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Original Article

Application and evaluation value analysis of PFU in PSUI

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Abstract: Objective: This study was designed to explore the application and evaluation values of pelvic floor ultrasound (PFU) in patients with postpartum stress urinary incontinence (PSUI). Methods: 31 patients treated in our hospital from January 2019 to December 2019 for SUI 6 weeks after delivery, and 40 healthy puerperants were included as the study objects for PFU. The 2 groups were compared for bladder neck rotation angle (BNRA) (θ), poster urethrovesical angle (PUVA) (Ar, As), distance from the bladder neck to the midpoint of synchondroses pubis (Br, Bs), bladder mobility (Mu), formation rate of internal urethral orifice, and the characteristics reflected on the 3D sonogram of urogenital hiatuses. Results: (1) puerperants in the SUIG showed higher values of θ, Ar, As, Br, Bs and Mu as compared with those healthy ones in the CG ($P<0.05$); (2) puerperants in the SUIG were observed with abnormal urogenital hiatuses or dilatation, manifested as deformation and abnormal enlargement, etc.; (3) the formation rate of internal urethral orifice was 74.19% (23/31) in the SUIG and 10.00% (4/40) in the CG ($X^2=3.903$, $P<0.001$). Conclusion: significant differences were found between the PSUI puerperants and healthy puerperants in the signs of pelvic floor. The severity and prognosis of SUI puerperants could be evaluated based on PFU signs to guide the clinical treatment.

Keywords: PFU, PSUI, application, evaluation values

Introduction

In recent years, the enforcement of two-child policy in China has resulted in a significant rise of birth rate, but also the incidence of postpartum diseases, which affects the normal life of puerperants to a certain degree. The female pelvic floor dysfunction is a kind of comprehensive disease characterized by the thinning, relaxation or fracture of the supporting structure of pelvic floor, which causes the pelvic organs to move downward in the female. The typical clinical manifestations of this disease include urinary incontinence, pelvic organ prolapse, sexual dysfunction, and chronic pelvic pain, etc., exerting severe impact on patients' normal sociality and work. Therefore, the disease is also called "social cancer" [1-3]. SUI is one of the most common kinds in female pelvic floor dysfunction. ICS defines it as the heteronomous urine leakage from the external urethral orifice when the abdominal pressure suddenly rises. Many causes account for SUI, including laughing, coughing, lifting weights, climbing stairs, etc. It is more frequently reported in the early postnatal period [4-6].

Pregnancy and childbirth are the most common causes of SUI. The reason is that pregnancy will produce continuous and chronic compression on the supporting structure of female pelvic floor, and the soft tissues on the pelvic floor will thin, tear or even break under the long-term traction, while vaginal delivery will directly damage them, and in some severe cases, vulva muscles may even tear or break [7]. Some studies have pointed out that during pregnancy or childbirth, the level of female hormones will change significantly, accompanied by reduced supporting effect of their pelvic floors. According to the published data, SUI patients account for more than 50% of the cases of urinary inconti-

nence, and about 20-50% of the female will suffer from it to various degrees after childbirth [8, 9]. At present, the clinical treatments of SUI are surgical and non-surgical. Accurate diagnosis and condition evaluation are the important basis and premise for the treatment, and also the key points in the studies by medical workers [10, 11]. PFU is one of the commonly used examination and diagnosis methods in clinic, and also the imaging method of first choice for pelvic floor dysfunction. It is real-time, simple and highly accurate [12]. The author of this study has found that the signs of pelvic floor of PSUI puerperants were significantly different from those of the normal puerperants, and PFU can be used to assess the conditions of early PSUI patients for later clinical treatment.

Materials and methods

General materials

The 31 patients treated in our hospital due to SUI 6 weeks after delivery from January 2019 to December 2019 were included into the SUIG, and 40 healthy puerperants were included as the CG.

Inclusion criteria: (1) Clear consciousness to cooperate with the study; (2) Complete case data; (3) No application of hormone in the last 6 months; (4) Single birth; (5) Approval from the Ethics Committee of the Hospital for investigation; (6) Introduction of the investigation process, methods and principles to the puerperants or their family members, and acquisition of the informed consents from them; (7) Uterogestation; (8) Vaginal delivery.

Exclusion criteria: (1) Patients complicated with mental diseases; (2) Teratismus according to ultrasound examination; (3) Mechanical assistance during delivery; (4) Incipient abortion; (5) Placenta praevia; (6) Abnormal volume of amniotic fluid; (7) Intrauterine growth retardation; (8) Severe pregnancy complications; (9) Tumors in the pelvis; (10) Prenatal pelvic floor dysfunction.

Instruments and methods

Instruments

A Philips HD 7 color Doppler ultrasound diagnostic system was applied to detect the pelvic floor of all puerperants. The system was equipped with a volume probe set to 4-8 MHz. 2D scanning was employed at the angle of 70°, and the volume scanning angle of 85°.

Methods

Before examination, all patients were required to empty their rectum and bladders. They lied on the back at the lithotomy position. Their hip joints were bent and extended outwardly. Applied with couplant, the probe was placed between and in close contact with the greater lips of pudendum at both sides. As the median sagittal plane was clearly displayed on the screen, the lower margin of synchondroses pubis was selected as the reference to observe the synchondroses pubis, retropubic space, urethra, bladder neck, urogenital hiatuses, and the posterior wall of urinary bladder from the front to the rear. Afterward, the images of puerperants in the quiescent condition and the maximal Valsalva maneuver were observed and compared for the changes in the untrasound signs, and the bladder neck rotation angle (θ), poster urethrovesical angle (PUVA) (Ar, As), distance from the bladder neck to the midpoint of synchondroses pubis (Br, Bs), and bladder mobility (Mu) were calculated for 3 times. The average values were recorded. The three sonographic images of the pelvic diaphragmatic hiatus were collected in the two groups for difference analysis, and then the formation rate of internal urethral orifice of the 2 groups was calculated by the ultrasound signs, and the differences between the groups were compared.

Observation indices and evaluation criteria

The average values of θ, Ar, As, Br, Bs, and Mu were calculated, the 3D sonograms and formation rate of internal urethral orifice of the 2 groups were compared.

Statistical analysis

Statistical analysis was performed with SPSS-22.0. In case of numerical data expressed as $\overline{x}$ ± sd, intergroup and intragroup comparison studies were carried out through independent-samples *t* test; in case of nominal data expressed as n (%), intergroup and intragroup comparison studies were carried out through X^2 test. Intergroup comparison at multiple points

Table 1. Comparison between the 2 groups for general clinical materials ($\bar{x} \pm$ sd)

Group	n	Average age (y)	Average gravidity (times)	Average parity (times)	BMI (kg/m^2)
SUI	31	30.26±2.15	2.65±0.51	1.94±0.32	22.63±5.32
CG	40	29.89±2.66	2.59±0.61	1.88±0.29	22.81±5.21
t	-	0.631	0.441	0.829	0.143
P	-	0.53	0.661	0.412	0.887

Table 2. Comparison between the 2 groups for PFU indexes ($\bar{x} \pm$ sd)

Group	n	θ (°)	Ar (°)	As (°)	Br (cm)	Bs (cm)	Mu (cm)
SUIG	31	32.51±4.21	102.62±9.62	130.29±5.26	3.71±0.26	4.36±1.01	1.62±0.29
CG	40	16.32±2.61	95.03±8.15	103.29±7.21	2.61±0.51	2.36±0.62	0.71±0.16
t	-	19.903	3.597	17.534	10.945	10.282	16.834
P	-	<0.001	0.001	<0.001	<0.001	<0.001	<0.001

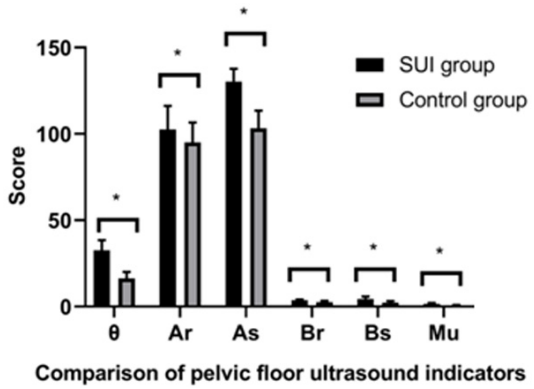

Figure 1. Comparison between the 2 groups for PFU indexes. According to comparison, the SUIG had higher θ, Ar, As, Br, Bs and Mu than the CG (P<0.05). * indicates P<0.05 as compared between the 2 groups for the same index.

was performed with ANVOA. For all statistical comparisons, significance was defined as P< 0.05.

Results

Comparison between the 2 groups for difference in general clinical data

Through calculation and comparison, the general clinical data of the 2 groups, including average age, average gravidity, average parity and BMI were not statistically different (P>0.05) but comparable (**Table 1**).

Comparison between the 2 groups for PFU indexes

Patients in both groups were tested by the same physician. The results showed that the θ, Ar, As, Br, Bs and Mu in the SUIG were higher than those in the CG (P<0.05) (P<0.05, **Table 2**; **Figures 1**-**3**).

Comparison between the 2 groups for 3D sonogram of urogenital hiatuses

The results showed that the pelvic diaphragm hiatus in the CG was relatively small with smooth and orderly edges, while the SUIG showed obvious abnormalities or dilatation signs in the pelvic hiatus, including deformation and irregularity of the pelvic diaphragm hiatus. Meanwhile, the area was significantly larger than that in the CG, presenting an abnormal state (**Figures 4** and **5**).

Comparison between the 2 groups for the formation rate of internal urethral orifice

After calculation and comparison, it was found that there were 23 cases of internal urethral mouth formation in the SUIG, with the formation rate of 74.19%, and 4 cases of internal urethral mouth formation in the CG, with the formation rate of 10.00%. There were statistically significant differences in the formation rate of internal urethral orifice between the two groups (X^2=3.903, *P*<0.001, **Figures 6** and **7**).

Discussion

The muscle groups, fascias, ligaments and related nervous system of the pelvic floor are the main parts of the female pelvic support structure. Their main physiological functions include closing the pelvic outlet, maintaining the pelvic organs in the normal anatomical

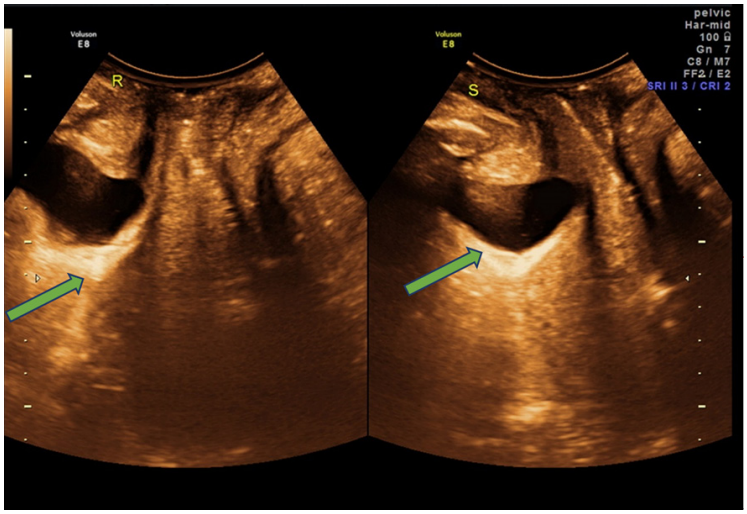

Figure 2. Sonogram of bladder descending in healthy people under quiescent condition and during valsalva maneuver. Left: distance from bladder neck to the lower margin of synchondroses pubis in quiescent condition; Right: bladder descending during Valsalva maneuver.

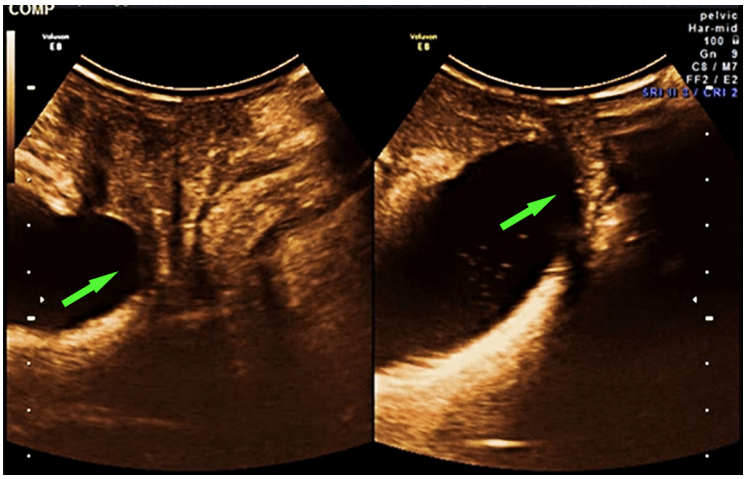

Figure 3. Sonogram of bladder descending in SUI patients under quiescent condition and during Valsalva maneuver. Compared with the sonographic characteristics of healthy puerperants, the bladder neck mobility rose beyond the normal range.

position, and motor support [5]. Anatomy shows that the structure of female pelvic floor is almost funnel-shaped, and elastic fiber is the main component of the muscles and the extracellular matrix, granting the pelvic floor with better elasticity [13]. During delivery, the birth canal will expand and the normal muscle fibers of the pelvic floor in a healthy puerperant will recover slowly from stretching. However, in cases where the fetal head is too large or the fetal position is not right, the muscle fibers will be overstretched, ruptured or damaged, resulting in the damage of pelvic floor muscles and compromised stability of pelvic organs [14]. Some studies have pointed out that those changes will also have an impact on the PUVA, reducing the pressure at the bladder neck. Therefore, the female is prone to increased number of urination, pain in urination, and decreased control of urination after childbirth, which account for the pathological changes of SUI [15, 16]. The data shows that SUI is the most common type among all kinds of urinary incontinence with a proportion more than 50%. In the second trimester of pregnancy, the probability of SUI is as high as 32-60%, and about 20% of female will experience persistent urinary incontinence in the early postpartum period [17]. In addition, epidemiological studies have figured out that the incidence of SUI is relatively high in adult Chinese women, and in the multiparas as compared with the primiparas. Through early diagnosis and effective intervention, the prognosis and quality of life of the puerperants can be significantly improved [18].

At present, the clinical diagnostic modes of SUI mainly include clinical symptom judgment, strength test of pelvic floor muscles, urine pad test, X-ray imaging, MRI, etc. [19]. The clinical symptom judgment mainly depends on the patient's description, which is subjective and hard to establish reliable and accurate judgment indicators. Although the strength test of the pelvic floor muscles is objective, it can only reflect patients' muscle strength, and fails to judge the position and function of the pelvic organs comprehensively. The urine pad test is long-term and miscellaneous with significant errors, which further limit

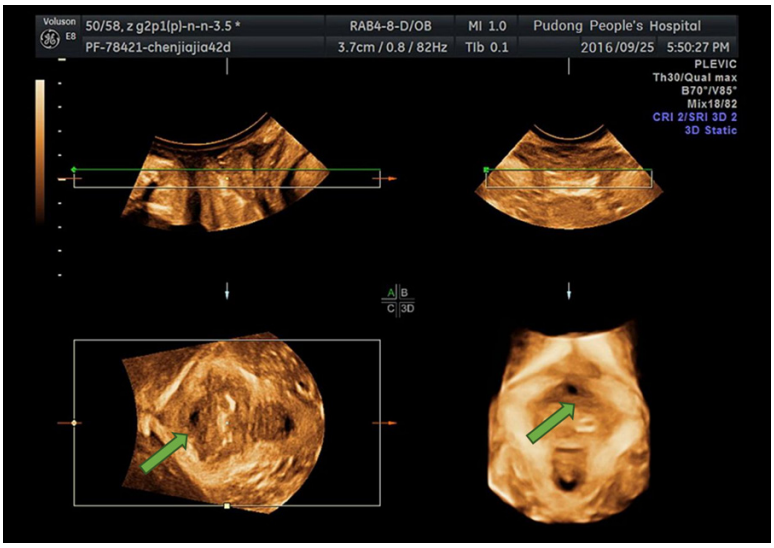

Figure 4. 3D sonogram of normal urogenital hiatuses.

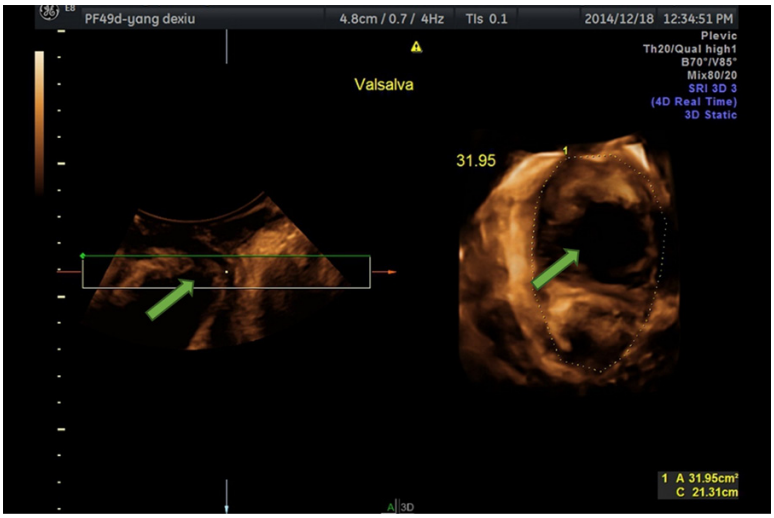

Figure 5. 3D sonogram of abnormal urogenital hiatuses. Compared with healthy puerperants, in the SUIG, abnormal urogenital hiatuses or dilatation was observed and manifested as deformation and abnormal enlargement, etc.

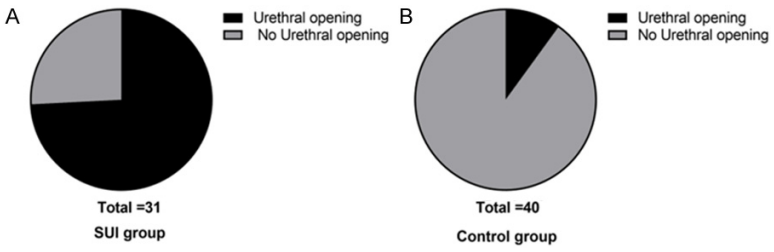

Figure 6. Comparison between the 2 groups for the formation rate of internal urethral orifice. The formation rate of internal urethral orifice was 74.19% (23/31) in the SUIG and 10.00% (4/40) in the CG (P<0.05).

its clinical application. While patients are exposed to radiation, the X-ray imaging is not suitable for women in lactation and is difficult to display soft tissue information, resulting in incomprehensive information evaluation and limited application. Although MRI can display information related to the pelvic organs and soft tissues at the same time, the images produced are unsatisfactory, the costs are high, and many contradictions (for those with a metal contraceptive ring or heart pacemaker) are involved, making it unsuitable for clinical census [20]. Ultrasound examination has always been one of the common means in gynecology. With the development of imaging technology in recent years, it has been widely promoted in clinic on the basis of advantages such as convenience, economy, good imaging effect, strong repeatability and zero radiation [21]. Some studies have shown that the transabdominal ultrasound examination is relatively far away from the organs on the pelvic floor, and it is not likely to obtain a clear image of the pelvic floor structure due to the abdominal adipose tissue, intestinal contents, skeleton, peristalsis and other factors. In another case, the transvaginal ultrasound requires inserting the probe into the vagina of the patients, which may produce certain pressure on the pelvic cavity, affecting the imaging effect, and cause vaginal injuries in some cases where patients may experience pains and fear. As the best choice, the PFU has a unique perineum window, and a broader scope of application

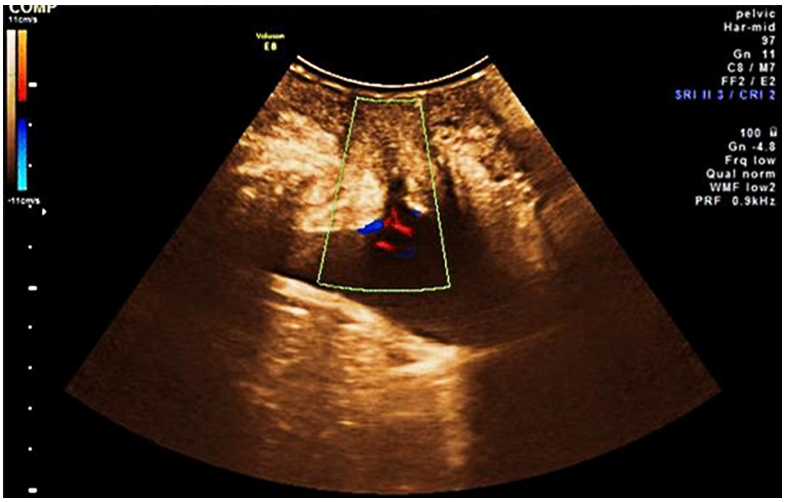

Figure 7. Ultrasound signs of the internal urethral orifice in SUIG. The internal urethral orifice in the SUIG shapes likes a beak, and is accompanied with leakage of urine.

compared with transabdominal ultrasound and transvaginal ultrasound examinations. It can avoid the interference of intestinal gases and bones to observe patients' bladder and urethra in a short distance. In the meanwhile, it can be used to judge patients' conditions and evaluate their prognosis through comparison of the positions and functions of organs in the pelvic cavity [22].

By grouping and comparing PSUI patients with healthy puerperants, this study explored the application values of PFU in the diagnosis and evaluation of PSUI, and analyzed the changes in support structures such as the urethra, pelvic cavity, urogenic hiatuses, etc. at the early stage. The results showed that the indexes such as θ, AR, As, Br, Bs and Mu were significantly elevated in the SUIG, which also yielded a higher formation rate of internal urethral orifice funnel ($P<0.05$).

According to studies, the urinary system is very complicated and subject to the effects from multiple structures such as bladders, urethra, muscle groups on the pelvic floor, connective tissues and the nervous system. Any abnormality of any link will lead to the operation error of the whole system. Indexes including θ, AR, As, Br, Bs, and Mu are commonly relied on in clinical practice to make sure the urinary system is normal [23]. Some scholars also reported higher values of those indexe in PUI puerperants as found in the present study. Through the analysis and comparison of the sonographic characteristics, it was also found that, compared with the healthy puerperants, the SUI puerperants were subject to increased mobility of the bladder neck beyond the normal range. At the same time, in the SUIG, the puerperants experienced abnormal urogenital hiatuses or dilatation, manifested as deformation and abnormal enlargement, etc. [24]. Some studies have poined out that the normal urine control mechanism applies abdominal pressure to the bladder neck directly or indirectly to stimulate and cause the urethral sphincters contracting, resulting in closed urethra. At the same time, the increase of bladder neck mobility will cause failure of the urethral sphincters to contract tightly, and consequently, the leakage of urine or urinary incontinence. Additional findings included that the area of urogenic hiatuses in puerperants selecting vaginal delivery was significantly larger than that in puerperants after caesarean delivery, and such a change would be more obvious and easy to observe in Valsalva state, just as evidenced in this study. Finally, the results of this study also suggested that the formation rate of internal urethral orifice was higher in the SUIG after childbirth, which also supported the above viewpoints.

In conclusion, given the significant difference between PSUI puerperants and healthy puerperants in terms of signs on the pelvic floor, PFU may be adopted and clinically publicized for early evaluation of PSUI patients' conditions to facilitate the late-stage clinical treatment. However, the subjects in this study had no significant pelvic floor dysfunction and were informed to participate in the investigation. The limited sample size also resulted in less representative results while only the application of PFU in the changes of indexes associated with the pelvic floor of PUI patients were analyzed instead of intragroup comparison and exploration of the application values of PFU in the diag-

nosis and treatment of pelvic floor dysfunctions. Future studies shall be based on a large sample size and more details.

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Disclosure of conflict of interest

None.

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