

Original Article

# Reliability of measuring pelvic floor elevation with a diagnostic ultrasonic imaging device

HITOMI UBUKATA, MS, PT<sup>1, 2)\*</sup>, HITOSHI MARUYAMA, PhD, PT<sup>2)</sup>, MING HUO, PhD, PT<sup>3)</sup>

<sup>1)</sup> Department of Physical Therapy, Faculty of Health Science, Takasaki University of Health and Welfare: 501 Nakaoorui, Takasaki, Gunma 370-0033, Japan

<sup>2)</sup> Department of Physical Therapy, Health and Welfare Science Course, Graduate School of International University of Health and Welfare, Japan

<sup>3)</sup> Department of Physical Therapy, Faculty of Health Care Sciences, Himeji Dokkyo University, Japan

**Abstract.** [Purpose] The purpose of this study was to investigate the reliability of measuring the amount of pelvic floor elevation during pelvic and abdominal muscle contraction with a diagnostic ultrasonic imaging device. [Subjects] The study group comprised 11 healthy women without urinary incontinence or previous birth experience. [Methods] We measured the displacement elevation of the bladder base during contraction of the abdominal and pelvic floor muscles was measured using a diagnostic ultrasonic imaging device. The exercise was a four-part operation undertaken with the subjects in the lateral position. The reliability analysis included use of the interclass correlation coefficient (ICC) was used to assess the reliability. [Results] ICC (1.1) values for the pelvic floor elevation measurement with a diagnostic ultrasonic imaging device were 0.98 [contraction of the transversus abdominis (TrA) muscle], 0.99 [contraction of pelvic floor muscles (PFMs)], 0.98 (co-contraction of the TrA and PFMs), and 0.98 (resistance of the TrA and PFMs). This study proved the reliability of the method because the coefficient of reliability was 0.97 or more for all of the measurements, even for those during exercise. [Conclusion] The diagnostic ultrasonic imaging device measures pelvic floor elevation with high reliability.

**Key words:** Bladder base, Pelvic floor muscles (PFMs), Stress urinary incontinence

(This article was submitted Mar. 18, 2015, and was accepted May 5, 2015)

## INTRODUCTION

Urine leakage that occurs when coughing and sneezing is called stress urinary incontinence. Leakage occurs because of weakness of the pelvic floor muscles (PFMs), usually the result of pregnancy, delivery, and/or aging<sup>1)</sup>. Currently in Japan, it has been reported that at least 50% of the population 60 years of age or older suffer from urinary incontinence, accounting for approximately four million persons<sup>2)</sup>.

Until recently, PFM actions have been assessed by measuring the contraction pressure when a medical appliance is inserted into the vagina or anus, or by using a vaginal examination<sup>3)</sup>. These assessment methods, however, cause patients embarrassment and are psychologically stressful. Recently, another technique was now been described that determines the pelvic floor elevation during voluntary contraction of the PFMs. It includes the use of diagnostic ultrasonic imaging device to correlate pelvic floor elevation with vaginal pressure<sup>4)</sup>. It has also been used to validate functional assessment of the PFMs<sup>5)</sup>. We found no studies, however, that reported

its reliability for measuring pelvic floor elevation. The purpose of this study, therefore, was to evaluate the reliability of measuring pelvic floor elevation with a diagnostic ultrasonic imaging device.

## SUBJECTS AND METHODS

### Subjects

The study group included 11 healthy women without urinary incontinence or previous birth experience. The mean age of the subjects was 21.8±7.1 years, their average height was 162.5±6.1 cm, and their average weight was 55.7±6.1 kg. All subjects gave their informed consent to participation in the study. This study was conducted with the approval of the Research Ethics Committee of the International University of Health and Welfare, which reviewed and approved all of the experimental procedures.

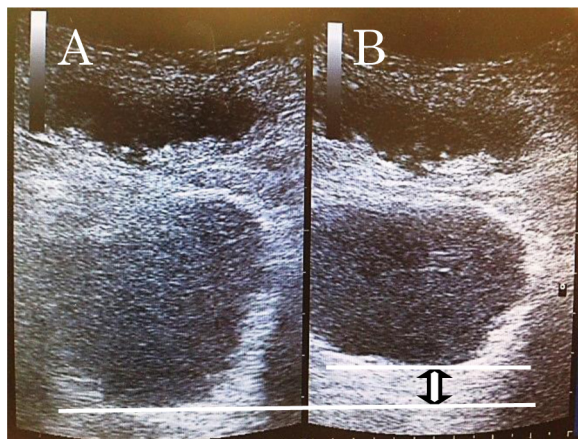
### Methods

For ultrasonic manipulation we used a diagnostic ultrasonic imaging device (My Lab 25; Hitachi, Tokyo, Japan) and a 3.5-MHz linear expression probe to measure pelvic floor elevation. We measured the amount of bladder base elevation by diagnostic ultrasonic imaging device as an indicator of contraction of the PFMs based on the method described by others<sup>5-7)</sup>. The subjects consumed 600–750 mL of water within a 1-h period that ended 30 min prior to testing. Voiding was not allowed during this period. Subjects

\*Corresponding author. Hitomi Ubukata (E-mail: ubukata@takasaki-u.ac.jp)

were tested in a side-lying position with a pillow under the head. The hips and knees were flexed to 60°, and the lumbar spine was in the neutral position. The diagnostic ultrasonic imaging device transducer was placed in the transverse plane, suprapubically angled in a caudal/posterior direction to obtain a clear image of the inferoposterior aspect of the bladder. The participants were required to perform maximum contraction and to maintain the contraction while breathing normally in the exercise. When the contraction was visualized on the diagnostic ultrasonic imaging device screen, the image was fixed, and the subjects were instructed to relax. The exercise took less than 3 s. A marker was then located on the bladder base at the point of maximum displacement during muscle contraction, and the amount of bladder base displacement from the resting position at the end of each contraction was measured (in millimeters) (Fig. 1). The diagnostic ultrasonic imaging device transducer was not displaced during the testing procedure, and the subjects were not able to see the diagnostic ultrasonic imaging device screen, thus avoiding any biofeedback training effect. Only contractions with cephalic movement of the bladder base were measured.

The measurements were a four-part operation undertaken with the subject in the lateral position. Measurements were taken of (1) maximum contraction of the transversus abdominis (TrA); (2) maximum contraction of the PFMs; (3) maximum co-contraction of the TrA and the PFMs; and (4) maximum co-contraction of the TrA and PFMs with knee resistance. All measurements were performed when the dia-



**Fig. 1.** Ultrasonography images of the pelvic floor at rest (A) and during maximum contraction (B)

phragm was moving upward during normal breathing and with the PFMs contracting during air expiration. Subjects performed three maximum contractions with no movement of the pelvis or lower back region. The mean values of the three contractions were used in the analyses. To evaluate the reliability of the measurements, the four tests were repeated 4 days after the first set of measurements. The reliability analysis was applied to the measurement of urinary bladder elevation using the interclass correlation coefficient [ICC (1.1)]. SPSS version 17.0 for Windows (SPSS, Chicago, IL, USA) was used for the statistical analysis.

**RESULTS**

ICC (1.1) values for the pelvic floor elevation measurement with a diagnostic ultrasonic imaging device were 0.98 for contraction of the TrA, 0.99 for contraction of the PFMs, 0.98 for co-contraction of the TrA and the PFMs, and 0.98 for resistance of the TrA and the PFMs (Table 1).

**DISCUSSION**

The values of the interclass correlation coefficients were quite high for measuring elevation of the pelvic floor which was very high in this study. According to the ICC criteria described by Lindis et al.<sup>8)</sup> an ICC of 0.81–1.00 is “almost perfect”, 0.61–0.80 is “substantial”, 0.41–0.60 is “moderate”, 0.21–0.40 is “fair”, and 0–0.20 is “slight”. These parameters suggest that the reliability for measuring pelvic floor elevation in this study was excellent because the coefficient of reliability was 0.97 or more under all conditions even when measurements were performed during exercise. Thus, the diagnostic ultrasonic imaging device is highly reliable for measuring pelvic floor elevation.

Because pelvic floor elevation can be observed in real time with this type of imaging device, the subjects/patient can also be provided with feedback regarding their physical conditions. It has also been reported that pelvic floor elevation is correlated with vaginal pressure<sup>4, 9)</sup>. It is therefore thought that this technique not only is able to assess the physical situation effectively, but also it can be used to re-educate the patients’ PFM aponeuroses in a clinical setting. Our study, with the diagnostic ultrasonic imaging device, allowed us to observe whether the pelvic floor muscles moved adequately to prevent urinary incontinence, demonstrating the actions of the PFMs can be studied easily and efficiently.

In conclusion, a diagnostic ultrasonic imaging device allowed reliable measurements of pelvic floor elevation. Our

**Table 1.** Pelvic floor elevation at the first and second measurements: intraclass correlation coefficient

Parameter	First measurements	Second measurement	ICC (1.1)
Movement of TrA	7.7±2.4	7.9±2.3	0.98
Movement of PFMs	9.2±2.8	9.3±2.9	0.99
Co-contraction of TrA and PFMs	9.3±2.7	9.1±2.5	0.98
Resistance	11.1±2.4	11.5±2.5	0.98

results also suggested that this type of device can be used clinically for this purpose. In the future, it would be interesting to use the diagnostic ultrasonic imaging device to assess the differences in the amount of PFM elevation in regards to actions of all of the internal urinary bladder components according to leg position.

#### ACKNOWLEDGMENTS

This work was supported by the Japan Society for the Promotion of Science KAKENHI Grant No. 26870537.

#### REFERENCES

- 1) Haylen BT, de Ridder D, Freeman RM, et al.: An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. *Int Urogynecol J Pelvic Floor Dysfunct*, 2010, 21: 5–26. [[Medline](#)] [[CrossRef](#)]
- 2) Kim H, Yoshida H, Suzuki T: [Risk factors associated with urinary incontinence in community-dwelling elderly women]. *Nippon Ronen Igakkai Zasshi*, 2008, 45: 315–322. [[Medline](#)] [[CrossRef](#)]
- 3) Rao SS, Seaton K, Miller M, et al.: Randomized controlled trial of bio-feedback, sham feedback, and standard therapy for dyssynergic defecation. *Clin Gastroenterol Hepatol*, 2007, 5: 331–338. [[Medline](#)] [[CrossRef](#)]
- 4) Chehrehrizi M, Arab AM, Karimi N, et al.: Assessment of pelvic floor muscle contraction in stress urinary incontinent women: comparison between transabdominal ultrasound and perineometry. *Int Urogynecol J Pelvic Floor Dysfunct*, 2009, 20: 1491–1496. [[Medline](#)] [[CrossRef](#)]
- 5) Sherburn M, Murphy CA, Carroll S, et al.: Investigation of transabdominal real-time ultrasound to visualise the muscles of the pelvic floor. *Aust J Physiother*, 2005, 51: 167–170. [[Medline](#)] [[CrossRef](#)]
- 6) Thompson JA, O'Sullivan PB, Briffa K, et al.: Assessment of pelvic floor movement using transabdominal and transperineal ultrasound. *Int Urogynecol J Pelvic Floor Dysfunct*, 2005, 16: 285–292. [[Medline](#)] [[CrossRef](#)]
- 7) Thompson JA, O'Sullivan PB, Briffa NK, et al.: Comparison of transperineal and transabdominal ultrasound in the assessment of voluntary pelvic floor muscle contractions and functional manoeuvres in continent and incontinent women. *Int Urogynecol J Pelvic Floor Dysfunct*, 2007, 18: 779–786. [[Medline](#)] [[CrossRef](#)]
- 8) Landis JR, Koch GG: The measurement of observer agreement for categorical data. *Biometrics*, 1977, 33: 159–174. [[Medline](#)] [[CrossRef](#)]
- 9) Kim BI, Hwang-Bo G, Kim HR: Comparison of abdominal muscle thickness with vaginal pressure changes in healthy women. *J Phys Ther Sci*, 2014, 26: 427–430. [[Medline](#)] [[CrossRef](#)]