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Original Article

Effects of Co-contraction of Both Transverse Abdominal Muscle and Pelvic Floor Muscle Exercises for Stress Urinary Incontinence: A Randomized Controlled Trial

Kimiko Tajiri, RNs, PhD[1)*], Ming Huo, PT, PhD[2)], Hitoshi Maruyama, PT, PhD[3)]

[1)] *Department of Nursing, School of Health Sciences, Bukkyo University: 96 Kitahananobo-cho, Murasakino, Kita-ku, Kyoto 603-8301, Japan*
[2)] *Department of Physical Therapy, Faculty of Medical Health, Himeji Dokkyo University, Japan*
[3)] *International University of Health and Welfare, Japan*

Abstract. [Purpose] The purpose of this study was to devise a new urinary incontinence exercise using co-contraction of both the transverse abdominal muscle (TA) and pelvic floor muscle (PFM) and examine the intervention effect in middle-aged women with stress urinary incontinence (SUI). [Subjects] The subjects were fifteen women with SUI who were divided into two groups: the TA and PFM co-contraction exercise group (n=9) and the control group (n=6). [Methods] Participants in the exercise group performed TA and PFM co-contraction exercise. The thickness of the TA was measured before and after 8 weeks of exercise using ultrasound. The thickness of the TA was measured under 4 conditions: (1) at rest, (2) maximal contraction of the TA, (3) maximal contraction of the PFM, and (4) maximal co-contraction of both the TA and PFM. [Results] There were no significant differences among the results of the control group. In the exercise group, the cure rate of SUI was 88.9% after the intervention. There were significant differences in the thickness of the TA during maximal co-contraction of both the TA and PFM after the intervention. [Conclusion] The TA and PFM co-contraction exercise intervention increases the thickness of the TA and may be recommended to improve SUI in middle-aged women.
Key words: Stress urinary incontinence, Transverse abdominal muscle, Exercise

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INTRODUCTION

Urinary incontinence (UI) is well-known to profoundly affect the QOL (quality of life) of women. Many cases of UI are stress urinary incontinence (SUI), and the success of pelvic floor muscle (PFM) exercise in the management of SUI has been confirmed by multiple randomized controlled studies. PFM exercise has been reported to be from 50% to 69% effective at reducing urine loss episodes in women[1–4)]. Many UI cases are the result of PFM weakness, suggesting that risk of UI can be evaluated by PFM. Recently, several studies reported that the PFM, as the inner unit along with the transverse abdominal muscle (TA), multifidus muscle, and diaphragm, acts to maintain the stability of the trunk, and the PFM has begun to be used in approaches for not only UI but also lumbar pain[5–7)]. In our previous study, we found a significant relationship between the thickness of the TA and the iEMG of the levator ani muscle[8)]. This result suggests that changes in the thickness of the TA may be used to indicate changes in the electrical activity of the PFM.

The purpose of this study was to devise a new urinary incontinence exercise using co-contraction of both the transverse abdominal muscle and pelvic floor muscle and examine the intervention effect in middle-aged women with stress urinary incontinence.

SUBJECTS AND METHODS

The subjects were fifteen women who had experienced one or more SUI events in the past 1 month. The subjects were divided into two groups randomly: the TA and PFM co-contraction exercise group (n=9) and the control group (n=6) (Table 1). All subjects gave their informed consent to participation in this study. All experimental procedures in this study were reviewed and approved by the Ethical Review Committee of Jilin Dianli Hospital.

All subjects completed a questionnaire about SUI. We evaluated the thickness of the TA using ultrasound. The thickness of the TA was measured in all subjects under four conditions at random in the supine position. 1) The first condition was the resting state. 2) The second condition was maximal contraction of the TA. For this, the subjects were instructed to draw in the lower abdominal wall toward the

*Corresponding author. Kimiko Tajiri (E-mail: huoming8@gmail.com)

Table 1. Subject characteristics

	Age (y)	Height (cm)	Weight (kg)
Exercise group (n= 9)	52.1 ± 9.5	156.1 ± 6.2	51.9 ± 5.3
Control group (n= 6)	52.0 ± 7.6	161.0 ± 7.4	55.7 ± 13.9

Values are means ± SD. There were no significant differences between groups at the 0.05 level.

Table 2. Comparison of the TA[a] thickness between before and after intervention (mm)

		Before	After 4 weeks	After 8 weeks
Exercise group (n= 9)	Resting state	2.5 ± 1.3	2.5 ± 1.0	2.7 ± 1.2
	Maximal contraction of TA	3.9 ± 1.7	3.7 ± 1.3	4.7 ± 1.8
	Maximal contraction of PFM [b]	3.5 ± 1.7	3.6 ± 1.3	4.5 ± 1.4
	Maximal co-contraction [c]	3.9 ± 1.0	4.1 ± 1.3	5.4 ± 1.4*
Control group (n= 6)	Resting state	2.2 ± 0.7	2.3 ± 0.4	2.4 ± 0.7
	Maximal contraction of TA	3.6 ± 1.1	3.6 ± 1.0	4.2 ± 0.7
	Maximal contraction of PFM [b]	3.4 ± 1.5	3.7 ± 0.8	3.6 ± 0.8
	Maximal co-contraction [c]	4.1 ± 1.3	4.1 ± 0.8	3.8 ± 0.7

Values are means ± SD. *$p<0.05$ (before and after 8 weeks).
[a] TA: transverse abdominal muscle, [b] PFM: pelvic floor muscle, [c] Maximal co-contraction: maximal co-contraction of both the TA and PFM

spine, an action that specifically activates the TA. The subjects were asked to breathe in a relaxed manner. No movement of the lumbar spine was allowed. 3) The third condition was maximal contraction of the PFM. For this the subjects were instructed to contract the muscles around the vagina "like a drawstring" and to lift them internally. No posterior tilt of the pelvis was allowed. There was no instruction to either use or not use the abdominal muscles. 4) The fourth condition was maximal co-contraction of both the TA and PFM. Subjects were instructed to draw in the lower abdominal wall toward the spine, an action that specifically activates the TA. When the TA sustained isometric contraction, the subjects were instructed to contract the muscles around the vagina "like a drawstring" to lift them internally and to keep this position for 3 seconds.

Under each condition, the subjects were in the supine position with the knees flexed at 90° and a pillow under the head. A Biofeedback Stabilizer was used to provide visual feedback. The three-chamber pressure cells were placed under the lumbar spine, and the subjects were asked to keep the baseline at 40 mmHg. If the pressure of the Biofeedback Stabilizer decreased under conditions 2, 3, or 4, abdominal muscle re-education was provided by a physical therapist.

Ultrasound images of the anterolateral abdominal wall were obtained using a SonoSite ultrasound (SonoSite 180PLUS,B mode,5 MHz linear transducer). Gel was interposed between the transducer and the skin. The transducer was positioned adjacent to and perpendicular to the abdominal wall, 25 mm anteromedial to the midpoint between the ribs and ilium on the midaxillary line, and parallel to the muscle fibers of the transversus abdominis[9]. The same person, a midwife, made the measurements to avoid inter-rater errors. Ultrasound images were saved as still images. All thickness measurements were of muscle only, that is, between the fascia boundaries. To judge the effect, the measurements were performed before the intervention, 4 weeks after the intervention, and 8 weeks after the intervention.

Subjects in the exercise group were provided with an 8-week TA and PFM co-contraction training program. The exercises prescribed were 40 repetitions (2 sets of 20 repetitions) of a 3-second co-contraction of both the TA and PFM. The women were told to perform 1 session of exercise 3 times per week. The women in the control group were asked not to exercise at home during the study but were offered the possibility of receiving a treatment at trial completion.

To determine whether there were differences between the exercise group and the control group, the independent t-test was performed on subject characteristics. The Mann-Whitney test was performed to investigate the differences between groups. The Friedman test and Wilcoxon test were performed to investigate the differences between before and after the intervention. Data were analyzed using SPSS Ver. 17.0 for Windows. The chosen level of statistical significance was 0.05.

RESULTS

There were no significant differences between the exercise group and control group subject characteristics or any measure before the intervention.

Table 2 shows the results for the thickness of the TA. There were significant differences in the thickness of the TA during maximal co-contraction of both the TA and PFM between before and after the 8 weeks exercise. In the control group, there were no significant differences after the intervention.

In the exercise group, the cure rates of SUI were 55.6% (5/9) after 4 weeks of the intervention and 88.9% (8/9) af-

ter 8 weeks intervention, and the control group showed no change.

DISCUSSION

This study investigated the effects of TA and PFM co-contraction exercise on stress urinary incontinence. The exercise group subjects showed not only an increased thickness of the TA during maximal co-contraction of both the TA and PFM but also improved SUI.

In our previous study, the cutoff value for the thickness of the TA during maximal co-contraction of both the TA and PFM was 5.00 mm. This result indicates that the detectability of the risk of urinary incontinence is high and that quantitative assessment of the risk of UI is possible through measurement of the thickness of the TA during maximal co-contraction of both the TA and PFM[10, 11]. In the present study, when the SUI disappeared, the thickness of the TA was greater than the cutoff value. The TA and PFM co-contraction exercise intervention increases the thickness of the TA and may be recommended to improve SUI in middle-aged women.

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