

The Evaluation of Chronic Low Back Pain by Determining the Ratio of the Lumbar Multifidus Muscle Cross-sectional Areas of the Unaffected and Affected Sides

QIUCHEN HUANG, PT¹⁻³*, YUYING ZHANG, PT¹, DESHENG LI, PT¹⁻³, DEGANG YANG^{2, 3}, MING HUO, PT, PhD⁴, HITOSHI MARUYAMA, PT, PhD¹

¹⁾ Department of Physical Therapy, International University of Health and Welfare: 2600-1 Kitakanemaru, Ohtawara City, Tochigi 324-8501, Japan

²⁾ Department of Physical Therapy, China Rehabilitation Center, China

³⁾ School of Rehabilitation Medicine, Capital Medical University, China

⁴⁾ Himeji Dokkyo University, Japan

Abstract. [Purpose] The primary purpose of this study was to evaluate chronic low back pain by determining the ratio of the cross-sectional areas of the lumbar multifidus of the unaffected and affected sides at the L5 level using the ultrasound imaging. [Subjects and Methods] The subjects were 24 young people (10 males, 14 females) with chronic low back pain lasting for more than 6 months on one side. The visual analog scale (VAS) value of pain was assessed and the cross-sectional areas of the bilateral multifidus muscle were measured with the subjects in a supine position in a resting state using ultrasound imaging. Correlation and linear regression analysis were performed on the VAS and the ratio of the cross-sectional areas of the lumbar multifidus of the unaffected and affected sides. [Results] The VAS and the ratio of the cross-sectional areas of the lumbar multifidus were linearly correlated. [Conclusion] The results of this research indicate that when the ratio of the cross-sectional areas of the lumbar multifidus of the unaffected and affected sides increases, the symptom of chronic low back pain deteriorates.

Key words: Multifidus, Chronic low back pain, Ultrasound imaging

(This article was submitted Mar. 10, 2014, and was accepted Apr. 21, 2014)

INTRODUCTION

Chronic low back pain (LBP) is considered to be a recurring human disease. In order to walk upright and hold their position, humans exert a heavy burden on the lumbar region¹. LBP is a multifactorial disease and it can't be managed by a simple treatment². Various factors affect the stabilization of the muscles which can protect the spine joints, such as micro trauma, recurrent pain, and degenerative changes. Chronic low back pain is defined as back pain lasting for more than 12 weeks, and it affects more than 50% of the general population³. It is estimated that over 70% of adults have at least one episode of low back pain during their lifetimes. The prevalence of LBP is higher in the young, economically active adults and it is the second most common reason for absenteeism from work, and one of the most common reasons for medical consultation⁴. Currently, the role of the multifidus muscle in the stabilization of the lumbar region is being given much attention. The inner abdominal muscle thicknesses (multifidus muscle,

transverse abdominal muscle) show high correlation with the stability of the lumbar region⁵. Low activity of the inner muscles requires the outer muscles (erector spinae, musculus rectus abdominis, abdominal oblique) to compensate to keep the lumbar region stable. This compensation is one of the causes of low back pain.

In the trunk structure, pathological change appears most often at the L4–L5 level. At this level the multifidus muscle is considered to be the main muscle protecting the spinal structure controlling the gliding motion at each articuli intervertebrales³. At this level ultrasound diagnostic imaging can easily measure this muscle. There are many evaluation methods for low back pain, such as the spinal column joint diagnostic radiation examination or the pressure pain threshold test, but the evaluation of muscles is still seldom performed⁶.

The primary purpose of this study was to evaluate chronic low back pain by determining the ratio of the cross-sectional areas of the lumbar multifidus of the unaffected and affected sides at the L5 level using ultrasound imaging.

SUBJECTS AND METHODS

The subjects were 24 young people (10 males, 14 females) with chronic low back pain lasting for more than 6 months on one side. The subjects' characteristics are detailed in Table 1. Low back pain patients with a history of neurological disease and orthopedic disease were excluded

*Corresponding author. Qiuchen Huang (E-mail: qiuchen_1984@126.com)

©2014 The Society of Physical Therapy Science. Published by IPEC Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License <<http://creativecommons.org/licenses/by-nc-nd/3.0/>>.

Table 1. Subject characteristics

M±SD N=24	
Age (y)	23.8 ± 5.2
Height (cm)	168.8 ± 8.6
Weight (kg)	62.6 ± 16.4

from this study.

The purpose and the content of this research were explained to the subjects, and all the subjects gave their informed consent to participation in this study. Approval for this study was granted by the Research Ethics Committee of International University of Health and Welfare, IRB approval number 12-155.

The subjects' pain severity was evaluated using a visual analog scale (VAS). The cross-sectional areas of the bilateral multifidus muscle were measured with the subjects in a supine position in a resting state. Each measurement was made twice, and the average value was calculated. Ultrasound images of the multifidus muscle wall were obtained using an ALOKA (SSD-650CL, ALOKA, Japan) in the B mode with a 7.5 MHz linear transducer. Gel was applied to the skin beneath the transducer. The transducer was placed on the skin 25 mm distal from the spinous process of L3 and parallel to the vertebral column. All measurements were carried out by the same physical therapist.

The ratio of the lumbar multifidus cross-sectional area (%) was calculated as: (unaffected side lumbar multifidus cross-sectional area/affected side lumbar multifidus cross-sectional area)×100%.

In order to determine the correlation of the ratio of the cross-sectional areas of the lumbar multifidus and VAS, and bivariate analysis between the ratio and VAS was carried out. Further, the linear regression (forced entry method) was evaluated using VAS as the dependent variable, and the ratio of cross-sectional areas of the lumbar multifidus of the unaffected and affected sides as the independent variable. The data were analyzed using SPSS Ver. 17.0 for Windows.

RESULTS

The cross-sectional area of the lumbar multifidus muscle of the unaffected side was $8.79 \pm 2.10 \text{ cm}^2$, and that of the affected side was $7.61 \pm 1.96 \text{ cm}^2$. The ratio of the cross-sectional areas of the lumbar multifidus of the unaffected and affected sides was 1.16 ± 0.10 , and the VAS was 2.22 ± 1.24 . Furthermore, VAS increased with the ratio of the lumbar multifidus cross-sectional area. The Spearman correlation coefficient for the ratio of the lumbar multifidus cross-sectional areas and VAS was 0.72, $p < 0.01$. In linear regression analysis, the coefficient of determination was 0.51, and the regression equation was: $\text{VAS} = 8.849 \times \text{ratio of cross-sectional areas} - 0.8054$.

DISCUSSION

Chronic low back pain is caused by dysfunction of the lumbar muscle. Recent research has developed many methods for measuring the cross-sectional area or density of muscles using CT, MRI, and ultrasound. Changes

in muscle thicknesses have been measured in attempts to evaluate chronic low back pain. In addition, CT and MRI can be used to evaluate muscle atrophy, fatty infiltration, and fat replacement of fibers⁷⁾. However, it is difficult to perform such measurements frequently, because MRI and CT equipment is very expensive, and their operating cost is high. Furthermore, MRI and CT measurement methods cannot evaluate the state of the muscle during exercise. In many imaging studies of patients with low back pain, only the lumbar paraspinal muscles have been measured, or together with the lumbar multifidus. And evaluation of the multifidus muscle alone has been rare.

Some studies have investigated atrophy of the paraspinal muscles in chronic low back pain. The reasons for atrophy are disuse and lack of exercise. In diagnostic imaging, partial atrophy of the paraspinal muscles was evident in patients with chronic low back pain. In particular, decrease of inner the part of the multifidus muscle was evident. Compared with the unaffected side, the mass of the multifidus muscle on the affected side showed a 10 to 30% reduction⁸⁾.

In this study, the cross-sectional areas of the bilateral multifidus muscle were measured using an ultrasound diagnostic imaging system. The degree of low back pain (VAS) and the ratio of the cross-sectional areas of the lumbar multifidus of the unaffected and affected sides were investigated. The results of bivariate correlation and linear regression analyse show that a correlation existed between the ratio of lumbar multifidus cross-sectional areas and the VAS assessment of pain in patients with chronic low back pain.

This result indicates that when the ratio of the cross-sectional areas of the lumbar multifidus of the unaffected and affected sides increases, the symptom of chronic low back pain deteriorates. In clinical practice, ultrasound imaging could be used to objectively evaluate chronic low back pain by measuring the ratio of cross-sectional areas of the lumbar multifidus of the unaffected and affected sides.

Future studies are suggested to collect more data for both healthy subjects and subjects who suffer from chronic low back pain, to find the standard value above which the symptom of chronic low back pain appears.

REFERENCES

- 1) Danneels LA, Vanderstraeten GG, Cambier DC, et al.: CT imaging of trunk muscles in chronic low back pain patients and healthy control subjects. *Eur Spine J*, 2000, 9: 266–272. [[Medline](#)] [[CrossRef](#)]
- 2) Lewin T, Moffett B, Vidik A: The morphology of the lumbar synovial intervertebral joints. *Acta Morphol Neerl Scand*, 1962, 4: 299–319. [[Medline](#)]
- 3) McGill SM: A revised anatomical model of the abdominal musculature for torso flexion efforts. *J Biomech*, 1996, 29: 973–977. [[Medline](#)] [[CrossRef](#)]
- 4) Hides JA, Richardson CA, Jull GA: Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. *Spine*, 1996, 21: 2763–2769. [[Medline](#)] [[CrossRef](#)]
- 5) Richardson C: Spinal segmental stability. In: *Therapeutic Exercise for Spinal Segmental Stabilization in Low Back Pain*, Edinburgh: Churchill Livingstone, 1999, pp 16–26.
- 6) Huang Q, Li D, Yokotsuka N, et al.: The intervention effects of different treatment for chronic low back pain as assessed by the cross-sectional area of the multifidus muscle. *J Phys Ther Sci*, 2013, 25: 811–813. [[Medline](#)] [[CrossRef](#)]
- 7) McGill S: Low back disorders. In: *Evidence based prevention and rehabilitation*, New Zealand: Human Kinetics, 2002, pp 81.
- 8) Hides JA, Stokes MJ, Saide M, et al.: Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms of acute/subacute low back pain. *Spine*, 1994, 19: 165–172. [[Medline](#)] [[CrossRef](#)]