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Effects of Three Bridging Exercises on Local and Global Muscles of Middle Aged Women

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Abstract. [Purpose] This study investigated the muscle activity differences of three different lumbar stabilization exercises in a comparison of middle-aged and young women. [Subjects] Seventeen middle-aged women and fifteen young women were enrolled in this study. Patients with a history of any neurologic disorders, orthopedic disorders, or cardiopulmonary problems that would have affected their lumbar stabilization exercise performance were excluded. [Methods] All subjects performed 3 exercises while the surface electromographic activity was recorded of the rectus abdominis, internal oblique, multifidus, and iliocostalis lumbolum. The mean electromyographic amplitudes obtained during the exercise were normalized to the amplitude of maximal voluntary isometric contraction (%MVIC) to produce an inter-individually comparable muscle activity index. [Results] The highest muscle activity of middle-aged women was observed in the ring bridging exercise. The middle-aged women had higher levels of all muscle activaties than the young women, particularly in the multifidus muscle and iliocostalis lumborum. No significant difference in muscle activity ratio was observed between the local muscles and global muscles in the three different exercises, though the muscle activity ratio was the highest in the ring bridging exercise. The young women group showed a higher ratio of the internal oblique/rectus abdominus than the middle aged women in the bridging exercise. [Conclusion] The ring bridging exercise should be used for stabilizing the lumbar area because the young women showed a higher ratio than the middle aged women.
Key words: Bridging exercise, Middle-aged women, Muscle activity

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INTRODUCTION

Sedentary lifestyles are considered a cause of weakening muscles and bones, and increasing body fat in middle-aged people. People show body weight-related decreases in small muscle mass, and weakening of muscle strength in the lumbar region, which ultimately cause musculoskeletal disorders, such as lower back pain, muscle spasm, muscle strain, and osteoarthritis. Therefore, middle age is the time to focus on interest and exercise to maintain healthy lifestyles. Accordingly, a range of approaches are needed to prevent disease and improve health status[1)].

Physical exercises have been reported to be an effective and economic method of reducing the chronic pain and disability of chronic lower back pain patients in middle age[2)]. Recently, spinal stability exercises have been used as a back pain treatment with the main purpose of preventing degenerational changes in the spinal articulation structure, and repetitive fine damage and pain. Therefore, lumbar stabilization is a critical factor back pain relief[3, 4)]. Previous studies have reported the effects of bridging exercises, with the feet or calves placed on a gymnastic ball, on the muscle activity ratio of the internal oblique and rectus abdominis in young adults[5)]. One study suggested that lower back pain improved during bridging exercise for lumbar stability alternating with knee stretching exercises of both limbs[6)]. Most studies of lumbar stabilization exercise have focused on healthy young adults, not middle-aged women[1, 6)].

This study investigated the muscle activity differences of three different lumbar stabilization exercises in a comparison of middle-aged and young women.

SUBJECTS AND METHODS

This study had a cross-sectional design, and 17 middle aged women over 40 years old and 15 young women in their twenties were enrolled in this study. Subjects were included if 6 months or longer had passed since they had suffered from lower back pain or received orthopedic surgery. The subjects provided their informed consent to participate in this study. Patients were excluded from the study if they had a history of neurologic disorders, orthopedic disorders, or cardiopulmonary problems that would have affected their lumbar stabilization exercise performance. Approval for the study protocol was received from the Sahmyook University institutional Review Board. Table 1 lists the general characteristics of the subjects.

The lumbar stabilization exercise program was composed of three different bridging exercises, including gen-

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Table 1. General characteristics of subjects

Characteristics	Young women (n=15)	Middle aged women (n=17)
Age (yrs)	25.6±2.9	51.3±3.6
Height (cm)	159.4±3.7	159.4±5.3
Weight (kg)	55.6±5.5	59.1±6.1
BMI	19.6±4.3	22.2±4.5

[a]mean±SD

eral bridging, ring bridging, and foam roller bridging exercises. The general bridging exercise is one of the basic and was conducted supine with the knee joints flexed at approximately 60° by lifting and maintaining the pelvis in a straight line with the knees and the ring bridging exercises involved lifting the pelvis while a ring (35 cm diameter) was held between the knees. Foam roller bridging exercises involved lifting the pelvis while lying straight on a cylinder-shaped foam roller, 15 cm in diameter and 90 cm in length, in the basic position.

Surface EMG data were collected using a Biopac MP150 system (Biopac system Inc., CA, USA) and analyzed using Acknowledge 3.81 software. Eight surface EMG electrodes were attached to the left and right parts of the local muscles (internal oblique and multifidus), and global muscles (rectus abdominis and iliocostalis lumborum). The sampling rate was 1000 Hz, and a bandpass filter of 20 to 300 Hz was used. The raw data was processed into root mean square (RMS) data with a window of 50 milliseconds. The maximum voluntary isometric contraction (MVIC) was measured in the manual muscle testing position and used to normalize the data of each muscle[11]. During the three bridging exercises, a verbal command of "sustain" was used to encourage subjects to sustain five seconds of consistent isometric exercise, while lifting the hips, and the muscle activities were measured using the EMG device. All EMG were recorded for five seconds and the amplitudes of the three seconds excluding the initial and last one seconds were used. The measurements were taken three times and the mean amplitude was used to analyze and interpret the data.

All statistical analyses were performed using SPSS version 13.0 software. One-way ANOVA was carried out to examine the statistical significance of the differences in the groups' general characteristics, such as age, height, weight and BMI. The independent t-test was used to analyze the differences in muscle activities between young females and middle-aged females during the general, ring, and foam roller bridging exercises. One-way ANOVA with repeated measures was used to compare the EMG activities of the three different bridging exercises, and post hoc tests were performed to identify the main mean differences using the Bonferroni's correction. The level of statistical significance was chosen as α=0.05.

RESULTS

The muscle activities of the four local and global muscles showed higher activaties in the middle-aged women than in the young women. The multifidus and iliocostalis lumborum showed significant differences among the three different bridging exercises, though the rectus abdominis and internal oblique did not. The activities of the four muscles differed significantly among the three different bridging exercises in the middle-aged women and young women (Table 2).

The muscle activity ratios of the internal oblique and rectus abdominis were similar among the three different bridging exercises. The muscle activity ratios of the multifidus and iliocostalis lumborum were also similar among the three different bridging exercises (Table 3).

DISCUSSION

This study compared the spinal muscles' EMG activity and muscle activity ratios across three different bridging exercises performed by middle-aged and young women. Contractions of the coxa adductor, pelvis fundus muscle and internal oblique cause severe pressure in the deep part of the abdomen and contribute to spinal stability by strongly supporting the multifidus muscle[7–9]. The increasing muscle activities of the internal oblique and multifidus control the lumbar vertebrae areas and enhance the stability of the trunk and pelvis[10, 11]. Therefore, pressure in the deep abdomen develops and enhances the contraction of the internal oblique and multifidus and can be used to evaluate the increase in lumbar stability.

All muscle activities were higher in the group of middle-aged women group and significantly higher in the multifidus and iliocostalis lumborum. Middle-aged women might have higher muscle activities in the trunk muscles than young-women, despite the immobility of young women, as office workers, and the mobility of middle-aged women in child caring and household chores.

Although there were no significant differences among the muscle activity ratios of the middle-aged women, the ratios were highest in the ring bridging exercise. The ratio of the internal oblique/rectus abdominis in young women was also higher in the ring bridging exercise, similar to the middle-aged women. Nevertheless, there were no significant differences in the muscle activity ratios between the middle-aged women and the young women in any of the bridging exercise. Regarding the multifidus/iliocostalis lumborum ratio, the values were higher in ring and foam roller bridging. The objective of using the muscle activity ratio of the internal oblique/rectus abdominis in recent studies has been to improve the understanding of coordinated contraction of both local and global muscles during stability exercise. Stevens VK et al. reported that the muscle activity ratio of local and global muscles increases due to local muscle activity increase compared to global ones[5], whereas Van Dieen et al. reported that an increase in the internal oblique rectus abdominis ratio indicates improvement of spinal stability[6]. In addition, Steven VK et al. showed that spinal stability improves in line with increases in the internal oblique/rectus abdominis ratio, and attributed it to reduced activity of the rectus abdominis[5]. Steven VK et al. reports that all muscles of the back operate to ensure stability of the spine during different exercises, because all muscles of the

Table 2. Muscle activities in the three different bridging exercises

Characteristics	Young women (n=15)				Middle aged women (n=17)			
	RA	IO	MF	IL	RA	IO	MF	IL
General bridging	12.8±3.4	15.3±5.8	22.9±9.9	27.7±7.4	13.5±6.3	18.0±7.7	34.4±6.3*	30.3±6.9*
Ring bridging	15.8±4.3	25.1±6.2	30.3±10.6	26.1±9.8	20.0±10.0	27.1±6.4	43.1±5.8*	36.0±7.8*
Foam roller bridging	14.0±4.20	19.7±5.0	22.1±7.1	20.3±7.5	15.8±7.2	23.4±9.4	35.1±4.6*	32.8±6.1*

Mean ± SD; *, Significantly different from the young women ($p<0.05$)

Post hoc test results of the comparison of the bridging postures

Characteristics		RA (p)	IO (p)	MF (p)	IL (p)
Young	BI:II	−3.06*	−9.83*	−7.42*	−4.42
	BII:III	1.87*	5.44*	8.14*	5.88*
	BI:III	−1.19	−4.39*	0.72	1.46
Middle aged	BI:II	−6.81*	−9.09*	−8.52*	−5.92*
	BII:III	4.37*	3.74*	8.042*	3.42*
	BI:III	−2.45	−5.35*	−0.48	−2.50*

Adjustment for multiple comparisons: Bonferroni. Mean ± SD; *, $p<0.05$ compared among the bridging postures.
RA, rectus abdominus; IO, internus obliquus; MF, multifidus; IL, iliocostas lumborum
BI, general bridging; BII, ring bridging; BIII, foam roller bridging

Table 3. Muscle activity ratios of the local and global muscle in three different bridging exercises

Characteristics	Young women (n=15)		Middle aged women (n=17)	
	IO/RA	MF/IL	IO/RA	MF/IL
General bridging	1.40±1.04	1.03±1.07	1.48±0.57	1.23±0.46
Ring bridging	1.80±1.08	1.42±0.95	1.69±1.06	1.26±0.39
Foam roller bridging	1.68±1.09	1.40±1.08	1.68±0.84	1.10±0.32

Mean ± SD; *, Significantly different from the young women ($p<0.05$)

Post hoc test results of the comparison of the bridging postures

Characteristics		IO/RA (p)	MF/IL (p)
Young	BI:II	−0.42*	−0.09
	BII:III	0.15	0.00
	BI:III	−0.27*	−0.09
Middle aged	BI:II	−0.25	−0.03
	BII:III	0.00	0.15
	BI:III	−0.25	0.12

Adjustment for multiple comparisons: Bonferroni. Mean ± SD; *, $p<0.05$ between the bridging postures
Abbreviations are the same as those used in Table 2.

back operate in a similar manner to control location, and spinal movement in general[5]. Therefore, in a comparison of the local and global muscles of the abdomen and back, there might be a significant difference in the abdomen muscle activity ratio depending on the lumbar stability exercise. On the other hand, there would be few differences in the back muscle activity ratio according to the exercise. In this study, there were no significant differences among the three different bridging exercises, and we consider the high activity ratio of the local and global muscles in ring bridging makes it suitable as lumbar stabilization exercise. Although middle-aged women group had higher muscle activities in each muscle, the ratio of the internal oblique/rectus abdominis of young women was higher in ring bridging, and similar in foam roller bridging. Also, the ratios of the multifidus/iliocostas lumborum of young women were higher in both ring and foam roller bridging. This suggests that ring bridging is a more effective exercise for young women's lumbar stability than for middle-aged women, despite their lower activity levels of the internal oblique and rectus abdominis muscles. Therefore, it is important to consider the benefit of exercise on the lumbar stability with adequate coordinated contraction in terms of the muscle activity ratio of the local and global muscles rather than the muscle activity. In

other words lumbar stability is not necessarily associated with higher muscle activity. Moreover, the ratio of the local and global muscles should be considered when selecting a lumbar stability exercise rather than the individual muscle activity levels.

The results of this study show the highest muscle activities of middle-aged women were shown in ring bridging, meaning that ring bridging is suitable for muscle strengthening of the lumbar stability muscles. Considering that ring bridging had the highest muscle activities despite not being significantly high in terms of the local and global muscle activity level, ring bridging would be more appropriate than general or foam roller bridging, because previous studies have suggested that a high muscle activity ratio of the internal oblique/rectus abdominis, due to minimal activity of the rectus abdominis, makes a greater contribution to lumbar stability. Regarding the muscle comparison of the middle-aged the women and the young women, the muscle activity levels of the multifidus and iliocostalis lumborum were higher in the middle-aged women than in the young women in all bridging exercise. On the other hand, their internal oblique/rectus abdominis ratios were not significantly different. Moreover, the muscle activities of the internal oblique and rectus abdominis were higher in the middle-aged women, whereas their ratio was higher among the young women in ring bridging. This suggests that middle-aged women should consider their exercise selection carefully to ensure that the exercise benefits lumbar stability with adequate coordinated contraction in terms of the muscle activity ratio of the local and global muscles rather than the muscle activity, since an increase in muscular strength does not necessarily mean an increase in lumbar stability. In addition, exercise selection by comparing the muscle activities of two different age groups would have more beneficial effects in the development of a lumbar stability exercise program for middle-aged women.

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