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Effect of different delivery modes on pelvic floor structure revealed by ultrasonography.

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Abstract

Objective: This study is to investigate the effect of different delivery modes on pelvic floor structure by using ultrasonography.
Method: A total of 194 cases of patients visited Liaocheng Peoples' Hospital aged between 25 to 40 y old were enrolled in this retrospective study. According to their fertility status, these 194 cases were divided into childless group and fertility group. The fertility group was divided into vaginal delivery group and cesarean section group according to the delivery modes. GE E8 cavity was used to detect relative distances (bladder neck-symphyseal short, BSD; bladder neck descent, BND; detrusor thickness, DT) and angles (bladder urethra after angle, bladder neck rotation angle) of each group in different states. We compare the differences between groups by corresponding statistical methods.
Results: There was no significant difference in BSD, DT and posterior vesicourethral angle (β) between childless and fertility groups under the resting states, while β was different between vaginal delivery and cesarean delivery groups. During Valsalva movement, BND, β, and bladder neck rotation angle were different between each groups, and the differences were statistically significant. The stress urinary incontinence diagnosis rate of fertility group was statistically higher than that of childless group, and so did the vaginal delivery and cesarean delivery.
Conclusion: Pregnancy and delivery can damage the pelvic floor system, and the pelvic anatomy changes caused by delivery might play a key role in the postpartum stress urinary incontinence. These results can provide the useful information to establish the meaningful guidelines to assist both patients and health care providers in making decision.

Keywords: Pelvic ultrasound, Delivery mode, Pelvic floor functional disorder.

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Introduction

Female pelvic floor, which is close to the pelvic outlet, is composed of multiple layers of muscle, fascia and ligament. It constitutes a complex pelvic support system and pelvic floor function is a dynamic equilibrium system that relies on the interaction of intact muscle, knotted tissue and nerve distribution [1]. If it is damaged in any of the bones, muscles, or nerves of three compartment levels of the pelvic floor, there may cause Pelvic Floor Dysfunction (PFD). Currently, PFD is one of the most common chronic diseases affecting women's physical and mental health, which developed in nearly 50% of women over 50 y old, has a significant impact on their quality of life [2]. The PFD was mainly manifested as stress urinary incontinence and pelvic organ prolapse.

The cause of PFD is multifaceted, and pregnancy and childbirth can lead to pelvic support tissue relaxation or rupture, which is one of the major risk factors for PFD [3,4]. Because of the wide range of symptoms and related diseases, simple clinical assessment is usually not sufficient to achieve complete diagnosis, so the comprehensive assessment of PFD is essential.

Comparison of anatomical function and structure of female pelvic floor between women with different delivery modes provides potentially useful information on the risk of subsequently developing PFD. If we determine the effects of different delivery modes on the anatomical function and structure of female pelvic floor, these findings will be important in establishing meaningful guidelines to assist both patients and health care providers in making decision.

Therefore, in this study, the effects of different delivery modes on the anatomical function and structure of female pelvic floor were analyzed by pelvic ultrasonography.

Materials and Methods

Objects

A total of 194 women of childbearing age visited our hospital from January 2014 to 2015 were enrolled in this study. Among the 194 participants, 50 cases were childless women and 144 cases were fertile women. There were 84 cases of vaginal delivery and 60 cases of cesarean delivery women. All subjects met the following criteria: no incontinence or childbirth before the symptoms of incontinence; without clinical and ultrasound examination identified urinary system diseases, kidney disease and pelvic surgery history; effectively complete the Valsalva movement and levator ani movement. The fertile women gave birth to a single baby.

Color Doppler ultrasound

As for parameter measurement, GE Voluson E8 color Doppler ultrasound was applied with the endocavity probe frequency of 6-12 MHz. Briefly, the perineum pelvic ultrasound measurement was as follows. The inspection was performed with moderate bladder filling (50~100 ml) and stool emptied. The patients were examined at lithotomy position, and the probe was adjusted to keep the axis of the pubic symphysis and the horizontal line in the lower edge of pubic symphysis forming 45 degrees. Images of resting state pubic symphysis, bladder neck, urethral, vaginal, anorectal connection and median sagittal images under the condition of the maximum Valsalva were obtained.

Parameter collection

Under the aforementioned two states, the following parameters were measured: (1) Bladder neck-Symphyseal Distance (BSD); (2) Posterior vesicourethral angle (β), that is, the angle between proximal urethra and the posterior wall of the bladder (the normal value was 90°~120°); (3) Bladder Neck Descent (BND), i.e., the difference of the bladder neck to the lower edge of the pubic symphysis between resting and the largest Valsalva state; (4) Detrusor thickness (DT), of which three points were measured and the average value was taken; (5) Bladder neck rotation angle, referring to the difference of the angle between the lower edge of pubic symphysis to the internal urethral connection and the axis of symphysis pubis at the two states (normal range <20°) [5,6].

Pelvic organ prolapse condition was observed with the horizontal line through the lower edge of the pubic symphysis as a reference. It was taken as negative if the pelvic organ was above the reference line. And it was taken as positive if the pelvic organ was under the reference. Negative and positive represent inside and outside the pelvic.

Stress incontinence ultrasound diagnostic criteria was defined as follows: (1) At resting state, bladder urethral angle ≥ 95°; (2) At Valsalva state, the vertical distance from the bladder neck to the pubic symphysis was ≥ 2.3 cm; (3) Bladder neck rotation angle was ≥ 20°. Patients with more than 2 of the 3 criteria were diagnosed as stress incontinence [7].

Statistical analysis

SPSS19.0 and GraphPad Prism 5.0 statistical software were applied for statistical analysis. The χ^2 test was used to compare the stress urinary incontinence distribution between two groups. and p<0.05 was considered as statistically significant.

Results

Baseline characteristics

In order to determine the comparability of subjects between different groups, the patient's age, Body Mass Index (BMI), and other baseline data were collected and compared. There was no significant difference in age, height and BMI between the childless group and the fertility group, and between vaginal delivery and cesarean delivery subgroups (P>0.05, Table 1). These results suggest that there were no difference in the patients in baseline characteristics.

Table 1. Comparison of baseline characteristics of each group.

	Unborn group (n=50)	Fertility group (n=144)		p
		Vaginal delivery group (n=84)	Cesarean delivery group (n=60)	
Age (y)	29.78 ± 3.79	30.24 ± 3.12	31.15 ± 2.96	0.077
Height (cm)	161.00 ± 5.47	160.73 ± 5.80	161.28 ± 6.35	0.855
BMI	21.54 ± 2.22	22.18 ± 2.40	22.5 ± 2.01	0.079

Perineal pelvic ultrasonography in resting state

To study the effects of gestation and delivery modes on female pelvic floor function under resting state, indexes of pelvic floor function was measured. In the resting state, there were no statistically significant differences in BSD, DT and β between the childless and fertile women (P>0.05, Table 2). Similarly, for BSD and DT, the same results were observed between vaginal delivery group and cesarean section group.

However, the angle of the cesarean section was significantly larger than that of the vaginal delivery group (P=0.000, Table 3). These results indicated that in the resting state, there was no significant change in the effects of pregnancy and delivery modes on the pelvic floor. However, the changes of the posterior horn of the urinary bladder were different in the resting state. It is suggested that women with vaginal delivery may have the possibility of concealed pelvic floor dysfunction.

Table 2. *Perineal pelvic ultrasonography between unborn group and fertile group in resting state.*

	Unborn group (n=50)	Fertility group (n=144)	P
BSD (mm)	21.14 ± 2.11	20.65 ± 2.01	0.145
DT (mm)	0.28 ± 0.18	0.28 ± 0.20	0.951
β (°)	132.75 ± 8.61	135.01 ± 13.34	0.173

Table 3. *Perineal pelvic ultrasonography between vaginal delivery group and cesarean delivery group in resting state.*

	Vaginal delivery group (n=84)	Cesarean delivery group (n=60)	P
BSD (mm)	20.76 ± 2.16	20.48 ± 1.80	0.424
DT (mm)	0.27 ± 0.23	0.29 ± 0.16	0.613
β (°)	131.5 ± 14.09	139.92 ± 10.49	0

Perineal pelvic ultrasonography in Valsalva state

In order to investigate whether there were differences of in each group under Valsalva, indexes of pelvic floor function was measured. In the fertility group, the BND (mm), β (°) and bladder neck rotation angle were significantly higher than that of the childless group, and there were statistical differences (P<0.05, Table 4).

Table 4. *Perineal pelvic ultrasonography between unborn group and fertile group in Valsalva state.*

	Unborn group (n=50)	Fertility group (n=144)	P
BND (mm)	16.26 ± 1.37	20.03 ± 2.43	0
β (°)	135.26 ± 11.51	144.05 ± 13.15	0
Bladder neck rotation angle	12.06 ± 2.22	19.76 ± 6.45	0

In contrast, in the vaginal delivery group, the BND (mm) and bladder neck rotation angle were significantly higher than that of the cesarean section group, but the β (°) in the vaginal delivery group was significantly lower than the cesarean section group (P<0.05, Table 5). These results showed that childbirth is one of the causes of pelvic floor dysfunction.

Table 5. *Perineal pelvic ultrasonography between vaginal delivery group and cesarean delivery group in Valsalva state.*

	Vaginal delivery group (n=84)	Cesarean delivery group (n=60)	P
BND (mm)	21.51 ± 1.83	17.97 ± 1.48	0
β (°)	139.90 ± 12.44	149.85 ± 11.96	0
Bladder neck rotation angle	23.96 ± 5.01	13.87 ± 2.23	0

Urinary incontinence

Further study was performed to illustrate the effects of gestation and delivery modes on the incidence of stress urinary incontinence. According to the diagnostic criteria of hypopharyngeal urinary incontinence, in the fertility group, stress urinary incontinence was 24.31%, which was significantly higher than that of the childless group (P<0.05, Table 6).

Table 6. *Comparison of stress urinary incontinence in the unborn group and fertility group.*

	Unborn group (n=50)	Fertility group (n=144)	x^2	p
Stress urinary incontinence	5 (10%)	35 (24.31%)	4.64	0.041
No stress urinary incontinence	45 (90%)	109 (75.69%)		

For the fertile women, in the vaginal delivery group, the urinary incontinence rate was higher than the cesarean delivery group. The difference between the two groups was statistically significant (P<0.05, Table 7). Together, the results argued that childbirth may be one of the reasons for the occurrence of stress urinary incontinence.

Table 7. *Comparison of stress urinary incontinence in the vaginal delivery group and cesarean delivery group.*

	Vaginal delivery group (n=84)	Cesarean delivery group (n=60)	x^2	p
Stress urinary incontinence	26 (30.95%)	9 (15%)	4.84	0.031
No stress urinary incontinence	58 (69.05%)	51 (85%)		

Discussion

Pelvic floor dysfunction could lead to the abnormal function of the anterior, middle and posterior pelvic cavity. The most common clinical manifestation of the pelvic organ dysfunction is postpartum stress urinary incontinence [8]. The posterior urethral angle, urethral rotation angle, bladder neck rotation angle and increased bladder neck mobility are considered as important etiological factors of female stress urinary incontinence, among which, bladder neck mobility is most closely related to stress urinary incontinence [9-12]. Measurement of bladder and urinary tract angle, urethral rotation angle, bladder neck rotation angle, and bladder neck mobility can directly reflect the occurrence of stress urinary incontinence.

Currently, the pelvic organ prolapse quantitative evaluation system published by the International Urinary Control

Association is used to evaluate the pelvic organ, which mainly relies on the anatomical relationship to evaluate the prolapse. However, due to the complexity of the pelvic floor anatomy, the evaluation is difficult and could not reflect the functional status of the pelvic organ. Transperineal ultrasonography can observe the movement of the pelvic organs both intuitively and dynamically, and by measuring the lowest point of pelvic organs from the pubic symphysis distance to determine whether the pelvic organ prolapse and evaluate prolapse stages.

Some studies focus on the relationship of delivery modes and the pelvic floor dysfunction was performed by questionnaire to obtain the data [13]. But we measured the BSD, DT, and β by ultrasonography to study the perineal pelvic structure in two states include the resting state and Valsalva state. And we not only designed the group of vaginal delivery and cesarean section, but also designed the childless and fertile group to study the role of pregnancy and childbirth on the pelvic floor dysfunction, while in some similar studies they usually performed their studies only in vaginal delivery and cesarean section, which is the advantage of our study. The results showed that the BSD, DT and β were not statistically significant in the resting state between the childless women and fertile women. The difference of β between women who were vaginal delivery and cesarean section was statistically significant in resting state. Some occult injuries may occur during pregnancy and childbirth.

There was a significant difference in the rotation angles of BND, β, and bladder neck between the childless and fertile groups, the vaginal delivery group and the cesarean section under Valsalva action. The incidence of stress urinary incontinence in the fertility group was significantly higher than that in the childless group. The incidence of postpartum stress urinary incontinence was higher in the vaginal delivery group than in the cesarean section group, and the difference was statistically significant. Another study has obtained the similar results, in the study the prevalence of pelvic organ prolapse, stress urinary incontinence, overactive bladder, and anal incontinence was assessed in a random sample of women aged 25-84 y by using the validated Epidemiology of Prolapse and Incontinence Questionnaire and they found that the risk of pelvic floor disorders is independently associated with vaginal delivery and cesarean delivery has a protective effect on the development of pelvic floor disorders when compared with vaginal delivery [14]. During the delivery process, under the mechanical compression and expansion by the foetal head, the pelvic floor muscles degenerate and leading to shortening of muscle fibers and diminished contractility [5]. Pelvic floor nerves are also damaged in this process which further induces denervation phenomenon of the pelvic floor muscle [15,16]. Additionally, some obstetric factors such as the increase of the number of childbirth, the overlong second stage of labor, the over-large foetal weight and foetal head circumference, perineal incision, etc., all can increase the denervation of pelvic floor and urethral striated muscle. Although the contraction force of the pelvic floor was not affected compared with the vaginal delivery, the changes in the location of the vaginal and bladder neck were also lighter than that of the vaginal delivery. The incidence of pelvic floor nerve injury was significantly reduced in cesarean section as surgical operation may cause connective tissue, fascia, muscle and ligament pelvic support structural abnormalities, nerve tissue damage, vascular nutritional disorders, etc., which will still affect the function of urinary tract urinary system, leading to urinary incontinence happened.

In summary, the changes in pregnancy itself may cause pelvic floor dissection and functional damage. The damage of the vaginal delivery on the pelvic support is greater than that of the cesarean section. However, the protection of cesarean section on pelvic floor is limited. The risk of pelvic functional disease in women taking vaginal delivery increased and pelvic ultrasound can improve detection rate of postpartum women with pelvic floor functional disease, which, is suitable for wide application in clinic.

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None.

Conflicts of Interest

All authors declare no financial and non-financial competing interests.

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