A Comparison of Urodynamic Parameters and Lower Urinary Tract Symptoms in Urodynamic Genuine Stress Incontinence Women with or without Stress Urinary Incontinence

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Background: The aim of this study was to investigate the urodynamic parameters and lower urinary tract symptoms (LUTS) of women with urodynamic genuine stress incontinence (GSI).

Methods: A cross-sectional study involving 3323 women with LUTS was conducted. We recruited 1261 women with urodynamic GSI and were further grouped as with or without symptomatic stress urinary incontinence (SUI). The LUTS and urodynamic measurements between the two groups were analyzed and compared.

Results: Women with symptomatic SUI had a greater maximal flow rate, larger voided volume, larger maximal cystometric capacity, and smaller maximal urethral closure pressure (MUCP) during both rest and stress. The amount of urine leakage during the 1-hour pad test of GSI women with symptomatic SUI was much greater than women without symptomatic SUI (26.0g vs 7.2g, $p < 0.001$). The significant differences in other lower urinary tract symptoms including nocturia, diurnal frequency, incomplete emptying, poor stream, urgency, urge incontinence, and post-void dribbling in women without symptomatic SUI were all less than women with symptomatic SUI.

Conclusions: The urodynamic parameters and LUTS between the GSI women with or without symptomatic SUI are different. Approximate 15% of the GSI women do not complain of symptomatic SUI. The lower urinary tract symptoms of women with GSI without symptomatic SUI were less prominent than for the GSI women with symptomatic SUI.

(Chang Gung Med J 2004;27:594-601)

Key words: **genuine stress incontinence, stress urinary incontinence, lower urinary tract symptoms, urodynamics, pad test.**

Stress urinary incontinence (SUI) is defined as the involuntary loss of urine that is objectively demonstrable and is a social or hygienic problem.[1-3] Genuine stress incontinence (GSI) is referred to the urodynamic diagnosis of stress incontinence.[1] Women with GSI may also experience other lower urinary tract symptoms (LUTS) and symptoms of SUI may not necessarily be present in women with

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Received: Apr. 30, 2004; Accepted: Jun. 7, 2004
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urodynamic GSI as observed in this study. Several studies have shown that 15-80% of women with genitourinary prolapse manifest SUI once the prolapse has been reduced.[4-6] The mechanism of continence has been reported to be as a result of either urethral kinking or elevation of urethral resistance as manifested by an increase in maximal urethral closure pressure (MUCP) and pressure transmission ratio with the prolapse unreduced.[4-9] However, apart from women with genitourinary prolapse, a subset of GSI women do not manifest symptoms of SUI. We found a limited number of reports in the literature about this topic especially when detrusor instability and mixed incontinence were excluded. We investigated the urodynamic parameters and LUTS of pure GSI women with or without symptoms of SUI.

METHODS

From March 1999 through March 2004, women with various manifestations of LUTS were screened at our Urogynecology center. All women who underwent urodynamic studies were asked to complete a questionnaire that examined all symptoms based on abnormal storage, abnormal voiding, and abnormal sensation including: urge incontinence (UI), diurnal frequency (DF), nocturia (N), nocturnal enuresis (NE), strain to void (SV), incomplete emptying (IE), hesitancy (H), poor stream (PS), postmicturition dribble (PD), dysuria (D), urgency (U), suprapubic fullness (SF), and unaware urine incontinence (UUI).[10] Each woman received a physical examination including pelvic and rectal examination with a detailed medical history. To avoid bias of sample selection and to keep the study population as homogeneous as possible, our study subjects were healthy women without history of systemic diseases and major abdominopelvic surgery. Patients with the following clinical conditions were excluded including previous pelvic reconstruction or anti-incontinence surgery, hysterectomy, spinal surgery, pelvic prolapse, urinary tract infection, underlying medical diseases who were taking medications, cancer, and patients who received hormone replacement therapy. Each symptom was graded as 0, 1, or 2 with zero representing no urinary symptoms at all, 1 representing occasional or moderate, and 2 representing frequent or severe urinary symptoms. Diurnal frequency were graded as 0, 1, or 2 according to voiding frequency less than 6, 7 to 8 or more than 8 times were graded as 1 and 2, respectively. Nocturia for 2 to 3 or more than 3 times per night or per week? Please include a time frame. were graded as 1 and 2, respectively. The pelvic examination, urinalysis, urine culture and 1-hour pad test were carried out in accordance with the procedures of the International Continence Society.[1]

The bladder was filled with distilled water at rate of 80 mL/minute in room temperature to the maximum cystometric capacity through a 8F double-lumen perfusion catheter (Dantec cystometry and urethral pressure profile catheter 2-way) attached to an external pressure transducer (Disposable Pressure Transducer System), as was an 18F rectal catheter to measure abdominal pressure.

The multichannel urodynamic evaluations (Dantec Menuet Compact Plus, Skovlunde, Denmark) were performed by an experienced technician (Hsu HT) and included uroflowmetry, filling and voiding cystometrography with electromyography, urethra pressure profile assessments, and direct visualization for fluid loss. Cough provocations were performed after every 100 ml of distilled water filled, at the maximal bladder capacity during filling cystometrography and also during stress urethral pressure profiling. The functional urethral length and MUCP during stress and rest were also measured. The average and maximal flow rates, voiding time, voiding amount, and post-void residual urine amount after uroflowmetry by catheterizing were recorded. Bladder capacity at the point of first, normal, and strong desire to void, maximal capacity, as well as the presence of low compliance bladder were recorded. Urodynamic diagnoses of GSI, detrusor instability (DI), and mixed urinary incontinence were made according to the recommendations of the International Continence Society.[1,11] The diagnosis of GSI was made if the subject had the symptom of stress incontinence and had observable leakage produced by stress without concurrently demonstrable detrusor activity during urethrocystometry or had a positive direct visualization test immediately after the catheters were removed in the total absence of detrusor instability during urethrocystometry.[12] The definition of bladder storage dysfunction from the urodynamic findings was decreased bladder capacity (less than 250 ml) at the point of maximal bladder capacity or the presence of low bladder compliance

during filling cystometrography. Women with DI, mixed incontinence, intrinsic sphincter deficiency (defined by MUCP < 20 cmH_2O), and urinary incontinence with coexisting storage dysfunction were excluded from the study. Only women diagnosed with genuine stress incontinence were considered in our analyses.

Women with urodynamic GSI were then divided into group A or B based on whether they were with or without clinical symptoms of SUI, respectively. The frequency of each LUTS was analyzed using the Chi-square method. Student's t-test was used to analyze the differences in the urodynamic measurements and the 1 hour pad test. Data are expressed as the mean and 95% confidence interval. Differences were considered statistically significant when $p \leq 0.05$.

RESULTS

During the study period, 3323 women visited our Urogynecology center and completed a survey questionnaire and the urodynamic study. A total of 1065 women were excluded from the study as a result of previous pelvic reconstruction or anti-incontinence surgery, hysterectomy, spinal surgery, pelvic prolapse, urinary tract infection, underlying medical diseases who are presently taking medications, cancer, and patients who received hormone replacement therapy. After the urodynamic study, a total of 997 women with DI, mixed incontinence, or urinary incontinence coexisting storage dysfunction were further excluded.

Of the 1261 women with urodynamic GSI, 1073 (85.1%) women had symptoms of SUI (group A) and 188 (14.9%) women did not have symptoms of SUI (group B) (Table 1). The comparison of other cumu-

Table 1. Case Distributions in 2258 Healthy Women with Lower Urinary Tract Symptoms

Urodynamic Diagnosis	Case number N (%)
Genuine stress incontinence	1261 (55.8)
Group A SUI (+)	1073 (85.1)
Group B SUI (-)	188 (14.9)
Others*	997 (44.2)

Abbreviations: SUI: stress urinary incontinence.

* Others, include detrusor instability, mixed incontinence, intrinsic sphincter deficiency, and urinary incontinence coexisting storage dysfunction.

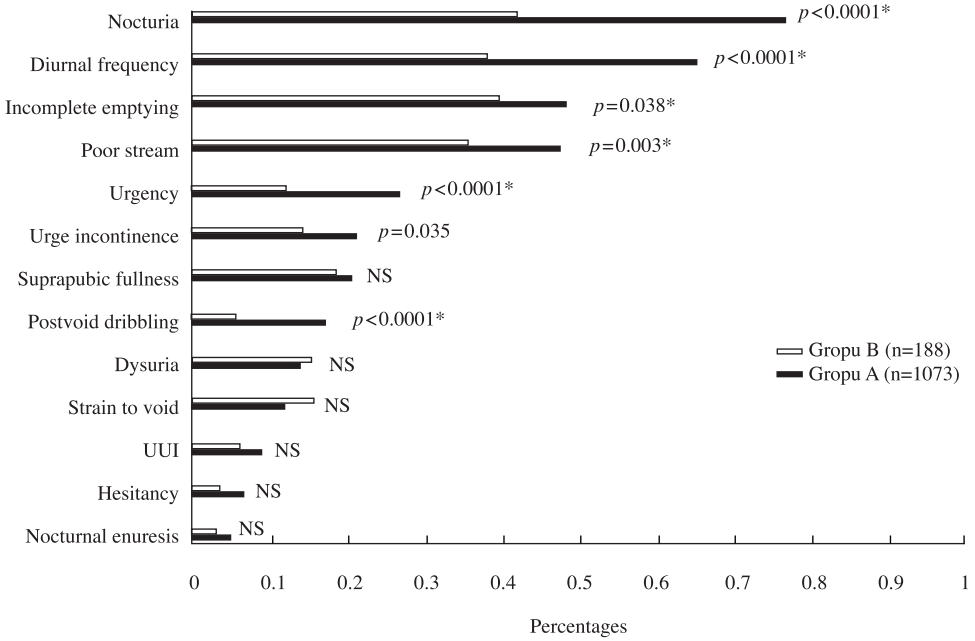

Fig. 1 Comparison of lower urinary tract symptoms between women with urodynamic GSI with symptomatic SUI (group A) and without symptomatic SUI (group B).

* Statistically significant, $p < 0.05$; NS: not significant (Chi-square test); UUI: unaware urine incontinence; GSI: genuine stress incontinence; SUI: stress urinary incontinence

Table 2. Analysis of Age, Urodynamic Variables and 1 Hour Pad Test between 1261 Urodynamic GSI Women with or without Symptomatic SUI

	Total (n=1261)	Group A (n=1073)	95% CI	Group B (n=188)	95% CI	*p*
Age (years)	49.5	49.3	(48.7- 49.9)	50.6	(48.6- 52.6)	0.144
Maximal flow rate (ml/s)	21.9	22.4	(21.4- 23.4)	18.3	(16.7- 20.0)	0.001
Average flow rate (ml/s)	10.4	10.6	(9.9- 11.3)	8.8	(7.3- 10.4)	0.054
Voided volume (ml)	296.2	302.8	(291.7-313.9)	243.8	(221.0-266.5)	< 0.001
Residual volume (ml)	22.2	21.6	(19.4- 23.7)	27.5	(20.5- 34.5)	0.051
First desire to void (ml)	160.1	160.6	(156.4-164.8)	155.2	(146.1-164.4)	0.330
Normal desire to void (ml)	226.8	227.9	(222.5-233.2)	217.8	(206.0-229.6)	0.146
Strong desire to void (ml)	279.3	281.2	(275.1-287.2)	266.1	(253.1-279.1)	0.054
Maximal capacity (ml)	339.7	342.2	(335.6-348.8)	323.6	(308.5-338.7)	0.032
MUCP - rest (cm H_2O)	78.8	77.4	(75.8- 79.1)	86.3	(82.2- 90.3)	< 0.001
MUCP - stress (cm H_2O)	72.3	70.9	(69.3- 72.5)	80.9	(76.7- 85.2)	< 0.001
Functional length (mm)	32.9	32.8	(32.3- 33.4)	33.3	(31.7- 34.9)	0.537
1-h pad test (g)	23.3	26.0	(24.5- 27.6)	7.2	(4.6- 9.9)	< 0.001

Abbreviations: SUI: stress urinary incontinence; GSI: genuine stress incontinence; MUCP: maximal urethral closure pressure; NS: not significant; Note: Total, sum of group A and group B; Group A, women with SUI; Group B, women without SUI; Values are mean and 95% CI, confidence interval, in parenthesis.

lative LUTS of women with or without symptomatic SUI are analyzed in Figure 1 as follows: nocturia (77.1% vs 42%), diurnal frequency (65.3% vs 38.3%), incomplete emptying (48.4% vs 39.9%), poor stream (47.6% vs 35.6%), urgency (26.8% vs 12.2%), urge incontinence (21.1% vs 14.4%), supra-pubic fullness (20.7% vs 18.6%), post-void dribbling (17.0% vs 5.3%), dysuria (13.8% vs 15.4%), strain to void (11.6% vs 15.4%), unaware urinary incontinence (8.6% vs 5.9%), hesitancy (6.2% vs 3.2%), and nocturnal enuresis (4.7% vs 2.7%). Significant differences in the LUTS were found between the women without SUI (group B) and the women with SUI (group A).

Table 2 outlines the analysis of age, urodynamic variables and the 1-hour pad test between the two groups. The average age between the two groups was not statistically different. The average and maximal flow rate of group A (10.6 ml and 22.4 ml) was significantly greater than group B (8.8 ml and 18.3 ml). Group B had a significant smaller voiding volume than group A (243.8 ml vs 302.8 ml, $p < 0.001$). The maximal cystometric capacity was smaller in group B than in group A (323.6 ml vs 342.2 ml, $p = 0.032$). The MUCP during rest and stress were both higher in group B than group A (86.3 and 80.9 cmH_2O vs 77.4 and 70.9 cmH_2O, *p* value both < 0.001). The functional length of both groups was not statistically different. The 1-hour pad test volume was higher in group A (26.0 g) than in group B (7.2 g), $p < 0.001$.

Table 3. Distribution of Urodynamic GSI Women According to Age Stratification in Decades.

Age groups (years)	Urodynamic GSI women n=1261 (%)	Average age Years (95% CI)*
20-30	27 (2.1)	27.7 (26.3-29.0)
31-40	209 (16.6)	36.8 (36.5-37.2)
41-50	543 (43.1)	45.8 (45.5-46.0)
51-60	272 (21.6)	54.8 (54.4-55.1)
61-70	144 (11.4)	64.8 (64.3-65.2)
>71	66 (5.2)	74.8 (74.0-75.7)

Abbreviations: GSI: genuine stress incontinent; CI: confidence interval.
*Statistically significant, $p < 0.001$

The distribution of women with urodynamic GSI according to age stratification increased with age and reached peak in those 41 to 50 years old at 43.1%, and decline gradually to < 5% after the age of 71 years (Table 3).

DISCUSSION

This study demonstrated that 1261 (55.8%) women with urodynamic GSI occurred in a cohort of 2258 healthy women with LUTS. This is similar to the prevalence rate of GSI (56%) in a study of 1500

women reported by Lin et al.[13] Many researchers have analyzed the sensitivity and specificity of GSI using symptoms of stress urinary incontinence followed by urodynamic examination and have reported a sensitivity of 78% to 100% and a specificity of 65% to 84%.[14,15] It has also been reported that symptoms of pure stress incontinence were misdiagnosed in 13% of women as having GSI.[16] However, there were no reports to date that discussed women without symptoms of SUI but diagnosed as GSI. Approximate 15% of our women with urodynamic GSI did not manifest symptomatic SUI. In this particular group, the incidences of other LUTS were lower when compared with GSI women with symptomatic SUI. The only LUTS that were higher in incidence among GSI women without SUI were strain to void, dysuria, and urine retention; however, they were not statistically significant in this study.

The distribution of our women with urodynamic GSI according to age stratification increased with age up to 43.1% in the women 41 to 50 years old and decline gradually to < 5% after the age of 71 years, which is compatible with the peak prevalence of stress urinary incontinence using the ICS criteria occurring in the women 40 to 50 years old in the study by Chen et al.[17] It is agreeable to have different percentages regarding similar cohort groups of different studies, based on differences in definitions, target populations, methods of assessment, and study design.

Women Urodynamic GSI with symptomatic SUI experienced greater amounts of urine leakage when compared with GSI women without symptomatic SUI (26.0g vs 7g). In this study, GSI women with symptomatic SUI had higher maximal cystometric capacity but decreased in MUCP during both rest and stress. It is reasonable to believe that women with smaller cystometric capacity and voiding volume may result in higher voiding frequencies. However, these observations were not evident in our study. Symptoms including nocturia, frequency, urgency, and urge incontinence were more prominent in women with GSI with larger cystometric capacity and voiding volume. This corresponds to a previous report about relaxation of the urethra and allowing passage of urine into the proximal urethra may result in contraction of the detrusor.[10,18] In addition, as Bump et al. reported that decreases in urethral pressure with an increased in vesical pressure may cause decreases in the positive pressure gradient in the urethra which may result in urine leakage.[7]

Changes in the reservoir function of bladder are common age-related alterations in urinary tract function including urinary frequency, nocturia, and incontinence along with changes in the renal and hormonal systems which control water and sodium excretion.[19] Symptoms of DI were believed to increase as age increases.[10,20,21] However, DI was excluded from our study and the average age between GSI women with or without SUI was not different in our study. Whether these women with GSI with symptomatic SUI could be potential candidates for developing DI or SUI symptom could be the provoking factor for the appearance of other LUTS needs further investigation. There is also the possibility that the detection of DI using a multichannel urodynamic machine in certain women is less sensitive than the ambulatory ones since ambulatory monitoring was suggested to be more physiological and sensitive by several authors.[13,22]

The maximal flow rates are positively correlated with bladder volume in both groups of women in this study. The rates were compatible with those from previous reports in a healthy population and also in women with urinary incontinence and pelvic organ prolapse.[23-26]

The 1-hour pad test was used as a semi-quantified diagnostic method for evaluation of urine leakage and also follow up for the extent of leakage. The pad test was suggested to verify and quantify the degree of incontinence especially if urine loss was not demonstrated on examination.[27] Modification of the 1-hour International Continence Society (ICS) pad test were performed by standardizing the bladder volume and a correlation of 0.74 to 0.97 was found in patients with different diagnosis.[28-30] However, there were wide individual variations of up to 24 g reported by Lose et al. when a standard volume of 50% of maximum cystometric capacity was used.[31] Even though the validations and reproducibility of the 1-hour pad test varied, it does play a useful role for survey of the extent of urine leakage and especially when the symptoms and urodynamic results are incompatible.

Treatment for incontinence including behavioral, pharmacological or surgical methods depends on the types of incontinence with precise evaluation of the patient.[2,32,33] Urodynamic diagnosis of lower

urinary tract dysfunction may help improve treatment results and reduce postoperative failure of continence surgery. Even though urodynamic studies have demonstrated a significant overlap of common urinary symptoms among different etiologies for urinary incontinence, it can also provide invaluable insights into the pathophysiologic mechanisms of urinary incontinence.[34,35] Several authors have recommended urodynamic evaluation for all patients to ensure that only those patients with GSI are treated surgically.[12]

In conclusion, there are approximately 15% of women with urodynamic GSI who did not manifest symptoms of SUI. The other LUTS tended to be aggravated in women with symptomatic SUI. We suggest that precise evaluations including the frequency/volume chart, quality of life assessment, treatment modalities, and outcome expectations be discussed thoroughly especially in women with GSI without symptomatic SUI.

Acknowledgement

We would like to thank Mr. Yao-Tsen Tsen at the Department of Public Health at the Kaohsiung Medical University for the data analysis.

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比較有主訴與無主訴尿失禁之眞性應力性尿失禁婦女在尿動力學上與下泌尿道症狀的表現

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背 景： 爲了探討眞性應力性尿失禁婦女，其下泌尿道症狀與尿動力學上的表現，和比較有主訴與無主訴應力性尿失禁之婦女彼此間的差異。

方 法： 這是個前瞻性、臨床觀察研究。收集3323位有下泌尿道症狀之婦女，全部接受問卷調查、尿動力學檢查、及一小時棉墊測試。經尿動力學診斷爲眞性應力性尿失禁有1261位。再進一步比較有主訴與無主訴應力性尿失禁之婦女在下泌尿道症狀與尿動力學上表現的差別。

結 果： 有85.1%的眞性應力性尿失禁婦女爲有主訴尿失禁，另有14.9%眞性應力性尿失禁之婦女是沒有尿失禁之主訴。無主訴應力性尿失禁之婦女 (Group B) 在其它統計上有意義的下泌尿道症狀包括夜尿、白天頻尿、殘尿感、小便細小、急尿、急尿性尿失禁、排尿後滴尿，都比有主訴應力性尿失禁之婦女 (Group A) 還低。Group B在最大尿流速，解尿量，最大膀胱容積 都比Group A還低。Group B的最大尿道閉鎖壓力於用力及休息時，都比Group A高。Group B在一小時棉墊測試比Group A還低 (7.2 g vs 26 g, $p < 0.001$)。

結 論： 眞性應力性尿失禁的婦女除了多數主訴應力性尿失禁外，尚會合併其他不同程度的下泌尿道症狀。約有15%診斷爲眞性應力性尿失禁之婦女並沒有主訴應力性尿失禁。無主訴應力性尿失禁之婦女的其它下泌尿道症狀，都比較輕微。有主訴與無主訴應力性尿失禁的眞性應力性尿失禁婦女，其尿動力學的表現也是不同的。
(長庚醫誌 2004;27:594-601)

關鍵字： 眞性應力性尿失禁，應力性尿失禁，下泌尿道症狀，尿動力學，棉墊測試。

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受文日期：民國93年4月30日；接受刊載：民國93年6月7日。
索取抽印本處：龔福財醫師，長庚紀念醫院 婦產科。高雄縣833鳥松鄉大埤路123號。Tel.: (07)7317123轉8915; Fax: (07) 7322915; E-mail: willcw@cgmh.org.tw