Alterations in Gluteus Maximus Activation in Subjects with Unilateral CLBP

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ABSTRACT

Background: The rising prevalence of chronic low back pain (**CLBP)** could be due to complex existence of undefined mechanisms including biomechanical and neurophysiological peripheral and central influences. There were inconsistent results regarding motor control changes of hip muscles in patients with **CLBP**. The present study was designed to examine activation pattern of the gluteus maximus (**GM**) muscle in subjects with unilateral chronic low back pain (**CLBP**) and healthy subjects during prone hip extension (**PHE**) test. **Methods:** Fifteen patients with unilateral **CLBP** and 15 healthy subjects without **CLBP** participated in this study. Surface electromyography (**EMG**) was used to record from the gluteus maximus during **PHE**. Independent t-tests was used to compare demographic information and (**EMG**) signal amplitude of the **GM** muscle between groups. **Results:** There was no significant difference between groups regarding normalized electromyographic signal amplitudes in gluteus maximus (P = 0.876). **Conclusions:** Although results were statistically non-significant, results of this study showed a general trend of higher **GM** muscle activity in patients with **CLBP** than did controls during **PHE.** Findings suggested that motor pattern of hip muscles could be affected in **CLBP** patients. Further, researches are required to support this suggestion.

Key words: Electromyography; Chronic low back pain; Gluteus maximus; Prone hip extension.

INTRODUCTION

Low back pain is one of the most common and prevalent musculoskeletal problems affecting both genders and most ages (1). Most cases experience a chronic (> 3 months) course (2) and the pain results in activity limitation and work absence (3). There are various factors associated with chronic low back pain (CLBP), changes in motor control and muscular recruitment have been the main concern of chronic low back pain treatments within the past decade (4,5,6). The interaction between the hip and spine is compromised in CLBP patients. Hip muscles strength was significantly lower in patients with LBP when compared to healthy controls (7). Hip muscles are important for the prevention and management of LBP (8).

Prone hip extension (PHE) test is frequently used and accepted test for assessment of lumbopelvic stability and muscle recruitment pattern of lumbopelvic region in patients with CLBP (9,10,11). Muscle activity pattern during PHE test has been theorized to be similar to those muscles activated during gait (11). Changes in this pattern may decrease lumbopelvic stability during walking (12).

Previous researches reported that patients with LBP have limited force generation in the hip extensors during leg raising (13), and during gait (14). GM atrophy was also found when assessed by pelvic computed tomography (CT) scans in subjects with CLBP (15), but results regarding muscle volume were inconsistent according to a recent systematic review (8).

Unilateral pain causes muscle imbalance and alterations in lumbopelvic muscles activity, LBP patients with unilateral pain used different muscle synergy at the painful side during PHE when compared to controls (16). Moreover, subjects with unilateral sacroiliac joint (SIJ) dysfunction displayed higher but non-significant GM amplitude when compared to contralateral side and matched controls (17).

There is limited evidence regarding the difference in amplitude of GM in EMG studies between CLBP patients and healthy subjects. While a study found significant GM hyperactivity in CLBP (9), other studies found no significant difference when compared to control (18,5). This controversy in previous results showed a need to check for the activity of GM during PHE which mimics GM activity during gait, thus should help to represent GM activation during functioning. Therefore, this study aimed to identify the difference, if any, between the amplitudes of GM during PHE test between patients with unilateral CLBP and healthy subjects. It could guide clinicians assessing and designing stabilization programs for patients with CLBP.

MATERIALS AND METHODS

Study design: cross-sectional study.

Participants: The study was conducted on thirty subjects. Fifteen patients with unilateral CLBP in CLBP group, and 15 healthy volunteers. All the subjects signed an informed consent form after being familiarized with the objectives, equipment, procedures of the study, privacy and use of data. The study protocol was approved by Research Ethical Committee of Faculty of Physical Therapy (NO: P.T.REC/012/001843).

Inclusion criteria: 1) Male and female patients age between 20-50yrs; 2) Patients with chronic low back pain (pain > 3 months); and 3) Patients with unilateral symptoms (facet, disc, SIJ dysfunction) with or without referral to the leg. Patients were referred by an orthopedist. Exclusion criteria: 1) Congenital pathology affecting spine; 2) Any neurological disorder; 3) Non-mechanical LBP (e.g., fracture, malignancy, infection); and 4) BMI 30 or higher as fat tissue may decrease the ability to measure surface EMG activity.

Measurement procedures:

All measurement procedures were carried out in a quiet laboratory setup. Initially subject's weight and height were measured using a standard weight/ height scale. Examiner calculated body mass index (BMI) from subject's weight and height. Then all demographic data were recorded in a data collection sheet that, basically, included patient's age, weight, height, and BMI.

Afterwards, participant assumed prone lying position with the arms by the side, and head, pelvis and hips in neutral position. Skin preparations for EMG recording were carried out. These preparations included hair shaving as required, and skin cleaning with isopropyl alcohol 70% to remove excess oils and debris.

EMG recording: EMG recording was done using a Neuro-MEP EMG (Neurosoft, Ivanovo, Russia), Neuro-MEP.NET (Version 4.1.7.0 software). EMG electrodes for GM recording were placed at half the distance between the greater trochanter and second sacral vertebra and at an oblique angle at, or slightly above, the level of the trochanter (19). The normalization procedure was performed using a sub-maximal voluntary contraction (sub- MVC) task, the prone double leg raise (20). For the sub-MVC of GM, the subjects were asked to lift both knees 5 cm off the examination table while the knees were flexed at 90 and held them for 5 seconds in a prone position as shown in fig. (1). Three trials were performed with 30 seconds rest in between. The mean value of three repetitions was determined for EMG data analysis.

Fig. (1): Prone double leg raise for sub-MVC of GM

Then to record from GM muscle during PHE, the subject maintained the prone lying position, with arms at the sides and with a neutral position of the head, pelvis and hip joint. The target angle was set at 10 degrees to control the amount of hip extension. A standard goniometer was used to determine when the leg was at 10 degrees extension, and an adjustable bar was placed at this level and provided feedback fig. (2). Further, feedback information at 10 degrees of hip extension was given to the subjects by verbal instruction. Three trials were performed with 30 seconds rest in between during PHE. The average root mean square (RMS) of the EMG signal during each PHE task trial was calculated and expressed as a percentage of the normalized value. The mean percent normalized value of three repetitions was determined for EMG data analysis.

EMG signal analysis: The signals were full-wave rectified and band pass (5-500 HZ) filtered, sampled at 1000 HZ and then the root mean square (RMS) was calculated (19).

Fig. (2): Prone hip extension test

Results

Descriptive statistics for the age, weight, height and **BMI** for both groups are shown in table (**1**).

Table (1): Mean values of the age, weight, height and BMI of both groups.

	CLBP group	**Control group**	**T- test**	
	Mean ±SD	Mean ±SD	t- value	Sig.
Age (years)	28.6 ±7.8	25.4 ±2.09	1.553	0.132
Weight (kg)	67.6 ± 13.15	65.5± 10.06	0.507	0.616
Height (cm)	165.3± 10.7	169.5± 9.4	-1.148	0.261
BMI (kg/m²)	24.5± 2.8	22.6± 2.3	1.996	0.056

$P < 0.05$ SD: Standard deviation

Root mean square (RMS) of gluteus maximus: There was no significant difference between **RMS** of gluteus maximus values between **CLBP** and control groups as shown in table (**2**) and fig. (**3**).

Table (2): Mean values of GM RMS in CLBP and control groups during PHE

Groups	**RMS GM**
CLBP Group Mean ± SD	43.08±23.04
Control Group Mean ± SD	41.87±18.69
Independent t- test	
T value	0.158
P value	0.876

P < 0.05; SD: standard deviation, GM: gluteus maximus

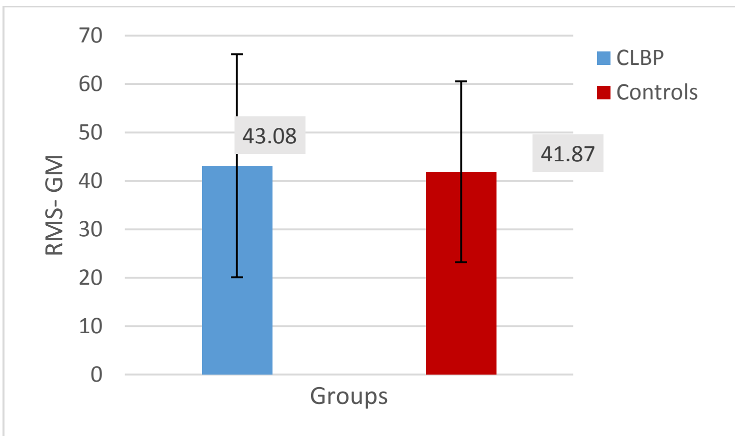

Fig. (3): Mean RMS-GM in CLBP and control groups

DISCUSSION

The results of the present study revealed a trend for higher amplitude of normalized electrical activity of GM during PHE of lower limb at the side of pain when compared to controls but results were not statistically significant. Results of the present study were consistent with previous studies which assessed GM during PHE (18,5,17). In partial support to this study, Kim et al. (2014) found a significant hyperactivity of GM (9). The evident significant hyperactivity reported by Kim et al. (2014) study might be due to the single gender assessment in, as they assessed only women with CLBP, while the present study assessed both males and females (9).

An explanation of the increased GM muscles activity reported in the current study, although not significant, may be a compensation to decreased passive stability (21,22). Panjabi, (1992) suggested that when the segmental stability of the passive system is compromised, the neuromuscular system might compensate to provide dynamic control to the lumbar spine as found in patients with disc degeneration (23).

This compensation was also found in patients with SIJ dysfunction to emphasize force closure (24). This is supported by results of Jung et al., (2015), where they assessed biceps femoris (BF), GM and erector spinae (ES) muscles during PHE in subjects with lumbar segmental instability and found significant hyperactivity (13).

Further, local back muscles were unable to compensate for increased segmental mobility. For instance, bilateral multifidus muscle atrophy was found in subjects with CLBP (25,26). Then global muscles as GM tend to be hyperactive to compensate for local muscles dysfunction (9).

In contrast to the results of this study, other studies found reduced activation of GM muscle during gait (14, 27). The contradiction between us could be explained as one study measured GM activity during gait (14) and the other study measured GM activity during trunk flexion-extension cycle in patients with CLBP (27).

Changes in GM activity could be explained through its relation to trunk muscle activity, subjects with recurrent LBP react to the Balance-Dexterity Task using hip muscles (GM and gluteus medius) more than trunk muscles but without difference in amplitude of the tested muscles (28).

It is suggestible that GM activation responses vary between muscles and tasks, redistribution of motor neuron recruitment within and between muscles could explain contrast findings (29). Future studies are needed to assess and compare changes in EMG of hip muscles, particularly GM, during PHE and gait to get more insight about motor control variations during these tasks in subjects with CLBP.

CONCLUSION

The current study suggested a trend towards increased activity of GM with PHE test, in patients with unilateral CLBP. Although results did not reached significance they pointed out to the need of future larger scale studies, which likely combine PHE and gait to confirm the detected trend.

Limitations:

The current study has several limitations that should be considered in future studies. First, prone hip extension doesn't represent function. Thus, we need to consider other functional tasks as gait. Second, assessing more muscles might provide more representative results. Besides, future studies could also include fine-wire EMG recording from the deep local muscles to identify different impairments regarding both local and global muscles. Finally, we might have type II error, so including larger sample size should be considered.

Recommendations:

1. Future studies are recommended to include larger sample size of either males or females.
2. Future studies are recommended to assess onset and duration of **GM** and other trunk muscles during functional tasks.

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