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ORIGINAL ARTICLE

Differences in Lumbar Multifidus Activity and its Association with Lumbar Range of Motion among patients With Unilateral Chronic Low Back Pain

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ABSTRACT

Aim: To determine the significant difference in lumbar multifidus activity within the patient with unilateral chronic low back pain and its association with lumbar range of motion.

Study design: Analytical cross-sectional study

Study setting and duration: Former institute of Dow University of Health Sciences, Karachi, Pakistan (Institute of Physical Medicine and Rehabilitation) which has become Sindh Institute of Physical Medicine and Rehabilitation and study duration was March 2020 to December 2020.

Methodology: About 128 patients with unilateral chronic low back pain were assessed for the lumbar multifidus activity based on the percentage of maximum voluntary contraction through surface electromyography. Lumbar flexion and extension range of motion was measured through Modified-Modified Schober's test. All the data were analyzed through the Statistical Package of Social Sciences 21. Nonparametric tests were employed. The level of significance was 0.05.

Results: The lumbar multifidus activity was significantly increased ($p<0.001$) on the painful side than the non-painful side. However, there was a significant negative correlation (rh=- 0.551, -0.703; $p<0.001$) of only painful side lumbar multifidus activity with flexion and extension range of motion.

Conclusion: Activity of painful side lumbar multifidus increases in unilateral chronic low back pain. Furthermore, it increases with a decrease in lumbar flexion and extension range of motion.

Keywords: Correlation Study, disability, Low Backaches, non-specific low back pain, Surface Electromyography

INTRODUCTION

Low back pain (LBP) is becoming a more common problematic condition and has increased about 54% since 1990 with the largest proportion in low-income and middle-income countries.[1] If the pathology could not be recognized or identified it is diagnosed as non-specific LBP (NSLBP). It is accountable for approximately 85% to 90% of cases[2]. It can lead to chronicity and recurrence episodes of lumbar pain which can sustain or increase the financial burden on the health care system[3]. The high rate of recurrence of LBP is suggested to be due to deficit knowledge of mechanism underlying LBP[4].

Recent researches have presented that the altered lumbar range of motion (ROM) has been found in patients with NSLBP and the lumbar multifidus (LM) activity impairment is also a determining factor[5,6]. The increase in lumbar ROM is shown to be consistently related to improved pain.[6] A systematic review showed evidence regarding the altered contribution of the lumbar spine among patients with NSLBP during the performance of active lumbar flexion (ROM). The same systematic review also presented steady results for the inter-related dependence of lumbar ROM and painful LM activity.[6] Furthermore, different authors suggested decreased lumbar ROM as a sign which patients use to cope with pain perception, [5-7] affecting the activity of LM muscle.[8] However the fact of this coping strategy for the perception of pain could not be described alone due to insufficient information. Therefore, the activity of LM should be analyzed to support the phenomenon, that patients having NSLBP use limited lumbar ROM as a coping strategy to minimize the perception of pain.

dditionally, many clinicians have also suggested that limitations in lumbar ROM among patients with NSLBP may accompany the impaired activity of lumbopelvic muscle.[5,6,9,10] Among those muscles the LM is proposed to have a strategic functional role in the dynamic stability of the trunk. So, changes in lumbar ROM may relate to the functional impairment of LM leading to its impaired activity.[11] However, differences in the activity of LM and its underlying association with lumbar ROM among patients with CLBP has not been systematically investigated. Therefore, this study aimed to: (1) determine the significant difference between painful and non-painful LM muscle activity among patients with unilateral CLBP, (2) determine the significant association between LM muscle activity and lumbar ROM among patients with unilateral CLBP. The building of facts resulting from this study would deliver a substantial direction toward investigating the activity of LM muscle and the ability of exercise training as an intervention to improve lumbar ROM and the activity of LM muscle.

Furthermore, the outcomes of this study may help to select physiotherapy interventions for specific patients; thus, improving clinical consequences and preventing recurrence of symptoms.

MATERIALS AND METHODS

This study used an analytical, cross-sectional design as a part of the Ph.D. project. The ethical approval from the institutional bioethical Committee (IBC) University of Karachi (KU), Pakistan was obtained (IBC KU-78/19) before collecting data. About 128 patients with unilateral NSCLBP between ages of 19 to 40 years were recruited

from the former Institute of Dow University of Health Sciences, Karachi, Pakistan (Institute of Physical Medicine and Rehabilitation) which has become Sindh Institute of Physical Medicine and Rehabilitation. The duration of the study was March 2020 to December 2020. The patients were with a present episode of LBP of more than 3 months. Patients were excluded if they had features of a specific pathology, signs of neurological dysfunction (like stroke), previous spinal surgical intervention or epidural injections, and contraindication to exercise[12]. Each patient undertook the process of written informed consent before providing data. This study constituted the baseline data analysis from a randomized control trial with pre-specified sample size; therefore, we did power analysis to justify the study sample size, we computed the power of the test. The power of the test found more than 99% using PASS version 15, based on paired sample t-test with 99% confidence of interval sample size of 128 patients of unilateral low back pain used, a difference of paired EMG activity mean+-SD 20.1 +- 16.4[5].

The demographics and pain intensity with numerical pain rating scale were recorded. Electromyography (EMG) (Surpass LT EMG system, EMS Biomedical, Inc., Korneuburg, Austria) with pair of surface electrodes was used to measure and record EMG activity of the LM, bilaterally. The skin was lightly rubbed with abrasive paper and cleaned using cotton with alcohol to lower the skin impedance. The electrodes were placed at 2 cm lateral to the L5 spinous process. Electrodes were placed parallel to the muscle fibers with an inter-electrode distance of 2 cm. The chosen parameters were a single channel with a sweep of 20 ms, sensitivity of 100 µV. The raw EMG signals were amplified, sampled at a rate of 1,000 Hz, and band-pass filtered was between 20 to 450 Hz. The patient was asked to raise the chest to the maximum extension of the lower back (reference or maximum voluntary contraction) in a prone lying position on the treatment couch and the EMG was recorded and the mean peak amplitude was selected manually and recorded. The patients were then made to quadruped (four-point kneeling posture) and asked to lift the contralateral arm and leg simultaneously as far as possible until both are approximately parallel to the floor while keeping normal lumbar lordosis. All patients were asked to sustain this position with isometric contraction for 5 s. The EMG was recorded again and the percentage of maximum voluntary contraction (%MVC) of LM muscle in this movement was calculated[13].

The ROM of lumbar was measured using the Modified Modified Schober's test (MMST). It is highly co-related with lumbar ROM measured through a radiograph.[14] Both posterior superior iliac spines (PSIS) of the participant were marked. A midline point on the sacrum (lower mark) between those two PSIS was localized and marked. Then the upper mark was marked at 15 cm above the midline lower mark at the sacrum. Then the patient was asked for forward bending with straight knees. Then, the distance between upper and lower marks was noted with measuring tape. This length was subtracted from 15 cm to indicate lumbar flexion ROM. Then, the participant was asked to bend backward. The distance between the marks was measured. The change in distance between those marks indicated the lumbar extension ROM.[15] It was measured three times and the average value was taken for both extension and flexion ROM.

All the data was analyzed through the, Statistical Package of Social Sciences 21 version. The frequency and percentage were calculated for gender. Mean and standard deviation was analyzed for all continuous variables. The data was not normally distributed Shapiro-Wilk test. So, the non-parametric test; Wilcoxon ranked test, and spearman's correlation analysis were conducted to analyze the significant difference of LM activity (%MVC) between painful and non-painful sides and associate between LM activity (%MVC) and lumbar ROM. The p-value for the significance was considered as 0.05.

RESULTS

Out of 128 patients, there were 82(64.1%) males. The mean and standard deviations of demographical data of patients with unilateral chronic low back pain are given (table 1).

The LM activity (%MVC) of painful side LM was analyzed as increased with a median of 102.7 than the non-painful side which was 78.35. It showed a significant difference ($p<0.001$) between painful and non-painful sides within-patient (Table 2).

There was a significantly strong negative association between %MVC of painful side LM and lumbar flexion ROM. However, a significant moderate association was found between % MVC of painful side LM and lumbar extension ROM. In contrast to this % MVC of the non-painful side, LM did not significantly correlate with both lumbar flexion and extension range of motion.

Table 1: Characteristics of patients (n=128)

Characteristics	Mean±SD	Range(min-max)
Age (years)	28.7 ±5.4	21(19-40)
BMI (kg/m2)	25.3 ±2.9	9.6(20.1-29.7)
Pain severity in walking (VAS-cm)	5.4±1.2	5.8(2.1-7.9)
F-ROM (cm)	4.2 ±1.0	4.2(2.1-6.3)
E-ROM (cm)	1.9 ±0.6`	2.5(1-3.5)

F-Rom-flexion range of motion; E-ROM- extension range of motion

Table 2: Comparison between painful and non-painful sides for lumbar multifidus activity within patient (n=128).

Variable	painful side[e]	non-painful side[e]	P-value†
LM activity (%MVC)	102.7(95.4–113.2)	78.35(72.7-83.4)	<0.001

Values are presented as median (IQR: 25th – 75th Percentile); † value reprented as Wilcoxon ranked test level of significance; LM, lumbar multifidus; %MVC, percentage of maximum voluntary contraction

Table 3: Correlation of lumbar multifidus activity with lumbar range of motion (n=128).

Lumbar Range of motion	Painful side LM activity (%MVC)[d]	Non painful side LM activity (%MVC)[d]
F-ROM (cm)	-0.702(<0.001)	0.032 (>0.05)
E-ROM (cm)	-0.551(<0.001)	-0.020(>0.05)

[d]Values are represented as Spearman's correlation (p-value); F-Rom,flexion range of motion; E-ROM, extension range of motion; LM, lumbar multifidus; %MVC, percentage of maximum voluntary contraction.

DISCUSSION

The result of our study was increased LM activity (%MVC) on the painful side than the non-painful side and its association with decreased flexion and extension range of motion of the lumbar spine.

nderstanding the association between the proportional activity of LM in pain can help deliver vision into the mechanisms underlying motor control of the trunk in reaction to nociceptive stimulation.[16] Current study showed that the %MVC had significant difference between both sides with increased EMG activity in the painful side than non-painful. The increased activity in painful side LM may be in response to the perception of pain in multifidus.[16, 17] The results of previous studies with the comparison of symptomatic and symptomatic individuals with CLBP and with the comparison of painful and non-painful sides are the same as current study elaborating the higher muscle contraction in CLBP than control.[17,18] However, contrary to this another study found no significant difference between non-painful and painful individuals with CLBP[19]. These differences in results may be due to differences in movement during the measurement of %MVC.

Studies have concluded that clinicians should focus on muscle activation patterns in clinical observation of a lumbar range of motion[5,18]. In the current study, the increase in %MVC of painful side LM correlated with the decrease in lumbar flexion. It directs to one of the points as stated by Clark, that the LM works eccentrically to allow lumbar flexion.[20] It suggests that increased or impaired activity of the lumbar multifidus can limit the flexion of the lumbar spine. A study found decreased activity in all extensor muscles of lumber including multifidus, in full flexion of lumbar among normal individuals. It is described as neuromuscular efficiency which is in contrast to impaired muscle activity. [21] As in the current study no significant correlation was found in non-painful side LM and lumbar flexion ROM. Ippersie et al conducted a study with a comparison of patients with low back pain to asymptomatic regarding flexion relaxation phenomenon in full lumbar flexion. They found reduced LM relaxation to allow the full lumbar flexion in the lower back pain group as compared to asymptomatic.[22] These findings also clarify the fact of increased lumbar multifidus activity correlation with lumbar flexion in the painful side and non-significant correlation in the non-painful side as found in the current study. It has been suggested that decreased muscular activity may associate with the fat infiltration of that muscle. [23] A study has concluded that fat infiltration of LM based on magnetic resonance imaging significantly correlated with decreased lumbar flexion among 42 patients with acute and chronic LBP. [24] However the current study provides direct results with related findings.

Another result of the current study was a negative correlation of %MVC of painful side LM with lumbar extension. During lumbar extension the LM contracts and co-contracts with other extensors to complete extension movement of the lumbar spine. This contraction and co-contraction may be limited due to over-activity of LM and pain perception. If there is impaired LM activity rather increased or decreased may compromise this contraction.[19] Another study found higher levels of LM activity among other extensor muscles in lumbar extension among patients with nonspecific CLBP.[25] This suggests a higher ratio of LM activity with extension in CLBP. However, the %MVC of non-painful side LM did not correlate with the lumbar extension range of motion in the current study. The LM is thought to contribute to lumbar extension[16]. These findings may be due to fact that there was no increase in %MVC at non-painful side limiting extension range of motion like painful side. So, it did not associate with a lumbar extension like a painful side. A study found a non-altered LM pattern in extension in comparison with painful side.18 their findings also relate with the results of the current study.

This study provides a novel method of non-invasive investigation of LM activity for the research ahead in the screening of LM as an outcome measure in LBP using the EMG system combined with surface electrodes. However, like other methods, there are also some limitations to this methodology. First, the method of electrode placement may irritate and trouble the patient. Second, due to not understanding, the patient may lack to perform his or her maximum ability during MVC of LM. To reduce this effect, encouragement was given verbally to achieve MVC during EMG analysis. As the MMST was employed manually with the participation of patients individually, So there might be a manual error as a limitation of the current study. To reduce the chance of this error, an average value of three readings was considered.

CONCLUSION

It is concluded that painful side LM shows impaired activity detected by the SEMG system with an increasing pattern than non-painful side in CLBP. Our results suggest increased activity of painful side lumbar multifidus as a compared non-painful side in unilateral CLBP. Furthermore, the activity of painful side lumbar multifidus increases with a decrease in lumbar flexion and extension range of motion. This correlational analysis provide initial data on impaired activation of LM based on %MVC through SEMG to clarify the mechanisms underlying motor control impairment of the LM in patients with unilateral CLBP. Future studies should assess larger studies with consideration of factors related to gender to investigate motor control patterns LM with other muscles in CLBP.

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Conflict of interest: Nil

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