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RESEARCH ARTICLE

THE FACTORS OF IMPACTING ON BLADDER NECK DESCENT IN EVALUATION OF FEMALE PATIENTS WITH STRESS URINARY INCONTINENCE

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ABSTRACT

Background: To explore the effects of bladder volume and intravesical pressure on bladder neck descent (BND) in female patients with stress urinary incontinence (SUI), and to provide a base for standardization of evaluation for pelvic floor mobility in female SUI. **Methods:** The urodynamic data of 30 female patients diagnosed with SUI by sonography video urodynamic studies (SVUDS) at the Second Affiliated Hospital of Guilin Medical University and Shaoyang Central Hospital from January 2021 to January 2024 are retrospectively analyzed. The changes of pelvic floor mobility in female patients with SUI were observed by comparison of the differences of BND in female patients with SUI between different bladder volume (100 ml, 200 ml, 300 ml) with various various intravesical pressure (resting state, 60 cmH₂O, 90 cmH₂O). **Results:** In this study, the difference of the bladder neck descent (BND) was statistically significant ($P < 0.05$) at different intravesical pressure with an identical bladder volume and the BND at 90cmH₂O was greatest. In Valsalva state, the difference of BND was statistically significant ($P < 0.05$) at various bladder volume with a same intravesical pressure, in which 200ml of bladder volume could generate the most remarked BND compared to that of 100ml and 300ml ($P < 0.05$). **Conclusions:** Higher of intravesical pressure was associated with more obvious BND of female patients with SUI. The effects of intravesical pressure on pelvic floor mobility is more obvious at 200ml of bladder volume compared to that of 100ml and 300ml. Therefore, beside intravesical pressure, bladder volume also was an important factor affecting pelvic floor mobility of female patients with SUI and 200ml of bladder volume should be recommended as the standard volume of bladder in evaluation of female SUI.

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INTRODUCTION

Female stress urinary incontinence (SUI) is characterized by uncontrolled leakage of urine when the abdominal pressure increases, such as coughing, heavy physical activities and sneezing. The urodynamic studies (UDS) can confirm the diagnosis of SUI (Mousa et al. 2019; Serati et al. 2016). At present, there is no standard measurement method for the pelvic floor mobility in female SUI and both bladder volume and intravesical pressure of patients are not standardized when measuring the pelvic floor mobility. It was possible that the activity of pelvic floor organs may be different in the same patient with the changes of bladder volume and intravesical pressure, which may lead to errors in anatomical classification of female patients with SUI, affecting the choice of treatment methods and even the prognosis of patients.

Sonography video urodynamic studies (SVUDS) has been reported to observe the dynamic changes of urethra and pelvic floor structures in female patients with SUI. Therefore, in the present study, the bladder neck descent (BND) was observed through a retrospective analysis of the urodynamic data of female patients with SUI using SVUDS to explore the effects of bladder volume and intravesical pressure on the pelvic floor mobility in female patients with SUI and to provide a base for standardization of evaluation for pelvic floor mobility in female SUI.

METHODS

30 female patients with SUI were enrolled into this study, in which their average age was 55.1±9.5 years and all patients

were treated for lower urinary tract symptoms (LUTS) with uncontrolled leakage of urine when increased abdominal pressure from January 2021 to January 2024 at the Second Affiliated Hospital of Guilin Medical University and Shaoyang Central Hospital. The SUI was diagnosed by observing leakage of urine from the urethral orifice during SVUDS when the abdominal pressure was increased by Valsalva movement or coughing. Eighteen patients combined with pelvic organ prolapse (POP). Exclusion Criteria included definite neurological history, mental disorder, history of diabetes, diagnosis with neurogenic bladder, spinal injury, pelvic nerve injury, pelvic surgery, and other neurological disorders. SVUDS was performed using Laborie urodynamic analyzer and DC-65 Doppler ultrasonography. The patient is placed in lithotomy position, semi-seated position, and the perineum is carefully disinfected, bladder and abdominal pressure monitoring tubes were indwelled. Then, the 37°C normal saline was poured into the patient's bladder at a 30ml/s. The transperineal ultrasound was used to observe and record the ultrasound images of pelvic floor at 100 ml, 200 ml, and 300 ml of bladder volume when the patients were at resting state and required to conduct Valsalva movement to slowly increase the intravesical pressure to 60 cmH₂O and 90 cmH₂O. BND was measured and calculated under different conditions (at different bladder volume and intravesical pressures). Meanwhile, patients were asked to increase abdominal pressure by Valsalva movement and coughing respectively at 100 ml, 200 ml and 300 ml of bladder volume. After micturition, the post voiding residual urine (PVR) was measured by transabdominal ultrasound, and the recorded urodynamics data were analyzed (Tang et al. 2021). The differences of BND in female patients with SUI at different bladder volume and different intravesical pressure were evaluated. Each patient was reexamined three times.

The SPSS 26.0 software was used for statistical analysis. If these measurement data conformed to the normal distribution, these measurement data were represented in the form of " $\bar{x} \pm s$ ". The comparison of data between two groups was evaluated by independent sample T-test, and the comparison between multiple groups was evaluated by one-way ANOVA. When $P < 0.05$ indicate that the difference was statistically significant.

RESULTS

The difference of the bladder neck descent (BND) was statistically significant ($P < 0.05$) at different intravesical pressure with an identical bladder volume and the BND at 90cmH₂O was greatest (Table 1). In Valsalva state, the difference of BND was statistically significant ($P < 0.05$) at various bladder volume with a same intravesical pressure, in which 200ml of bladder volume could generate the most remarked BND compared to that of 100ml and 300ml ($P < 0.05$) (Table 2). There was a tendency that the increasing pelvic floor mobility would reach the maximum point at 200ml of bladder volume with different intravesical pressure affecting synchronously pelvic floor mobility (Image 1).

DISCUSSION

The urinary incontinence (UI) is recognized by the World Health Organization (WHO) as one of the five major chronic diseases that threaten the physical and mental health of adult

female and the incidence of UI increased with age. The domestic and foreign literature shows that the incidence of female UI is about 4.5% ~ 53.0%, and the stress urinary incontinence (SUI) is the most common type with an incidence of about 50% and the incidence is higher in postmenopausal women compared to pre-menopause (Zhu et al. 2009). The SUI is mainly caused by pelvic floor organ dysfunction, although it is not fatal for patients, however, it seriously affected patients' social activities, physical and mental health (Harland et al. 2023). Currently, it is believed that the most possible reason of female SUI is the abnormal activity of bladder neck and the functional urethra is relatively short in patients with SUI. The bladder neck descent (BND) refers to the transition of the bladder neck and the proximal urethra at increasing abdominal pressure and moves in the normal range in normal female. However, in the female patients of SUI, due to the pelvic floor dysfunction, the abnormal range of movement of the bladder neck will result in the low position of the bladder neck under stress, and the weak support structure of the back wall of the bladder neck and incomplete closure of the bladder neck leads to SUI (Zhu et al. 2009).

The urethral sphincter is thickest in the middle part of the entire urethra and when the abdominal pressure increases in patients with SUI, the bladder neck and proximal urethra move down, forming a "funnel shape" and resulting in relative short length of the functional urethra and reduction of the urethral resistance, which is likely to lead to SUI. The tension-free vaginal tape (TVT) in middle urethra has been adopted to ensure the length of middle urethra when increased abdominal pressure, which is widely used in clinical treatment for female SUI (Yang et al. 2022). The control of voiding mainly depends on the joint coordination of bladder neck, urethra, and peripheral sphincter. However, in female patients with SUI, both long-term increased abdominal pressure due to these conditions, such as multiple delivery, obesity, and chronic cough, and chronic pelvic injury causes abnormal functions of periurethral ligaments, muscles and pelvic organ prolapse. When in sneezing, coughing, heavy physical activities and other conditions increasing intravesical pressure, the suddenly increased abdominal pressure causes the uncontrolled leakage of urine (Enhörning et al. 1961; Routzong et al. 2022).

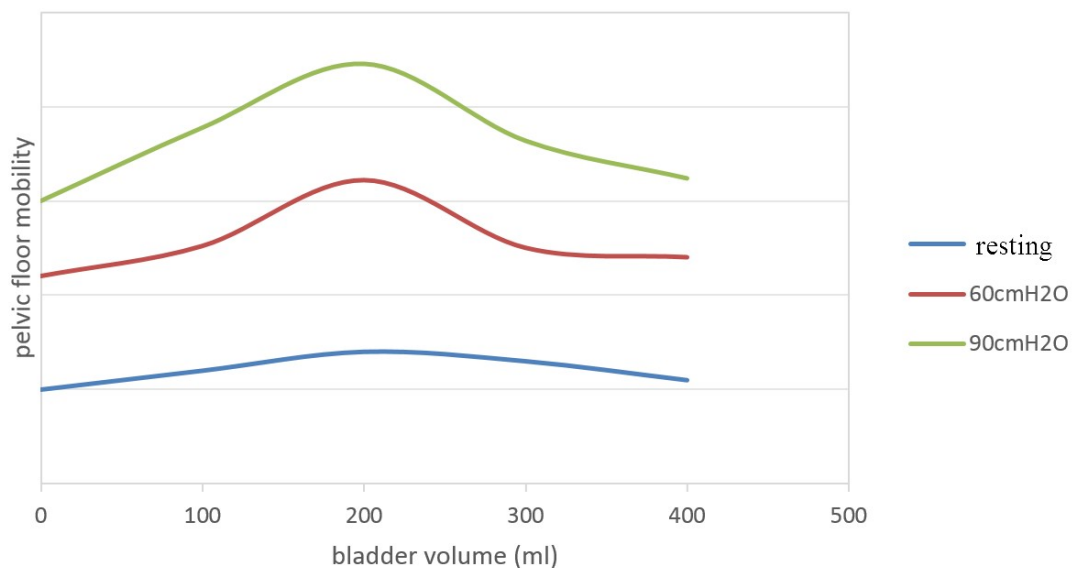
In methods for diagnosing SUI, the urine pad test can quantitatively reflect the degree of urine leakage in patients, but it is easily affected by vaginal secretions, sweat and other external factors (Yang et al. 2022). Although the cotton swab test can visually observe the change of urethral shape angle in Valsalva state, which can reflect the degree of support of bladder neck and urethra, the method can't evaluate the defect of urethral sphincter function. The diagnostic technology of X-ray urodynamic studies was relatively common used, but the X-ray can cause radioactive damage, which increase the risk of patients and operators and the display of tissue around urethra and bladder neck is also limited (Ansari et al. 2019). Li et al. pointed out that BND can be a diagnostic method for early SUI and their finding suggested that effective diagnosis of SUI was achieved by BND and its location (Li et al. 2017), meanwhile Huang et al. also had the similar conclusion (Huang et al. 2015). The relevant reports showed that the observation indicators of pelvic floor motion, such as BND, was closely related to SUI, which further confirm that the BND can be effective diagnosis of SUI (Routzong et al. 2022; Jamard et al. 2022).

Table 1. Bladder neck descent at different intravesical pressure and an identical bladder volume

BND/cm	Intravesical pressure		t	P
	resting-60cmH ₂ O	resting-90cmH ₂ O		
100 ml	1.26 ± 0.62	1.89 ± 0.74	9.622	0.002
200 ml	1.61 ± 0.73	2.23 ± 0.72	4.714	0.032
300 ml	1.25 ± 0.77	1.82 ± 0.73	3.968	0.048

Table 2. Bladder neck descent at different bladder volume with a same intravesical pressure

BND/cm	Bladder volume			F	P
	100 ml	200 ml	300 ml		
resting-60 cmH ₂ O	1.26±0.62	1.61±0.73	1.25±0.77	4.57	0.012
resting-90 cmH ₂ O	1.89±0.74	2.23±0.72	1.82±0.73	5.71	0.004

**Image 1. The tendency of the effects of bladder volume and intravesical pressure on the pelvic floor mobility**

At present, the pelvic floor mobility is generally measured when the patients were required to achieve the maximum abdominal pressure, and the bladder volume and intravesical pressure of the patients are not standardized. There is no literature to report the effects of bladder volume and intravesical pressure on pelvic floor mobility during evaluation of female patients with SUI. However, it was suggested that there were significant differences in BND at different bladder volume with an identical intravesical pressure, and the most obvious mobility of pelvic floor organs was detected at 200 ml of bladder volume and 90 cmH₂O of intravesical pressure. Additionally, the higher the intravesical pressure, the more remarkably BND of female patients with SUI. Therefore, both bladder volume and intravesical pressure were important factors impacting the pelvic floor mobility of female patients with SUI. However, given that the degree of BND has been regarded to decide anatomical diagnostic classification, both bladder volume and intravesical pressure were also considered important factors affecting the anatomical diagnostic classification of SUI. The results of this study confirmed that BND is more obvious at 200 ml of bladder volume with different bladder volume than that of 100 ml and 300 ml, which has not been reported in the literature to my best knowledge. We hypothesized that larger bladder volume (300 ml) might be associated with limited activity space of the pelvic floor structure around the bladder and limited surface cross-sectional area of small bladder (100 ml) might bear limited abdominal pressure and related to Less degree of

BND. Therefore, when the bladder is moderately filled (200 ml) the two factors, bladder volume and intravesical pressure, influence each other less, and the bladder neck mobility may be closer to the real situation and be more obvious. At present, the international continence society (ICS) describes the anatomical classification standard of female SUI according to Blaivas classification standard and BND ≥ 2 cm under stress is taken as the cut-off value for diagnosis of SUI (Blaivas *et al.* 1988). The activity of pelvic floor organ under stress reflects the severity of SUI, and early intervention of the disease can reduce the damage to the physical and mental health of patients. Therefore, if the pelvic floor status of SUI patients is not standardized during the measurement, errors in anatomical diagnostic classification might not uncommon and thus the treatments would also be not adopted correctly (Bergman *et al.* 1988). Therefore, the measurement methods of pelvic floor mobility are of great significance for the diagnosis of SUI. In this study, although it was confirmed that higher intravesical pressure the more obvious pelvic floor mobility in female patients with SUI, the effects of intravesical pressure on pelvic floor mobility is more obvious at 200 ml of bladder volume compared to that of 100 ml and 300 ml. However, the maximum intravesical pressure that patients can achieve may be variant that might cause errors in the measurement of pelvic floor mobility. Therefore, taking 200 ml as the standard volume of measuring pelvic floor mobility in female patients with SUI, the anatomical diagnostic classification of SUI patients might be more accurate.

CONCLUSION

Higher of intravesical pressure was associated with more obvious BND of female patients with SUI. The effect of intravesical pressure on pelvic floor mobility is more obvious at 200ml of bladder volume compared to that of 100ml and 300ml. Therefore, beside intravesical pressure, bladder volume also was an important factor affecting pelvic floor mobility of female patients with SUI and 200ml of bladder volume should be recommended as the standard volume of bladder in evaluation of female SUI.

Conflicts of Interest: All authors have no conflicts of interest to declare.

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