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Impact of urethral catheterization on uroflow during pressure-flow study

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Abstract

Objective: To investigate the impact of urethral catheterization on uroflow by comparing urodynamic parameters of free uroflowmetry versus pressure-flow study in adult patients with benign prostatic hyperplasia, female stress incontinence, lumbosacral spinal injury or spina bifida.
Methods: Each patient was required to perform pressure-flow study immediately following free uroflowmetry. Maximum flow rate (Q_{max}), average flow rate (Q_{ave}), voided volume (VV), T_{max} (time to Q_{max}) and post-voiding residual urine (PVR) were compared between the two tests.
Results: Out of 120 patients, transurethral catheterization significantly impacted uroflow. In male patients with benign prostatic hyperplasia ($n = 50$), Q_{max}, Q_{ave} and T_{max} were significantly different between free uroflow and pressure-flow study. In patients with female stress incontinence ($n = 30$), there were no statistically significant between-test differences in VV and T_{max}, but Q_{max}, Q_{ave} and PVR were significantly different. In patients with spinal injury or spina bifida ($n = 40$), Q_{max}, Q_{ave} and VV were significantly different between free uroflow and pressure-flow study.
Conclusion: Urethral catheterization adversely impacts uroflow in patients with benign prostatic hyperplasia, female stress incontinence, spinal injury or spina bifida. Free uroflowmetry should be performed before pressure-flow study.

Keywords

Urodynamics, uroflowmetry, catheterization

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Introduction

Pressure-flow urodynamic study has been widely used to evaluate bladder and pelvic floor dysfunction,[1,2] and demands urethral catheterization to measure the changes of pressure within the bladder. Various investigations have been performed to define the exact impact of transurethral catheterization

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on urodynamics, however, each study has typically focused on only one or a couple of conditions.[3,4] Data relating to the impact of catheterization on urodynamics remains inconsistent.

The aim of the present study was to investigate the impact of catheterization on uroflow by comparing the urodynamic parameters of free uroflowmetry with those of pressure-flow study in adults with disease areas that are commonly associated with bladder and pelvic floor dysfunction: benign prostatic hyperplasia, female stress incontinence and spinal injury or spina bifida.[1–3]

Patients and methods

Study population

This single centre, prospective study was conducted at the Department of Urology, Xiang Ya Hospital, Central South University, Changsha, China between January 2009 and December 2015. Adult patients (aged > 18 years) with benign prostatic hyperplasia, female stress incontinence or with spina bifida (all types) or lumbosacral spinal injury were sequentially enrolled. Patients were diagnosed according to published diagnostic guidelines.

All enrolled patients underwent free uroflowmetry and pressure-flow study. Patients whose voided urine volume was < 100 ml during free uroflowmetry or pressure-flow study were excluded from the investigation. Children were excluded from the study due to differences in anatomy and function compared with adults. The study was approved by the ethics committee of Xiangya Hospital, Central South University, China, and written informed consent was obtained from all participants.

Free uroflowmetry

Patients were required to drink water prior to undergoing free uroflowmetry. When a natural desire to void was felt, patients were asked to void according to their normal daily habits (standing or sitting) into a rotating disk uroflowmeter (Laborie, Mississauga, ON, Canada), while being provided with adequate privacy. Immediately after free-flow voiding, a double-lumen catheter (10 Fr; Laborie) was slowly introduced into the urethra without local anaesthesia (approximately a 5 min procedure). Post-voided residual urine was extracted from the bladder via this catheter, using a 20 ml syringe, and the value of post-voiding residual urine (PVR) was measured and recorded. The maximum flow rate (Q_{max}), average flow rate (Q_{ave}), voided volume (VV), and T_{max} (time to Q_{max}) were recorded using Aquarius® TT software (Laborie). Patients were asked to confirm that the voiding was representative of their usual voiding. The catheter was left in place and used for subsequent pressure-flow study.

Pressure-flow study

Catheterization was performed following free uroflowmetry voiding, and prior to initiation of pressure-flow study, to facilitate extraction of residual urine, bladder filling and measurement of intravesical pressure. The 10Fr double-lumen catheter end with two orifices had been placed into the bladder, the other bifurcate end was then connected to a pressure transducer and saline-filling tube (Laborie). Sterile saline at 26–28°C was continuously filled into the bladder at 20 ml/min using a controlled pump (Laborie). Abdominal pressure was measured through a balloon 6 Fr catheter (Laborie) placed in the rectum. An electromyogram was simultaneously recorded and displayed on a combined urodynamic system with Aquarius® TT software (Laborie).

The Q_{max}, Q_{ave}, VV and T_{max} was recorded by the Laborie urodynamic system computer. PVR was immediately measured following voiding by extracting the urine through the catheter using a 20 ml syringe before removing the catheter. Bladder filling was usually stopped when the patient developed a strong desire to void, and prior to voiding. In patients who were unable to postpone voiding, bladder filling was stopped when voiding was noticed. In addition, bladder filling was stopped when urine leakage occurred, such as in patients with compromised bladder sensation. The catheters were removed at the end of the procedure.

Statistical analyses

Data are presented as mean ± SD. Wilcoxon signed-rank test and Student's paired-samples *t*-test were used to compare Q_{max}, Q_{ave}, VV, PVR and T_{max} between free uroflowmetry and pressure-flow study. All calculations were performed using SPSS software, version 13.0 (SPSS Inc., Chicago, IL, USA). A P value < 0.05 was considered statistically significant.

Results

A total of 120 patients with either benign prostatic hyperplasia, female stress incontinence, or with lumbosacral spinal injury or spina bifida, were included. Mean patient age was 59.6 years (range, 30–86 years), and the study population comprised 71 male and 49 female patients (Table 1).

The urodynamic parameters during free uroflowmetry and pressure-flow study are presented in Table 2, and transurethral catheterization was shown to affect the uroflow in all three clinical conditions. In male patients with benign prostatic hyperplasia, Q_{max} and Q_{ave} values were significantly higher, and T_{max} values were significantly lower with free uroflowmetry compared with pressure-flow study ($P < 0.05$). In patients with female stress incontinence, there was no statistically significant difference in VV and T_{max} between free uroflowmetry and pressure-flow study, however, Q_{max}, Q_{ave} and PVR were significantly different between the two urodynamic study methods ($P < 0.05$). In patients with lumbosacral spinal injury or spina bifida, Q_{max}, Q_{ave} and VV were significantly higher with free uroflowmetry compared with pressure-flow study ($P < 0.05$), but there were no statistically significant differences in terms of T_{max} or PVR.

Table 1. Demographic and clinical characteristics of 120 adult patients who underwent free uroflowmetry followed by pressure-flow study.

Clinical characteristic	Demographic	
	Male/Female	Age, years
Benign prostatic hyperplasia ($n = 50$)	50/0	60.8 ± 24.4
Female stress incontinence ($n = 30$)	0/30	51.3 ± 19.6
Spinal injury or spina bifida ($n = 40$)	21/19	38.9 ± 14.5

Data presented as *n* patient prevalence or mean ± SD.

Discussion

Pressure-flow study can provide valuable data concerning the causes of lower urinary tract and pelvic floor dysfunction, and requires transurethral or suprapubic catheterization to record intravesical pressure.[1–3] Transurethral catheterization is known to interfere with the reliability of urodynamic recordings: a mechanical increase in outflow resistance has been observed with the use of transurethral catheters, and such increases in outflow resistance have also been observed in suprapubic catheter pressure-flow studies.[1] The aim of the present study was to investigate the effects of catheterization on uroflow via comparison of several urodynamic parameters during free uroflowmetry and pressure-flow study in three

Table 2. Comparison of urodynamic parameters between free uroflowmetry and pressure-flow study in 120 adult patients.

Patient group	Study type	Urodynamic parameter Q_{max}, ml/s	Statistical significance	Q_{ave}, ml/s	Statistical significance	VV, ml	Statistical significance	T_{max}, s	Statistical significance	PVR, ml	Statistical significance
BPH ($n = 50$)	f	13.7 ± 5.7	$P < 0.001$	7.9 ± 4.1	$P < 0.001$	240 ± 90	NS	11.7 ± 6.9	$P = 0.022$	75 ± 31	NS
	p	9.9 ± 5.7		5.1 ± 1.9		210 ± 98		15.8 ± 8.5		70 ± 37	
FSI ($n = 30$)	f	17.9 ± 10.5	$P < 0.001$	16.6 ± 5.9	$P < 0.001$	310 ± 110	NS	12.0 ± 6.3	NS	30 ± 11	$P = 0.016$
	p	14.4 ± 8.1		11.5 ± 6.1		295 ± 95		11.8 ± 6.9		50 ± 15	
Spinal ($n = 40$)	f	10.1 ± 3.4	$P < 0.001$	7.0 ± 3.6	$P = 0.011$	180 ± 69	$P < 0.001$	15.7 ± 9.7	NS	45 ± 21	NS
	p	6.1 ± 3.7		4.8 ± 2.7		140 ± 21		17.9 ± 9.5		43 ± 26	

Data presented as mean ± SD.

Q_{max}, maximum flow rate; Q_{ave}, average flow rate; VV, voided volume; T_{max}, time to Q_{max}; PVR, post voiding residual urine; BPH, benign prostatic hyperplasia; FSI, female stress incontinence; Spinal, spinal injury or spina bifida; f, free uroflowmetry; p, pressure-flow study.

NS, no statistically significant difference between free uroflowmetry and pressure-flow study ($P \geq 0.05$; Wilcoxon signed-rank test or paired-samples Student's *t*-test).

common aetiologies that frequently require urodynamic examination, namely benign prostatic hyperplasia, female stress incontinence, and lumbosacral spinal injury or spina bifida.[1–3,5]

The present study showed that in patients with benign prostatic hyperplasia, Q_{max} and Q_{ave} were higher in free uroflowmetry than pressure-flow study, and T_{max} had a shorter duration in free uroflowmetry versus pressure-flow study. Consistent with the present findings, a study into the effect of a 6 Fr catheter on flow rate in 133 male participants concluded that a 6 Fr transurethral catheter significantly lowered Q_{max} by 4 ml/s.[5] According to another study however,[6] in the majority of male patients who presented with lower urinary tract symptoms secondary to benign prostatic hyperplasia, an 8 Ch (1 Ch ≈ 1 Fr) urethral catheter appeared to have no significant impact on uroflow rate. Regardless of the discrepancy in findings, the present authors believe that the effect of transurethral catheterization should be considered when analysing any results from pressure-flow study in patients with benign prostatic hyperplasia.

Uroflow in adult females is characterized by a shortened urethra and decreased resistance,[5] and normal female uroflow is influenced only by the voluntary part of the sphincter mechanism.[7] Due to adult female urinary physiology, uroflow may be expected to be less influenced by catheterization in female than in male patients. According to previously published findings by the present authors and other investigators, however, uroflow is generally shown to be reduced independently of catheter size or health status in female patients.[8–13] In the present female patients with stress incontinence, Q_{max} and Q_{ave} during pressure-flow study were significantly lower than during free uroflowmetry, and higher levels of PVR were found during pressure-flow study. There was no significant difference in VV and T_{max}, however, between the two tests.

The present study indicates that uroflow can be greatly affected in adult male and female patients during pressure-flow urodynamic study. Except for mechanical reasons, one possible explanation for the apparent impact of catheterization on urinary flow rate is that the presence of any foreign object in the urethral lumen during voiding, regardless of size, may incite a subtle (non-detectable) dyssynergic pattern, thereby decreasing the flow.[8]

In patients with lumbosacral spinal injury or spina bifida in the present study, catheterization was found to affect uroflow. Q_{max}, Q_{ave} and VV were significantly higher with free uroflowmetry than with the use of a transurethral catheter in pressure-flow study. To the best of the authors knowledge, there are no published studies concerning the impact of catheterization during urodynamic study in neurological patients. In a study investigating the impact of catheterization in male patients with hypocontractile detrusor, which was not caused by neurological diseases,[4] catheterization was found to cause a reduction in uroflow. Since detrusor function is usually compromised in patients with lumbosacral spinal injury or spina bifida,[4] the results from the published study[4] indirectly support the present findings.

The greatest limitation of the present study was the relatively small number of patients available, and as a result, the study was conducted in patients with only three conditions that commonly require urodynamic examination. Further investigations are required concerning the impact of catheterization on other conditions. In addition, only adult patients were included in present study, and the authors are currently gathering more data to study the impact of catheterization in children stratified by age.

In conclusion, catheterization has an adverse impact on uroflow in patients with benign prostatic hyperplasia, female stress incontinence and lumbosacral spinal injury or spina bifida. Thus, free uroflowmetry must be performed prior to pressure-flow study. The impact of catheterization should be considered in the interpretation of pressure-flow study to avoid errors or artefacts.

Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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