J. Phys. Ther. Sci.
26: 605–607, 2014

Original Article

The Effects of Precise Contraction of the Pelvic Floor Muscle Using Visual Feedback on the Stabilization of the Lumbar Region

Jin-Hee Kim, MS, PT[1)], Sung-Hak Cho, MS, PT[1)*], Jun-Hyeok Jang, PhD, PT[2)]

[1)] *Department of Physical Therapy, College of Health Sciences, Catholic University of Pusan: 9 Bugok 3-dong, Geumjung-gu, Busan 609-757, Republic of Korea*
[2)] *Department of Physical Therapy, Haeundae Jaseng Hospital of Oriental Medicine, Republic of Korea*

Abstract. [Purpose] The purpose of this study is to verify whether precise contraction of the pelvic floor muscle (PFM) using visual feedback actually affects the thickness of abdominal muscles. [Subjects] The subjects were 29 healthy adults in their 20s who consented to participate in this study. [Methods] This study provided visual feedback on PFM using one ultrasound device and identified changes in the transversus abdominis (TRA) using another ultrasound device. Abdominal muscle thicknesses were measured by ultrasound under three conditions (rest, PFM contraction, PFM contraction with visual feedback). [Results] There were no statistically significant differences in the external oblique (EO) and internal oblique (IO) muscles between the measurements taken at rest and during the contraction of the PFM, and between those taken at rest and during the contraction of the PFM with visual feedback. There were significant differences in the TRA. In particular, TRA thickness was highest in the order of PFM contraction, PFM contraction with visual feedback, and rest. [Conclusion] Hollowing with visual feedback is not an efficient stabilization exercise method for the PFM.
Key words: Pelvic floor muscle, Visual feedback, Abdominal muscles

(This article was submitted Oct. 8, 2013, and was accepted Nov. 15, 2013)

INTRODUCTION

The pelvic floor muscle (PFM) is known to support the pelvic organs and contribute to the locking mechanism of the urethra and anus, adjusting incontinence, and it has recently been found to perform diverse functions, such as stabilization of the lumbopelvic girdle and spine, and postural adjustment. They also support the ventilation and adjustment of incontinence in the urinary bladder[1–5)]. The PFM supports trunk stabilization by adjusting or responding to abdominal pressure in cooperation with the muscles surrounding the abdominal cavity[1, 2, 6)].

Abdominal hollowing training for stabilizing the lumbopelvic region, pulls the abdominal wall toward the inside of the lower abdomen, contracting the transversus abdominis (TRA), and it provides effective stabilization training[7)].

Neumann and Gill[6)] reported that contraction of the PFM prompted activation of the TRA and internal oblique muscle (IO), and also raised the abdominal pressure by 6 mmHg. Kim Ha-ru[8)] reported that there were significant changes in the thickness of the TRA and IO during contraction of the PFM, but electromyography showed there was a significant difference only in the IO when the was PFM contracted. Kim Bo-in[1)] noted that when the vaginal pressure increased, there was a significant difference in the thickness of the TRA.

Critchley[9)] observed that there was a more significant difference in the thickness of the TRA when contraction of the PFM was made together with the abdominal hollowing motion than when only the abdominal hollowing motion was conducted. These study results show that contraction of the PFM promotes activation of the TRA, a deep muscle. However, the PFM is not often used in daily life, and therefore performance of appropriate exercises and precise contraction of the muscle is very difficult. As a measure to resolve such problems for women with urinary incontinence and cystocele, biofeedback using ultrasound is being used to visualize the contraction of the PFM, to provide precise and immediate visual feedback to subjects[10)]. Nevertheless, no research has analyzed the effects of precise PFM contraction on abdominal muscles. Therefore, the purpose of this study was to verify whether precise contraction of the PFM using visual feedback actually affects the thickness of the abdominal muscles.

SUBJECTS AND METHODS

The subjects were 29 adults in their 20s who consented to participate in this study. They had no history of neuro-

*Corresponding author. Sung-Hak Cho (E-mail: wow1300@hanmail.net)

logical or muscle lesions within the previous six months. This study was approved by the Ethics Committee of the Catholic University of Pusan.

First, the thicknesses of the external oblique muscle (EO), IO, and TRA were measured with the subjects lying in a supine position at rest. After a 10-minute rest, the subjects were instructed to contract the PFM in an ordinary way during the hollowing motion, and then the thicknesses of their abdominal muscles were measured. In order to exclude a carry-over effect, the thicknesses of the abdominal muscles were measured as the subjects contracted the PFM while watching a visual feedback video the next day.

The subjects were instructed to tighten the internal muscles of the pelvis, as if to hold in urine, and slowly pull and raise them internally. They were careful not to move the pelvis or the lumbar region. However, they were not instructed to induce or prevent the utilization of the abdominal muscles[6)].

To provide subjects with accurate visual feedback, a convex ultrasound probe was positioned, with the angle between the abdomen and the probe at 10° (ESAOTE Europe B.V., Netherland), from 5 cm above the symphysis pubis, and visual feedback was given by casting the probe on the perineum. Changes in imaging during the contraction of the PFM were explained, and the subjects were taught how to contract the PFM.

For the abdominal hollowing motion, a stabilizer (Chattanooga Group Inc., USA) was used in order to minimize the contraction of the IO and EO and to trigger selective contraction of the TRA. Subjects were asked to maintain the pressure on the manometer at 40 mmHg[11)].

Ultrasonic diagnostic equipment (SONOACE X4, Korea) was used to measure the thickness of the abdominal muscles. The thicknesses of the external oblique abdominal, the internal oblique abdominal, and the transversus abdominis muscles were measured at the end point of expiration[3)]. They were measured in an anteromedial direction using a linear probe (7.5 MHz) at the middle, between the iliac crest and the eleventh rib on the right side of the subjects[12, 13)]. One-way analysis of variance was employed in order to compare the thicknesses of the abdominal muscles under the three different conditions. Duncan's test was used as a post hoc test (α=0.05).

RESULTS

The general characteristics of the subjects are shown in Table 1.

There were no statistically significant differences in the EO and IO between the measurements taken at rest and during the contraction of the PFM, and between those taken at rest and during the contraction of the PFM with visual feedback (Table 2).

According to the post hoc test result, there were significant differences in the TRA between the measurements taken at rest and during the contraction of the PFM, and between those taken at rest and during the contraction of the PFM with visual feedback. In particular, the thickness of the TRA was highest during the contraction of the PFM without visual feedback (Table 2).

DISCUSSION

According to the results of the present study, there were no significant differences in the thicknesses of the EO and IO during contraction of the PFM between rest and with and without visual feedback when the subjects conducted the abdominal hollowing motion. However, the thickness of the TRA saw a statistically significant increase. The TRA thickness increased more during the contraction of the PFM without visual feedback than during the precise contraction of the PFM with visual feedback.

In a study where subjects were instructed to contract the PFM lightly, at a moderate intensity, and at a strong intensity, reported that the thickness of the TRA and IO increased as the contraction intensity increased, but that there was no change in the thickness of the EO[14)]. This result is similar to the results of our present study, in that the contraction rate of the TRA was higher during the contraction of the PFM without visual feedback. Critchley[2)] compared subjects that conducted abdominal hollowing only and those that contracted the PFM in a crawling position, and reported that the thicknesses of the EO and IO decreased, but that the thickness of the TRA increased during abdominal hollowing compared to the at-rest measurements. This result is similar to that of the present study, in that the thickness of the TRA showed a statistically significant increase under both contraction conditions. However, Critchely[2)] noted that because precise contraction of the PFM was difficult when

Table 1. General characteristics of subjects (n=29)

	Mean ± SD
Gender (M/F)	29 (13/16)
Age (yrs)	23.2±2.7
Heights (cm)	167.2±7.6
Weights (kg)	61.0±11.3

Table 2. Comparison of abdominal muscle thicknesses under the different conditions (n=29)

Muscle	Rest	PFMC + AH	Feedback PFMC + AH
External Oblique	0.68±0.20	0.65±0.16	0.62±0.11
Internal Oblique	0.53±0.15	0.63±0.09	0.58±0.25
Transverse Abdominis*	0.31±0.09[a]	0.51±0.15[b]	0.48±0.21[c]

PFMC: Pelvic floor muscle contraction, AH: Abdominal hollowing
[a]: Rest vs. PFMC, [b]: PFMC vs. Feedback PFMC, [c]: Feedback PFMC vs. Rest

subjects conducted the hollowing motion and contracted the PFM at the same time, there was a possibility that movement of the PFM did not occur or that subjects concentrated more on the contraction of the deep abdominal muscles drawing in the lower abdomen than on the contraction of the PFM. This could explain our result, that the thickness of the TRA increased less during the precise contraction of the PFM with visual feedback than during the contraction of the PFM without visual feedback.

Due to the PFM's anatomical location and structure, it is hard to voluntarily conduct precise contraction of the PFM. This may result in the iliacus muscle, the abductor muscle inside the hip joint, and the abdominal muscles, in particular the TRA and the IO, contracting together, rather than a contraction of the PFM[9, 15]. Therefore, we presume that when subjects conduct the hollowing motion without precisely performing the contraction of the PFM, they concentrate on the contraction of the deep abdominal muscles, such as the TRA, which affects the thickness of the TRA.

This study verified that there is an increase in the thickness of the TRA during PFM contraction, but that the increase in the thickness of the TRA was smaller during the contraction of the PFM with visual feedback. We speculate that this is likely because the precise contraction of the PFM decreases mobilization of the deep muscles reducing the simultaneous contraction rate of the TRA.

Training to strengthen the PFM may be an effective exercise for improving continence. However, if the purpose is to strengthen the TRA simply for the stabilization of the lumbopelvic girdle, hollowing with visual feedback is not an efficient exercise method for the PFM.

ACKNOWLEDGEMENT

Jin−hee Kim unpublished master's degree thesis of this paper was part of the excerpt.

REFERENCES

1) Kim BI: During vaginal pressure change comparative analysis abdominis thickness and activity in healthy women. Daegu University Graduate School of Rehabilitation Sciences. Master's thesis.
2) Sapsford R: Rehabilitation of pelvic floor muscles utilizing trunk stabilization. Man Ther, 2004, 9: 3–12. [Medline] [CrossRef]
3) Hodges PW, Gandevia SC: Changes in intra-abdominal pressure during postural and respiratory activation of the human diaphragm. J Appl Physiol 1985, 2000, 89: 967–976. [Medline]
4) Smith MD, Coppieters MW, Hodges PW: Postural activity of the pelvic floor muscles is delayed during rapid arm movements in women with stress urinary incontinence. Int Urogynecol J Pelvic Floor Dysfunct, 2007*a*, 18: 901–911. [Medline] [CrossRef]
5) Smith MD, Coppieters MW, Hodges PW: Postural response of the pelvic floor and abdominal muscles in women with and without incontinence. Neurourol Urodyn, 2007b, 26: 377–385. [Medline] [CrossRef]
6) Neumann P, Gill V: Pelvic floor and abdominal muscle interaction: EMG activity and intra-abdominal pressure. Int Urogynecol J Pelvic Floor Dysfunct, 2002, 13: 125–132. [Medline] [CrossRef]
7) Kisner C: Therapeutic exercise, 5th ed. Philadelphia: F.A. Davis Company, 2007. pp 451–456.
8) Kim HR: Comparative analysis of measured vaginal pressure, abdominal EMG, thickness according to the delivery method during pelvic floor contraction and valsalva maneuver. Daegu University Graduate School of Rehabilitation Sciences, Master's thesis.
9) Critchley D: Instructing pelvic floor contraction facilitates transversus abdominis thickness increase during low-abdominal hollowing. Physiother Res Int, 2002, 7: 65–75. [Medline] [CrossRef]
10) Thompson JA, O'Sullivan PB: Levator plate movement during voluntary pelvic floor muscle contraction in subjects with incontinence and prolapse: a cross-sectional study and review. Int Urogynecol J Pelvic Floor Dysfunct, 2003, 14: 84–88. [Medline] [CrossRef]
11) Richardson CA, Jull GA: Muscle control-pain control. What exercises would you prescribe? Man Ther, 1995, 1: 2–10. [Medline] [CrossRef]
12) Beith ID, Synnott RE, Newman SA: Abdominal muscle activity during the abdominal hollowing manoeuvre in the four point kneeling and prone positions. Man Ther, 2001, 6: 82–87. [Medline] [CrossRef]
13) Hides J, Gilmore C, Stanton W, et al.: Multifidus size and symmetry among chronic LBP and healthy asymptomatic subjects. Man Ther, 2008, 13: 43–49. [Medline] [CrossRef]
14) Sapsford RR, Hodges PW, Richardson CA, et al.: Co-activation of the abdominal and pelvic floor muscles during voluntary exercises. Neurourol Urodyn, 2001, 20: 31–42. [Medline] [CrossRef]
15) Bø K, Sherburn M: Evaluation of female pelvic-floor muscle function and strength. Phys Ther, 2005, 85: 269–282. [Medline]