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Comparison of Abdominal Muscle Activities with Vaginal Pressure Changes in Healthy Women

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Abstract. [Purpose] The purpose of this study was to verify the effect of a Pelvic Floor Muscle exercise program by comparing muscle activities at different ages, using biofeedback to regulate vaginal pressure. [Subjects] Two groups of female participants without medical history of pelvic floor muscle dysfunction were evaluated. The mean age of Group I was 33.5 years and that of Group II 49.69 years. [Methods] Participants were instructed to perform the pelvic floor muscle exercise. Biofeedback was given for vaginal pressure of the pelvic floor muscles, and we measured the activities of the rectus abdominis, external oblique, and internal oblique muscles by electromyogram at 5 different levels of vaginal pressure. [Results] In Group II, as the vaginal pressure increased, the internal oblique values showed significant differences. When the vaginal pressure was 20 cmH_2O, 30 cmH_2O, and Maximum, the muscle activities of Group II increased significantly more than in Group I. [Conclusion] When the pelvic floor muscles were contracted, Group I showed greater differences in the internal oblique muscle activity than Group II.
Key words: Pelvic floor muscle contraction, Vaginal pressure

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INTRODUCTION

The pelvic floor muscles have two functions, control of the bladder and stabilization of the lumbo-pelvic region through the formation of the pelvic floor and abdominal cavity[1)]. Dysfunction of the pelvic floor muscles is usually associated with dysuria and lumbo-pelvic pain[2)].

A recent study found that the pelvic floor muscles are essential for the strength and stabilization of trunk centering muscles[3)]. Liebenson C (2007)[4)] reported that the diaphragm, transverses abdominis, pelvic floor and deep spinal intrinsic muscles behave in harmony, and the dysfunction of any one of them affects the others. This inevitably affects spinal stability and causes pain.

Many recent studies have tried to maximize the effects of pelvic floor muscle exercise. Miller (2002)[5)] investigated changes in abdominal muscle pressure and motions of the pelvic floor muscles according to breathing. Sapsford et al. (2001)[6)] found that during maximum contraction of the pelvic floor muscles, all the abdominal muscles including the transverses abdominis, internal oblique, external oblique, and rectus abdominis were activated. When the pelvic floor muscles were lightly contracted, the transverse abdominis is activated most regardless of lumbar position. Neumann and Gill (2002)[7)] claimed that co-contraction of the pelvic floor muscles and abdominal muscles showed good effects. Furthermore, Hung et al. (2010)[8)] suggested the retraining of the combined functions of diaphragm, deep and pelvic floor muscle as an alternative solution for urinary incontinence. Bo et al. (2010)[9)] also recommended the synergic effect of co-contraction of the pelvic floor muscle and transverses abdominis for the treatment of urinary incontimence.

In this study, we measured the surface electromyograms of the abdominal muscles, as surface electromyography is affordable, practical, and widely used for muscle activity measurement[10)].

The study was conducted to investigate the pelvic floor muscle activity during pelvic floor muscle contraction modulated by vaginal pressure feedback to provide data for the design of ideal pelvic floor muscle exercise.

SUBJECTS AND METHODS

The subjects of this study were classified by age. There were 11 subjects in their 20s and 30s (Group I) and 13 subjects in their 40s and 50s (Group II). The average ages of Group I and Group II were 33.55 ± 0.73 and 49.69 ± 1.60, respectively, with a significant difference between the two groups. However, there were no significant differences between the two groups in vaginal pressure, height, weight, and BMI.

The vaginal pressure was measured with a perineum vaginal pressure meter (perineometer, Peritron 9300, Cardio Design Pty Ltd Australia).

Subjects adopted the supine position, with the hips flexed at approximately 60°. They were instructed to strongly tighten their vagina, as if pulling it into their body, while avoiding lumbar and pelvic motions. They receive visual feedback about their contraction force through the perinometer connected to a pressure biofeedback device. Pelvic floor muscle contraction was performed at 5 pressures: resting (0 cmH_20), 10 cmH_20, 20 cmH_20, 30 cmH_20, and maximum contraction. Subjects maintained the target pressure for 5 seconds and took a rest for 10 seconds before the next measurement to rest the muscles after contraction. Three measurements were made for each subject and the average values were calculated.

For surface electromyography, Biopac Student Lab's MP36 (Biopac System Inc. USA) was used. Foreign substances were removed from the electrode placement points using alcohol swabs before electrode placement. Then, triode surface electrodes (Triode^{TM} electrode, Thought Technology Ltd., Canada), consisting of three poles, (positive-ground-negative) were attached.

The EMG electrodes were positioned at 3 cm outward and 5 cm downward from the xiphoid process for the rectus abdominus, at 2 cm below the 8th rib on the virtual line between the pubic tubercle and the 8th rib for the external oblique muscle, and 2 cm inward from the anterior superior iliac spine for the inferior phrenic part of the internal oblique muscle. The muscle activities were measured three times at the maximum isometric contraction of each muscle. To normalize the signal amplitudes of the data for 5 seconds, the maximal voluntary isometric contraction (%MVIC) was used.

For statistical analysis and data analysis, SPSS 12.0 for Window was used. For comparison between groups, the independent test was conducted and the significance level was chosen as 0.05.

RESULTS

As shown in Table 1, the muscle activities of rectus abdominis, external oblique, and internal oblique in Group I did not show any significant differences. The rectus abdominis and internal oblique muscle activities were higher in Group II than in Group I, but the difference was not statistically significant. In Group II, the muscle activities of the rectus abdominis and external oblique did not show any significant differences. However, in Group II, as the vaginal pressure increased, the internal oblique activity increased significantly ($p<0.05$).

At vaginal pressures of 20 cmH_2O, 30 cmH_2O, and the maximum, the internal oblique muscle activities of Group II increased significantly more than those of Group I ($p<0.05$).

Table 1. Abdominal muscle activities of each group (unit : %MVIC)

		Group I	Group II
RA	Resting	16.6 ± 2.3	26.8 ± 5.5
	10cmH_2O	19.3 ± 4.2	35.0 ± 7.1
	20cmH_2O	19.3 ± 4.3	37.3 ± 7.7
	30cmH_2O	21.3 ± 5.2	32.2 ± 5.2
	Maximum	20.8 ± 19.6	34.9 ± 5.0
EO	Resting	32.4 ± 7.0	38.5 ± 6.3
	10cmH_2O	31.6 ± 7.8	37.8 ± 6.1
	20cmH_2O	30.8 ± 7.1	38.0 ± 5.8
	30cmH_2O	34.3 ± 5.9	44.9 ± 6.1
	Maximum	34.5 ± 8.1	44.4 ± 6.0
IO	Resting	17.5 ± 5.1	31.1 ± 5.0
	10cmH_2O	24.2 ± 6.0	35.1 ± 5.7
	20cmH_2O	23.7 ± 5.8	41.7 ± 5.6*
	30cmH_2O	27.5 ± 6.3	47.6 ± 6.0*
	Maximum	29.8 ± 6.6	54.5 ± 6.6*

*: statistically signicant, $p<0.05$ (independent t-test).

DISCUSSION

Group I did not show any significant differences in the activities of abdominal muscles. The pelvic floor muscles mainly contracted which increased vaginal pressure, but abdominal muscle activities did not change. This shows that the subjects in their 20s and 30s increased their vaginal pressure using only their pelvic floor muscles. On the other hand, while Group II subjects did not show differences in muscle activities of the rectus abdominis and external oblique, they showed differences in the internal oblique. This indicates that subjects in their 40s and 50s, not only contract the pelvic floor muscle but also the internal oblique abdominal muscle.

A morphometric study of the rhabdo-urethral muscle reported that the volume of the levator ani muscle decreases with age[11]. A histological study found that as age increases, the transverse muscles decrease along the back of the urethra and the bladder neck[12]. The findings of previous studies, that pelvic floor muscle activity increases more when pelvic floor muscles are contracted using the abdomen, suggest that older women increase their vaginal pressure by contracting their abdominal muscles together with their pelvic floor muscles rather than using only their pelvic floor muscles.

Among the pelvic floor muscles, the levator ani muscle consists of slow-twitch fibers (type I) that support the pelvic organs and fast-twitch fibers (type II) that support the pelvic organ and prolapsed occurs when abdominal pressure increases. If the levator ani muscle is contracted by using only 19–34% of the slow-twitch fibers (type I) that comprise 70% of the levator ani muscle[13], we would be able to accurately confirm the mobilization of pelvic floor muscles without overcompensating changes. In this way, we could devise an exercise program that allows the selective isometric contraction of the abdominal and pelvic floor muscles with appropriate strength.

The atrophy of the urethra smooth muscle and relaxation of the pelvic floor muscle may also cause urinary incontinence with aging[14]. Women in their 40s and 50s who use more abdominal muscles during pelvic floor muscle contraction would be able to reduce urethra resistance and change the sphincter function better than women in their 20s and 30s. Normal adult women in their 40s and 50s need to first strengthen their pelvic floor muscles during pelvic floor muscle contraction and selectively use their abdominal muscles.

As this study was conducted with healthy women with no pelvic floor muscle dysfunction as subjects, the findings of this study cannt be generally applied to patients with pelvic floor muscle dysfunction. Therefore, future studies need to investigate the effects of pelvic floor muscle exercise through change of vaginal pressure with age in patients with pelvic floor muscle dysfunction.

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