Factors Affecting Voiding Function in Urogynecology Patients

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SUMMARY

Objective: Our objective was to assess the impacts of menopause, age and parity on voiding function in urogynecology patients.

Materials and Methods: The medical records of 4,470 patients with urodynamic studies were reviewed at our center between January 1999 and May 2003. Patients with conditions including a prior continence procedure, advanced pelvic prolapse, hysterectomy or neurologic deficits were excluded from our study. Comprehensive medical histories, physical examinations, bladder diaries and results of multi-channel urodynamic testing were analyzed.

Results: The mean age of the 3,161 women enrolled was 50 years, and the mean parity was three. Four urodynamic variables served as voiding parameters: maximum flow rate (Qmax) and post-void residual (PVR) from uroflowmetry, and maximum flow rate (Qmax.p) and detrusor pressure at maximum flow (PdetQmax) from pressure-flow studies. Of the three factors studied (menopause, age, and parity), only parity had a significant impact on uroflowmetry and pressure-flow study results (Qmax, $p = 0.007$; PVR, $p < 0.001$; Qmax.p, $p = 0.002$; PdetQmax, $p < 0.001$). Twenty-five percent of the patients in our study were diagnosed with voiding dysfunction.

Conclusion: Our results indicated that parity had a significant impact on voiding function in urogynecology patients. Twenty-five percent of patients in our study were diagnosed with voiding dysfunction. The bladder behavior in women after childbirth may be more complex than previously thought, and special attention should be paid to women who suffer from bladder symptoms after childbirth. [*Taiwan J Obstet Gynecol* 2008;47(4):417–421]

Key Words: age, lower urinary tract, menopause, parturition, urodynamics, voiding function

Introduction

The mechanisms of micturition are complex and the precise neural pathways involved still remain controversial. Normal voiding requires a high level of coordination between voluntary and reflex neural arcs that cause relaxation of the urethra and contraction of bladder until emptying is complete. Urodynamic studies (UDSs) are the most objective means of documenting the underlying pathology in patients with lower urinary tract symptoms (LUTS). Previous reports [1–3] have shown that UDS defined the underlying pathophysiology, so facilitating better treatment of the symptoms. It is important to recognize the nature of a patient's complaints and so be able to utilize urodynamic evaluation as a provocative test to reproduce the symptoms. LUTS have a high prevalence in the community and have a significant negative impact on quality of life. These problems, therefore, deserve further investigation.

Uroflowmetry and pressure-flow studies (PFS) are the main tests used to assess detrusor contractibility and urethral obstruction. Uroflowmetry characterizes the interaction between detrusor activity and outlet resistance, while PFS evaluate the presence of urethral obstruction. Urethral pressure profilometry is an alternative way of evaluating urethral competency, which assists the analysis of detrusor function during voiding.

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Studies by Karram et al [4] and Lemack et al [5] suggested that different voiding mechanisms existed in women who were urinary continent and those who suffered from stress incontinence. Karram et al [4] also identified menopausal status as the only factor that significantly affected maximum detrusor pressure during voiding. The aim of this study was to explore the impacts of aging, childbirth and menopausal status on voiding function in urogynecology patients.

Materials and Methods

Patients

Between January 1999 and May 2003, a total of 4,470 women with LUTS (nocturia, urgency, frequency, stress or urge urinary incontinence, incomplete emptying, or voiding difficulties) were referred to our urodynamic center. Informed consent was obtained from all patients and institutional review board approval was granted for the study.

Study design

Each woman underwent a clinical interview and physical examination. The interview included questions related to age, parity, hysterectomy, medical illness and/or previous continence procedures. The physical examination included measurements of height and weight, and a pelvic examination to detect the presence of cystocele, uterine prolapse or rectocele [6]. A digital examination and pinprick test were performed to assess the S2–4 dermatome. Patients with abnormal neurologic signs, such as Babinski sign, during pelvic examination or unsteady gait were assessed for underlying diseases. Patients with preexisting neurologic diseases were excluded from the study. All women in the study group underwent catheterized urinalysis and culture, a 1-hour pad test, and urodynamic testing. Each patient was catheterized immediately after uroflowmetry using a 14F catheter, in order to determine the post-void residual. Menopause was defined as ≥12 months of amenorrhea after the final menstrual period, or an elevated serum follicle stimulating hormone concentration >30–40 mIU/mL in women who had undergone a hysterectomy.

Exclusion criteria

Exclusion criteria included a prior continence procedure, pelvic prolapse greater than stage II of the International Continence Society (ICS) grading system [6], hysterectomy, neurologic deficit, and incomplete results. Thus, 3,163 of 4,470 women were eligible for this study.

Urodynamic study

Multichannel UDS was performed using a six-channel recorder (Dantec Medical A/S, Skovlunde, Denmark), with patients in the sitting position. Uroflowmetry, filling (provocative) and voiding cystometry, and a 1-hour pad test were recorded. All procedures were carried out in accordance with ICS guidelines [7]. The bladder was filled to the maximum cystometric capacity with room-temperature distilled water at a rate of 60 mL/min through a 10F double-lumen perfusion catheter attached to an external pressure transducer, with an 18F rectal catheter (Dantec Medical A/S, Skovlunde, Denmark) to measure abdominal pressure. Perineal surface electrodes were used to monitor the electrical activity of the periurethral striated muscle.

Data collection

Five groups of women were identified: urodynamic stress incontinence (USI), detrusor overactivity (DO), mixed incontinence (MI), voiding dysfunction (VD), and normal. Voiding dysfunction was defined as a maximal flow rate of noninvasive uroflowmetry <15 mL/s with a volume of 150 mL, without concomitant incontinence, and a sustained detrusor contraction of at least 20 cmH_2O with a flow rate of <12 mL/s [8]. The UDS data included uroflowmetry (maximum free flow rate [Qmax], voided volume, and post-void residual [PVR]), provocative filling cystometry (first desire to void, maximum cystometric capacity) and voiding cystometry (maximum flow rate [Qmax.p], detrusor pressure at maximum flow [PdetQmax]), and urethral pressure profilometry (maximum urethral closure pressure, functional profile length on stress, and pressure transmission ratio).

All procedures were performed by an experienced technician or physician, and the terminology was in accordance with ICS guidelines [7].

Statistical analysis

Values are given as mean (±standard deviation). The data were analyzed and the statistical software used was SPSS version 10 (SPSS Inc., Chicago, IL, USA) for Windows. A difference was considered statistically significant at $p<0.05$. Since the UDS variables in our database did not show a normal distribution, nonparametric tests (Mann-Whitney U or Kruskal-Wallis tests, as appropriate) were used to analyze the intergroup data.

Results

Of the 3,161 women who underwent UDS, 55% had USI, 7.3% had DO, 4.5% had MI, 25.1% had VD, and

Table. Demographic characteristics and urodynamic parameters*

	Urodynamic stress incontinence	Detrusor overactivity	Mixed incontinence	Voiding dysfunction	Normal
n (%)	1,755 (55.5)	231 (7.3)	142 (4.5)	793 (25.1)	240 (7.6)
Age (yr)	50.7 (10.6)	54.8 (14.6)	55.6 (13.9)	50.4 (13.1)	49.3 (12.1)
Parity	3.5 (1.2)	3.6 (1.3)	4.1 (1.3)	3.2 (1.4)	3.1 (1.3)
Pad test (g)	15.2 (12.3)	8.9 (5.7)	23.9 (16.5)	6.4 (1.7)	1.5 (1.2)
Qmax (mL/s)	24.2 (11.1)	18.2 (9.7)	21.1 (10.3)	18.1 (9.2)	23.1 (10.3)
VV (mL)	340.5 (169.9)	245.3 (125.6)	250.3 (157.2)	250.1 (139.1)	348.6 (156.3)
PVR (mL)	38.3 (23.1)	55.1 (36.5)	44.7 (24.5)	56.2 (28.1)	34.9 (20.8)
FD (mL)	175.7 (125.4)	141.7 (116.9)	123.6 (80.7)	140.8 (95.2)	176.2 (90.2)
CC (mL)	427.5 (210.5)	306.6 (165.8)	286.7 (128.7)	333.8 (149.7)	440.2 (182.3)
MUCP (cmH_2O)	81.5 (36.1)	82.5 (43.6)	68.6 (33.9)	92.8 (39.6)	97.7 (34.5)
FL (mm)	27.4 (13.4)	30.6 (14.4)	26.1 (9.7)	27.9 (11.3)	27.9 (9.7)
PTR (%)	46.1 (20.8)	57.1 (28.3)	38.8 (18.4)	48.2 (27.7)	49.6 (25.8)
Qmax.p (mL/s)	14.8 (5.8)	11.1 (5.2)	13.1 (6.7)	11.6 (4.9)	14.6 (4.9)
PdetQmax (cmH_2O)	21 (16.5)	24.1 (15.1)	22.3 (14.9)	24.5 (17.6)	22.1 (15.7)

**Data are presented as mean (standard deviation). Qmax = maximum free flow rate; VV = voided volume; PVR = post-void residual; FD = first desire to void; CC = maximum cystometric capacity; MUCP = maximum urethral closure pressure; FL = functional profile length on stress; PTR = pressure transmission ratio; Qmax.p = maximum flow rate on pressure-flow studies; PdetQmax = detrusor pressure at maximum flow on pressure-flow studies.*

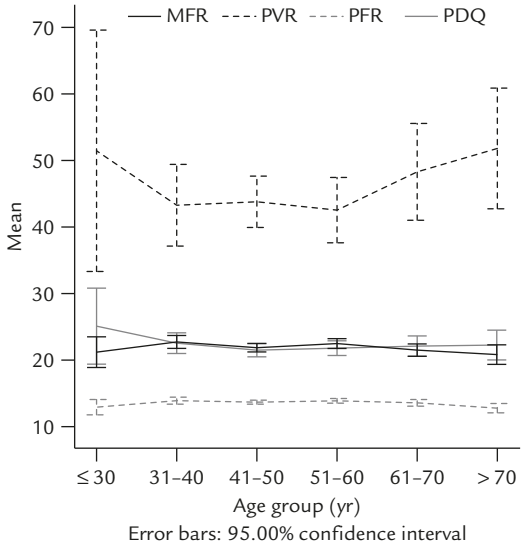

Figure 1. Various voiding parameters in different age groups. Values are expressed as mean (standard deviation). MFR = maximum free flow rate; PVR = post-void residual; PFR = maximum flow rate on pressure-flow study; PDQ = detrusor pressure at maximum flow on pressure-flow study.

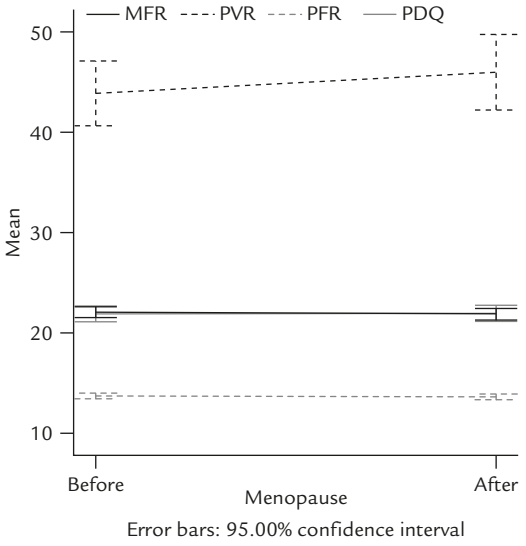

Figure 2. Various voiding parameters before and after menopause. Values are expressed as mean (standard deviation). MFR = maximum free flow rate; PVR = post-void residual; PFR = maximum flow rate on pressure-flow study; PDQ = detrusor pressure at maximum flow on pressure-flow study.

7.6% had normal results. The Table presents the groups' demographic characteristics and urodynamic results. The mean age was 50 years, and mean parity was three. We used four urodynamic variables (Qmax, PVR, Qmax.p, and PdetQmax) as voiding parameters to assess voiding function. There were no significant differences in voiding function based on age of the patients (Figure 1) or their menopausal status (Figure 2). Parity (Figure 3) was the only significant factor that affected voiding function, especially when parity was greater than three ($p < 0.001$). Repeated measures analysis of variance was used to determine the accuracy of data analysis.

Discussion

Four urodynamic variables served as voiding parameters: maximum flow rate (Qmax) and post-void residual (PVR) from uroflowmetry, and maximum flow rate (Qmax.p) and detrusor pressure at maximum flow

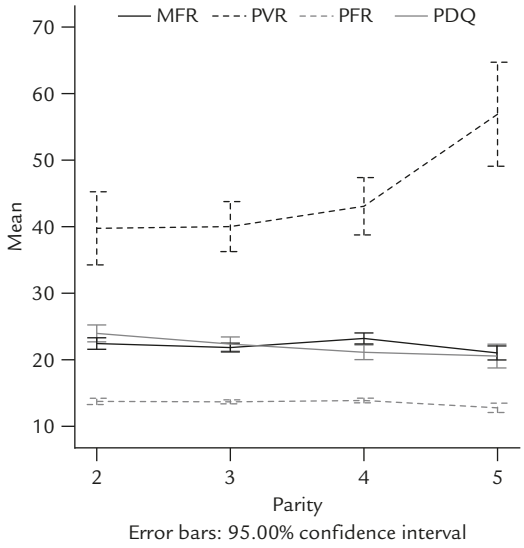

Figure 3. Various voiding parameters according to parity. Values are expressed as mean (standard deviation). MFR = maximum free flow rate; PVR = post-void residual; PFR = maximum flow rate on pressure-flow study; PDQ = detrusor pressure at maximum flow on pressure-flow study.

(PdetQmax) from PFS. Of the three factors studied (menopause, age, and parity), only parity had a significant impact on uroflowmetry and PFS results: Qmax, $p = 0.007$; PVR, $p < 0.001$; Qmax.p, $p = 0.002$; and PdetQmax, $p < 0.001$. Menopause and age had no significant effect on voiding function.

Even with the most advanced technology, UDS cannot perfectly reproduce the natural voiding environment in women with LUTS, though the data generated can be used to guide treatment. Women with prior continence procedures, pelvic prolapsed > stage II of the ICS grading system, hysterectomy or neurologic deficits that may have direct effects on voiding function were excluded from our study.

Uroflowmetry represents a simple initial test to assess the emptying phase of the lower urinary tract. PFS represents the simultaneous study of urinary flow and intravesical or detrusor pressure during voluntary voiding, which enables the classification of patients as obstructed, equivocal or unobstructed. Uroflowmetry combined with PFS is, therefore, the most commonly employed method for assessing voiding function in women with LUTS.

Analysis of the results of UDS in our study revealed the following distribution: USI, 55.5%; DO, 7.3%; MI, 4.5%; VD, 25.1%; and normal results, 7.6%. This distribution of UDS-defined prevalences, however, differed from those in previous reports. Lin et al [9] reported a distribution of 56% (USI), 5.8% (DO), 16% (MI), and 20.9% (VD), and Klingele et al [10] reported an evenly divided distribution. This discrepancy in reported survey results has been well described and may be attributed to variations in study samples and survey procedures, or to variations in the effects of the interventions [11].

If the voided volume was adjusted using the Liverpool Nomogram [12] for the maximum flow rate, our study groups had lower Qmax and higher PVR than average. Higher Qmax (24.2 ± 11.1 mL/s) in the USI group patients might be related to decreased outlet resistance, and lower Qmax (18.1 ± 9.2 mL/s) in the VD group patients might reflect the detrusor-sphincter dyssynergia. Detrusor contraction pressure was > 20 cmH_2O in our patients, which was higher than that reported in previous studies [13]. This may suggest that women in our study group voided by detrusor contraction, abdominal straining or some combination of these, while urethral pressure remained high. Normal detrusor function in accordance with ICS guidelines [7] was defined as follows: that for a given detrusor contraction, the magnitude of the recorded pressure rise will depend on the degree of outlet resistance. Many women voided with almost no detectable increase in detrusor pressure, though this does not necessarily mean that no detrusor contraction occurred; it may mean that the outlet resistance was so low that no pressure rise could be detected. The stop test was abandoned during urodynamic testing to avoid an isometric rise in detrusor pressure measurement. The routine clinical use of the stop test has some disadvantages and might be misleading. A high isometric detrusor pressure might imply good detrusor contraction, but a low or absent rise in pressure is not necessarily indicative of a lack of detrusor contraction. In addition, a patient may be unable to interrupt her urine stream completely on command.

Age had no significant effect on voiding function in our study, which was inconsistent with earlier reports. Yang and Huang [14] studied 125 women and indicated that age might have affected the uroflowmetry, but not the PFS. Haylen et al [15] also showed that urinary flow rates in urogynecology patients were negatively correlated with increased age. We chose a 10F catheter at a filling rate of 60 mL/min, while Yang and Huang [14] used a 4.5F catheter with a filling rate of 80 mL/min. The discrepancy between our data and those of Yang and Huang might simply reflect the different catheter sizes and filling rates. Klausner et al [16] reported that the use of 10F catheters could result in both a significant decrease in Qmax.p and an increase in PdetQmax, compared with a 5F catheter. He suggested that larger 10F catheters should be avoided, especially in patients with borderline symptoms. The 8F catheter was used to replace the 10F catheter in our hospital, following this study.

Our findings suggested that menopause [17] had no effect on voiding function. The atrophic change of the urethral epithelium and submucosa caused by menopause may increase susceptibility to LUTS, but its impact remains controversial [18,19].

Parity was significantly correlated with voiding function, which was consistent with the results of a previous report [4]. Schick et al [20] reported that urethral closure pressure fell significantly when urethral hypermobility was present. Childbirth undoubtedly contributes to urethral hypermobility, and delivery-associated injury would lessen urethral closure pressure. These factors could explain the reduction in maximum urethral closure pressure found in our study. The correlation was strengthened when parity was greater than three.

The UDS data in the DO and VD groups showed lower Qmax.p (< 12 mL/s) and higher PVR (> 50 mL). These two groups accounted for one-third of our study population. More complex techniques, such as video urodynamics, may need to be employed in order to explain the urethral activity during voiding in this group of patients.

In conclusion, our data indicated that of the three factors studied (menopause, age, and parity), only parity had a significant impact on voiding function. The effects of other factors, such as anterior vaginal prolapse, bladder neck mobility and prior pelvic surgery, on voiding function require further investigation. More advanced studies are needed to understand the complete picture in patients with DO and VD.

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