

Does Lumbar Proprioception Affect Hip Abductor and Extensor Muscles Strength in Chronic Low Back Pain Patients?

ESRAA S. ABO-ELWAFI, M.Sc.*; NAHED A. SALEM, Ph.D.*; ABDELAZIZ A. ELSHERIF, Ph.D.* and WAEL M. EZZAT, M.D.**

The Department of Physical Therapy for Neurology, Faculty of Physical Therapy and Department of Neurology, Faculty of Medicine**, Cairo University*

Abstract

Background: Chronic low back pain was found to be the most disabling work-related musculoskeletal disorder worldwide. Patients with low back pain have been found to have uncontrolled lumbopelvic mobility which may be related impaired muscular performance.

Aim of Study: This study aimed to determine if there a relationship between lumbar proprioception and hip abductor and extensor muscles strength in chronic low back pain patients.

Patients and Methods: Seventy-five subjects from both sexes were enrolled in this study. Their age ranged from 20 to 30 years. They were assigned into two group: Study group (GI) included forty-five patients with chronic low back pain. Control group (GII) included thirty matched healthy subjects. They all have undergone evaluation of lumbar joint position error (JPE) using Biodex System 3 Pro Isokinetic through the lumbar reposition accuracy test at 30° of lumbar flexion: Using passive joint position detection mode. Hip abductor and extensor strength on both sides were assessed using Instrumented digital hand-held dynamometer.

Results: There was a statistically significant higher mean values of lumbar JPE in the study group compared to the controls. There was a statistically significant higher mean values of hip abductor and extensor strength on both sides in the study group compared to the controls. There was a statistically non-significant negative correlation between JPE and hip abductor and extensor muscles strength in both sides in the study group.

Conclusion: Patients with chronic low back pain have significant alteration in lumbar joint position sense and hip abductor and extensor muscles strength. Prolonged assumption of

awkward posture during daily activities alters lumbar afferent input and reduce hip muscular activation. Decline in hip muscles strength not related to lumbar proprioceptive impairment but could be related to LBP.

Key Words: Lumbar Proprioception – Joint Position Error – Hip abductors – Hip extensors – Muscle Strength – Hand held dynamometer.

Introduction

LOW back pain (LBP) is a common work-related musculoskeletal disorder (WRMSD). Chronic LBP was found to be the most prevalent and disabling WRMSD worldwide [1]. More than 40±20% of the population suffers from LBP at least once in their lifetime. Each year, up to 35% of adults experience this symptom [2]. Painful low back may not indicate a specific pathology but may be related to restricted, excessive, or poorly controlled lumbar motion [3].

Proprioception is crucial for sensory-motor control, joint stability, coordination, and balance [4]. Trunk position sense plays a crucial role in the maintenance of normal spinal mobility and stability and in the development of motor skills and postural control. Lower trunk and hip muscular coactivity provides lumbo-pelvic stability. Altered recruitment of hip abductors and extensors influences this stability that may explain persistence and recurrence of LBP [5].

Material and Methods

It is a cross-sectional observational study induced to determine if there is a relation between lumbar proprioception and hip abductor and extensor muscles strength. The study was carried

Correspondence to: Dr. Esraa S. Abo-Elwafa,
The Department of Physical Therapy for Neurology,
Faculty of Physical Therapy, Cairo University

out at the outpatient clinic of the Faculty of Physical Therapy, Cairo University in the period from March 2022 to February 2023. Seventy-five subjects from both sexes were enrolled in this study. Participants were assigned into two groups (study and control groups). Study group (GI) included forty-five patients with chronic low back pain. Control group (GII) included thirty matched healthy subjects without low back pain. Patients in group I were diagnosed as chronic nonspecific low back pain based on careful clinical evaluation by the neurologist and normal plain X-ray and magnetic resonance imaging (MRI) of the lumbar spine. The participants were recruited from the Faculty of Physical Therapy, Cairo University.

Inclusion criteria for the patients were:

- 1- Forty-five subjects of both sexes (forty-five with chronic low back pain, and thirty matched healthy subjects).
- 2- Age ranged from 20-30 years.
- 3- Body mass index (less than 30Kg/m^2).
- 4- Duration of low back pain was more than six months [6].
- 5- Mild (5-44mm) to moderate (45-74) low back pain on visual analogue scale [7].

Patients were excluded from the study if they had:

- 1- Lumbar disco genic lesions or any inflammatory arthritis, tumors, infection involving the lumbar spine.
- 2- Lumbar spondylolisthesis.
- 3- Lumbar spondylosis.
- 4- Patients with decreased range of motion (ROM) of lumbar region or hip secondary to congenital anomalies, muscular contracture, or bony block.
- 5- Any spinal deformities such as scoliosis.
- 6- Any hip structural abnormality such as malformations, impingements and degeneration.
- 7- True leg length discrepancy.
- 8- Previous lumbar or hip surgery or trauma.
- 9- Pregnancy.

All the patients signed an informed consent form after receiving information on the study purpose, procedure, possible benefits and risks, privacy and use of data then the following assessment steps were applied: All participants have undergone evaluation of lumbar joint position error using Biodex System 3 Pro Isokinetic through the lumbar reposition accuracy test: target lumbar repositioning (passive joint position detection). Target lumbar repositioning test measures the individual's ability to recognize established position when reproduced

passively. The target positions was 30° of lumbar flexion. Joint position error was calculated as the absolute value of the difference between the target angle and subject's repositions angle. Hip abductor and extensor isometric strength on both sides were assessed using Instrumented digital hand-held dynamometer. The subject was asked to push maximally against the dynamometer for five seconds and to avoid any substitution. Scores of three successive trials were recorded for each attempt with one-minute rest between each attempt. The average of three trials was taken in the kilogram (Kg) unit.

Statistical methods:

Descriptive statistics in form of mean, standard deviation, minimum, maximum and frequency were conducted to present the measured variables. Pearson Correlation Coefficient was conducted to investigate the correlation between pelvic tilt, JPE and hip muscle strength in the study group. Unpaired *t*-test was conducted for comparison of pelvic tilt, JPE and hip muscle strength, between subjects with LBP and control group. The level of significance for all statistical tests was set at $p < 0.05$. All statistical tests were performed through the statistical package for social studies (SPSS) version 25 for windows. (IBM SPSS, Chicago, IL, USA).

Results

Participant's characteristics:

Seventy-five subjects were enrolled in this study divided into two groups. Forty-five patients (36 females and 9 males representing 80% and 20% respectively) with CLBP were included in the study group. Their mean $\pm$ SD age, weight, height and BMI were 26.82 ± 2.27 years, 69.95 ± 10.23 kg, 165.82 ± 8.44 cm and 25.46 ± 3.59 kg/m^2 respectively. Thirty matched subjects (16 females and 14 males representing 53% and 47% respectively) were included in the control group. Their mean $\pm$ SD age, weight, height and BMI were 26.35 ± 2.39 years, 72.75 ± 9.91 kg, 164.1 ± 7.12 cm and 27.14 ± 4.4 kg/m^2 respectively (Table 1). There was no significant difference in age, height, weight, and BMI and sex distribution between both groups.

The mean $\pm$ SD VAS of study group was 5.06 ± 1.23 with a minimum value of 3 and maximum value of 7. The mean $\pm$ SD ODI of study group was $11.33 \pm 5.03\%$ with a minimum value of 3% and maximum value of 24%.

Comparison of JPE between subjects with LBP and control group:

The mean value $\pm$ SD of JPE at 30 degrees of subjects with CLBP was 6.04 ± 2.42 degrees and

that of control group was 3.84 ± 1.96 degrees. The mean difference between groups was 2.2 degrees. There was a significant increase in JPE in subjects with CLBP compared with that of control group ($p=0.001$).

Comparison of muscle strength between subjects with CLBP and control group:

The mean value of right hip abductors of subjects with CLBP was 8.63 ± 3.42 kg and that of control group was 10.62 ± 3.42 kg. The mean value $\pm$ SD of left hip abductors of subjects with CLBP was 8.17 ± 3.37 kg and that of control group was 10.17 ± 3.76 kg. The mean value $\pm$ SD of right hip

extensors of subjects with CLBP was 10.95 ± 5.04 kg and that of control group was 14.89 ± 5.49 kg. The mean value $\pm$ SD of left hip extensors of subjects with CLBP was 11.39 ± 6.01 kg and that of control group was 15.76 ± 6.36 kg. There was a significant decrease in right and left hip abductor and extensor muscle strength in subjects with CLBP compared with that of control group.

The relation between JPE and hip muscles strength (kg):

There was negative non-significant correlation between JPE and right and left hip abductor and extensor muscle strength.

Table (1): Basic characteristics of participants.

	Subjects with CLBP	Control group	MD	t-value	p-value	Sig.
	X $\pm$ SD	X $\pm$ SD				
Age (years)	26.82 $\pm$ 2.27	26.35 $\pm$ 2.39	0.47	0.76	0.45	NS
Weight (kg)	69.95 $\pm$ 10.23	72.75 $\pm$ 9.91	-2.8	-1.02	0.31	NS
Height (cm)	165.82 $\pm$ 8.44	164.1 $\pm$ 7.12	1.72	0.79	0.43	NS
BMI (kg/m ²)	25.46 $\pm$ 3.59	27.14 $\pm$ 2.4	-1.68	-1.62	0.11	NS

Table (2): Comparison of JPE between subjects with CLBP and control group.

JPE (Degrees)	Subjects with CLBP	Control group	MD	t-value	p-value	Sig.
	X $\pm$ SD	X $\pm$ SD				
30°	6.04 $\pm$ 2.42	3.84 $\pm$ 1.96	2.2	3.55	0.001	S

Table (3): Comparison of muscle strength between subjects with CLBP and control group.

Muscle strength (kg)	Subjects with CLBP	Control group	MD	t-value	p-value	Sig.
	X $\pm$ SD	X $\pm$ SD				
Right hip abductors	8.63 $\pm$ 3.42	10.62 $\pm$ 3.42	-1.99	-2.16	0.03	S
Left hip abductors	8.17 $\pm$ 3.37	10.17 $\pm$ 3.76	-2	-2.12	0.03	S
Right hip extensors	10.95 $\pm$ 5.04	14.89 $\pm$ 5.49	-3.94	-2.82	0.006	S
Left hip extensors	11.39 $\pm$ 6.01	15.76 $\pm$ 6.36	-4.37	-2.63	0.01	S

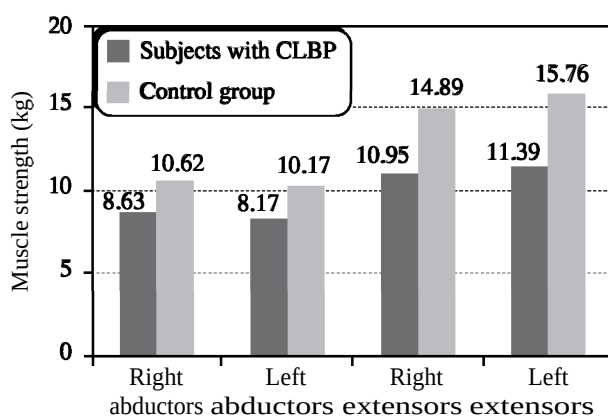


Fig. (1): Comparison of muscle strength between subjects with CLBP and control group.

Table (4): Correlation between JPE and hip muscles strength (kg).

	t-value	p-value	Sig.
JPE at 30° (degrees)			
Right hip extensors (Kg)	-0.083	0.59	NS
Left hip extensors (Kg)	-0.043	0.78	NS
Right hip abductors (Kg)	-0.0038	0.98	NS
Left hip abductors (Kg)	-0.06	0.69	NS

Discussion

The current study was conducted to examine the relationship between lumbar proprioception and hip abductor and extensor muscles strength in patients with chronic non-specific low back pain. The participants' age in the present study ranged from 20-30 years to avoid age-related degenerative changes as it has been found that there is an inevitable deterioration in muscle strength and function as a result of different mechanical and neuromuscular changes that normally accompany ageing process [8].

The results of this study showed that there was a significant decrease in hip abductor and extensor muscles strength (in both sides) in the study group in comparison to the control group. These results agreed with a study conducted to compare lower limb muscle strength in patients with LBP to matched healthy controls. It revealed that the strength of hip abductors and extensors was significantly lower in LBP patients compared to that of healthy controls [9].

Reham et al. [10] investigated electromyography activity of gluteus maximus muscle in nonspecific chronic LBP patients. This study found a decrease in the activity of the gluteus maximus in NSCLBP pain patients when compared to the controls. The gluteus maximus muscle (GM) acts as a local and global stabilizer of the lower back, pelvis and hip. It Acts as a tri-planar stabilizer to allow more controlled mobility of the lumbopelvic complex especially in the sagittal plane [11].

It is thought prolonged sitting reduces the activation of GM and over time these muscles become atrophied and weak. This weakness increases reliance on the synergistic hip extensor muscles, such as the hamstrings and erector spinae to produce hip extension torque. This would contribute to back pain and strain injuries associated with these muscles. Also, altered posture of the pelvis places the muscle in a mechanically disadvantaged position reducing its stabilizing capacity resulting in back pain [12].

Another explanation, back pain is considered a potent inhibitor of gluteal muscles resulting in delayed and reduced activation. This leads to redistribution of activity within or between muscles and modify movement patterns [13]. This effect is thought to act as a protective mechanism providing short term pain relief and protection from further damage and re-injury [14]. These results disagreed with Sutherlin and Hart, (2015) and Cai and Kong, (2015) who found that there was no difference in

gluteus medius strength in LBP when compared to healthy subjects [15]. The difference among studies might be attributed to that; Sutherlin and Hart assessed muscle strength and activation during repeated bouts of side-lying hip abduction exercise. Also, Cai and Kong assessed gluteus muscle strength during in weight bearing position.

Results of this study can be explained in that, gluteus medius, primary hip abductor, is one of the main pelvic stabilizer Muscles. It plays a significant role in controlling transverse and frontal plane motion providing stability to the lumbopelvic-hip complex [16]. Its weakness results in loss of dynamic lateral stability of the pelvis and lower back. That leads to increased lateral trunk flexion and subsequent intervertebral joint compression. It alters movement patterns which may contribute to the development or exacerbation of LBP [17].

Also, its weakness drops the pelvis to the unsupported side during single leg stance during the gait [18]. This uncontrolled pelvic mobility is suggested to cause repetitive micro traumas to lumbar structures and so contribute to the development of LBP [19].

The results of this study found non-significant correlation between JPE and hip abductors and extensors on each side. To the best of our knowledge, this is a preliminary study to correlate the lumbar JPE and gluteal muscle strength. This finding may be explained in that appropriate muscular performance does not depend only on absolute muscular strength but require coordinated muscular activity (timing of contraction).

Coordinated muscular activity requires proper sensory motor activity. Sensory motor integration involves proper sensory input (proprioception), cortical processing and motor output. So, gluteal performance may be affected by proprioception but there were no relation.

So, the decline of gluteal strength may be related to maladaptive cortical processing and organization. Also, the decline in gluteal strength could be related to LBP, as maladaptive cortical reorganization in response to pain leads to alteration in sensory-motor integration [20].

So, the proprioceptive impairment in LBP might affect gluteal performance in form of muscular timing of activation rather than absolute strength.

Conclusion:

In view of these findings, Patients with chronic nonspecific low back pain have significant alteration

in lumbar joint position sense and hip abductor and extensor muscles strength. Lumbar afferent input can be altered by adopting an uncomfortable position for extended period of time during regular activities. Also, these awkward postures can impact pelvic muscles performance which in turn may affect lumbo-pelvic controlled mobility during gait and daily activities. This alteration in performance was not related to altered lumbar joint position sense.

References

- 1- MEISHA D.E., ALSHARQAWI N.S., SAMARAH A.A. and AL-GHAMDI M.Y.: Prevalence of work-related musculoskeletal disorders and ergonomic practice among dentists in Jeddah, Saudi Arabia. *Clinical, cosmetic and investigational dentistry*, 11: 171–179, 2019.
- 2- RUFFILLI A., NERI S., MANZETTI M., BARILE F., VIROLI G., TRAVERSARI M. and FALDINI C.: Epigenetic Factors Related to Low Back Pain: A Systematic Review of the Current Literature. *International Journal of Molecular Sciences*, 24 (3): 1854, 2023.
- 3- KOCH C. and HÄNSEL F.: Chronic non-specific low back pain and motor control during gait. *Frontiers in Psychology*, 9: 2236, 2018.
- 4- GONZÁLEZ-GRANDÓN X., FALCÓN-CORTÉS A. and RAMOS-FERNÁNDEZ G.: Proprioception in action: A matter of ecological and social interaction. *Frontiers in Psychology*, 11: 3372, 2021.
- 5- KARTHIKABABU S., CHAKRAPANI M., GANESAN S. and ELLAJOSYULA R.: Relationship between pelvic alignment and weight-bearing asymmetry in community-dwelling chronic stroke survivors. *Journal of neurosciences in rural practice*, 7 (S 01): S037-S040, 2016.
- 6- MISAILIDOU V., MALLIOU P., BENEKA A., KARAGIANNIDIS A. and GODOLIAS G.: Assessment of patients with neck pain: A review of definitions, selection criteria, and measurement tools. *Journal of chiropractic medicine*, 9 (2): 49-59, 2010.
- 7- HABIBI A.M., ALAWAMRY A.E., ABDULAZIZ M.R., AHMED A.E. and ISMAEIL A.S.: Assessment of Facet Joint Block in Treatment of Persistent Lower Back Pain in Patients with and without Modic Changes. *The Egyptian Journal of Hospital Medicine*, 87 (1): 1491-1496, 2022.
- 8- WU R., DELAHUNT E., DITROILO M., LOWERY M. and DE VITO G.: Effects of age and sex on neuromuscular-mechanical determinants of muscle strength. *Age*, 38: 1-12, 2016.
- 9- DE SOUSA C.S., DE JESUS F.L.A., MACHADO M.B., FERREIRA G., AYRES I.G.T., DE AQUINO L.M. and GOMES-NETO M.: Lower limb muscle strength in patients with low back pain: A systematic review and meta-analysis. *Journal of musculoskeletal & neuronal interactions*, 19 (1): 69, 2019.
- 10- REHAM H., HATEM Y.M., MOHAMED P.D. and RANIA R.: Electromyographic Activity of Gluteus Maximus Muscle in Nonspecific Chronic Low Back Pain. *The Medical Journal of Cairo University*, 87 (March), 1241-1245, 2019.
- 11- SAHRMANN S., AZEVEDO D.C. and VAN DILLEN L.: Diagnosis and treatment of movement system impairment syndromes. *Brazilian journal of physical therapy*, 21 (6): 391-399, 2017.
- 12- BUCKTHORPE M., STRIDE M. and DELLA VILLA F.: Assessing and treating gluteus maximus weakness a clinical commentary. *International journal of sports physical therapy*, 14 (4): 655, 2019.
- 13- NELSON-WONG E., ALEX B., CSEPE D., LANCAS-TER D. and CALLAGHAN J.P.: Altered muscle recruitment during extension from trunk flexion in low back pain developers. *Clinical biomechanics*, 27 (10): 994-998, 2012.
- 14- HODGES P.W. and TUCKER K.: Moving differently in pain: A new theory to explain the adaptation to pain. *Pain*, 152 (3): S90-S98, 2011.
- 15- CAI C. and KONG P.W.: Low back and lower-limb muscle performance in male and female recreational runners with chronic low back pain. *Journal of Orthopaedic & Sports Physical Therapy*, 45 (6): 436-443, 2015.
- 16- SADLER S., CASSIDY S., PETERSON B., SPINK M. and CHUTER V.: Gluteus medius muscle function in people with and without low back pain: A systematic review. *BMC musculoskeletal disorders*, 20: 1-17, 2019.
- 17- BUSSEY M.D., KENNEDY J.E. and KENNEDY G.: Gluteus medius coactivation response in field hockey players with and without low back pain. *Physical Therapy in Sport*, 17: 24-29, 2016.
- 18- FUJITA K., KABATA T., KAJINO Y., IWAI S., KURODA K., HASEGAWA K. and TSUCHIYA H.: Quantitative analysis of the Trendelenburg test and invention of a modified method. *Journal of Orthopaedic Science*, 22 (1): 81-88, 2017.
- 19- POOJA A., SIDDHARTHA S. and AMIT D.: Correlation between Anterior Pelvic Tilt, Abdominal Muscle Endurance and Lumbar Proprioception in Asymptomatic Young Collegiate Students. *Journal of Physiotherapy & Sports Medicine*. 5: 1-13, 2016.
- 20- ZAMORANO A.M., RIQUELME I., KLEBER B., ALTENMÜLLER E., HATEM S.M. and MONTOYA P.: Pain sensitivity and tactile spatial acuity are altered in healthy musicians as in chronic pain patients. *Frontiers in human neuroscience*, 8: 1016, 2015.

هل يؤثر الاحساس العميق القطنى على قوة العضلات الجانبية والخلفية للفخذ فى مرضى الام أسفل الظهر المزمنة

الخلفية: ان آلام أسفل الظهر المزمنة هى أكثر اضطرابات الجهاز العضلى الهيكلى المرتبطة بالعمل انتشاراً. وقد وُجد أن مرضى آلام أسفل الظهر يعانون من انعدام التناسق الحركى فى منطقة أسفل الظهر والحوض، والتي قد تكون مرتبطة بضعف الأداء العضلى.

هدف الدراسة: هدفت هذه الدراسة إلى تحديد ما إذا كانت هناك علاقة بين الإحساس العميق للفقرات القطنية وقوة العضلات الجانبية والخلفية بالفخذ لدى مرضى آلام أسفل الظهر المزمنة.

الأشخاص والأساليب: أجريت هذه الدراسة على خمسة وسبعين شخصاً تراوحت أعمارهم بين العشرين والثلاثين عاماً وقد تم تقسيمهم الى مجموعتين. ضمت المجموعة الاولى (مجموعة الدراسة) خمسة وأربعون مريضاً يعانون من آلام أسفل الظهر المزمنة الغير محددة وضمت المجموعة الثانية (المجموعة الضابطة) ثلاثين شخصاً من الأصحاء. تم اخضاع جميع المشاركين لتقييم معدل خطأ الإحساس بالفقرات القطنية باستخدام جهاز الأيزوكينيتيك وذلك من خلال إختبار إعادة تحديد الوضع القطنى إلى الهدف في الإنحناء الأمامى عند الزاوية ثلاثين وخمسة وأربعين وكذلك تقييم القوة العضلية للعضلات الجانبية والخلفية بالفخذ باستخدام جهاز الديناموميتر الرقمى لقياس قوة العضلات.

الاستنتاج: أظهرت النتائج وجود إرتفاع كبير فى معدل خطأ الإحساس بالوضع القطنى ووجود إنخفاض كبير فى القوة العضلية للعضلات الجانبية والخلفية بالفخذ فى مجموعة الدراسة مقارنة بالمجموعة الضابطة. كما أظهرت عدم وجود إرتباط ذو دلالة إحصائية بين معدل خطأ الإحساس بالوضع القطنى والقوة العضلية للعضلات الجانبية والخلفية بالفخذ فى مجموعة الدراسة. العضلات الجانبية والخلفية فى مجموعة الدراسة.