

Effects of neuromuscular joint facilitation on bridging exercises with respect to deep muscle changes

BIN ZHOU¹⁻³*, QIU CHEN HUANG¹⁻³), TAO ZHENG¹⁻³), MING HUO⁴), HITOSHI MARUYAMA¹)

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 Research Center, China

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

⁴) Department of Physical Therapy, Himeji Dokkyo University, Japan

Abstract. [Purpose] This study examined the effects of neuromuscular joint facilitation on bridging exercises by assessing the cross-sectional area of the multifidus muscle and thickness of the musculus transversus abdominis. [Subjects] Twelve healthy men. [Methods] Four exercises were evaluated: (a) supine resting, (b) bridging resistance exercise involving posterior pelvic tilting, (c) bridging resistance exercise involving anterior pelvic tilting, and (d) bridging resistance exercise involving neuromuscular joint facilitation. The cross-sectional area of the multifidus muscle and thickness of the musculus transversus abdominis were measured during each exercise. [Results] The cross-sectional area of the multifidus muscle and thickness of the musculus transversus abdominis were significantly greater in the neuromuscular joint facilitation group than the others. [Conclusion] Neuromuscular joint facilitation intervention improves the function of deep muscles such as the multifidus muscle and musculus transversus abdominis. Therefore, it can be recommended for application in clinical treatments such as that for back pain.

Key words: Back pain, Cross-sectional area of multifidus muscle, Bridging exercises

(This article was submitted Nov. 21, 2014, and was accepted Jan. 17, 2015)

INTRODUCTION

Back pain is a recurring human disease that can incur various burdens including economic burdens¹). Some treatments can relieve back or leg pain, but pain can recur in daily life. Although the activities of the joints between vertebrae are very small, the overall function of the spine depends on these small activities²). The activity of a single joint muscle in a lumbar vertebra will be reduced along with a reduction of the performance of the multifidus muscle. Consequently, multiple joint muscles such as the erector spinae, rectus abdominis, and obliquus abdominis will compensate to support the stability of the back. This kind of compensation is one of the causes of back pain³).

Bridging exercises are a common training method for improving the performance of trunk muscles⁴). They are closed-chain exercises that involve a dynamic load and are helpful for improving body stability. However, in such exercises, the position of the pelvis and application of resistance are insufficient; in addition, the influence of bridging

exercises on deep muscles such as the multifidus muscle and musculus transversus abdominis have not been thoroughly researched⁵).

Neuromuscular joint facilitation (NJF) is a new therapy based on the theoretical knowledge of kinematics and can be combined with proprioceptive neuromuscular facilitation to improve joint function through passive, active, and resistance exercises⁶). As for bridging exercises, NJF has its own intervention paradigm that emphasizes improving the performance of the muscles around the hip joint; thus, subjects should perform the bridging resistance exercises at the proximal hip joint. However, the effects of this exercise on deep muscles have not been reported.

Therefore, this study examined the effects of bridging exercises as part of an NJF intervention at the proximal hip joint. Changes in deep muscles, including the cross-sectional area of the multifidus muscle and thickness of musculus transversus abdominis, were evaluated.

SUBJECTS AND METHODS

The subjects were 12 adult males (Table 1) who had severe low back pain but no orthopedic or neurological diseases. They were informed of the purpose and contents of the study and provided consent prior to participation. This study was approved by the Ethics Committee of the International University of Health and Welfare (13-10-125).

The supine position was adopted for assessment. The

*Corresponding author. Bin Zhou (E-mail: zhoubin1026@sohu.com)

subject's knee joint was flexed at 90° with their arms at their sides. The subjects were divided into groups and performed the following exercises: (a) supine rest; (b) bridging resistance exercise involving posterior pelvic tilting (resistance was applied to the bilateral anterior superior iliac spine), (c) bridging resistance exercise involving anterior pelvic tilting (resistance was applied to both anterior and superior iliac spines), and (d) bridging resistance exercise involving NJF intervention (resistance was applied to the bilateral hip joints and greater trochanters).

Ultrasonography was performed by using a SonoSite (American Sonosite), matching convex linear probe was HFL50, frequency was 7.5 MHz. The measurement position of the multifidus muscle was 2.5 cm at the right side of the fifth lumbar spine, and the probe vertical to the spine. When measuring the thicknesses of the musculus transversus abdominis and obliquus internus abdominis, the probe was laid parallel at the center of the costal margin and crista iliaca, with the center at the right anterior axillary line. A photograph was taken at the end of expiration.

The data obtained were analyzed using univariate ANOVA adjusted for multiple comparisons and excluding individual differences. At rest, the area of the multifidus muscle, thicknesses of the musculus transversus abdominis and obliquus internus abdominis, and body mass index were analyzed by the two-way ANOVA. All analyses were performed using SPSS version 19.0. The level of significance was set at $p < 0.05$.

RESULTS

The NJF group had the largest multifidus muscle area ($p < 0.01$). Meanwhile, the posterior pelvic tilting group had the thickest musculus transversus abdominis ($p < 0.01$); furthermore, that of the NJF group was larger than the supine resting and anterior pelvic tilting groups ($p < 0.01$) (Table 2).

Table 1. Subject characteristics

	Mean \pm SD (N = 12)
Age (years)	32.8 \pm 4.8
Height (cm)	175.0 \pm 5.1
Weight (kg)	67.1 \pm 11.1
BMI (kg/m ²)	22.0 \pm 3.8

Table 2. Effects bridging exercises on the cross-sectional area of the multifidus muscle thickness of the musculus transversus abdominis and obliquus internus abdominis

Exercise	Multifidus muscle		Musculus transversus abdominis thickness (cm)		Obliquus internus abdominis thickness (cm)
	cross-sectional area (cm ²)				
Supine rest	6.26 \pm 1.70	a < c, d**	0.23 \pm 0.08	a < b, d**	0.86 \pm 0.21
BREPPT	6.15 \pm 2.03	b < c, d**	0.52 \pm 0.17		1.11 \pm 0.22
BREAPT	7.03 \pm 2.72	c < d**	0.25 \pm 0.10	c < b, d**	0.91 \pm 0.22
BRENJF	8.48 \pm 2.60		0.41 \pm 0.17	d < b**	1.12 \pm 0.30

BREPPT: bridging resistance exercise involving posterior pelvic tilting; BREAPT: bridging resistance exercise involving anterior pelvic tilting; BRENJF: bridging resistance exercise involving neuromuscular joint facilitation

DISCUSSION

The results show that in the bridging exercises, the best effect of muscle contraction was achieved when resistance was applied to the bilateral hip joints and greater trochanters. When the position was at the anterior superior iliac spine, this resulted in a significant increase compared with the posterior pelvic tilting group and the cross-sectional area of the multifidus muscle of the anterior pelvic tilting group. The thickness of the musculus transversus abdominis was significantly greater in the NJF group than the supine rest and anterior pelvic tilting groups; however, that of the posterior pelvic tilting group was largest. The obliquus internus abdominis was remarkably thickened in the NJF and posterior pelvic tilting groups.

A recent study shows that the activities of lower-limb muscles can influence abdominal pressure, which can be applied in defecation treatment⁷. In the present study, at the proximal hip joint, NJF caused the surrounding muscles to contract more effectively, consequently increasing abdominal pressure. In bridging exercises, this may be helpful for maintaining body stability. Higher abdominal pressure causes the lumbar vertebrae to sustain greater pressure from the front (i.e., intraperitoneal); in order to resist such pressure, the multifidus muscle behind the spine (as the intervertebral joint muscle) should be stronger to maintain spine balance and stability⁸.

In order to verify the above inference, the effects of each exercise on the transverse abdominal muscles were evaluated. Compared to the thickness of the transverse abdominal muscle during anterior pelvic tilting, that in NJF was obviously greater; this indicates that the abdominal pressure was elevated. However, during bridging resistance exercise with posterior pelvic tilting, like patients with urinary incontinence, it is very important that the transverse abdominal muscle maintains a good contraction state, although during contraction, torn muscles are passively stretched because of the movement caused by the sacroiliac pelvic joint, making it harmful to complete contraction⁹. Therefore, compared to the NJF group, while the thickness of the transverse abdominal muscle obviously increased, the cross-sectional area of the multifidus muscle did not increase significantly.

In conclusion, NJF is beneficial for bridging exercise interventions by improving musculus transversus abdominis thickness and deep muscle function. Therefore, it should be recommended in the clinical treatment of diseases such as

lumbago.

The major limitation of this study is that the subjects were all healthy adult males. In the future, this method can be applied to elderly people, women, and in the clinical treatment of patients with low back pain. If the multifidus muscle, transversus abdominis, and rectus femoris are measured simultaneously, the effect of the intervention will be more accurate and comprehensive.

REFERENCES

- 1) 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](#)]
- 2) 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](#)]
- 3) Ishida K: About lumbar stabilization function—comparison between the normal subjects and low back pain. *J Hokkaido Phys Therapist*, 2000, 19: 15–18.
- 4) Stevens VK, Coorevits PL, Bouche KG, et al.: The influence of specific training on trunk muscle recruitment patterns in healthy subjects during stabilization exercises. *Man Ther*, 2007, 12: 271–279. [[Medline](#)] [[CrossRef](#)]
- 5) Jang EM, Kim MH, Oh JS: Effects of a bridging exercise with hip adduction on the EMG activities of the abdominal and hip extensor muscles in females. *J Phys Ther Sci*, 2013, 25: 1147–1149. [[Medline](#)] [[CrossRef](#)]
- 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) Huang Q, Li D, Zhang Y, et al.: The intervention effects of different treatments for chronic low back pain as assessed by the thickness of the musculus transversus abdominis. *J Phys Ther Sci*, 2014, 26: 1383–1385. [[Medline](#)] [[CrossRef](#)]
- 8) Huang Q, Zhang Y, Li D, et al.: 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. *J Phys Ther Sci*, 2014, 26: 1613–1614. [[Medline](#)] [[CrossRef](#)]
- 9) Huang Q, Li D, Zhang Y, et al.: The reliability of rehabilitative ultrasound imaging of the cross-sectional area of the lumbar multifidus muscles in the PNF pattern. *J Phys Ther Sci*, 2014, 26: 1539–1541. [[Medline](#)] [[CrossRef](#)]