

The Intervention Effects of Different Treatment for Chronic Low Back Pain as Assessed by the Cross-sectional Area of the Multifidus Muscle

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Abstract. [Purpose] The purpose of this study was to examine the immediate effects of intervention of proprioceptive neuromuscular facilitation (PNF), neuromuscular joint facilitation (NJF) and NJF+pelvic floor muscle (PFM) exercise. [Subjects] Thirteen young people (5 males, 8 females) who had chronic low back pain on one side for more than 6 months. [Methods] Subjects were asked to lie on their sides with the painful side upmost. The subjects received PNF, and NJF, NJF+PFM exercise treatments. The changes in the cross-sectional area of the multifidus muscle were measured using ultrasonography. [Results] The cross-sectional area of the multifidus muscle of NJF+PFM group showed the largest increases on both the sides with and without pain. [Conclusion] Our results show that chronic low back pain can be improved by a combination of PFM exercise and the NJF pattern.

Key words: Neuromuscular joint facilitation, Low back pain, Multifidus muscle

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INTRODUCTION

Chronic low back pain (LBP) is considered to be a recurring illness. In order to walk upright and maintain posture, a heavy burden is placed on the lumbar region. Low back pain is caused by many factors, which can't be managed by a simple treatment.

Chronic low back pain is defined as back pain lasting more than 12 weeks, and it affects more than 50% of the general population. 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 young, economically active adults; indeed, low back pain is the second most common reason for absenteeism from work, and one of the most common reasons for medical consultation. One important risk factor of low back pain is weakness of the superficial trunk and abdominal muscles, and strengthening of these muscles is often associated with significant improvements in LBP, as well as with decreased functional disability. Another independent risk factor of LBP is weakness and lack of motor control of the deep trunk muscles, such as the lumbar multifidus and transversus abdominis muscles¹⁾.

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 region²⁾. 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.

The lumbar muscle activity of patients with low back pain is low compared to healthy subjects³⁾. The multifidus muscle of patients with low back pain was reported to be atrophied and replaced by adipose tissue¹⁾. Furthermore, selective training is necessary for recovery of the multifidus⁴⁾.

Conservative therapy is used in the treatment of more than 90% of patients with low back pain. "Postural exercise" has been widely used in clinical treatments for the prevention of lumbar lordosis. However, its efficacy is controversial. A posture with lumbar lordosis creates shear compression. If the angle of lumbar lordosis is reduced, the burden on the spine would increase⁵⁾. Improvement of the muscle contraction rate and coordinated neuromuscular movement is very important in the treatment of patients with low back pain.

There are many treatment approaches for low back pain, and treatment methods vary among therapists. In order to carry out lumbar stabilization exercises for the inner abdominal muscles, an understanding of lumbar stabilization is necessary. There are two systems involved in the lumbar stabilization mechanism. The first is passive stabilizers such as the centrum, intervertebral disk, intervertebral joint and vinculum. The other one is active stabilizers such as the

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abdominal flexor and extensor (multifidus) muscles.

Although there are many studies about automatical lumbar stabilization mechanisms and global muscles, research on local muscles (transversus abdominis and multifidus muscle) has been rare.

The multifidus muscle consists of a number of fleshy and tendinous fasciculi, which fill up the groove on either side of the spinous processes of the vertebrae, from the sacrum to the axis. The multifidus muscle is a very thin muscle. Deep in the spine, it spans three joint segments, and works to stabilize the joints at each segmental level. Because the muscle fiber is Type I, the function of the multifidus muscle is endurance rather than explosive force⁶. In the early seizures after low back pain, atrophy of the multifidus muscle is very apparent¹. The inner abdominal muscle and neuromuscular adjustments are extremely important for lumbosacral contraction stability.

In clinical research, the resistance movement of the pelvis, the pattern of proprioceptive neuromuscular facilitation (PNF), neuromuscular joint facilitation (NJF), and mobilization are used to treat low back pain, and stationary contraction is selected in clinical treatment. Although the symptoms improve temporarily, the effect of the treatment is not maintained.

Neuromuscular joint facilitation is a new therapeutic exercise based on kinesiology, and integrates the facilitation element of PNF and the joint composition movement, aiming to improve the movement of the joint through passive exercise, active exercise and resistance exercise⁷. It is used to increase strength, flexibility and range of motion.

The aim of this study was to examine the immediate effects of PNF, NJF and NJF+pelvic floor muscle exercise on low back pain.

SUBJECTS AND METHODS

The subjects were thirteen young people (5 males, 8 females) had chronic low back pain for more than 6 months on one side. Subjects' characteristics are detailed in Table 1. The purpose and the content of this research were explained to the subjects, and all subjects gave their informed consent to participation in the study.

Before the treatment, the subjects were evaluated for pain severity using a visual analogue scale (VAS). Three interventions were administered to subjects while they lay on their sides, with the painful side uppermost: the front lower pelvic pattern of PNF; the front lower pelvic pattern of NJF; and the front lower pelvic pattern of NJF+pelvic floor muscle exercise.

For the front lower pelvic pattern of PNF, the two hands of the examiner were placed against the upper knee. When subjects performed the front lower pelvic pattern, traction and resistance was added throughout the process. Static resistance and traction were given in opposition to the PNF pattern by the examiner.

For the front lower pelvic pattern of NJF, one hand of the examiner was placed against the knee, and traction and resistance were added to the PNF pattern. The other hand was placed on the spinous process of L3, to prevent upward

Table 1. Subject characteristics

	Mean±SD N=13
Age (y)	23.6 ± 5.1
Height (cm)	166.5 ± 7.3
Weight (kg)	64.9 ± 14.9
VAS	3.3 ± 1.7

curvature.

For the front lower pelvic pattern of NJF+pelvic floor muscle exercise (PFM exercise), the front lower pelvic pattern of NJF was used together with a pelvic floor muscle exercise. For the pelvic floor muscle exercise subjects were asked to perform maximal contraction of the transverse abdominal and pelvic floor muscles. Subjects were instructed to draw in the lower abdominal wall toward the spine, an action which specifically activates the transverse abdominal muscle. The subjects were required to breathe in a relaxed manner. No movement of the lumbar spine was allowed. Subjects were instructed to simultaneously contract the muscles around the anus "like a drawstring" and to lift them internally, an action which specifically activates the pelvic floor muscle. No posterior tilt of the pelvis was allowed. All the interventions were conducted by one physiotherapist.

The maximum contraction which was maintained for 5 seconds was performed in the middle part of each intervention pattern. At this time, the cross-sectional areas of the bilateral multifidus muscle were measured. 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 vertical to the vertebral column. All measurements were carried out by the same physical therapist.

In order to determine the main effect of the 3 intervention methods, one-way analysis of variance with the Bonferroni correction was used; the factor was the cross-sectional area of the multifidus muscle. The data were analyzed using SPSS Ver. 17.0 for Windows.

RESULTS

The results for the cross-sectional area of multifidus muscle of the 13 subjects are shown in Table 2.

The cross-sectional area of the multifidus muscle of the side with pain of the PNF, NJF, and NJF+PFM groups showed significant increases compared to at rest, and the increase of the NJF+PFM group was the greatest. On the side without pain, the cross-sectional areas of multifidus muscle of the NJF and NJF+PFM groups showed significant increases, but that of the PNF group decreased. The cross-sectional area of the multifidus muscle of the NJF+PFM group of both sides showed the largest increases.

The rates of increase on the sides with and without pain of cross-sectional area of the multifidus in the different in-

Table 2. The cross-sectional areas of the multifidus on the sides with and without pain

	cross-sectional area of the multifidus (cm ²)			
	Pain side		No pain side	
a.Rest	5.88±1.02	a<b.c.d**	7.0±1.36	a<c.d**
b.PNF	6.06±1.11	b<c.d**	6.80±1.49	b<a.c.d**
c.NJF	7.13±1.36	c<d**	7.17±1.29	c<d**
d.NJF	8.15±1.67		7.91±1.45	
PFM				

*p<0.05, **p<0.01

intervention methods are shown in Table 3. The rates of increase of the cross-sectional area of the multifidus muscle on both sides significantly increased after the NJF and NJF+PFM treatments. The increase rate of the NJF+PFM group was the greatest.

DISCUSSION

Although the lumbar stabilization exercise is emphasized in clinical practice, there is no objective assessment for the treatment. In this research, the cross-sectional area of the multifidus muscle was used to measure the effects of different intervention methods. The therapeutic effects of PNF, NJF, and NJF+PFM were different. Compared to PNF, the cross-sectional area of the multifidus muscle NJF was significantly increased. This is because, in the NJF pattern, proximal resistance is exerted, promoting the contraction of the multifidus muscle.

When NJF+PFM exercise was performed, the cross-sectional area of the multifidus muscle showed the greatest increase on both the sides with and without pain. The NJF promoted the isometric contraction of the multifidus, and at the same time the abdominal pressure was increased by simultaneous contraction of pelvic floor muscles in the

Table 3. The increase rate of the cross-sectional area of the multifidus in different intervention methods

	increase rate of cross-sectional area of the multifidus (%)			
	Pain side		No pain side	
a.PNF	1.03±0.01	a<b.c**	0.98±0.01	a<b.c**
b.NJF	1.20±0.02	b<c**	1.02±0.01	b<c**
c.NJF	1.35±0.02		1.13±0.02	
PFM				

*p<0.05, **p<0.01

PFM exercise. The combination of NJF and PFM exercise strongly promoted the multifidus muscle contraction and fixed the spinous process. The results suggest that imbalance of the multifidus muscle can be improved by a combination of PFM exercise and the NJF pattern.

Future studies are needed to investigate the different effects of different treatments after long-term intervention for patients with low back pain.

REFERENCES

- 1) Hides JA, Richardson CA, Jull GA, et al.: Multifidus muscle recovery is not automatic following resolution of acute first-episode low back pain. *Spine*, 1996, 21: 2763–2769. [Medline] [CrossRef]
- 2) Richardson C: Spinal segmental stability. In: *Therapeutic Exercise for Spinal Segmental Stabilization in Low Back Pain*, Edinburgh: Churchill Livingstone, 1999, pp 16–26.
- 3) Isida K: About lumbar stabilization function- comparison between the normal subjects and low back pain. *J Hokkaido Phys Therapist*, 2000, 19: 15–18.
- 4) Mayer TG, Vanharanta H, Gatchel RJ, et al.: Comparison of CT scan muscle measurements and isokinetic trunk strength in postoperative patients. *Spine*, 1989, 14: 33–36. [Medline] [CrossRef]
- 5) McKenzie RA: *The Lumbar Spine*. In: *Mechanical Diagnosis and Therapy*, Spinal Publications, New Zealand: Waikanae, 1981, pp 155–168.
- 6) Richardson C: Exercise therapy for spinal segmental stability. In: *Scientific and clinical basis of treatment of low back pain*. Edinburgh: Enterprise, 2002, pp 9–146.
- 7) Huo M: *Neuromuscular Joint Facilitation*. Tokyo: Ipec press, 2010, p 3.