The effect of a 6 Fr catheter in women: Are they obstructive?

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Abstract

Objectives: Our objective was to evaluate the effect of a 6 Fr transurethral catheter on the uroflowmetry and to assess whether it potentially contributes to the bladder outlet obstruction (BOO) in women.

Methods: We reviewed the charts of 1367 women who underwent an urodynamic study. We included patients with a non-invasive free-flow study (NIFFS) and pressure flow study (PFS) performed through a 6 Fr double lumen transurethral catheter.

Results: In total, 120 women met the inclusion/exclusion criteria. Mean maximal flow rate (Q_{max}) was significantly higher ($p < 0.001$) in the NIFFS (27.2±11.1 mL/s) than in the PFS (19.3±10.6 mL/s). The mean difference between both Q_{max} was 7.9±12.0 mL/s. Of these women, 92.3% (24/26) with a Q_{max} <12 mL/s during PFS were found to have a Q_{max} ≥12 mL/s during the NIFFS. Ten of the 72 women with an available $P_{det.}Q_{max}$ were deemed to have a BOO according to the PFS and all of them had a Q_{max} >12 mL/s during the NIFFS. Of the 10 patients, only 2 reported obstructive symptoms.

Conclusion: The presence of 6 Fr transurethral catheters alters the PFS and results in a significant reduction of the Q_{max} in patients who voided more than 250 mL. We believe that NIFFS should be performed in all patients before any urethral manipulation to lower a possible overdiagnosis of BOO and findings should always be correlated to clinical symptoms.

Introduction

Voiding dysfunction is a common urologic problem affecting women of all ages. Urodynamic studies (UDS) allow us to directly assess lower urinary tract symptoms (LUTS). Pressure-flow studies (PFS) provide important parameters during the UDS for the evaluation of bladder outlet obstruction (BOO). Several different UDS criteria for the diagnosis of BOO in women have been proposed,[1-6] but there are currently no accepted universal definition.

To objectively document BOO, physicians generally perform PFS through transurethral catheters, yet there are some concerns due to their potential obstructive nature. Several reports, both in men and women, have shown that the catheters themselves contribute to the obstruction observed,[7,8] while others did not.[9] However, most of these studies failed to control for initial bladder volume and voided volume in their comparisons. Thus, at this point, it remains controversial whether these transurethral catheters affect PFS parameters.

Our objectives were to evaluate the effect of 6 Fr transurethral catheter on the uroflowmetry and to evaluate whether it may potentially contribute to obstruction in women.

Methods

This is a retrospective study in which we reviewed the charts of 1376 women who underwent an UDS for the evaluation of LUTS. Patients were included if a NIFFS was performed before the UDS. UDS were performed with patients in a sitting position. Cystometrogram (CMG) was performed using a 6 Fr double lumen transurethral catheter through which a normal saline solution was infused at a rate a 20 mL/min. In the event of uninhibited bladder contractions, filling was stopped; once the pressures returned to baseline, the infusion was resumed at 10 mL/min. CMG was completed once the bladder was filled to maximal cystometric capacity. PFS was subsequently performed.

Patients were included if their voided volumes were more than 150 mL during both studies. Patients with a documented pelvic organ prolapse ≥2 were excluded.

All uroflowmetry tracings were inspected and analyzed manually. Comparisons were made between the NIFFS and the PFS. Compared parameters included the initial bladder volume, the maximum flow rates (Q_{max}), voided volume and postvoid residual urine (PVR). Detrusor pressure

at maximum flow ($P_{det}Q_{max}$) was also assessed during the PFS. Patients with unavailable $P_{det}Q_{max}$ measurements (due to technical difficulty or because the catheter fell during the voiding attempt, as well as those in which the measurement was deemed unreliable due to valsalva efforts during voiding) were included in the Q_{max} comparison analyses, but excluded from the BOO analyses. The PVR were measured using a transurethral catheter. There was a delay in the PVR measurement at our centre after the NIFFS due to the UDS suite set-up. Such a delay was nonexistent after the PFS.

Further analyses were performed in the subgroup of women who had similar initial bladder volume and who then voided similar volume between both studies (both varying by less than 20%). These analyses were performed because of the known correlation between the initial bladder volume in bladder, the flow rate and the voided volume.[10] This group is referred as the sub-analyzed group in the sections below. Analyses were also performed according to the voided volume during PFS: 150-250 mL, 250-350 mL, 350-450 mL and over 450 mL.

BOO was defined according to the UDS criteria by Defreitas and colleagues;[4] it is defined as a combination of a Q_{max} ≤12 mL/s and a $P_{det}Q_{max}$ ≥25 cmH_2O. Symptoms were evaluated using standardized questionnaires according the reason of the consultation.

Statistical analyses were performed using SPSS version 17.0 (SPSS Inc, Chicago, IL). Results were analyzed using either the student paired T test or the Wilcoxon signed-rank test for continuous variables according to the distribution. A *p* value of less than 0.05 was considered statistically significant. Data are presented as the mean plus or minus standard deviation, as percentage or as the median plus or minus the 25% to 75% range.

Results

Of the 1367 women, 473 women met the criteria (669 women were excluded because of inadequate voiding volume during either the NIFFS or the PFS, 126 women because of an unavailable NIFFS and another 99 were excluded because of a documented pelvic organ prolapse greater than grade 2). Of the total 473 women, 120 had a similar initial bladder volume and a similar voided volume between both studies (and were part of the sub-analyzed group). All the measured parameters, including the $P_{det}Q_{max}$, were available in 274 women (57.9%) in the overall population, and in 72 (60.0%) in the sub-analyzed group.

The mean age of the population was 61±13 years old. Most women were referred from the incontinence clinic (Table I). The median voided volume during NIFFS was significantly lower than during the PFS (281 mL [range: 210-397] vs. 402 mL [range: 300-524]; $p < 0.001$). The Q_{max} was significantly higher during the NIFFS (23.3±11.6 mL/s) than during the PFS (20.6±11.9 mL/s). The mean difference between both Q_{max} was 2.7±12.8mL/s (Table 2). This mean difference became even greater (7.9±12.0 mL/s) when only the women in the sub-analyzed group were compared (Table 3).

Further stratification according to voided volume during PFS showed a significant difference between the Q_{max} of both studies in each of the categories, with the exception of the 150-250 mL one. Excluding this category, the difference between Q_{max} remained independent of the voided volume (Table 4).

Of the overall population, 103 women (21.8%) and 26 women in sub-analyzed group (21.6%) had a Q_{max} ≤12 mL/s during PFS. Of these women, 73 (70.9%) in the overall population and 24 (92.3%) in sub-analyzed group had a Q_{max} >12 mL/s during the NIFFS.

From the women with a recorded $P_{det}Q_{max}$ in the overall population (n = 274), 43 (15.7%) were classified as having a BOO; similarly, from the women in the sub-analyzed group with a recorded $P_{det}Q_{max}$ (n = 72), 10 (13.9%) were classified as having a BOO. When we reviewed the charts of patients with a UDS suspicious of BOO, only 7 women (16.3%) in the overall population and 2 (20%) in the sub-analyzed group reported symptoms suggestive of BOO. This means that as much as 13.1% (36/274) in the overall population group and 11.1% (8/72) in the sub-analyzed group might have been wrongly diagnosed with BOO based on the UDS results alone. The initial indications for the UDS study in these patients were urinary incontinence in 40, voiding dysfunction in 2 and recurrent cystitis in 1. The indications for the 7 patients complaining of obstructive symptoms were incontinence in all of them, except 1 (voiding dysfunction).

Discussion

Several studies have observed a reduced Q_{max} during PFS in comparison to NIFFS, while others did not. However, most of these studies did not take into account the known correlation between the initial bladder volume, the voided volume and the flow rate. To our knowledge, our study is the first to demonstrate, while controlling for these parameters, that the presence of a 6 Fr transurethral catheter results in a

Table 1. Indication for urodynamic study (n=473)

	N (%)
Urinary incontinence	408 (86.3)
– Stress urinary incontinence	160
– Urge urinary incontinence	42
– Mixed urinary incontinence	206
Painful bladder syndrome/interstitial cystitis	13 (2.7)
Recurrent cystitis	6 (1.3)
Voiding dysfunction	46 (9.7)

Table 2. Comparison of the overall population (n=473)

Parameter	Non-invasive free-flow studies	Pressure-flow studies
Q_{max} (mL/s)	23.3 ± 11.6	20.6 ± 11.9*
Initial bladder volume (mL)	329 (240–461)	442 (334–573)*
Voided volume (mL)	281 (210–397)	402 (300–524)*
Postvoid residual (mL)	42 (11–100)	12 (0–49)*
$P_{det}Q_{max}$ (cm H2O)†	n/a	26 (14.0–41)

Data are medians (25-75% range) and means ± SD. *$p < 0.001$. †PdetQmax was available in 274 women. PdetQmax: Detrusor pressure at maximum flow; Qmax: maximum flow rate; SD: standard deviation.

Table 3. Comparison of the population with similar voided volume (n=120)

Parameter	Non-invasive free-flow studies	Pressure-flow studies	*p* value
Q_{max} (mL/s)	27.2 ± 11.1	19.3 ± 10.6	<0.001
Initial bladder volume (mL)	392 (309–455)	401 (318–516)	0.102
Voided volume (mL)	360 (280–474)	372 (299–488)	0.013
Postvoid residual (mL)	40 (6–99)	5 (0–34)	0.017
$P_{det}Q_{max}$ (cm H2O)‡	n/a	26 (14–55)	n/a

Data are medians (25-75% range) and means ± SD. ‡PdetQmax was available in 72 women. PdetQmax: Detrusor pressure at maximum flow; Qmax: maximum flow rate.

lower Q_{max} (-7.9 mL/s). This effect seemed to be independent of voided volume. Moreover, although we observed a significance difference between the PVR of both studies, this is most likely explained by the delay of its measurement following the NIFFS, which was nonexistent after the PFS. Finally, we have demonstrated that the PFS alone resulted in the overdiagnosis of BOO in at least 11.1% of the subanalyzed group.

In one of the first reports on the effect of catheters on flow rates, Gleason and Bottaccini concluded that its presence significantly reduced the Q_{max} and that this effect was more important in "normal" subjects and in women suffering from stress urinary incontinence.[11] In 1989, Sorensen and colleagues studied 30 healthy women and found that 7 Fr catheters also had obstructive consequences on uroflowmetry.[12] This was later confirmed by Groutz and colleagues; they assessed a population of 100 women who voided similar volumes between the NIFFS and the PFS.[13] They suggested that the 7 Fr catheters lowered the Q_{max} by as much as 13 mL/s. Using 7 and 9 Fr catheters, Costantini and colleagues demonstrated that both catheters resulted in a lower Q_{max} in comparison to NIFFS.[14] Baseman and colleagues evaluated the effect of 6 Fr transurethral catheters and acknowledged that they lowered the Q_{max} by 6.4 to 7.4 mL/s.[15] This was confirmed by Scaldazza and Morosetti.[16] They evaluated the impact of 3 different sized catheters (4.5, 6 and 7 Fr). They demonstrated that all 3 may obstruct micturition. They also stated that the 6 Fr catheters lowered the Q_{max} by about 8 mL/s, which was not significantly different from the 4.5 Fr catheters. Finally, 2 recent studies on this subject confirmed these previous findings.[17,18]

On the contrary, Lose and colleagues reported no difference between the Q_{max} of 60 symptomatic women when two 5 Fr catheter were used simultaneously.[19] However, voided volume was significantly higher during the PFS than during the NIFFS. Haylen and colleagues reported that a 7 Fr catheter had a mildly favourable effect rather than the expected negative effect when they investigated a population of 145 symptomatic women.[20] Similarly, DiGrazia and colleagues evaluated the effect of the 4Fr catheters in 33 women with similar voided volumes and concluded that it did not adversely affect the maximal flow rate in women.[21]

Interestingly, Scaldazza and Morosetti have also confirmed that the use of smaller catheters (4.5 Fr) resulted in a decrease $P_{det}Q_{max}$ in comparison to bigger ones (7 Fr).[16] This effect on the $P_{det}Q_{max}$ has also been studied in men by Zhao and colleagues.[22] These authors concluded that the use suprapubic catheters lowered the $P_{det}Q_{max}$ by more than 10 cmH_20 in comparison of transurethral catheters. However, this comparison is yet to be done in women. Thus, these obstruction effects caused by the transurethral catheter itself may lead to erroneous diagnosis, as well as unnecessary investigations and treatments.

The exact reason for this lowering of the maximal flow rate is yet to be elucidated, but it is possible that the presence of the catheters creates additional flow resistance (likely proportional to its size). Other explanations are a decrease in urethral compliance,[23] an individual normal variation of flow pattern between studies and an "artificial" voiding pattern created by the procedure[16] (possibly related to numerous other factors, including supraphysiological filling rate, psychogenic inhibition and incomplete relaxation of the external sphincter due to the presence of a foreign material in the urethra).[24] Valentini and colleagues also recently suggested that the lowering of the Q_{max} might be due a break in the detrusor excitation or a compression-like effect due to a urethral reflex.[18]

Table 4. Stratification of the population with similar voided volume according to voided volume

Voided volume (n)	Q_{max} (mL/s)-NIFFS	Q_{max} (mL/s)-PFS	Mean difference between Q_{max} (mL/s)	*p* value
150-250 mL (21)	20.0 (16.5–28.2)	19.5 (10.8–22.6)	4.9 (-4.3–11.6)	0.164
250-350 mL (38)	25.8 (16.9–33.3)	16.2 (9.5–22.1)	7.4 (1.8–16.4)	<0.001
350-450 mL (26)	22.5 (18.8–29.0)	18.7 (13.2–22.3)	4.5 (-2.0–10.9)	0.026
>450 mL (35)	32.0 (24.0–37.9)	18.0 (16–29.7)	9.0 (4.0–16.7)	<0.001

Data are medians (25-75% range) and means ± SD. NIFFS: Non Invasive Free-flow studies; PFS: Pressure-flow studies; Qmax: maximum flow rate.

Limitations of this study include its retrospective nature. The fact that the bladder was filled to the maximal cystographic capacity during the UDS could also have resulted in a lower Q_{max} due to overfilling. This limitation was, however, overcome by comparing the studies from the sub-analyzed group. The high proportion of women with unavailable $P_{det}Q_{max}$ (42%) is another obvious limitation. Furthermore, the design of the study did not allow us to definitely conclude on the risk of overdiagnosis of BOO as the effect of the catheter on the $P_{det}Q_{max}$ remains to be studied in women. By assuming that it was at least the same, 11.1% of the women in the sub-analyzed group might have been wrongly diagnosed with BOO if NIFFS would not have been performed. Finally, another significant limitation is the fact that the UDS definition of BOO in women is based on static variables that are yet to be validated and, unlike in men, there is no validated nomogram to assess its linear function.

It is our opinion, and also suggested by Schäfer and colleagues,[25] that a NIFFS should be performed before any urethral manipulation in all women evaluated with LUTS to lower the possible overdiagnosis. NIFFS are easy to perform, non-invasive, inexpensive and provide a baseline maximal flow rate untainted by the obstructive effect of the catheter. Perhaps, as proposed by Nitti and colleagues,[1] concomitant fluoroscopic imaging could also be performed in patients suspected clinically of suffering from BOO. Finally and most importantly, one is to remember that the diagnosis of BOO is not only a urodynamic one; the findings should always be correlated with clinical symptoms.

Conclusion

The presence of a 6 Fr transurethral catheter creates an obstructive effect on uroflowmetry by lowering the maximal flow rate by an average of 8 mL/s. This decrease in Q_{max} was statistically significant in patients who voided more than 250 mL. This effect may result in overdiagnosis of BOO, as well as subsequent unnecessary investigations and treatments. We believe that NIFFS should be performed in all patients before any urethral manipulation to lower this possible overdiagnosis.

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References

1. Nitti VW, Tu LM, Gitlin J. Diagnosing bladder outlet obstruction in women. *J Urol* 1999;161:1535-40. http://dx.doi.org/10.1016/S0022-5347(05)68947-1
2. Chassagne S, Bernier PA, Haab F, et al. Proposed cutoff values to define bladder outlet obstruction in women. *Urology* 1998;51:408-11. http://dx.doi.org/10.1016/S0090-4295(97)00634-1
3. Lemack GE, Zimmern PE, Shariat SF. Pressure flow analysis may aid in identifying women with outflow obstruction. *J Urol* 2000;163:1823-7. http://dx.doi.org/10.1016/S0022-5347(05)67552-0
4. Defreitas GA, Zimmern PE, Lemack GE, et al. Refining the diagnosis of anatomic female bladder outlet obstruction: a comparison of pressure-flow study parameters in clinically obstructed women to those of normal controls. *Urology* 2004;64:675-81. http://dx.doi.org/10.1016/j.urology.2004.04.089
5. Kuo HC. Urodynamic Parameters for the Diagnosis of Bladder Outlet Obstruction in Women. *Urol Int* 2004;72:46-51. http://dx.doi.org/10.1159/000075272
6. Blaivas JG and Groutz A. Bladder outlet obstruction nomogram for women with lower urinary tract symptomatology. *Neurourol Urodyn* 2000;19:553-64. http://dx.doi.org/10.1002/1520-6777(2000)19:5<553::AID-NAU2>3.0.CO;2-B
7. Lose G, Thunedborg P, Colstrup H, et al. Spontaneous versus intubated flow in male patients. *Urology* 1988;32:553-6. http://dx.doi.org/10.1016/S0090-4295(98)90044-9
8. Klingler HC, Madersbacher S, Schmidbauer CP. Impact of different sized catheters on pressure flow studies in patients with benign prostatic hyperplasia. *Neurourol Urodyn* 1996;15:473-8. http://dx.doi.org/10.1002/(SICI)1520-6777(1996)15:5<473::AID-NAU4>3.0.CO;2-C
9. Reynard JM, Lim C, Swami S, et al. The obstructive effect of a urethral catheter. *J Urol* 1996;155:901-3. http://dx.doi.org/10.1016/S0022-5347(01)66341-9
10. Drach GW, LaytonTN, Binard WJ. Male peak urinary flow rate: Relationships to volume voided and age. *J Urol* 1979;122:210-2.
11. Gleason D, Bottaccini M. The effect of a fine urethral pressure-measuring catheter on urinary flow in females. *Neurourol Urodyn* 1984;3:163-71. http://dx.doi.org/10.1002/nau.1930030305
12. Sorensen S, Janler M, Knudsen UB, et al. The influence of a urethral catheter and age on recorded urinary flow rates in healthy women. *Scand J Urol Nephrol* 1989;23:261-6. http://dx.doi.org/10.3109/00365598909180335
13. Groutz A, Blaivas JG, Sassone AM. Detrusor pressure uroflowmetry studies in women: effect of a 7Fr transurethral catheter. *J Urol* 2000;164:109-14. http://dx.doi.org/10.1016/S0022-5347(05)67460-5
14. Costantini E, Mearini L, Biscotto S, et al. Impact of Different Sized Catheters on Pressure-Flow Studies inWomen With Lower Urinary Tract Symptoms. *Neurourol Urodyn* 2005;24:106-10. http://dx.doi.org/10.1002/nau.20099
15. Baseman AG, Baseman JG, Zimmern PE, et al. Effect of a 6F urethral catheterization on urinary flow rates during repeated pressure-flow studies in healthy female volunteers. *Urology* 2002;59:843-6. http://dx.doi.org/10.1016/S0090-4295(02)01600-X
16. Scaldazza CV, Morosetti C. Effect of Different Sized Transurethral Catheters on Pressure-Flow Studies in Women with Lower Urinary Tract Symptoms. *Urol Int* 2005;75:21-5. http://dx.doi.org/10.1159/000085922
17. Nager C, Albo M, FitzGerald MP, et al. Reference urodynamic values for stress incontinent women. *Neurourol Urodyn* 2007;26:333-40. http://dx.doi.org/10.1002/nau.20348
18. Valentini F, Marti B, Robain G, et al. Differences Between the Data From Free Flow and Intubated Flow in Women With Urinary Incontinence. What Do They Mean? *Neurourol Urodyn* 2008;27:297-300. http://dx.doi.org/10.1002/nau.20518
19. Lose G, Thunedborg P, Jorgensen L, et al. A comparison of spontaneous and intubated urinary flow in female patients. *Neurourol Urodyn* 1986;5:1-4. http://dx.doi.org/10.1002/nau.1930050102
20. Haylen BT, Cerqui A, Law M, et al. Effect of size 7 Fr. urethral catheter on urine flow rates in urogynaecology patients. *Int Urogynecol J* 1999;10:S98.
21. DiGrazia E, Bartolotta S, Nicolosi F, et al. Detrusor pressure uroflowmetry studies in women: Effect of 4-Fr transurethral catheter. *Arch Ital Urol Androl* 2002;74:134-7.
22. Zhao SC, Zhang P, Huang ZM, et al. Suprapubic puncture: preferable to transurethral catheterization for pressure-flow determination in BPH patients. *Zhonghua Nan Ke Xue* 2008;14:973-6.
23. Susset JG, Ghoniem GH, Regnier CH. Abnormal urethral compliance in females diagnosis, results and treatment. Preliminary study. *J Urol* 1983;129:1063-5.
24. Hennebelle D, Valentini F., Robain G, et al. Decrease of maximum flow rate during intubated flow is not only due to the urethral catheter in situ. *J Urol* 2011;185:e872 [abstract 2176].
25. Schafer W, Abrams P, Liao L, et al. Good urodynamic practices: uroflowmetry, filling cystometry, and pressure-flow studies. *Neurourol Urodyn* 2002;21:261-74. http://dx.doi.org/10.1002/nau.10066

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