Revista Argentina de Clínica Psicológica
2020, Vol. XXIX, N°4, 1304-1312
DOI: 10.24205/03276716.2020.1127

Study on Application Value of Pelvic Floor Ultrasound in Functional Screening of Pelvic Floor in The Third Trimester of Pregnancy and Postpartum Period

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Abstract

Purpose: To study the application value of pelvic floor ultrasound in functional screening of pelvic floor during the third trimester of pregnancy and postpartum period.

Data and Methods: From January 2018 to January 2019, 80 puerperas with vaginal delivery who were admitted in the Department of Obstetrics of the Hospital were selected as study objects. Three-dimensional ultrasonography of pelvic floor was performed to measure the left and right diameter, anteroposterior diameter and area of levator ani muscle tear in the third trimester of pregnancy and 42-56 days after delivery, after Valsalva maneuver and in the state of anal contraction. The changes of levator ani muscle tear in the third trimester of pregnancy and postpartum puerperas were observed, and pelvic prolapse was evaluated.

Results: There were 10 cases of stress urinary incontinence in 80 puerperas, and no abnormalities were found in other tissues of pelvic floor. The postoperative urethral rotation angle, retrovesical angle and bladder neck mobility of puerperas with urethral funnels, cystocele and uterine prolapse were significantly greater than those in the third trimester of pregnancy ($P < 0.05$);In puerperas with abnormal shape of levator ani muscle, rupture of levator ani muscle or rupture anal sphincter, the left and right diameter, anteroposterior diameter and area of levator ani muscle tear in 42-56 days after delivery, in Valsalva maneuver and in the state of anal contraction were significantly higher than those of the third trimester of pregnancy ($P < 0.05$).

Conclusion: There are significant differences in the indexes of pelvic floor ultrasonography between postpartum period and the third trimester of pregnancy in puerperas with pelvic floor dysfunction. The pelvic floor ultrasonography can be used to screen the puerperas with pelvic floor dysfunction scientifically and effectively, which is of great significance in the diagnosis and early treatment of related diseases.

Keywords Pelvic floor ultrasound; Third trimester of pregnancy; After delivery; Pelvic floor function; Application value

Instruction

Delivery is a process that most women need to undergo. In recent years, relevant studies have shown that delivery not only has a significant effect on physical and mental health of puerperas, but also has a significant effect on pelvic cavity function. Pregnancy and delivery are important causes of female pelvic dysfunction[1-2]. Female pelvic floor dysfunction is caused primarily by defects in pelvic floor support structures or by degeneration, damage, and dysfunction, resulting in common disorders such as pelvic organ prolapse, stress urinary incontinence and sexual dysfunction. Relevant studies have demonstrated that pregnancy and delivery have a significant impact on the development of pelvic floor dysfunction in women, especially vaginal delivery, and pregnant women and puerperas using scientifically valid tests to assess pelvic floor

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function is of great importancefor early diagnosis and treatment of pelvic related diseases[3]. With the progress of medical technology and equipment, the methods and approaches of female pelvic function examination and evaluation have been gradually innovated and perfected. Among them, computerized tomography (CT), magnetic resonance imaging (MRI), pelvic floor ultrasound and urodynamic examination are feasible examination methods. Pelvic floor ultrasound has the advantages of convenient operation, safe free radiation and reasonable price in clinical examination application, and ultrasound detection can realize dynamic detection, with high image resolution and high degree of patient acceptance, which is the important imaging method commonly used in clinical examination. From January 2018 to January 2019, 80 puerperas with vaginal delivery who were admitted in the Department of Obstetrics of the Hospital were selected as study objects. Three-dimensional ultrasonography of pelvic floor was performed to measure the left and right diameter, anteroposterior diameter and area of levator ani muscle tear in the third trimester of pregnancy and 42-56 days after delivery, after Valsalva maneuver and in the state of anal contraction. The changes of levator ani muscle tear in the third trimester of pregnancy and postpartum puerperas were observed, and pelvic prolapse was evaluated, and the application value of pelvic floor ultrasound in functional screening of pelvic floor during the third trimester of pregnancy and postpartum period was studied, and the report is presented below.

1. Study Data and Methods

1.1 General data

80 puerperas with vaginal delivery admitted from January 2018 to January 2019 in the Department of Obstetrics of the Hospital were selected as the study objects. The age ranged from 23 years old to 32 years old, with a mean age of (27.46±3.34) years old. The inclusion criteria for puerperas were: (1) Signed the informed consent form for the study approved by the Ethics Committee in the Hospital; (2) Underwent regular prenatal examination; (3) The mode of delivery was vaginal delivery; (4) Primiparous puerperas with gestational weeks ranging from 37 weeks to 42 weeks; (5) They were re-examined in the Hospital in the postpartum period of 42d-56d; (6) They were able to complete the Valsalva maneuver anal levator anus movement as directed. Exclusion criteria of patients: (1) Puerperas complicated with complications of pregnancy; (2) Puerperas complicated with urinary system infection and other organic diseases of organs; (3) Puerperas with abnormal spirit or language dysfunction; (4) Puerperas undergoing cesarean section; and (5) Puerperas whose case data were incomplete or who were unable to achieve follow-up.

1.2 Methods

All the included puerperas were probed with Philips color Doppler ultrasound diagnostic device, the three-dimensional matrix probe of abdomen was set to 1.5MHz - 6.0MHz, the maximum scanning angle of 2D was set to 90°, and the field of view of 3D imaging was set to 90°×90°.Before the examination was carried out, the medical personnel told the patients to empty the bladder, chose the lithotomy position of the bladder, carried out the perineum ultrasonic examination, smeared the sterilized coupling agent on the probe surface, and covered the condom on the outside; set the instrument as a three-dimensional model of the maternity, and placed the probe between the perineum urethra and the vaginal orifice, respectively, to carry out two-dimensional imaging and three-dimensional imaging examination. Two- dimensional imaging was used to measure the urethral rotation angle, posterior bladder angle and bladder neck mobility degree of pregnant women and puerperas, to explore whether the posterior bladder angle was more than 140° during Valsalva maneuver, and to evaluate urinary leakage. The bladder position was examined for whether it is below the reference line to determine the presence or absence of cystocele; the horizontal distance between the cervix and pubis and the resting movement during Valsalva maneuver were examined to assess the presence or absence of uterine prolapse, and the standard values for both were 30mm and 20mm; the bulging height of the anterior rectal wall was examined to determine the presence of rectocele;Then, the 3D acquisition system was started to detect the parameters related to the levator ani muscle tear in different states of the objects. In the state of anal contraction movement, the fault image was examined and observed using the tomography slice technique, and the continuous fault image with layer spacing of 1mm was obtained. When the anal elevator muscle interruption condition was found in 8 or more consecutive fault images, it was judged that there might be anal elevator muscle tear. If the anal sphincter was continuously

interrupted in 8 or more consecutive planes and the defect was >30°, the presence of anal sphincter injury can be assessed.

1.3 Statistical processing method

For the measurement and statistical data in this study, SPSS 20.0 statistical software was used for calculation and processing, and (*t*) for data verification. $P < 0.05$ indicates that the difference is statistically significant.

2. Results

2.1 Analysis of clinical examination results

10 out of 80 puerperas showed stress urinary incontinence after delivery, the incidence rate was 12.50%, no other abnormal symptoms of pelvic floor tissues such as anal sphincter injury and rectocele were found;The remaining puerperas had no obvious clinical manifestations. 22 out of the 80 patients had urethral funnels 42d to 56d after delivery, 10 cases had cystocele and 4 cases had uterine prolapse; 46 out of the 80 puerperas had abnormal morphological symptoms of levator ani muscle tear 42d to 56d after delivery, of which 9 had central axis deviation, 37 had ellipsoid or round shape, 3 had symptoms of levator ani muscle rupture, and 1 had anal sphincter rupture.

2.2 Comparison of ultrasound findings in the third trimester of pregnancy and postpartum period under Valsalva maneuver

In puerperas with postproduction urethral funnels, cystocele and uterine prolapse, the rotational angle of urethra, the posterior angle of bladder and the movement degree of bladder neck under Valsalva maneuver after delivery were significantly greater than those in the third trimester of pregnancy ($P < 0.05$). As shown in Table 1 below.

Table 1. **Comparison of Ultrasound Findings in the Third Trimester of Pregnancy and Postpartum Period under**

Valsalva Maneuver ($\bar{x}$ ±s) Group	Urethral rotation angle (°)	Posterior angle of bladder (°)	Bladder neck mobility (cm)
The third trimester of pregnancy	28.95±8.76	112.85±9.87	0.15±0.04
Postpartum 42d - 56d	38.35±12.69	131.26±14.64	0.24±0.04
t	8.956	10.884	12.964
P	0.035	0.029	0.025

2.3 Comparison of ultrasonic examination findings of levator ani muscle tear in different states of the third trimester of pregnancy and postpartum period

In puerperas with abnormal shape of levator ani muscle, rupture of levator ani muscle or rupture anal sphincter, the left and right diameter,anteroposterior diameter and tear area of levator ani muscle tear in 42-56 days after delivery, in Valsalva maneuver and in the state of anal contraction were significantly higher than those of the third trimester of pregnancy ($P < 0.05$). As shown in Table 2 below.

Table 2. **Comparison of Ultrasonic Examination Findings of Levator Ani Muscle Tear in Different States of the Third Trimester of Pregnancy and Postpartum Period**

($\bar{x}$ ±s)

	Left and right diameter (mm)			Anteroposterior diameter (mm)			Area (cm^2)		
Group	Rest state	Valsalva maneuver	Anal contraction state	Rest state	Valsalva maneuver	Anal contraction state	Rest state	Valsalva maneuver	Anal contraction state
The third trimester of pregnancy	38.95±2.68	41.28±3.08	36.95±2.98	48.85±4.08	51.85±3.67	42.37±1.76	13.06±1.68	16.85±2.18	11.94±1.19
Postpartum 42d - 56d	41.03±3.18	44.24±3.02	38.14±3.08	51.32±3.59	54.24±2.82	48.14±3.12	15.74±2.34	18.93±2.62	13.83±1.72
t	12.215	12.135	9.964	12.035	11.954	14.254	10.012	9.678	9.854
P	0.026	0.026	0.032	0.026	0.027	0.022	0.03	0.033	0.032

3. Discussion

3.1 Significance of functional examination and evaluation of pelvic floor

Female pelvic floor is mainly composed of related organs supporting pelvic cavity, muscle blocking pelvic outlet, fascia and pelvic viscera,

etc. In this complex entirety, any tissue being damaged or degraded will break pelvic floor tissue balance, and the risk of pelvic floor dysfunction will be significantly increased after exceeding the compensation range. Women during pregnancy have a significant increase in uterine gravity, coupled with the unavoidable effects of neurological function and hormonal changes during pregnancy, the significant changes will be occurred in the structure and function of the pelvic floor tissue[4-5]. During pregnancy and delivery, pelvic floor tissue will undergo a series of remodeling processes. The increasing of uterus in pregnancy will cause that pelvic floor muscle and pelvic floor connective tissue in pelvic floor undergo obvious traction and elongation, and its tension will gradually decrease, while the changes of hormone levels in pregnant women will lead to degeneration or relaxation of pelvic floor connective tissue, and coupled with long-term compression during pregnancy, pelvic floor structure will be ischemic, hypoxic and damaged, while vaginal delivery is more likely to cause direct damage to the levator ani group[6-7]. Under the influence of the above factors, pelvic floor dysfunction can develop if pelvic floor tissue cannot be restored by self-repair after puerperas' delivery. Pelvic floor dysfunction can cause a range of diseases such as pelvic organ prolapse, stress urinary incontinence and sexual dysfunction, especially the former two kinds will result in the leakage of urine in the daily life and will even seriously affect their sexual life and activities of daily living, and the long-term exposure and wear of prolapsed organs even will have the phenomena of erosion and carcinogenesis, and serious effects will be produced on female physical and mental health as well as family and life[8-9]. Therefore, through early examination after delivery, timely detection and diagnosis of pelvic floor tissue and function abnormalities are of great significance for improving the early diagnosis rate of pelvic floor dysfunction, preventing and controlling the occurrence and development of diseases. At present, the imaging examination methods of pelvic floor structure and function mainly include CT, MRI and pelvic floor ultrasonography, etc. Among them, CT examination may cause certain radioactive damage to human body, its acceptance range and popularization value have certain limitation, while MRI examination is expensive, and the examination time is long, so it cannot be widely popularized and applied. Ultrasound technology has significant safety and non-invasive advantages, with relatively low examination cost, high acceptance degree, and repeatability of ultrasound examination, which can form dynamic imaging and realize dynamic observation of pelvic floor structure. These are also the functions that cannot be realized by MRI examination currently. Based on the above advantages, the application range of pelvic floor ultrasonography in clinical diagnosis and treatment has become more extensive. It plays an important role in women's pelvic floor function screening and assessment and treatment outcomes[10].

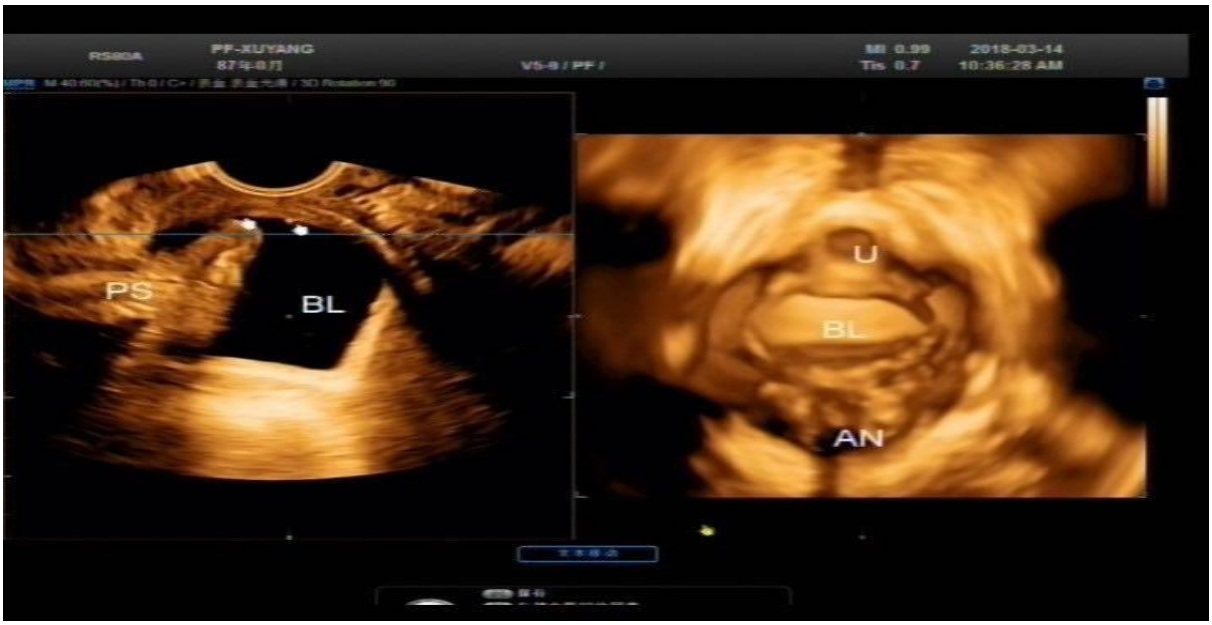

Figure 1. **Pelvic Floor Ultrasonography Image**

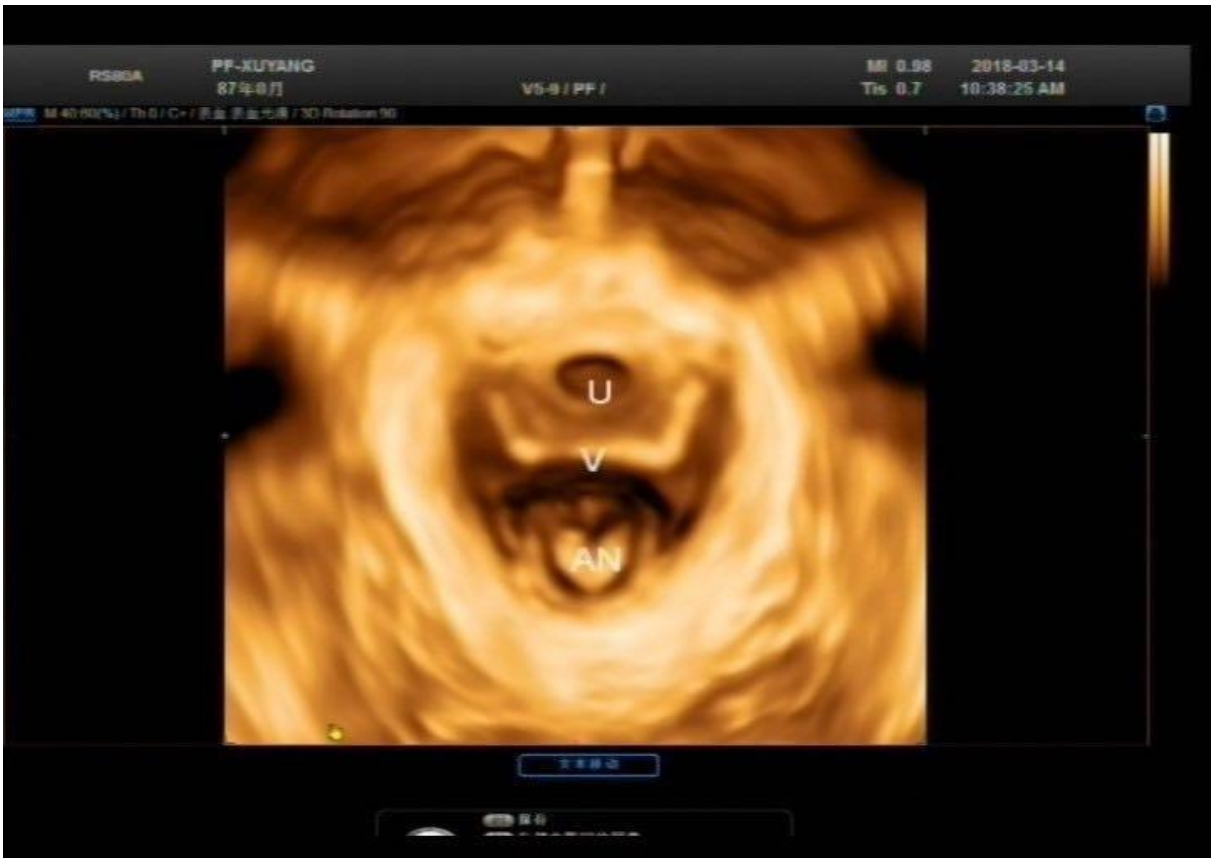

Figure 2. **Pelvic Floor Ultrasonography Image**

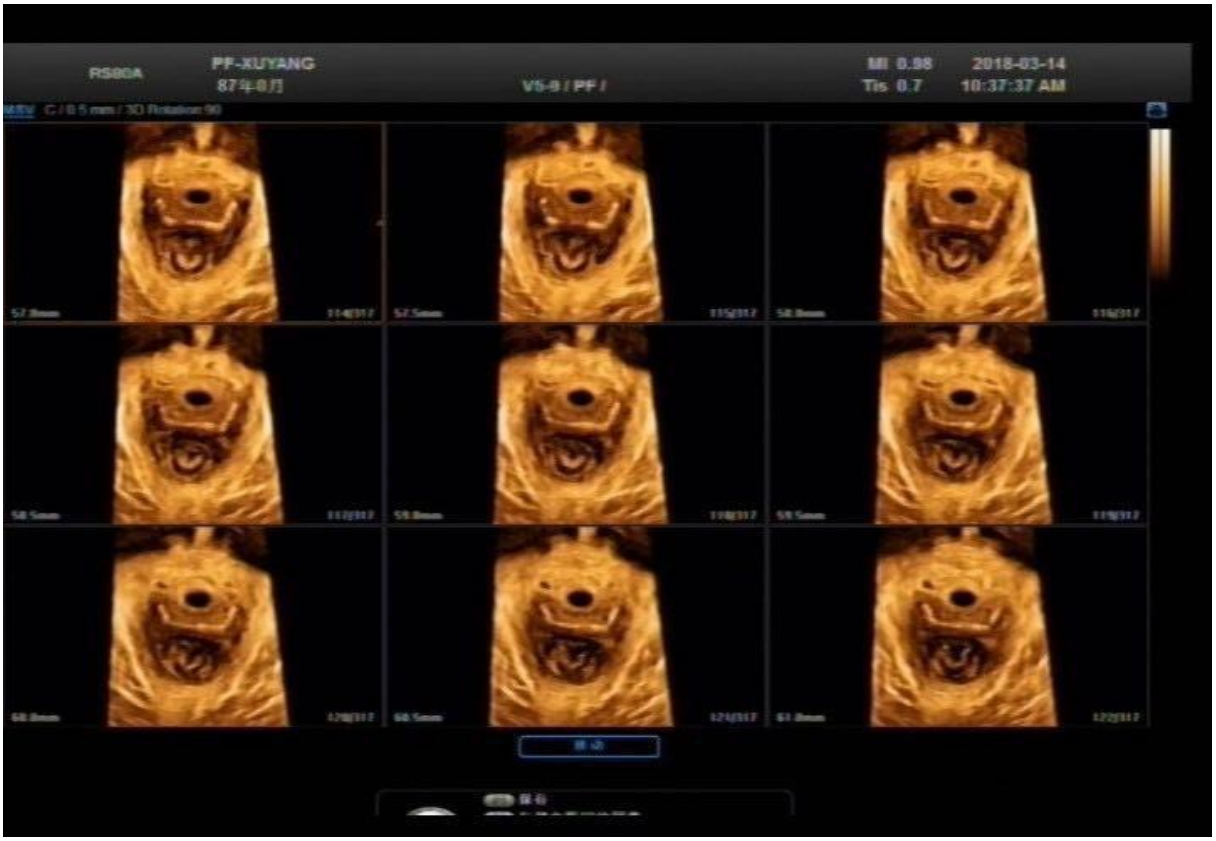

Figure 3. **Pelvic Floor Ultrasonography Image**

3.2 Overview of pelvic floor ultrasound

In the 1980s, foreign medical personnel had used transperineal ultrasound to examine and assess female urinary incontinence and pelvic organ prolapse. After decades of research and practice, the technical level and practical application of pelvic floor ultrasound technology have been gradually improved and become mature, which play an increasingly important role in pelvic function assessment and diagnosis, especially in the development and application of three-dimensional and four-dimensional ultrasound volume imaging technology, making pelvic floor ultrasound application and pelvic floor function examination enter a new stage[11]. Although the pelvic floor ultrasonic technology in China has been relatively late compared with some foreign countries, it has also achieved rapid and long-lasting development under the continuous deepening of clinical research and practice, and has a certain application range in the diagnosis of pelvic floor diseases in women. However, the reference value range of pelvic floor ultrasonic parameters has a wide range of data, which is still missing. Pelvic floor ultrasonography is effective in the treatment of recurrent urinary tract infections, stress urinary incontinence, overactive bladder, pelvic pain, pelvic organ prolapse, micturition disorders, bowel disorders, fecal incontinence, and post-pelvic floor surgery complications[12]. During the implementation of pelvic floor ultrasound, the lithotomy site is taken. After exposure of the perineum, the volume probe is placed in the perineum. Through two-dimensional ultrasound, the rest state and Valsalva state changes are compared, and the symptoms such as urethra funnel and urine leakage can be examined. The indicators such as residual urine, urethral rotation angle, posterior angle of bladder, right angle of anus and elevator plate angle can be measured. The application of three-dimensional four-dimensional pelvic floor ultrasound can observe the changes of pelvic organs and levator ani muscle tear in different motion states, and can measure the aperture and area of levator ani muscle tear. At the same time, tomographic ultrasoundimaging (TUI) technique can be used to observe and measure the injury of levator ani muscle and thickness of levator ani muscle layer by layer.In addition, rotating the probe at 90° and tilting towards the posterior and inferior direction, it is feasible to inspect the transverse section of anal canal. Under the four-dimensional ultrasonography, observe the movement changes of anal canal and rectal ampulla under the anal contraction action of puerperas. In combination with and using ultrasound tomography technology, it is feasible to observe the damage of internal and external sphincter of anus and peripheral lesions. The use of pelvic floor ultrasonography for the diagnosis of pelvic organ prolapse and pelvic floor muscle group has been found to be highly consistent with MRI (magnetic resonance imaging).

3.3 Analysis on application value of pelvic floor ultrasound in functional screening of pelvic floor in the third trimester of pregnancy and postpartum period

In the two-dimensional ultrasonography of perineum, it can clearly display organs such as pubic symphysis, urethra, vagina as well as uterus and rectum, and can also display their positions in anterior, middle and posterior pelvic cavity. Dietz et al. showed that using the inferior border of the symphysis pubis as a reference point in pelvic floor ultrasonography can detect structural information such as bladder neck or posterior bladder bulging inferior border, thus providing reference data for the degree of pelvic organ prolapse. Correlation studies found that quantitative ultrasound assessment of pelvic and posterior pelvic prolapse was highly consistent with clinical assessment. Under the research and practice analysis for many years, it is widely believed that the bladder neck mobility exceeds 10mm and the posterior angle of urinary bladder in stress period is ≥110°, which is the most objective and valuable indicator for clinical diagnosis of stress urinary incontinence. The above parameters can be accurately measured in pelvic floor ultrasonography[13-14]. Three- dimensional pelvic floor ultrasound can represent the axial plane and visually and accurately display the plane of levator ani muscle tear, which is the innovation and progress compared with two- dimensional ultrasound. Under this technical guarantee, the diagnostic mode of pelvic floor ultrasound image is optimized and innovated. Under the guarantee of three-dimensional pelvic floor ultrasound, ultrasonic detection can realize the measurement and examination of the parameters such as anteroposterior diameter, transverse diameter and area of the tear in the plane of the levator ani muscle, the levator ani muscle at rest, Valsava maneuver and the anal contraction, etc., and it is easy to operate and can realize the repeated measurement. The combined application of ultrasound tomography can realize multi-level and continuous detection of the shape and movement

of levator ani muscle, so as to provide more scientific and accurate data basis for the diagnosis of injury and tear of levator ani muscle.

The detection and evaluation of pelvic floor function in women during pregnancy and after delivery mainly needs to examine the integrity of the overall structure of levator ani muscle, especially the morphology and area of the levator ani muscle tear during Valsalva maneuver, which can effectively reflect the compliance and elasticity of the levator ani muscle tear. In this study, pelvic floor ultrasonography was performed with Philips color Doppler ultrasonography. The results showed that 10 out of 80 puerperas showed stress urinary incontinence after delivery, the incidence rate was 12.50%, no other abnormal symptoms of pelvic floor tissues such as anal sphincter injury and rectocele were found;The remaining puerperas had no obvious clinical manifestations. 22 out of the 80 patients had urethral funnels 42d to 56d after delivery, 10 cases had cystocele and 4 cases had uterine prolapse; 46 out of the 80 puerperas had abnormal morphological symptoms of levator ani muscle 42d to 56d after delivery, of which 9 had central axis deviation, 37 had ellipsoid or round shape, 3 had symptoms of levator ani muscle rupture, and 1 had anal sphincter rupture;In puerperas with postproduction urethral funnels, cystocele and uterine prolapse, the rotational angle of urethra, the posterior angle of bladder and the movement degree of bladder neck after delivery were significantly greater than those in the third trimester of pregnancy ($P < 0.05$);In puerperas with abnormal shape of levator ani muscle, rupture of levator ani muscle or rupture anal sphincter, the aperture and area of levator ani muscle tear in 42- 56 days after delivery, in Valsalva maneuver and in the state of anal contraction were significantly higher than those of the third trimester of pregnancy ($P < 0.05$)., and the area of levator ani muscle tear in three states after delivery was significantly higher than that in the third trimester of pregnancy.

Pelvic organ prolapse and stress urinary incontinence are the most common disease types in pelvic floor dysfunction on delivery imaging. The use of pelvic floor ultrasonography can not only determine the presence or absence of pelvic organ prolapse, but also clearly show the location and type of prolapsed organs, as well as examine the presence or absence of implanted material after disease treatment. Although pelvic floor ultrasonography is unable to directly examine and diagnose stress urinary incontinence and fecal incontinence, it can detect characteristic ultrasound manifestations in such patients, thereby laying the foundation for the early diagnosis of the disease. It has been suggested that female pelvic floor structure is stereoscopic and complex, and the treatment with ultrasound-guided collagen injection can significantly improve the therapeutic effect of stress urinary incontinence, with good repeatability. Three-dimensional pelvic floor ultrasonography can clear the position and volume of periurethral collagen after injection treatment in patients, which is helpful for clinical monitoring and guidance of disease treatment[15]. Pelvic floor ultrasonography can not only dynamically observe urine leakage points in patients with stress urinary incontinence, but also provide reasonable explanation beyond urodynamics, increase the morphological basis of disease diagnosis and treatment, and improve the effectiveness of pelvic floor function evaluation and screening. In the examination and evaluation of pelvic organ prolapse, the measured values of each indicator in ultrasound examination and POP-Q standard can be statistically analyzed by the pelvic floor ultrasonography, and the truncation value of pelvic organ prolapse can be obtained by ultrasonography. For anterior pelvic prolapse, pelvic floor ultrasound can show the dropping contents of the anterior wall of the vagina, and can identify the Green type of prolapse of the bladder; for mid-pelvic examination, pelvic floor ultrasound can use vaginal gas lines and cervical cysts to identify the characteristic structure of the cervix uteri. The pelvic floor ultrasonography not only can effectively evaluate the position of pelvic floor functional defect, but also can distinguish the specific structure of bulge, clarify the degree of organ prolapse, and effectively break the limitation of the original examination method.

In addition, the related research indicated that the pelvic floor ultrasonography also has the high value in the surgery treatment and the effect evaluation. With the development of the theory and technology of pelvic floor reconstruction, the surgical treatment of pelvic floor's functional disorders has been innovated and optimized. Surgical treatment methods, such as transvaginal tension-free urethral suspension and mesh implantation, have significant effects on the treatment of pressure urinary incontinence and pelvic organ prolapse, while the examination of the placement and morphology of the implant material after the completion of surgery is an important indicator to evaluate the surgical effect. MRI and X- ray examination methods almost

cannot show the implanted materials, but the pelvic floor ultrasonography can clearly show the suspender and mesh and other implanted materials, together with the application of three-dimensional and four- dimensional ultrasound, the implanted materials can be located throughout the whole process, and the elastic degree of suspender and other materials can be assessed by ultrasound imaging. In the pelvic floor ultrasonography, the problems such as poor operation effect and tight suspender of the patients with complications can all be clearly checked out, which has the vital significance to the clinical treatment plan adjustment and optimization. With the advantages of convenient operation, safe and quick operation, low price and good mode of implementation, pelvic floor ultrasonography can play an active role in the examination of pelvic floor anatomic structure and functional changes, timely and accurately discover pelvic functional defects of patients, and realize four-dimensional imaging, which is of great significance for prenatal examination, postpartum follow-up and pelvic functional screening and evaluation. At the same time, pelvic floor ultrasonography can also play its great potential in the treatment of pelvic floor dysfunction disease evaluation and pelvic floor rehabilitation training guidance, develop a more perfect pelvic floor muscle training program for patients through the whole-process and dynamic monitoring and evaluation of pelvic floor muscle contraction, and assess pelvic floor function, and can provide women with more scientific and rigorous imaging data for the diagnosis and treatment of pelvic floor dysfunction disease and rehabilitation. To sum up, there are significant differences in the indexes of pelvic floor ultrasonography between postpartum period and the third trimester of pregnancy in puerperas with pelvic floor dysfunction. The pelvic floor ultrasonography can be used to screen the puerperas with pelvic floor dysfunction scientifically and effectively, which is of great significance in the diagnosis and early treatment of related diseases.

Funding

The work was supported by Hebei Provincial Department of Health Medical Science Research Key Project Project, Project Number: 20191437

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