combined with TENS and Massage; Group 4: patients that received only drugs (control group) Participants went through the protocol twice weekly for 8 consecutive weeks. Assessment of lumbar multifidus muscle thickness using ultrasound scanning machine was done at baseline and end of 8th week.
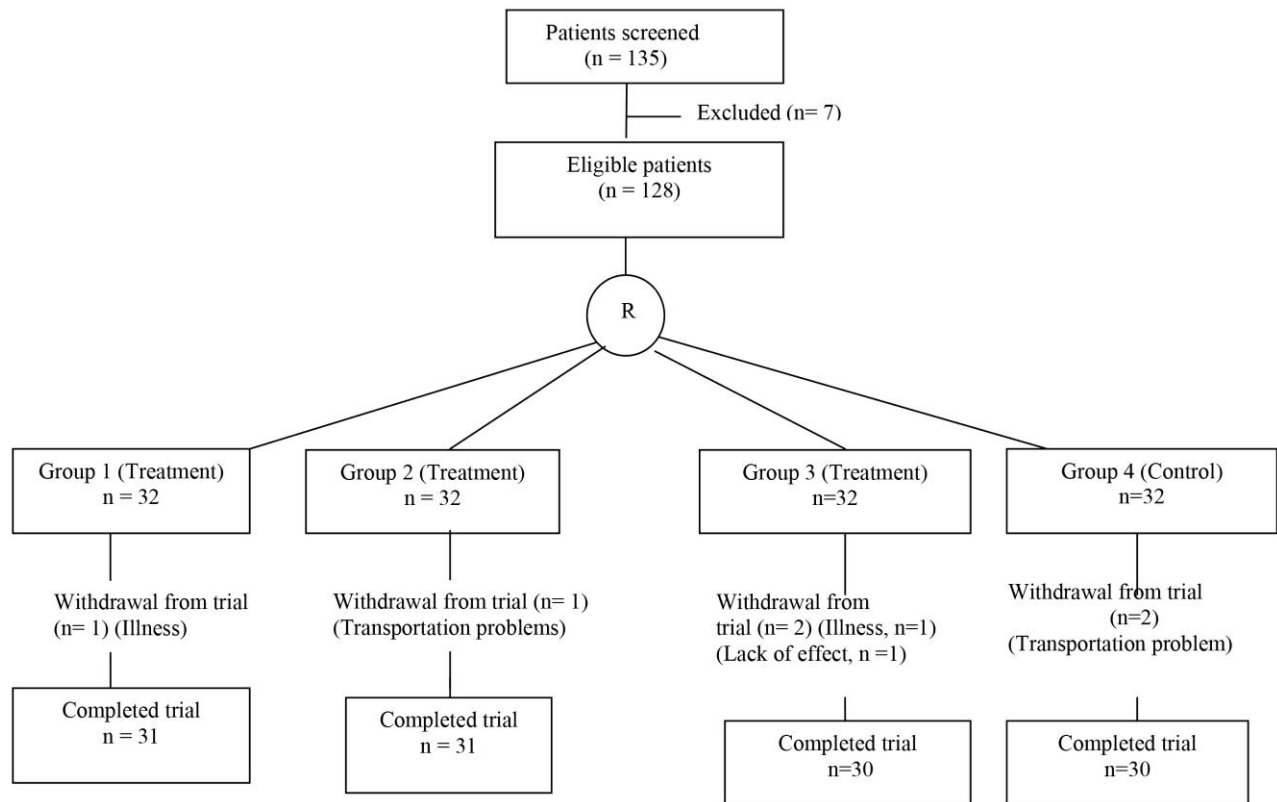
Figure 1. Recruitment and allocation of patients' R

Analysis of variance (ANOVA) was used to analyze the thickness of lumbar multifidus muscle pre and post treatment intervention across the groups. A least significant difference post hoc analysis was carried out to determine the exclusively significant group in the thickness of lumbar multifidus muscle. Paired t-test was used to compare the thickness of the lumbar multifidus muscle within the groups. Level of significance was set at $p<0.05$.

Results
Demographic characteristics of the participants - The mean age of participants in Groups 1, 2, 3 and 4 were 45.84±9.95 years, 47.03±12.07 years, 44.57±11.82 years and 50.83±13.03 respectively. Four groups did not differ significantly in age and height table (1).

Table 1. Demographic Characteristics of the Participants

	All participants X±SD N=122	GRP1 X±SD n=31	GRP2 X±SD n=31	GRP3 X±SD n=30	GRP4 X±SD n=30	F	p-value
Age (yrs)	47.06±11.84	45.84± 9.95	47.03±12.07	44.57±11.82	50.83±13.03	1.59	0.19
Height (m)	1.72 ± 0.10	1.71±0.89	1.71±0.98	1.71±0.10	1.75± 0.11	1.41	0.24
Weight (kg)	74.85±11.14	78.10±11.70	74.23± 14.16	75.83±9.31	75.27±7.91	0.72	0.54
BMI(Kg/m^2)	25.45± 3.97	26.57±3.76	25.50±3.42	26.31± 4.47	24.81± 3.88	1.28	0.28

Analysis of variance (ANOVA) shows that there was no significant difference in the lumbar multifidus muscle thickness at L4 - L5 vertebrae level post-intervention assessment across the four groups table (2).

Table 2. Comparison between the pre- post-treatment assessments of Lumbar Multifidus Thickness at the level of L4-L5 vertebral level.

Thickness	GRP1 X ± SD	GRP2 X ± SD	GRP3 X ± SD	GRP4 X±SD	F	p – value
L4-L5						
PRE- RX	2.69 ± 0.74	2.81 ± 0.51	2.66 ± 0.57	2.93±0.57	0.51	0.60
POST-RX	3.19 ± 0.69	3.28 ± 0.47	3.01 ± 0.51	2.97±0.54	5.57	0.18
t	2.63	2.92	2.52	0.00		
p-value	0.01*	0.01*	0.01*	1.00		

* Significant difference at $P < 0.05$

Paired t- tests indicated that there was a significant difference between pre- and post intervention assessment of lumbar multifidus muscle thickness in groups 1, 2&3 while there was no significant difference in group 4 (control) table (2). Least significant difference (LSD) post hoc analysis shows that the significance lies between group 1& 3, groups 1&4 and groups 2&4 post intervention assessment figure (2).
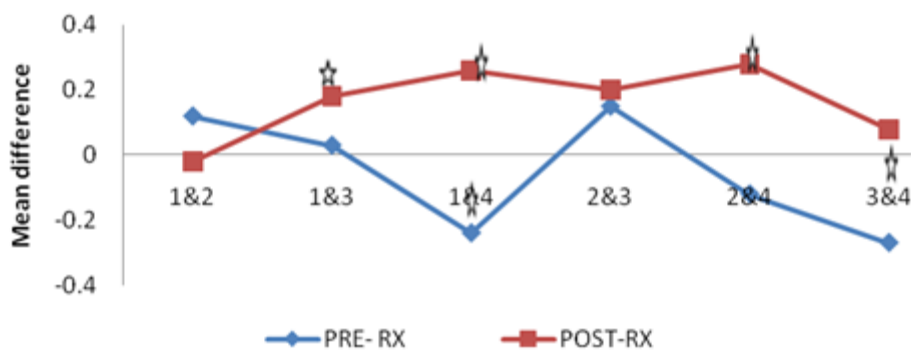

Figure 2. Schematic representation of post hoc analysis of the pre- post-treatment at L4-L5.

Discussion

The results of this research showed that the use of stabilization exercise in the treatment of patients with non-specific chronic low back pain, improves lumbar multifidus muscle thickness. Participants in the four groups were similar in age and physical characteristics, and there were no significant difference in the physical characteristic in the four groups, this suggests that all the groups were comparable. It also revealed that LM muscle thickness measured in the pre-intervention assessment increased significantly at 8th week post-intervention assessment across three of the groups except group 4 i.e. the control group at L4-L5 vertebral level. This finding implies that increased contracted LM muscle was associated with greater improvement in CLBP patients with pain and functional disability. This is in agreement with the finding of previous studies; it agrees with the findings of Kiesel [14], Van [15], and Akbari [16] who reported that stabilization exercise decreased pain and increased LM muscle thickness in patients with chronic low back pain. It has been reported that muscle thickness changes when the muscle is activated [17]. Muscle contraction is seen on the ultrasound image as an increase in thickness of the muscle as it shortens along its length. The amount of thickness change that occurs with muscle activation has been quantified using ultrasound imaging; by comparing resting muscle thickness values to those obtained during muscle activation. The present study showed that there was an improvement in the LM muscle thickness in three of the groups (1-3) after intervention. This increase in contracted LM muscle thickness was predictive of improved functional ability and hence promotes clinical improvement in patients with NCLBP.

In this study, the mean value of LM muscle thickness of patients with NCLBP at L4-L5 vertebral level corresponds with the mean value of other studies (3, 18, 19) such as Wallwork [20] who assessed thickness of LM muscle of healthy participants without a history of low back pain. This implies that increased contracted LM muscle

was associated with greater improvement in CLBP patients with related pain and functional disability. This is consistent with theories and evidence supporting the importance of the LM muscle to normal back function (7, 19, 20).

It has been reported that patients with LBP are less able to contract the LM muscle (21).Results from the present study suggest that changes in the contracted muscle thickness may be relevant clinically, since it has been shown that muscle contraction of LM seen on ultrasound image represents an increase in thickness of the LM muscle. However, it is very likely that the change in LM muscle thickness was due to greater activity of the muscle.

Conclusion - The study established that stabilization exercise alone and in combination with TENS and massage is effective in increasing the thickness of LM muscle in patients with NCLBP.

References
1. Dankaerts W, O'Sullivan PB, Burnett AF, Straker LM. The use of a mechanism-based classification system to evaluate and direct management of a patient with non-specific chronic low back pain and motor control impairment--a case report. Manual therapy. 2007;12(2): 181-91.
2. Burton AK, McClune TD, Clarke RD, Main CJ. Long-term follow-up of patients with low back pain attending for manipulative care: outcomes and predictors. Manual therapy. 2004;9(1):30-5.
3. Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis. Spine. 1996; 21(22): 50-6640.
4. Van Dieen JH, Selen LP, Cholewicki J. Trunk muscle activation in low-back pain patients, an analysis of the literature. Journal of electromyography and kinesiology: official journal of the International Society of Electrophysiological Kinesiology. 2003;13(4):333-51.
5. Panjabi MM. The stabilizing system of the spine. Part II. Neutral zone and instability hypothesis. Journal of spinal disorders. 1992;5(4):390-6; discussion 7.
6. Renkawitz T, Boluki D, Grifka J. The association of low back pain, neuromuscular imbalance, and trunk extension strength in athletes. The spine journal: official journal of the North American Spine Society. 2006;6(6):673-83.
7. Hides JA, Jull GA, Richardson CA. Long-term effects of specific stabilizing exercises for first-episode low back pain. Spine. 2001;26(11):E243-8.
8. Hodges PW, Richardson CA. Contraction of the abdominal muscles associated with movement of the lower limb. Physical therapy. 1997;77(2):132-42; discussion 42-4.
9. Richardson CA, Jull GA, Hodges PW, Hides JA. Therapeutic Exercise for Spinal Segmental Stabilization in Low Back Pain: Scientific Basis and Clinical Approach. Edinburgh: Churchill Livingstone; 1999.
10. Stokes M, Hides J, Nassiri DK. Musculoskeletal ultrasound imaging: diagnostic and treatment aid in rehabilitation. Physical Therapy Reviews. 1997;2(2):73-92.
11. Larrie-Baghal M, Bakhtiary AH, Rezasoltani A, Hedayati R, Ghorbani R. Multiplying linear dimension techniques may predict the cross-sectional area of multifidus muscle at all levels of lumbar spine. Journal of back and musculoskeletal rehabilitation. 2012;25(3):171-6.
12. Hides JA, Richardson CA, Jull GA. Magnetic resonance imaging and ultrasonography of the lumbar multifidus muscle. Comparison of two different modalities. Spine. 1995;20(1):54-8.
13. Stokes M, Rankin G, Newham DJ. Ultrasound imaging of lumbar multifidus muscle: normal reference ranges for measurements and practical guidance on the technique. Manual therapy. 2005; (2)10: 26-116.
14. Kiesel KB, Uhl TL, Underwood FB, Rodd DW, Nitz AJ. Measurement of lumbar multifidus muscle contraction with rehabilitative ultrasound imaging. Manual therapy. 2007;12(2):161-6.
15. Van K, Hides JA, Richardson CA. The use of real-time ultrasound imaging for biofeedback of lumbar multifidus muscle contraction in healthy subjects. The Journal of orthopaedic and sports physical therapy. 2006; 36(12):920-5.
16. Akbari A, Khorashadizadeh S, Abdi G. The effect of motor control exercise versus general exercise on lumbar local stabilizing muscle thickness: Randomized controlled trial of patients with chronic low back pain. Journal of Back and Musculoskelet Rehabil. 2008;21(2):105 - 12.
17. Hodges P, Kaigle Holm A, Holm S, Ekstrom L, Cresswell A, Hansson T, et al. Intervertebral stiffness of the spine is increased by evoked contraction of transversus abdominis and the diaphragm: in vivo porcine studies. Spine. 2003;28(23):2594-601.
18. MacDonald DA, Moseley GL, Hodges PW. The lumbar multifidus: does the evidence support clinical beliefs? Manual therapy. 2006;11(4):254-63.
19. Hides J, Gilmore C, Stanton W, Bohlscheid E. Multifidus size and symmetry among chronic LBP and healthy asymptomatic subjects. Manual therapy. 2008;13(1):43-9.
20. Wallwork TL, Hides JA, Stanton WR. Intrarater and interrater reliability of assessment of lumbar multifidus muscle thickness using rehabilitative ultrasound imaging. The Journal of orthopaedic and sports physical therapy. 2007;37(10):608-12.
21. Kiesel KB, Uhl T, Underwood FB, Nitz AJ. Rehabilitative ultrasound measurement of select trunk muscle activation during induced pain. Manual therapy. 2008;13(2):132-8.