J. Phys. Ther. Sci. 31: 108–111, 2019

The Journal of Physical Therapy Science

Original Article

Relationship between transversus abdominis muscle thickness and urinary incontinence in females at 2 months postpartum

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Abstract. [Purpose] Urinary incontinence is a frequent postpartum complication. Thus, this study aimed to examine the associations of transversus abdominis muscle thicknesses at rest and during an abdominal drawing-in maneuver with urinary incontinence in females at 2 months postpartum. [Participants and Methods] The participants included 18 females at 2 months postpartum with or without urinary incontinence, and 10 nulliparous females as controls. Transversus abdominis thickness was measured at rest and during the abdominal drawing-in maneuver using diagnostic ultrasonography. The Japanese version of the International Consultation on Incontinence Questionnaire-Short Form was used to evaluate urinary incontinence. [Results] Females at 2 months postpartum were divided into groups with and without urinary incontinence according to questionnaire scores. The muscle thickness during the abdominal drawing-in maneuver contraction was significantly lower in those with urinary incontinence than in those without urinary incontinence and controls. [Conclusion] The results showed significantly reduced transversus abdominis thickness during contraction, which suggested reduced transversus abdominis strength in females with postpartum urinary incontinence. Thus, promoting synergistic contraction of the inner unit, including the transversus abdominis, in exercise therapy may be more effective for postpartum urinary incontinence.

Key words: Postpartum urinary incontinence, Transversus abdominis, Drawing

(This article was submitted Sep. 7, 2018, and was accepted Oct. 24, 2018)

INTRODUCTION

Urinary incontinence is a frequent postpartum complication. According to various reports in the literature, 21–45.5% of puerperal women have urinary incontinence[1–3)]. It has also been reported that postpartum urinary incontinence persists into later life and affects the quality of life (QOL)[4, 5)]. The most common form of urinary incontinence in the puerperal period is stress urinary incontinence during coughing, sneezing, flexion, lifting, jumping, etc. With regard to the effect of delivery on the pelvic floor, Chaliha[6)] pointed out that the surrounding structure of the pelvic floor is extensively dilated upon delivery of a fetus and that the injury (e.g., incision, laceration, internal hidden rupture, etc.) of the perineum and muscle fiber tissue from a more difficult delivery leads to mechanical reduction in the pelvic floor support. Insufficient contraction of the pelvic floor muscles due to their loosening or injury, perineal laceration, or episiotomy wound during pregnancy and delivery may all be causes of postpartum urinary incontinence. Pelvic floor exercises are prescribed for the prevention of urinary incontinence and the recovery of pelvic floor support. These exercises are recommended because they have been reported to improve urinary incontinence[7)]. During pelvic floor exercises, only the pelvic floor muscles should be contracted in order to reduce abdominal pressure on other muscle groups. Using needle electromyography, Sapsford et al.[8)] found that the pelvic floor muscles work in conjunction with the transversus abdominis (TrA) muscle, a deep trunk muscle. It has been reported that the strength of the transversus abdominis muscle, which is known to stabilize the trunk, is reduced in patients with low

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back pain[9]. Thus, in some cases, patients with low back pain are asked to perform exercises that require contraction of the transversus abdominis muscle. Abdominal drawing-in maneuver (ADIM), an exercise that requires contraction of the TrA muscle, is used as a spinal stabilization exercise for patients with low back pain[10]. It has been reported that the intentional abdominal muscle contraction stabilizes the lumbar spine by increasing the activity of the deep muscles of the trunk (i.e., the TrA and multifidus muscle)[11, 12]. In addition to the pelvic floor muscles, the abdominal muscles undergo substantial anatomical changes during pregnancy and delivery, causing rectus diastasis and a significant reduction in rectus abdominis muscle thickness.[13]With regard to urinary incontinence in middle-aged and elderly women, Tajiri et al.[14] reported reduced TrA muscle thickness as one of the predictors of urinary incontinence. However, we could not find any study of the relationship between urinary incontinence and the thickness of the TrA muscle in postpartum subjects. Thus, the purpose of this study was to elucidate the relationship between TrA muscle thickness measured at rest and during ADIM contraction, using a diagnostic ultrasound imaging system, and urinary incontinence in women at 2 months postpartum.

PARTICIPANTS AND METHODS

The participants consisted of 18 puerperal women at 2 months postpartum (mean age and standard deviation 33.2 ± 3.7 years, body mass index (BMI) 20.7 ± 1.6, abdominal circumference 72.9 ± 6.1 cm) and 10 nulliparous women as a control group (mean age and standard deviation 32.3 ± 4.8 years, BMI 19.8 ± 1.7, abdominal circumference 68.3 ± 4.4 cm).

Fifteen postupartum women delivered by vaginal delivery and three postpartum women by cesarean section. The Japanese version of the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) was applied to all participants to evaluate urinary incontinence[15]. The participants were divided in with or without urinary incontinence groups. All the participants in this study were provided with a detailed explanation of the nature of the study, and written informed consent was obtained before performing the study procedures. This study was approved by the Medical ethics committee of Kanazawa University (no. 447).

TrA muscle thickness measured using the diagnostic ultrasound imaging system was used as an index of TrA muscle activity. A significant positive correlation between the muscle thickness measured using the diagnostic ultrasound imaging system and electromyography has been reported[16]. Thus, it is reasonable to use muscle thickness as a muscle activity index. In addition, the reproducibility of this method has also been reported[17]. The digital ultrasound equipment Mylab 25 (Esaote, Indianapolis, IN, USA) was used to measure TrA muscle thickness. A 7.5–12 MHz linear probe was used, and the setting was B mode. Imaging and the measurement of muscle thickness were performed by the same examiners. Measurements were made in the supine position with the knee flexed at 90°. The muscle thickness measurement site was 2 cm from the TrA muscle tendon at the level of the umbilicus[18]. Three measurements of the TrA muscle were performed at rest and during contraction, respectively. The ADIM was used to assess changes in TrA muscle thickness during contraction. The uniform instructions on how to contract the TrA muscle were as follows: “Contract your abdomen while exhaling.” The stabilizer unit (Chattanooga Group Inc., Hixson, TN, USA) was used to reduce pelvic inclination. The participants were instructed to maintain abdominal pressure at 40 mmHg during the exercise. The measurements of muscle thickness were performed after the participants had mastered the ADIM. The measurements were made at end-expiratory pause extracted from the obtained videos, using the measurement function of the device in 0.1-mm increments in a double-blind manner (i.e., blinded to the information on the group with urinary incontinence and the group without urinary incontinence).

The ICIQ-SF is based on symptom and QOL questionnaire consisting in four items: frequency, amount, type, and overall impact of urinary incontinence[15]. The participants were divided into three groups according to the results of the ICIQ-SF: (i) the puerperal group without urinary incontinence at 2 months postpartum; (ii) the puerperal group with urinary incontinence at 2 months postpartum; and (iii) the control group. TrA muscle thickness at rest and during contraction was compared among the three groups using one-way ANOVA and Tukey’s test. The data were analyzed using IBM SPSS Statistics 23 (IBM, Armonk, NY, USA). P-values<0.05 were considered statistically significant.

RESULTS

The puerperal women at 2 months postpartum were divided into two groups according to the ICIQ-SF scores: (i) the group without urinary incontinence (0 point: n=14) and the group with urinary incontinence (N=4) (3 points: n=2; 6 points: n=2). On the basis of the answers to the questions on the types of urinary incontinence, all members in the group with urinary incontinence were determined to have stress urinary incontinence. Urinary incontinence was not seen in the subject of the cesarean section. There was no patient with urinary incontinence in the control group. The intra-class correlation coefficient (ICC) calculated to determine the reproducibility of the measurement of transversus abdominis muscle thickness was ≥0.90, both at rest and during contraction. There were no significant differences in age, BMI, and abdominal circumference among the three groups: the group without urinary incontinence, the group with urinary incontinence, and the control group (Table 1). There were no significant differences in TrA muscle thickness at rest among the three groups. Muscle thickness during contraction was significantly lower in the group with urinary incontinence than in the group without urinary incontinence ($p<0.05$) and control group ($p<0.01$). The contraction rate of the group with urinary incontinence was significantly lower than that of the group without urinary incontinence ($p<0.05$). The contraction rate of the group with urinary incontinence was slightly but not

Table 1. Characteristics of participants

	Control group	No-UI group[a]	UI group[b]
Number	10	14	4
Age (yrs)	32.3 ± 4.8	33.1 ± 4.0	33.5 ± 3.0
BMI (kg/m^2)	19.8 ± 1.7	21.1 ± 1.4	19.3 ± 1.4
Abdominal girth (cm)	68.3 ± 4.4	73.2 ± 6.8	72.1 ± 3.9

Values are expressed as mean ± SD.
There were no significant differences between groups at the 0.05 level.
[a]No-UI group: women with no urinary incontmence in postpartum.
[b]UI group: women with urinary incontinence in postpartum.

Table 2. Muscle thicknesses of TrA and contraction ratio

	Control group	No-UI group	UI group
Resting state (mm)	2.86 ± 0.5	2.55 ± 0.47	2.47 ± 0.64
Contraction state (mm)	4.65 ± 0.86	4.44 ± 0.84	2.98 ± 0.83*,†
Contraction state/Resting state	1.62 ± 0.35	1.74 ± 0.33	1.21 ± 0.14*

Values are expressed as mean ± SD.
*Significant difference compared with No-UI group, $p<0.05$.
†Significant difference compared with Control group, $p<0.05$.

statistically significantly lower than that of the control group ($p<0.08$) (Table 2).

DISCUSSION

In this study, 22.2% of participants had urinary incontinence. The results were consistent with those of previous studies. In addition, the results of the ICIQ-SF showed that all patients with urinary incontinence in this study had stress urinary incontinence, a common postpartum symptom. There was no significant difference in transversus abdominis muscle thickness at rest between the control group and the postpartum group with or without UI. As with this study, Weis et al.[19] measured abdominal muscle thickness at rest and found no significant difference in TrA muscle thickness but found significant differences in the thickness of the rectus abdominis muscle and internal oblique muscle between the nulliparous group and the group at 1 month postpartum. Coldron et al.[13] also reported that rectus abdominis muscle thickness in the puerperal group at 1 year postpartum was significantly lower than that in the nulliparous group. The rectus abdominis muscle is anatomically attached to the front of the trunk. On the other hand, the TrA muscle has a large surface with attachment sites on the back as well. Thus, the muscle is likely to be more affected by abdominal distention during pregnancy. On the other hand, with regard to TrA muscle thickness during contraction, it was suggested that muscle thickness and TrA muscle strength in the group with postpartum urinary incontinence was significantly lower than those in the group without postpartum urinary incontinence. The reduction in postpartum pelvic floor muscle strength was associated with urinary incontinence[20]. Synergistic contraction of the TrA muscle and pelvic floor muscle has been reported[8, 21]. Thus, the results of this study suggest that the contraction of not only the pelvic floor muscle but also the TrA muscle affects urinary incontinence. The TrA muscle is one of the muscles that increase abdominal pressure and stabilize the spine. It is important as a postural muscle. Reduced contraction of this muscle may lead to poor posture in the urinary incontinence group. Because the participants in this study were at 2 months postpartum, they might have been at higher risk of persisting changes in the alignment of the pelvis due to delivery, in addition to poor posture due to breastfeeding and holding the baby. Future studies should include further investigation of the relationship between posture and urinary incontinence. The TrA muscle also increases abdominal pressure. Sudden transmission of abdominal pressure onto the pelvic floor, one of the causes of stress urinary incontinence, may be preventable by confining high pressure to the intra-abdominal area through contraction of the transversus abdominis muscle. Attention is required in setting the activity mode and timing of sit-ups as a postpartum rehabilitation exercise to prevent urinary incontinence because of sudden transmission of abdominal pressure onto the pelvic floor[22]. Future studies should include further exploration of appropriate exercise methods. In general, pelvic floor exercises are recommended for the rehabilitation of patients with urinary incontinence. However, the results of this study suggest that it is more effective to promote synergistic contraction of the inner unit including the TrA muscle and better posture in patients with postpartum urinary incontinence.

It has been reported that the risk of urinary incontinence varies with delivery methods such as vaginal delivery and cesarean section[23]. One of the limitations of this study is that the participants were not divided into groups according to delivery method owing to the small sample size. Further studies with a larger sample size are required to enable the grouping of participants.

The muscle thickness measurement site in this study was 2 cm from the transversus abdominis muscle tendon. Measurements at other sites are necessary because these sites may be affected differently. If possible, it is would also be informative to study contraction of the pelvic floor muscle in addition.

This study examined the relationship between TrA muscle thickness and urinary incontinence in puerperal women at 2 months postpartum. The results showed significantly reduced TrA muscle thickness during contraction, suggesting reduced transversus abdominis muscle strength in women with postpartum urinary incontinence. Thus, it was suggested that it is more effective to promote synergistic contraction of the inner unit including the TrA muscle in exercise therapy for postpartum urinary incontinence.

Conflict of interest

None.

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