Clinical Evaluation of Scapular Positioning in Patients With Nonspecific Chronic Low Back Pain: A Case-Control Study

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ABSTRACT

Objective: The purpose of this study was to investigate the position of scapula in patients with nonspecific chronic low back pain.

Methods: A total of 17 participants with a history of nonspecific chronic low back pain and 17 healthy participants in the same age, sex, and weight range were enrolled in this case-control study. Lateral scapular slide test and Lennie test were used for clinical evaluation of scapular position in the frontal plane using a tape measure. The data were analyzed using an independent *t* test.

Results: The results of lateral scapular slide test indicated that there were significant differences between patients with nonspecific chronic low back pain and healthy individuals in both left and right sides in 2 positions: shoulder in neutral position and shoulder at 40°-45° abduction. Also, in the Lennie test, there was only a significant difference between groups when we measured the distances from thoracic spinous process to the inferior angle of the scapula in both left and right sides.

Conclusion: This study indicated that upward rotation of the scapula can be seen in patients with nonspecific chronic low back pain. (*J Chiropr Med* 2017;16:195-198)

Key Indexing Terms: *Low Back Pain; Scapula; Posture*

INTRODUCTION

Nonspecific chronic low back pain (CLBP) is a common problem that can cause economic and social problems for an individual.¹ It has been reported that imbalance in the length, function, and strength of the trunk and hip muscles can lead to low back pain.²

Myofascial slings are interconnected muscle chains that lead to trunk stability during movement and force transmission from the lower to upper limbs.³ Most muscle injuries occur in the same sling that leads to pain and imbalances and can provoke trigger points. A myofascial sling that plays a critical role in trunk extension is the posterior oblique sling, which is composed of erector spina, hamstring, gluteal maximus (GM), and latissimus dorsi muscles.³⁻⁵ The latissimus dorsi has a synergetic role with gluteus maximus through the thoracolumbar fascia in trunk extension.⁶ Kim et al³ reported a greater muscular

activation pattern of latissimus dorsi in CLBP patients during prone hip extension test. When the function of gluteus maximus is reduced to control the lumbopelvic region, the contralateral latissimus dorsi may be activated to compensate GM insufficiency and spinal instability.^{3,6} Laudner et al⁷ reported that there was a link between increased latissimus dorsi stiffness and scapular dyskinesia using kinematic analysis among asymptomatic collegiate swimmers. They stated that latissimus dorsi stiffness increased scapular upward rotation and posterior tilt; however, scapular internal rotation decreased during humeral elevation.⁷ Therefore, Laudner et al⁷ stated that latissimus dorsi stiffness affects the scapular movement because of its attachment to the inferior border of the scapula.

Regarding the greater muscular activation pattern of latissimus dorsi in CLBP patients³ and its attachment to the inferior border of the scapula, it seems that latissimus dorsi dysfunction could alter scapular position. To the best of our knowledge, no study has investigated scapular position in CLBP patients. Therefore, the purpose of the present study was to evaluate scapular position among participants with and without CLBP to improve knowledge about myofascial sling function in CLBP patients.

METHODS

This case-control study involved a total of 17 participants with chronic low back pain within the past 3 months and 17

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healthy participants recruited through leaflet advertising. All the participants were students at Shiraz University of Medical Sciences. Anyone with a history of fracture or spinal dislocation, cardiovascular disease, disk herniation, pregnancy, neuromuscular and musculoskeletal diseases, leg limb discrepancy, previous shoulder surgery, thoracic and/or shoulder girdle pain, or obesity (body mass index ≥ 32) were excluded from the study. The participants were matched according to their age, sex, weight, and height. All the participants signed written informed consent forms approved by the Ethics Committee of Shiraz University of Medical Sciences (ec-p-9373-7543).

Lateral scapular slide test (LSST) and Lennie test were used for clinical evaluation of scapular positions. In LSST, the participants were instructed to stand in a static position. The examiner measured the distance between the inferior angle of the scapula and spinous process of T7-9, using a tape measure in 3 different positions: shoulder in neutral position (0° abduction), shoulder at 40° – 45° abduction, and shoulder at 90° abduction with internal rotation.

In the Lennie test, the participants were asked to stand with arms relaxed at their sides. The examiner measured the distance between the thoracic spinous processes and bony landmarks of the scapula in 3 locations: the superior angle of the scapula, at the root of the scapula, and the inferior angle of the scapula.

Both sides of each participant were measured. Each measurement was performed 3 times and the average of the 3 measurements was used for the final analysis. The order of examinations was randomized.

To blind the assessor, 1 physical therapist divided the participants based on inclusion and exclusion criteria into 2 groups (the control and experimental group), and another physical therapist, who was unaware of the participants' groups, evaluated them.

The sample size calculation was performed using Power SSC. The calculations were based on detecting differences between the 2 groups (mean: 15 cm), a standard deviation of 13.3, an α of 0.05, and a power of 80%. The sample size was determined with least 14 participants in each group. By anticipating the dropout rate, the minimum number per group was considered 17 participants in each group.

Data normality was checked using Shapiro-Wilk test ($P > .05$). Comparisons between both groups were made with independent t tests for age, weight, and height. The results of both tests were analyzed by independent t test. Because 6 comparisons were made for each test, the Bonferroni correction was used to reduce a type I error; hence, the α level was adjusted from 0.05 to 0.008. Statistical analysis was performed using SPSS 16 for Windows XP (SPSS Inc., Chicago, Illinois).

RESULTS

The results indicated that there were no significant differences in demographic variables between patients with nonspecific CLBP and healthy individuals (Table 1).

Table 1. Demographic Characteristics of Healthy and LBP Groups

Variables	Healthy Group (Mean $\pm$ SD)	LBP Group (Mean $\pm$ SD)
Age (y)	31.35 $\pm$ 4.97	32 $\pm$ 5.49
Weight (kg)	68.68 $\pm$ 9.02	69.87 $\pm$ 10.43
Height (cm)	169.70 $\pm$ 8.32	170.20 $\pm$ 5.00
NRS (scale 0-10)	N/A	6.20 $\pm$ 0.70

LBP, low back pain; N/A, not applicable; NRS, Numerical Rating Scale; SD, standard deviation.

Table 2 lists the result of LSSTs for both groups. The findings revealed that there were significant differences between the 2 groups in both left and right sides in neutral position and shoulder at 40° – 45° abduction. The other measurements were not statistically significant between the 2 groups.

Also, the results of the Lennie test are shown in Table 3. Analysis performed by independent t tests indicated that there was a significant difference only in the distance measured from thoracic spinous processes to the inferior angle of the scapula in both left and right sides.

DISCUSSION

The results indicated that the scapula's upward rotation was identified in patients with CLBP. This result suggests that CLBP may affect the adjacent structures.

The thoracolumbar fascia is attached to internal and external oblique, transverse abdominis, latissimus dorsi, and gluteal maximus, which distributed load between upper and lower extremities.⁴ Additionally, latissimus dorsi muscle is attached to the inferior border of the scapula.⁷ Thus, the biggest change occurred in the inferior margin of the scapula in CLBP patients as a result of latissimus dorsi muscle attachment to the scapula.

Table 2. Mean (cm) and SD of Distances in 3 Positions in the Lateral Scapular Slide Test

Variables		Healthy Group (Mean $\pm$ SD)	LBP Group (Mean $\pm$ SD)	P
90° Abduction and internal rotation	Right	9.20 $\pm$ 1.62	9.65 $\pm$ 1.49	.41
	Left	8.88 $\pm$ 1.57	9.47 $\pm$ 1.15	.22
Shoulder at 40°–45° abduction with hands resting on hips	Right	8.15 $\pm$ 0.37	8.91 $\pm$ 1.03	.009
	Left	7.73 $\pm$ 0.36	8.73 $\pm$ 1.12	.002 ^a
Neutral position (0° abduction)	Right	7.70 $\pm$ 0.44	8.68 $\pm$ 1.01	.001 ^a
	Left	7.78 $\pm$ 0.30	8.53 $\pm$ 0.86	.002 ^a

LBP, low back pain; SD, standard deviation.

^a Indicates significant differences.

Table 3. Mean (cm) and SD of Distances in the 3 Levels in the Lennie Test

Variables		Healthy Group (Mean ± SD)	LBP Group (Mean ± SD)	P
Superior angle of scapula	Right	7.26 ± 0.66	7.26 ± 0.56	1
	Left	7.35 ± 0.49	7.15 ± 0.49	.23
Root of scapula	Right	7.35 ± 0.52	7.23 ± 0.73	.59
	Left	7.26 ± 0.69	7.21 ± 0.5	.79
Inferior angle of scapula	Right	7.35 ± 0.52	8.68 ± 1.01	.001 ^a
	Left	7.78 ± 0.3	8.53 ± 0.86	.002 ^a

LBP, low back pain; SD, standard deviation.

^a Indicates significant differences.

Our finding is consistent with the results of Vleeming et al⁴ and Laudner et al.⁷ Laudner et al⁷ reported that there was an association between the increased latissimus dorsi stiffness and scapular dyskinesia using kinematic analysis. They stated that latissimus dorsi pulled the inferior border of the scapula toward the superior and lateral sides during humeral elevation (increased upward rotation) because of its attachment to the humerus.⁷ Similarly, Kim et al³ reported a greater muscular activation pattern of the latissimus dorsi in CLBP patients during a prone hip extension test. When the function of the gluteus maximus is reduced to control the lumbopelvic region, the contralateral latissimus dorsi can be activated to compensate for GM insufficiency. Previous studies have reported that trunk muscle activities increases during lifting and trunk rotation in CLBP patients.^{8,9} It seems that increased activity of the trunk muscles can be due to abnormal motor recruitment patterns.³ Stokes et al¹⁰ reported that increased superficial trunk muscle activation was due to a “pain-adaptation” hypothesis. Participants with CLBP adopt a stiffening strategy to increase spine stability and to reduce the exacerbation of existing pain.^{10,11} Thus, in our study, increased activity of latissimus dorsi could be due to pain severity (6 of 10 based on the data in Table 1) in patients with CLBP. According to the “pain-spasm-pain” theory, pain increases muscle activity and a vicious cycle of muscle spasm develops.¹¹ Indeed, this level of pain could increase latissimus dorsi activity to avoid further pain, which finally leads to scapular hypomobility.

Furthermore, the result of this study indicated that there were no differences between 2 groups at 90° abduction with shoulder internal rotation. It seems that abnormal position of the scapula was masked in CLBP patients during upward scapular rotation at 90° abduction.

Our study highlighted that any scapular hypomobility caused by the latissimus dorsi may increase the risk of scapulocostal syndrome in patients with CLBP. It is presumed that this syndrome occurs as a result of changes in the relationship between the scapula and the thoracic wall.^{11,12} In this condition, patients usually complain of shoulder and neck pain caused by changes in scapula biomechanics.^{11,12} Based on our findings, it

may be beneficial to use stretching or other effective manual therapies during latissimus dorsi rehabilitation. It could also help to prevent various injuries associated with scapular hypomobility including scapulocostal syndrome.

Limitations

First, the experiment was performed on participants with nonspecific low back pain and cannot be generalized for other groups of low back pain patients. Second, we merely evaluated the scapula in frontal plane, and there is a possibility that the scapular position could change in other planes. Hence, future studies should investigate the scapular position using a motion analysis system and electromyography in patients with CLBP. Third, latissimus dorsi stiffness was not evaluated, which can be a significant factor.

CONCLUSIONS

We found scapula upward rotation in patients with chronic low back pain using clinical tests. This finding may be helpful when designing a therapeutic protocol for treating scapular asymmetry.

FUNDING SOURCES AND CONFLICTS OF INTEREST

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CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): A.S., F.K.

Design (planned the methods to generate the results): S.P., S.T., A.S., F.K.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): S.P., S.T.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): A.S., F.K.

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Practical Applications

- Impaired scapular position highlights the importance of physical examination of the scapula in CLBP patients.
- These findings may be helpful when designing therapeutic protocols for treating scapular asymmetry.

REFERENCES

1. O'Sullivan P. Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. *Man Ther.* 2005;10(4):242-255.
2. Page P, Frank C, Lardner R. *Assessment and Treatment of Muscle Imbalance: The Janda Approach*. Champaign, IL: Human Kinetics; 2010.
3. Kim JW, Kang MH, Oh JS. Patients with low back pain demonstrate increased activity of the posterior oblique sling muscle during prone hip extension. *PM R.* 2014;6(5):400-405.
4. Vleeming A, Pool-Goudzwaard AL, Stoeckart R, van Wingerden JP, Snijders CJ. The posterior layer of the thoracolumbar fascia. Its function in load transfer from spine to legs. *Spine (Phila Pa 1976).* 1995;20(7):753-758.
5. Carvalhais VO, Ocarino Jde M, Araújo VL, Souza TR, Silva PL, Fonseca ST. Myofascial force transmission between the latissimus dorsi and gluteus maximus muscles: an in vivo experiment. *J Biomech.* 2013;46(5):1003-1007.
6. Clark M, Lucett S. *NASM essentials of corrective exercise training*. Sudbury, MA: Lippincott Williams & Wilkins; 2010.
7. Laudner KG, Williams JG. The relationship between latissimus dorsi stiffness and altered scapular kinematics among asymptomatic collegiate swimmers. *Phys Ther Sport.* 2013;14(1):50-53.
8. Ferguson SA, Marras WS, Burr DL, Davis KG, Gupta P. Differences in motor recruitment and resulting kinematics between low back pain patients and asymptomatic participants during lifting exertions. *Clin Biomech (Bristol, Avon).* 2004; 19(10):992-999.
9. Pirouzi S, Hides J, Richardson C, Darnell R, Toppenberg R. Low back pain patients demonstrate increased hip extensor muscle activity during standardized submaximal rotation efforts. *Spine (Phila Pa 1976).* 2006;31(26):E999-E1005.
10. Stokes IA, Fox JR, Henry SM. Trunk muscular activation patterns and responses to transient force perturbation in persons with self-reported low back pain. *Eur Spine J.* 2006; 15(5):658-667.
11. van Dieën JH, Selen LP, Cholewicki J. Trunk muscle activation in low back pain patients, an analysis of the literature. *J Electromyogr Kinesiol.* 2003;13(4):333-351.
12. Cohen CA. Scapulocostal syndrome: diagnosis and treatment. *South Med J.* 1980;73(4):433-434, 437.