J.Phys. Ther. Sci
23: 867-869, 2011

Effects of Bridging Exercise Methods on the Muscular Activity of the Neck, Trunk and Lower Limbs

YOUNGSANG RYU, MD, MSc[1)], SUNGBUM JU, PhD[2)], GIDUCK PARK, PhD[3)], HYUNJEONG JANG, MSc, PT[4)]

[1)] *Department of Tuina, Traditional Chinese Medicine University*
[2)] *Department of Health & Physical Education, Kochi University: 2–5–1, Akebono-cho, Kochi, 780-8520 Japan. TEL: +81 88-844-8391, FAX: +81 88-844-8391, E-mail: accent-ju@daum.net*
[3)] *Department of Health & Fitness Management, Namseoul University*
[4)] *Graduate School of Daejeon University*

Abstract. [Purpose] The purpose of this study was to investigate the effects of different bridging exercise methods, varied by the position of the lower limbs, on the muscular activity of the neck, trunk, thigh and lower limbs. [Subjects] The subjects of this study were 14 males in their twenties. [Methods] The muscular activities of the longissimus capitis and sternocleidomastoid in the neck, the erector spinae and rectus abdominis in the trunk, the rectus femoris and lateral hamstring in the thigh, and the tibialis anterior and lateral head of the gastrocnemius in the lower leg were measured using a surface electromyography. [Results] The comparison of the muscular activities showed significant differences in the longissimus capitis, rectus abdominis, erector spinae, rectus femoris, biceps femoris and gastrocnemius muscles among the bridging exercise methods. [Conclusion] Action and activity of muscle groups varies according to the position of the lower limbs during the bridging exercise.

Key words: Balance, Bridging exercise, Knee joint peak torque

(This article was submitted Jun. 16, 2011, and was accepted Jul. 5, 2011)

INTRODUCTION

Lumbar stabilization exercise trains patients to control force in unstable positions and consciously and unconsciously regulates motion so as to maintain the spine in a neutral position in which it is best adapted to external load. Recently, lumbar stabilization exercise has drawn attention as a therapeutic exercise as well as a method for preventive management[1)]. Bridging exercise, one type of lumbar stabilization exercise, is a closed-chain weight bearing exercise that increases the muscular strength of the hip joint extensor muscles and promotes trunk stabilization[2)]. The bridging exercise position, an advanced form of the knee-up recumbent position, allows the weight load to be controlled by the feet, improves knee stand, develops sit-to-stand control, exercises the hip, and strengthens the lower spine and hip joint extensors in preparation for the stance phase in gait[3)].

Studies of bridging exercises have focused on analysis of the trunk stabilization effect. Arokoski et al. (2004) reported that the activity of the rectus abdominis and external oblique muscles was not significantly changed by bridging exercise in chronic back pain patients[4)]. Stevens et al. (2006) reported that the internal oblique (a local muscle) was activated at a significantly higher ratio than the rectus abdominis (a global muscle) during bridging stabilization exercises performed by healthy subjects[5)]. Konrad et al. (2001) compared muscular activity of the trunk and lower limbs during trunk-training and bridging exercise and reported that the muscular activity in the erector spinae at the hip and chest during the bridging exercise was significantly lower (14%) than that of the gluteus maximus and other hip joint extensors during the trunk-training exercise[6)].

Although many previous studies have been conducted on the trunk stabilization effect of bridging exercise, information is still lacking on comparison of muscular activity between different bridging exercise methods. This includes various bridging exercise positions and the positioning of the lower limbs during the exercise. Therefore, the objective of this study was to investigate the effects of different bridging exercise methods, varied by the position of the lower limbs on the muscular activity of the neck, trunk, thigh and lower limbs.

SUBJECTS AND METHODS

The effect of different bridging exercise methods on the muscular activity of the neck, trunk, thigh and lower limb of 14 male students at G University in Korea was

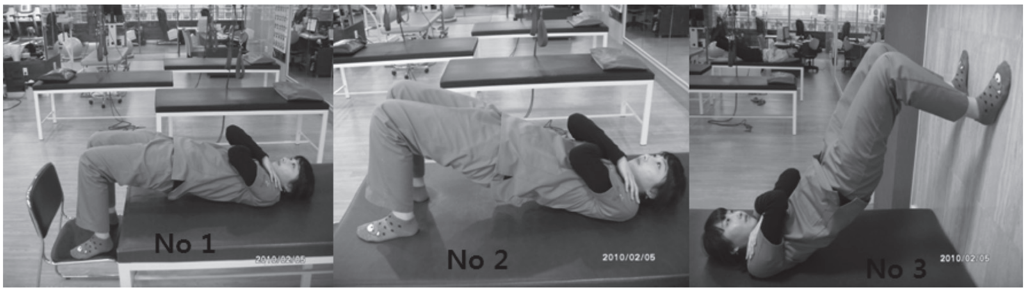

Fig. 1. Bridging exercise methods No. 1, 2 and 3

Table 1. Comparison of muscle activities among the bridging methods (Mean ± SD) (unit: Nm)

Region	Muscle	Method 1	Method 2	Method 3	Contrast
Cervical	Longissimus capitis*	10.51 ± 7.09	5.64 ± 6.07	10.53 ± 7.57	1,3>2
	Sternocleidomastoideus	10.56 ± 8.37	11.72 ± 9.47	15.94 ± 8.13	
Trunk	Rectus abdominis*	2.06 ± 0.94	1.71 ± 0.81	2.90 ± 1.63	3>2
	Erector spinae*	17.46 ± 10.57	15.81 ± 8.21	8.96 ± 9.56	1,2>3
Thigh	Rectus femoris*	4.78 ± 3.53	1.90 ± 0.55	2.06 ± 1.14	1>2, 3
	Biceps femoris*	14.45 ± 12.70	19.25 ± 9.24	10.80 ± 9.37	2>3
Leg	Tibialis anterior	8.27 ± 8.92	10.42 ± 10.51	5.28 ± 3.67	
	Gastrocnemius*	2.08 ± 2.15	7.25 ± 5.69	9.60 ± 9.30	2, 3>1

*p<0.05.

investigated. The subjects were informed about the procedure and risks of the experiment, and provided their written consent before participation. Subjects were selected if they had no neurological diseases, previous surgery or any back pain within the last six months. Subjects were rejected if they had an abnormality in the nervous system, cardiopulmonary system or musculoskeletal system in the back or lower limbs. The average age of the subjects who participated in the study was 23.6 ± 3.79 years, their average height was 170.5 ± 7.10 cm, and their average weight was 71.0 ± 17.49 kg. To be familiar with the methods before the implementation of the bridging exercise program, the subjects were given an explanation about the exercise methodology, and exercises were then implemented randomly using a random number table. One minute of rest was given after each of the exercises, as the exercises cause significant fatigue.

In bridging exercise method No. 1, the subject adopts the supine position on a bed, gathers both arms to the chest, drops the knee joints off the side of the bed and bends them to 90 degrees, while keeping the sole in contact with the ground. The subject then lifts the pelvis until hip joint flexion reaches 0 degrees and maintains this position. In bridging exercise method No. 2, the subject adopts the supine position on the ground, gathering both arms to the chest, and bends the knees to 90 degrees, while keeping the sole in contact with the ground. The subject then lifts the pelvis as in method No. 1 and maintains the position. In bridging exercise method No. 3, the subject adopts the supine position on the ground, gathering both arms to the chest and bending the hip joints and the knee joints to 90 degrees. The subject then lets the sole touch the wall, lifts the pelvis and maintains this position (Fig. 1).

To investigate the muscular activity of the flexors and extensors in the trunk and the lower limbs, we employed a wireless eight-channel surface electromyograph (TeleMyo TM 2400T G2, Noraxon, USA). Measurements were performed at the longissimus capitis and sternocleidomastoid in the neck, the erector spinae and rectus abdominis in the trunk, the rectus femoris and lateral hamstring in the thigh, and the tibialis anterior and lateral head of the gastrocnemius in the lower leg[3,7,8]. Measurement of muscular activity was performed three times per motion, five seconds each time. The measured data were converted to the effective values (Root Mean Square: RMS), and the values of the middle three seconds of measurement were used, excluding the values for the first and last one second. The muscular activity was compared and analyzed with the mean of the measured values obtained from the three repeated measurements. In the surface electromyography, the maximal voluntary isometric contraction (MVIC) was set as the baseline value to standardize the individual measurements and show the ratio of the measured value at the time of maximum abdominal muscular strength.

One-way repeated ANOVA was performed with the measured data using SPSS 12.0 (SPSS, Chicago, IL, USA) for Windows to compare the individual exercise methods, and the significance level, α, was chosen as 0.05.

RESULTS

The comparison showed that muscular activity of the longissimus capitis in the neck was significantly higher in exercise methods No. 1 and 3 than in No. 2 ($p<0.05$), but there was no significant difference in the muscular activity of the sternocleidomastoid. The muscular activity of the rectus abdominis muscle in the trunk was significantly higher in exercise method No. 3 than in method No. 2 ($p<0.05$), and that of the erector spinae muscle was significantly higher in exercise methods No. 1 and 2 than in No. 3 ($p<0.05$). The muscular activity of the rectus femoris muscle in the thigh was significantly higher in exercise method No. 1 than in methods No. 2 and 3 ($p<0.05$), and that of the biceps femoris muscle was significantly higher in exercise method No. 2 than in method No. 3 ($p<0.05$).

The activity of the tibialis anterior muscle in the lower leg did not show a significant difference among the methods, but that of the gastrocnemius muscle was significantly higher in exercise methods No. 2 and 3 than in method No.1 ($p<0.05$) (Table 1).

DISCUSSION

Many previous studies have been conducted on the effects of bridging exercise on muscular activity. However, this study was conducted to provide fundamental information about the effects of bridging exercise by investigating the effects of different bridging exercise methods, varied by the position of the lower limbs on muscular activity. The comparison of muscular activities showed that the muscular activity was significantly different in the longissimus capitis, rectus abdominis, erector spinae, rectus femoris, biceps femoris and gastrocnemius among the bridging exercise methods ($p<0.05$). Bridging exercise can provide retraining of the coordination of local stabilizer muscles and global motor muscles in an appropriate ratio[3)], and has been clinically used to increase the muscular strength of the gluteus maximus, other hip extensors and hamstrings[9)]. The application of closed-chain weight bearing exercise to the lower limbs is not just limited to the hip joint muscles but includes motions of all the joints and muscles within the closed chain. These motions are made by the action of an antagonistic two-joint muscle in which an optimal length-tension relationship is maintained: when a muscle becomes longer at one joint, it becomes shorter at the other joint[10)]. When the hip joint is lifted during the bridging exercise, the decreased area of the support base significantly increases the muscular activity of the semitendinosus, biceps femoris and the gastrocnemius in order to overcome the instability, while keeping the head, both arms and feet on the ground[11)]. However, the increase in muscular activity may be significantly different depending on the position of the lower limbs during bridging, and this was shown in our result. Additionally, the varied bridging exercise methods in this study brought about changes in the hip joint and knee joint motions as a closed-kinematic chain, causing significant change in the muscular activity of the neck muscles, rectus abdominis and erector spinae.

From the theoretical mechanisms proposed in previous bridging exercise studies and the results of this study, it can be concluded that muscular activity can be changed by variation of the position of the lower limbs when performing bridging exercise.

REFERENCES

1) Magee DJ: Orthopedic physical assessment. Philadelphia: Saunders, 1997.
2) Richardson CA, Jull GA: Muscle control-pain control. What exercises would you prescribe? Man Ther, 1995, 1: 2–10.
3) O'Sullivan SB, Schmitz TJ: Physical Rehabilitation: Assessment and Treatment. Philadelphia: F.A. Davis, 2001.
4) Arokoski JP, Valta T, Kankaanpaa M: Activation of lumbar paraspinal and abdominal muscle during therapeutic exercises in chronic low back pain patients. Arch Phys Med Rehabil, 2004, 85: 823–832.
5) 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.
6) Konrad P, Schmitz K, Danner A: Neuromuscular evaluation of trunk training exercises. J Athl Train, 2001, 36: 109–118.
7) Vezina MJ, Hubley-Kozey CL: Muscle activation in therapeutic exercises to improve trunk stability. Arch Phys Med Rehabil, 2000, 81: 1370–1379.
8) Cram JR, Kasman GS, Holtz J: Introduction to surface electromyography. Maryland: Aspen Publishers, 1988.
9) Hodges PW, Gandevia SC: Activation of the human diaphragm during a repetitive postural task. J Physiol, 2000, 522: 165–175.
10) Haynes W: Core stability and the unstable platform device. J Bodyw Mov Ther, 2004, 8: 88–103.
11) Kisner C, Colby LA: Therapeutic Excercise: Foundations and Techniques. Philadelphia: F.A. Davis, 2002.