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Free Uroflow Versus Pressure-Flow Urodynamic Outcomes: Does the Transurethral Catheter Cause a Measurement Artifact?

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ABSTRACT

INTRODUCTION: The effect of a transurethral catheter on urodynamic pressure-flow studies has been questioned, especially for patients with bladder outlet obstruction (BOO). The purpose of this retrospective study was to compare urodynamic outcomes measured during free uroflowmetry with pressure-flow studies using a transurethral catheter.

METHODS: We retrospectively reviewed the records of 22 adult patients who had voided volume that did not differ by more than 20% during 2 assessments: free uroflow and pressure-flow with a transurethral 5 Fr catheter in situ. The outcome measures were maximum flow (Qmax), average flow rate, voiding time, time to Qmax, and flow acceleration. Free uroflow and pressure-flow outcomes were compared using paired *t* tests. A Bonferroni adjustment was applied; probability < .01 was considered statistically significant.

RESULTS: There were 17 males and 5 females. The mean age was 39.9 years (range, 18-80 years). The urodynamic findings were reported as: normal (n = 6), hypocontractile detrusor (n = 5), BOO (n = 5), overactive bladder symptom complex (n = 4), and low pressure-low flow system (n = 2). Qmax was significantly higher during free uroflow than during pressure-flow recordings (*P* = .001). Average flow rate was also significantly higher during free uroflow (*P* < .001). Voiding time was significantly slower and acceleration was significantly faster during free uroflow (both with *P* = .001). There was no significant difference between recording conditions in the time to Qmax.

CONCLUSION: There appears to be a significant decrease in some uroflow measurements with a 5 Fr urethral catheter in situ during pressure-flow studies, which is contrary to the previous claim that any catheter smaller than 6 Fr does not alter the results. This measurement artifact needs to be considered when interpreting urodynamic studies, particularly if the patient has BOO. To compensate for differences between the free uroflow rate and uroflow rate with a catheter, the free uroflow rate and detrusor pressure may need to be considered when evaluating the degree of BOO.

KEYWORDS: Bladder outlet obstruction; Urodynamics

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Abbreviations and Acronyms

BOO, bladder outlet obstruction
Pdet, detrusor pressure
Qmax, maximum flow

INTRODUCTION

Urodynamics is a functional assessment of the lower urinary tract that provides objective pathophysiological explanations for voiding or storage symptoms and/or dysfunction. It is comprised of a series of tests. Selection of appropriate tests for a given lower urinary tract symptom helps to define its cause, if the test reproduces the symptom in question to a reasonable degree. The major drawbacks of urodynamic studies have been the need for an invasive approach and a possible inability to reproduce the clinical situation in question, for which there may be many reasons.

In recent years, the use of urodynamic pressure-flow studies has increased as objective quantification of lower urinary tract dysfunction has been sought. Therefore, any inaccuracies or measurement artifacts arising from the technique need to be considered.

Currently, transurethral catheters are widely used for the simultaneous recording of pressure and flow during voiding. Bladder pressure, detrusor pressure, abdominal pressure, and uroflow rate can be recorded in synchrony. Assessment of the function of the patient's lower urinary tract is then made based on the recorded outcomes.

The effect of the catheter on data collected when evaluating lower urinary tract dysfunction by pressure-flow studies, especially data regarding the degree of bladder outlet obstruction (BOO) and detrusor contraction, has recently been questioned. Suspicion remains as to whether the transurethral catheter affects the uroflow rate and, ultimately, the measured degree of BOO [1].

The purpose of the present retrospective study was to assess the impact of a 5 Fr transurethral catheter on uroflow parameters during pressure-flow studies, when compared with the results from free uroflow. We wanted to know whether the presence of a transurethral catheter causes enough obstruction to significantly alter the outcome.

METHODS

We retrospectively reviewed the urodynamic records of the patients who underwent urodynamic study at our institute from March 2007 to July 2010. Of the total 552 studies done during this period, we first selected only those studies with both free uroflow and pressure-flow components that had been conducted on adults; 116 patients met these criteria. Among these, we excluded those with free uroflow voided volume < 150 mL. Finally, only those patients with voided volume that did not differ by more than 20% in free uroflow and pressure-flow studies were chosen for the study. A 5 Fr transurethral urodynamic catheter was used for all pressure-flow studies. The final sample size was 22.

The outcome measures were maximum flow (Qmax), average flow rate, voiding time, time to Qmax, and flow acceleration. Free uroflow and pressure-flow outcomes were compared using paired *t* tests by SPSS version 17 (IBM Corp, Somers, NY). A Bonferroni adjustment was applied because there were 5 paired comparisons with a small number of patients; a probability < .01 was considered statistically significant. The means were also determined for each outcome measure according to the patient's urodynamic results.

RESULTS

The sample size was 22. There were 17 males and 5 females. The mean age was 39.9 years (range, 18-80 years). The urodynamic findings were reported as: normal (n = 6), hypocontractile detrusor (n = 5), BOO (n = 5), overactive bladder symptom complex (n = 4), and low pressure-low flow system (n = 2).

The mean voided volumes from the free uroflow and pressure flow studies were 301.09 mL and 315.82 mL, respectively. The difference was not statistically significant ($P = .265$). There was no statistically significant differences between the males and females for any of the outcome measures.

Table 1 contains the mean, standard deviation (SD), and standard error (SE) values for each of the outcome measures and the probability of significant differences between the free uroflow and pressure-flow recordings. Qmax was significantly higher during free uroflow than during pressure-flow recordings ($P = .001$). Average flow rate was also significantly higher during free uroflow ($P < .001$). Voiding time was significantly slower and acceleration was significantly faster during free uroflow (both with $P = .001$). There was no significant difference between recording conditions in the time to Qmax ($P > .01$).

Table 2 contains the means for each outcome measure obtained during free uroflow and pressure-flow recordings, presented according to the patient's urodynamic results. Statistical comparisons were not made because of the small and unequal number of patients. The previous conclusions based on overall comparisons with combined patient categories were consistent with the trends observed in the individual subgroups. The only exception was a slower mean acceleration during free uroflow for patients with a low pressure-low flow system. Additionally, it should be noted that there was a large amount of variability in mean time to Qmax between patient subgroups.

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Table 1. Outcomes From the Free Uroflow and Pressure-Flow Recordings; Probability of Significant Differences (N = 22).
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Outcome Measure	Free Uroflow Recording			Pressure-Flow Recording			*t*	*P*
	Mean	SD	SEM	Mean	SD	SEM		
Maximum flow, mL/s	17.57	11.63	2.38	11.91	7.65	1.63	4.044	.001
Average flow rate, mL/s	9.07	6.17	1.32	6.31	4.66	0.99	4.273	<.001
Voiding time, s	43.47	30.52	6.51	85.41	62.85	13.40	3.960	.001
Time to maximum flow, s	15.18	14.47	3.09	32.06	42.09	8.97	2.198	.039
Acceleration, mL/s²	2.35	2.12	0.45	0.80	0.82	0.17	3.802	.001

Abbreviations: SD, standard deviation; SEM, standard error of the mean..

DISCUSSION

Results of urodynamic tests are important for the diagnosis of urinary tract disorders and for evaluation of treatment. Overdiagnosis of obstruction based on urodynamic tests has been reported in various studies. In addition, claims of efficacy made by newer and alternative therapies for BOO are increasingly based on small differences in urodynamic data. The accuracy of these tests is essential, and any possible measurement artifact due to the use of a transurethral catheter must be considered.

The results of the present investigation support those from most previous studies. A catheter as small as 6 Fr or 8 Fr gauge reduces the voiding flow rate in both men [2-5] and women with a corresponding rise in detrusor pressure at peak flow rate (PdetQmax), which may result in an erroneous diagnosis of BOO [6,7]. A catheter as small as 5 Fr increases the voiding pressure even in males, which was clearly evident in our study. Kingler et al [8] reported a decrease in flow rate and simultaneous increase in voiding pressure with the use of a 10

Table 2. Means for the Outcome Measures Obtained During Free Uroflow and Pressure-Flow Recordings, Presented According to the Patient's Urodynamic Results (N = 22).
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Outcome Measure	Subgroup Based on Urodynamic Results: Normal (n = 6)	Overactive Bladder (n = 4)	Hypocontractile Detrusor (n = 5)	Low Pressure-Low Flow System (n = 2)	Bladder Outlet Obstruction (n = 5)
Maximum flow, mL/s					
Free uroflow	25.24	19.90	11.06	12.30	11.28
Pressure-flow	18.03	9.97	6.60	9.90	8.75
Average flow rate, mL/s					
Free uroflow	13.39	10.17	6.04	4.70	5.58
Pressure-flow	10.51	5.01	3.00	3.50	4.35
Voiding time, s					
Free uroflow	25.91	45.33	39.76	108.6	49.25
Pressure-flow	52.25	181.33	53.20	156.0	84.75
Time to maximum flow, s					
Free uroflow	8.61	26.53	9.66	25.10	21.75
Pressure-flow	18.55	86.30	7.00	68.60	31.43
Acceleration, mL/s²					
Free uroflow	3.50	3.40	2.76	0.30	1.08
Pressure-flow	1.26	0.13	0.98	0.90	0.38

Fr polyurethane urodynamic catheter. Another study showed that a 4 Fr transurethral catheter did not significantly alter uroflow values in females, although some decrease in uroflow parameters was found [9]. An 8 Fr catheter tends to increase the measured Valsalva leak point pressure [10]. Zhang et al [1] found that a 7 Fr transurethral catheter decreases uroflow parameters significantly. However, they also concluded that the degree of decline in these parameters did not parallel the severity of obstruction [1]. Therefore, it appears that catheters over 4 Fr gauge have some effect on urodynamic measurements.

Urethral catheters for bladder filling and pressure measurement should be as small in diameter as possible so that they do not interfere with observations of incontinence (leakage) and voiding. However, with a small catheter it may be difficult to drain the bladder when desired. If catheter-mounted transducers are employed, the catheter size and the type of transducer (eg, strain gauge, fiberoptic) are important to test interpretation and should be specified in the report. The manufacturer of the catheter and the model number or name should also be indicated [11].

According to Tessier and Schick [12], any type of urethral instrumentation (including a transurethral catheter) significantly affects uroflow parameters. Walker et al [13] compared a suprapubic catheter with a transurethral catheter for pressure-flow studies and concluded that transurethral catheters created a statistically significant increase in the degree of obstruction.

It is interesting to note that outlet resistance decreases in sequential voids, as measured in free uroflow and pressure-flow studies [14]. Hence, resultant flow parameters should increase. Instead, flow parameters decrease when a transurethral catheter is used for pressure-flow studies. This suggests a significant obstructive effect of the catheter. Recently, Valentini et al [15] demonstrated that the sphincter relaxed normally during free uroflow voiding, which was indicated by an absence of electrical activity. Conversely, the electrical activity of the sphincter was maximum during pressure-flow voiding with a catheter in situ. As a result, the flow pattern is likely to be substantially reduced in pressure-flow studies with a transurethral catheter in situ.

In our study, the transurethral catheter significantly reduced uroflow parameters in pressure-flow studies, confirming the fact that the presence of a urethral catheter is important to consider when interpreting uroflowmetric results. The transurethral catheter reduces the uroflow parameters even when the patient does not have bladder outflow obstruction, suggesting that the significant obstructive effect of a transurethral catheter on voiding is universal. None of the previous literature addresses the universality of the obstructive effect.

Detrusor pressure (Pdet) values could be altered if the peak flow rate value is erroneous based on pressure-flow studies using a transurethral catheter, especially in borderline cases of obstruction. As mentioned in other studies, voiding pressures may also be altered in a catheterized patient, which may also alter Pdet. This fact could not be verified in our study because we did not have Pdet values from the free uroflow recording; hence, comparison of Pdet in both measurement conditions was not possible.

In clinical urodynamic practice, absolute pressure values sometimes seem less important than pressure patterns and it is not yet determined whether the small decrease in flow that is caused by a catheter is clinically significant. The reliability of the absolute value plays an important role in the control of measurement quality. In many clinical situations it is essential to ensure that the measured pressures are correct. Examples include: (1) when comparisons with reference values from the literature are used in clinical decision-making; (2) when cystometric values before and after treatment are compared in outcome analysis based on multicenter data; or (3) when longitudinal observations on a single patient are compared. Specific examples include leak point pressure measurement and grading of BOO by pressure-flow analysis [11].

Currently, pressure-flow studies are the *gold standard* for assessment of BOO. Noninvasive nonurodynamic and urodynamic methods of diagnosing BOO in men exist, as reviewed by Belal and Abrams [16,17]. Noninvasive techniques for the measurement of isovolumetric bladder pressure include an external condom catheter and inflatable cuff around the penis [18]. However, the latter methods are not yet proven, nor are they being used in widespread clinical settings. Ambulatory urodynamics are also available if conventional urodynamics do not provide a diagnosis that is considered consistent with the patient's symptoms.

No treatment decisions should be based entirely on a urodynamic study. Other tests such as free uroflow, frequency/volume chart, and a bladder diary should be considered. However, if uroflowmetry with a transurethral catheter is used, it may be wise to choose the thinnest possible catheter during pressure-flow studies. To compensate for differences between the free uroflow rate and uroflow rate with a catheter, the free uroflow rate and detrusor pressure may have to be considered when evaluating the degree of BOO.

There are some limitations to the present study. It is a retrospective, the sample size is small, the age range is large, and the urodynamic findings are heterogenous and include patients that were categorized as normal. Although the study demonstrated an obstructive effect of an in situ 5 Fr urethral catheter during pressure-flow studies, this result needs to be confirmed by a randomized prospective investigation.

CONCLUSION

There appears to be a significant decrease in some uroflow measurements with a 5 Fr urethral catheter in situ during pressure-flow studies, which is contrary to the previous claim that any catheter smaller than 6 Fr does not alter the results. This measurement artifact needs to be considered when interpreting urodynamic studies, particularly if the patient has BOO.

Conflict of Interest: none declared.

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