

# A Comparison of Vaginal Pressures and Abdominal Muscle Thickness According to Childbirth Delivery Method during the Valsalva Maneuver

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**Abstract.** [Purpose] The purpose of this study was to compare the effect of childbirth delivery method on vaginal pressure and abdominal thickness during the Valsalva maneuver (VAL). [Subjects] Thirty healthy female volunteers (26–39 years of age) were selected for this research. Their delivery histories were: nulliparous 10, vaginal delivery 10, and Cesarean delivery 10. None of the participants had a history of incontinence. [Methods] In the crook-lying position, a perineometer probe was inserted into the vagina and the transducer was placed transversely on the right side of the body during the Valsalva maneuver. [Results] There were significant differences in the thickness of the transverses abdominis (TrA) between in all the groups rest and the Valsalva maneuver, and there were significant differences in the internus oblique (IO) in the nulliparous group. During the Valsalva maneuver, there were significant differences in the TrA between the nulliparous group and the vaginal delivery group, and there were significant differences in the IO between the nulliparous delivery group and the vaginal delivery group, and between the nulliparous group and the Cesarean section group. Delivery history changed vaginal pressure, and there were significant differences between the nulliparous group and the vaginal delivery group, and between the nulliparous group and the Cesarean delivery group. [Conclusion] Pregnancy and delivery method may affect pelvic floor and abdominal muscles during the Valsalva maneuver.

**Key words:** Ultrasound image, Valsalva maneuver, Vaginal pressure

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## INTRODUCTION

The pelvic floor muscles (PFMs) play a significant role in continence control, pelvic organ support<sup>1)</sup>, and stabilization of the lumbo-pelvic region<sup>2)</sup>. Recent studies have found that the PFMs perform subsidiary roles in posture control and ventilation<sup>3)</sup>, and contribute to spinal stability<sup>4)</sup>. The most established risk factor for pelvic floor dysfunction and weakening of the PFM is childbirth by vaginal delivery<sup>5–7)</sup>. During vaginal childbirth, the PFMs, nerves, and connective tissue are forcibly stretched, compressed, and bruised<sup>8)</sup>. During vaginal delivery, the PFMs are extended, triggering fatal damage to the perineum<sup>5)</sup>, and weakening of the contraction force of the PFMs due to vaginal birth can cause disabilities<sup>9)</sup>. Kisner and Colby<sup>8)</sup> listed pregnancy and delivery, constipation and the associated inability to empty the bowel, chronic cough, and overweight as causes of weakening of the PFMs. Hence, it is likely that vaginal childbirth will reduce the vaginal resting pressure (VRP) and the strength and endurance of the PFMs, and that Ce-

sarean section (CS) may not induce prevent these adverse effects.

The occurrence of lumbar pain during pregnancy is closely related with urinary incontinence<sup>10)</sup>. Muscle strengthening exercise focuses on the stretching and weakening of the abdominal muscles during delivery<sup>11)</sup>. Janis<sup>12)</sup> reported changes in abdominal pressure during respiration and found that pelvic floor muscle exercises were effective at treating urinary incontinence, pointing to an association between the PFMs and the abdominal muscles. The Valsalva maneuver was reported to relax the PFMs<sup>13)</sup>, and PFMs activity and isometric contraction increase during the Valsalva maneuver<sup>14, 15)</sup>. Recently, it was reported that measurement of external changes in muscles were possible during selective muscle contraction through ultrasound imaging<sup>16)</sup>. There were demonstrated validity and the reliability of ultrasound in measuring changes in muscle activity and muscle shape, showing that ultrasound is a useful clinical method for measuring the activity of the deep muscles.

Research on women in their 20s and 30s with delivery experiences is scarce and there has been little research on the methods of delivery. The aim of this study was to examine the effects of delivery and delivery method on the thickness of the abdominal muscles and on vaginal pressure in healthy women during the Valsalva maneuver.

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**Table 1.** By group comparison of muscle thickness between rest and the Valsalva maneuver

		Rest	VAL	
NP	TrA	0.28±0.02	0.52±0.04	*
	IO	0.47±0.03	0.71±0.03	*
	EO	0.58±0.04	0.53±0.06	
VD	TrA	0.25±0.01	0.38±0.03	*
	IO	0.38±0.03	0.47±0.04	
	EO	0.54±0.03	0.47±0.03	
CD	TrA	0.25±0.01	0.40±0.04	*
	IO	0.43±0.03	0.51±0.02	
	EO	0.55±0.03	0.54±0.05	

\*Significant difference ( $p < 0.05$ ). Unit: cm; NP, nulliparous; VD, vaginal delivery; CD, Cesarean delivery Mean±SD

## SUBJECTS AND METHODS

The subjects of this study were 30 female adults in their 20s and 30s. Their average age was  $32.4 \pm 3.8$  years, their average body weight was  $54.1 \pm 5.0$  kg, and their average height was  $160.5 \pm 4.2$  cm. The subjects were divided into nulliparous, vaginal delivery and Cesarean delivery groups, and there was an average birth number of  $1.5 \pm 0.5$  in the latter two groups. There were 10 subjects in each group. Those who had more than two deliveries, had genital diseases currently or in the past, had a delivery within the last 12 months, had pelvic pain or back pain, could not perform the exercise due to lack of understanding, or had neurological injuries were excluded from this study. Data for the general characteristics of obesity, height, age, weight, delivery method, and the number of deliveries were obtained before starting the experiment. This study was approved by the institutional review board of Hospital. Subjects provided their written informed consent prior to participation in this study.

A digital perineometer (Peritron 9300, Cardio Design Pty Ltd., Australia) was used to measure the vaginal contraction pressure during the Valsalva maneuver. In the crook-lying position, the perineometer probe was inserted into the vagina. Before starting the measurement, the subjects practiced the correct maneuver method. As repeated measurements can tire the muscles after contraction, they were measured after resting for at least 5 seconds. To minimize the effect of errors on the measurements, one skilled researcher measured each subject three times and calculated the average value.

The ultrasound equipment used was a HDI 5000, ALTPHILIPS machine with a linear probe transducer which could be operated at a frequency of 7 MHz. The transducer was placed transversely on the right side of the body, with its center positioned at a point 25 mm anterior to the mid-axillary line at the midpoint between the inferior rib and the iliac crest.

To measure the thickness of the abdominal muscles, a 10 mm horizontal line was drawn from the fascial attachment point of the posterior rectus sheath and the transversus

**Table 2.** Comparison of muscle thickness across the groups during the Valsalva maneuver

		NP	VD	CD	
Rest	TrA	0.28±0.02	0.25±0.38	0.25±0.01	
	IO	0.47±0.03	0.38±0.03	0.43±0.03	
	EO	0.58±0.04	0.54±0.03	0.55±0.03	
VAL	TrA	0.52±0.04	0.38±0.03	0.40±0.04	*
	IO	0.71±0.03	0.47±0.04	0.52±0.02	*
	EO	0.53±0.06	0.47±0.03	0.54±0.05	

\*Significant difference ( $p < 0.05$ ). Unit: cm; NP, nulliparous; VD, vaginal delivery; CD, Cesarean delivery Mean±SD

abdominis (TrA). A vertical line was then drawn from this point to measure the thicknesses of the TrA, the internus obliquus (IO), and the externus obliquus (EO). The subjects were then asked to perform a maximum effort Valsalva maneuver. The Valsalva maneuver is defined as the maximum straining effort with forced expiration against a closed glottis. The degree of effort during the Valsalva maneuver was not standardized, but the subjects were encouraged to perform maximal straining. During this maneuver, they were instructed not to make any pelvic or lumbar motion. However, the subjects were not instructed to use or to avoid using their abdominal muscles.

The study results were analyzed using SPSS version 12.0. To compare the abdominal muscle thickness among the three groups during the Valsalva maneuver, the data were analyzed by one-way ANOVA and multiple comparisons. To analyze the intrarater reliability in the ultrasonographic measurements, the intraclass correlation coefficients for the measured values were calculated. The significance level was chosen as  $\alpha = 0.05$ .

## RESULTS

There were significant differences in the thickness of the TrA in all the groups between rest and the Valsalva maneuver, and there were significant differences in the IO in the nulliparous group ( $p < 0.05$ ) (Table 1). During the Valsalva maneuver, there were significant differences in the TrA between the nulliparous group and the vaginal delivery group, and there were significant differences in the IO between the nulliparous group and the vaginal delivery group, and between the nulliparous group and the Cesarean section group ( $p < 0.05$ ) (Table 2). The vaginal pressure was  $25.5 \pm 24.02$  in the nulliparous group,  $16.10 \pm 3.18$  in the vaginal delivery group, and  $15.33 \pm 1.70$  in the Cesarean delivery group during the Valsalva maneuver (Table 3). There were significant differences between the nulliparous group and the vaginal delivery group, and between the nulliparous group and the Cesarean delivery group these results suggest that child birth delivery method changes the vaginal pressure ( $p < 0.05$ ).

**Table 3.** Vaginal pressures of the groups during the Valsalva maneuver

Group	Nulliparous	Vaginal delivery	Cesarean delivery
Vaginal pressure	25.52±4.02	16.10±3.18	15.33±1.70 *

\*Significant difference (p<0.05). Unit: cmH<sub>2</sub>O

## DISCUSSION

Sapsford et al.<sup>17)</sup> reported that the abdominal muscles contract during PFM contraction and that the contraction is particularly conspicuous in the TrA, IO, EO. In this study, the activities of the TrA and IO increased in conjunction with the contraction of the PFM during the Valsalva maneuver. The measurement of the thickness of the TrA muscle using ultrasonography imaging has been validated in previous studies (range 0.87–0.99)<sup>16, 18)</sup>. The intra-examiner reliability with regard to the measurement of the muscle thickness in the present study during the Valsalva maneuver was similar to those reported in previous studies. During the Valsalva maneuver, the thickness of the TrA increased most in the nulliparous group (from 0.28 to 0.52), and it also increased from 0.25 cm to 0.40 cm in the Cesarean delivery group. During the Valsalva maneuver, the mobilization ability of the TrA was greater in the nulliparous group than in the other two groups. This is likely due to excessive extension of the abdominal muscles during pregnancy weakening the contraction ability of the abdominal muscles.

There was no change in the EO in any of the groups during the Valsalva maneuver, suggesting that the experience of pregnancy and method of delivery do not affect the EO. During PFM contraction, the vaginal delivery group showed lower muscle activities than the Cesarean delivery and the nulliparous groups<sup>9)</sup>. Thompson et al.<sup>14)</sup> reported that the activity of the PFM increased during the Valsalva maneuver. Another study reported that the TrA supported the perineum through eccentric contraction when the abdominal pressure increased<sup>19)</sup>.

In the present study, the vaginal pressure was 25.52±4.02 in the nulliparous group, 16.10±3.18 in the vaginal delivery group, and 15.33±1.70 in the Cesarean delivery group during the Valsalva maneuver. When abdominal pressure increases, the activity of the TrA may increase during strong coughing or strong expiration<sup>20)</sup>. The low vaginal pressure in the vaginal delivery and Cesarean delivery groups, group with delivery experience, supports the results of research that pregnancy and delivery weaken the contraction ability of the TrA. In this study, the experience of delivery affected the vaginal pressure during the Valsalva maneuver, and the TrA and the IO were influenced by the experience and the method of delivery.

The limitations of this study were the difficulty in standardizing the Valsalva maneuver and in determining the abdominal muscle thickness during the Valsalva maneuver. The performance of the Valsalva maneuver is dependent on the ability of the subject to repeat the task in a reliable manner, which is difficult to establish and control. Future research should validate the ultrasonography findings of this study while simultaneously assessing muscle activation with surface EMG.

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