Effect of Aging on Storage and Voiding Function in Women with Stress Predominant Urinary Incontinence

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Abbreviations and Acronyms

BCI = bladder contractility index
MCC = maximum cystometric capacity
NIF = noninvasive flow
Pdet = detrusor pressure
PdetQmax = Pdet at Qmax
PFS = pressure flow study
PVR = post-void residual urine volume
Qmax = maximum flow
SISTEr = Stress Incontinence Surgical Treatment Efficacy Trial
SUI = stress urinary incontinence
TOMUS = Trial of Mid-Urethral Slings
UITN = Urinary Incontinence Treatment Network
VLPP = Valsalva leak point pressure
VV = voided volume

Purpose: We investigated age related changes in urodynamic parameters in 2 large cohorts of women planning stress urinary incontinence surgery.

Materials and Methods: Using a standardized protocol we obtained urodynamic parameters for participants in SISTEr (Stress Incontinence Surgical Treatment Efficacy Trial) and TOMUS (Trial of Mid-Urethral Slings) undergoing baseline noninvasive flow followed by filling cystometrogram and pressure flow study. The bladder contractility index (defined as detrusor pressure at maximum flow + 5 × maximum flow) and detrusor hypocontractility (defined as detrusor pressure at maximum flow less than 10 cm H_2O) were also characterized. Patients excluded from analysis had undergone prior stress urinary incontinence surgery or had prolapse stage greater than II. Propensity score analysis controlled for the potential bias of combining participants from 2 clinical trials. Linear and logistic regression analysis adjusting for propensity score quintile was done to assess the association of age and an age cutoff (less than 65 vs 65 or greater years) with urodynamic parameters.

Results: A total of 945 women (468 in SISTEr and 477 in TOMUS) were included in analysis. Mean age was 50 years in SISTEr (range 27 to 75) and 51 years (range 24 to 82) in TOMUS. Noninvasive maximum urinary flow decreased significantly with age (26.2 vs 22 ml per second, $p = 0.002$). Noninvasive flow voiding time increased 2.7 seconds for each 10-year age increment and detrusor pressure at maximum flow decreased 2.1 cm H_2O for each 10-year increase in age (each $p = 0.003$). Hypocontractility was more likely in women 65 years old or older (OR 2.89, 95% CI 1.59, 5.27). The bladder contractility index was inversely related to age, decreasing a mean ± SD of 7.68 ± 1.96 cm H_2O for each 10-year age increase ($p < 0.001$).

Conclusions: In these 2 cohorts the observed changes in voiding parameters suggest that detrusor contractility and efficiency decrease with age.

Key Words: urinary bladder; female; urinary incontinence, stress; urodynamics; aging

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Study received institutional review board approval at all participating centers.

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EFFICIENT voiding requires bladder outlet relaxation followed by a detrusor contraction sufficient to overcome the remaining resistance of the outlet. While many men show increased outlet resistance with age as a result of prostatic hypertrophy, to our knowledge no anatomical corollary exists in women. Women often present with symptoms commonly associated with voiding dysfunction, such as a slow urine stream, straining to void, a feeling of incomplete bladder emptying, need to repeat voiding and position dependent micturition. Voiding symptoms generally have poor sensitivity and specificity to predict increased PVR in women[1,2] and they correlate poorly with urodynamic evidence of obstruction.[3–5]

Urodynamic studies, specifically NIF studies and PFSs, can assist in the evaluation of women who present with voiding dysfunction symptoms. Various characteristics of urinary flow are examined, such as flow curve, VV, Qmax, average flow rate, time to Qmax and voiding time. PFSs also measure bladder VV and maximal PdetQmax, and identify characteristic voiding patterns. NIF Qmax and average flow rate depend on VV and were independent of age in small studies in asymptomatic (no prolapse or incontinence) women[6,7] while age related changes were reported in men.[8]

Recently published clinical trials from UITN enrolled more than 1,500 women who underwent urodynamic studies before surgical intervention for stress incontinence.[9–11] We reviewed NIF, cystometric and PFS parameters of these women who did not have advanced prolapse to understand the impact of aging on bladder function. Several hypotheses were considered at baseline, including a decrease in voiding pressure with age along with a decrease in Qmax and an increase in voiding time. In addition, with increasing age we expected to see no increase in PVR and a decrease in total bladder capacity.

METHODS

This was a secondary analysis of data from SISTEr and TOMUS performed by UITN.[12] The NIDDK (National Institute of Diabetes and Digestive and Kidney Diseases) sponsored UITN consists of urologists and urogynecologists from 9 clinical centers and a data coordinating center. SISTEr (fascial pubovaginal sling vs Burch bladder neck suspension) and TOMUS (retropubic vs transobturator mid urethral sling) were multicenter, randomized surgical trials comparing the efficacy and morbidity of surgical procedures for SUI. In SISTEr 655 women with stress predominant urinary incontinence were randomized between February 2002 and June 2004. In TOMUS 597 women with stress predominant urinary incontinence were randomized between April 2006 and June 2008. Details of enrollment criteria for each trial were previously published.[10,12,13] The studies were approved by the institutional review board at each participating clinical center and the biostatistical coordinating center. All patients provided written informed consent before enrollment.

The primary aim of this secondary analysis was to assess whether age is associated with differences in urodynamic variables of voiding using age as a continuous variable or comparing women younger than 65 years to those 65 years old or older. We chose 65 years as the age cutoff because it is commonly referred to in the geriatric literature.

Exclusions

SISTEr and TOMUS exclusion criteria included increased PVR (defined as greater than 100 ml for pelvic organ prolapse stage I or less and greater than 500 ml for pelvic organ prolapse stage II or greater), or a medical condition, previous pelvic surgery or cancer treatment known to affect bladder or urethral function. For this analysis additional exclusion criteria were used to minimize the potential for mechanical obstruction to confound urodynamic data. These criteria were prolapse greater than stage II and prior surgery for urinary incontinence.

Urodynamic Testing

SISTEr and TOMUS participants underwent preoperative urodynamic testing according to ICS (International Continence Society) guidelines,[14] including NIF and PFS performed according to a standardized urodynamic protocol.[15] Tracings were centrally reviewed by a urodynamic committee for quality review.[15] Urodynamic study began with a NIF study, which required a minimum VV of 150 ml. Filling cystometrogram was then performed with the participant standing using a dual lumen urethral catheter (8Fr or less) at a fill rate of 50 ml per minute. Simultaneous abdominal pressure monitoring was done through a fluid filled rectal balloon catheter. Pressure was measured using external pressure transducers zeroed to atmospheric pressure using the level of the symphysis pubis as the reference height. After the filling phase, which included VLPP, PFS was performed with the participant seated after transducers were repositioned at the level of the symphysis pubis. Vesical pressure was measured at baseline, just before voiding and at Qmax. The difference between Pdet before voiding and that at Qmax was calculated as PdetQmax. Collected data included Qmax, time to Qmax, voiding time, VV and PVR for NIF studies, and PdetQmax, PFS Qmax, time to Qmax, VV and voiding mechanism for PFSs. In this series specific calculations were added for detrusor hypocontractility with PdetQmax less than 10 cm H_2O pressure as the cutoff value.[15] Since voiding pressure reflects outlet resistance as much as detrusor function, BCI (PdetQmax $+ 5 \times$ Qmax) was also examined and compared between the 2 groups.[16,17]

Because eligibility criteria for the 2 studies differed, propensity score analysis was done to aid in controlling for bias between the samples selected from the 2 studies.[18] Briefly, using logistic regression we calculated the propensity of subjects to be in each study based on baseline