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A Comparison of Urethral Profilometry using Microtip and Fiberoptic Catheters

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Abstract: This paper compares urethral profilometry measurements using two different types of catheter: the Millar microtip transducer and the FST fiberoptic catheter. Outcome variables were functional urethral length (FUL), maximum urethral closure pressure (MUCP), and mean pressure/transmission ratio (PTR). Thirty women presenting to the urodynamics laboratory with symptoms of stress urinary incontinence were evaluated with both catheters. All subjects underwent two passive urethral pressure profiles and two dynamic (cough) urethral pressure profiles with each catheter. For FUL and MUCP, the means of the two passive measurements were compared between catheters. For PTR, the means of the two dynamic measurements were compared between catheters. There was no difference in FUL between the two catheter types. The FST measurements of MUCP and PTR were lower than the microtip measurements. Twenty per cent of patients would have been diagnosed with low-pressure urethra with the FST catheter, but not with the microtip catheter. Caution must be used when applying urethral measurements taken with the fiberoptic catheters to standards set with microtip catheters.

Keywords: Profilometry; Urethral pressure; Urinary incontinence; Urodynamics

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Introduction

Clinicians rely on urodynamic testing to guide management decisions, whereas researchers use the results to quantify treatment outcomes in women with urinary incontinence and severe pelvic organ prolapse. Water-filled catheter systems have long been widely available, but the majority of published literature reflects the use of microtip electronic transducers to make the urodynamic measurements. Fiberoptic pressure catheters have been utilized during invasive cardiac monitoring, but only recently applied to the study of the function of the lower urinary tract in women [1].

The microtip catheters are reliable and widely accepted, but disadvantages include the expense, the tendency of the catheters to accumulate protein deposits which affect accurate measurements, and the requirement for delicate handling. In addition, the microtip catheters measure in a unidirectional manner, requiring proper orientation of the pressure diaphragm [2].

A proposed advantage of fiberoptic catheters for use in urodynamic testing is the relatively low cost, allowing them to be marketed as disposable or multiuse. They are also sturdier than the microtip catheters and less prone to breaking with everyday usage. In addition, the fiberoptic catheter measures pressure circumferentially. This not only alleviates the need to orient the catheter in the urethra properly, but in theory gauges the true pressure of the urethral lumen, as opposed to simply the forces affecting the urethra at the position where the microtip diaphragm is placed.

The aim of this study was to compare the Millar microtip catheters to the FST-200 fiberoptic catheter in urodynamic testing, specifically the measurement of both active and passive urethral profilometry.

Materials and Methods

Subjects were recruited from women presenting to the urogynecology unit at a university center for the evaluation of urinary incontinence. Enrolment was limited to those with symptoms of stress urinary incontinence. Those with predominantly urge incontinence symptoms or other complaints suggestive of a diagnosis of detrusor overactivity were excluded. Institutional review board approval was obtained. All women gave informed consent.

The system in use in our urodynamics laboratory was the Lifetech 1106-Urolab analog system. The Mikrotip SUPC-780B (Millar Instruments Inc., Houston, TX) was used as the microtip catheter (MT). The vesical and urethral pressures were recorded with a dual-sensor 8-Fr catheter with an infusion port. The abdominal pressure was recorded with an 8-Fr MT catheter placed either in the vagina or the rectum, if more than second-degree prolapse was present. The fiberoptic (FST) catheter (previously FST 200 System, Fiberoptic Sensor Technologies Inc., Ann Arbor, MI; currently Bard, Covington, GA) was also an 8-Fr diameter vesical/urethral dual-sensor catheter with a filling port. The abdominal pressure was recorded with a rectal balloon catheter.

All participants underwent a comprehensive standardized evaluation, including history, physical examination, measurement of postvoid residual, retrograde subtracted slow-fill (30 ml/min) provocative cystometry using room-temperature saline, and direct visualization for urine loss in the 45° sitting position. A more detailed description of the technique is given elsewhere [3]. Women with urinary tract infection, abnormally elevated postvoid residual urine or detrusor instability were eliminated from the study. At 300 ml volume or at maximum capacity, whichever came first, urethral profiles were performed. The urethral transducer was withdrawn from the bladder to the external urethral meatus by means of a remote-controlled mechanical arm, at a speed of 5 mm/s. The passive urethral profiles were taken with the patient at rest. For the dynamic (cough) profile, the woman was asked to cough forcefully on command as the urethral transducer was withdrawn. Each woman underwent eight consecutive urethral pressure profiles (UPPs): two passive and two dynamic UPPs with one catheter, and then two passive and two dynamic UPPs with the other catheter. The order in which the catheters were used was varied so that half of the patients were tested with the microtip catheters first and a half were tested with the fiberoptic catheters first, i.e. a two-sequence two-period crossover design.

Outcome variables were functional urethral length (FUL), maximum urethral closure pressure (MUCP) and mean pressure/transmission ratio (mnPTR). All terminology conforms to the recommendations of the International Continence Society [4].

Genuine stress incontinence (GSI) was diagnosed when a spurt of fluid was observed to exit the external meatus at the peak of a maximal cough [5].

Statistical Analysis

After the collection of pilot data a preliminary analysis was performed to determine sample size. For this calculation, clinically meaningful differences of 10 mmH_2O in MUCP, a 20% change in PTR and 5 mm change in FUL were selected. To achieve a significance level less than 0.05 and power of at least 80% required at least 15 patients in each arm of the study for MUCP and FUL, and at least 16 patients in each arm of the study for mean PTR.

For a given catheter, because each measurement was taken twice, a chance exists for the first measurement to be statistically significantly different from the second, i.e. for a repetition effect to exist. A test for repetition effect was performed for each variable (MUCP, FUL and PTR) using a general linear mixed model. In each case the repetition effect was not significant and the two measurements on a given catheter were averaged.

After this averaging, the analysis data set consisted of one measurement on each of the two catheters per patient. For each variable, a test was performed for the carryover effect of the first catheter while taking measurements with the second catheter. In each case, the carryover effect was not statistically significant.

The mixed model was also used to determine whether there was a significant difference between the catheters for a given variable. The mixed model is a generalization of the stanard linear model, and fits both fixed (treatment, period, sequence, carryover difference) and random (patient) effects. FUL and PTR data were normally distributed, but a log (base 10) transformation of the MUCP data was necessary for appropriate use of the mixed model. Because the MUCP data did not follow a normal distribution, the logs of the means were compared for this variable.

Results

Thirty women with urodynamically diagnosed pure GSI were included in the study. The patients had a mean age of 58.4 years (ranged 33–81). Twenty-one had undergone prior hysterectomy, and of these 12 had undergone previous prolapse repair of incontinence surgery (9 anterior colporrhaphies, 3 retropubic urethropexies and 1 needle suspension).

Using the Baden–Walker halfway grading system [6], 7 patients had no cystocele, 17 had a first-degree cystocele, 4 had third-degree anterior vaginal wall prolapse, and two had complete prolapse. Twenty-three of the women were diagnosed with urethral hypermobi-

Table 1. Comparison of fiberoptic versus microtip catheters: urethral pressure profiles

Variable (mean)	FST	MT	*P* value
FUL (mm)	20.8	19.6	NS
MUCP (cmH_2O)	20.7	32.7	<0.0001
PTR (%)	63.8	88.0	0.0002

Table 2. MUCP results by patient

Patient	Microtip MUCP cmH_2O	Fiberoptic MUCP cmH_2O
A	20.0	14.0
B	15.0	15.0
C	17.5	15.0
D	22.5	17.0
E	53.0	25.0
F	30.5	14.0
G	42.0	38.0
H	72.0	33.5
I	44.0	24.5
J	16.0	13.0
K	20.0	13.0
L	5.0	5.0
M	67.0	29.0
N	35.0	26.0
O	15.0	6.0
P	43.0	24.0
Q	38.0	18.0
R	22.5	20.0
S	26.0	25.0
T	18.5	17.0
U	12.5	9.0
V	45.0	28.0
W	28.0	14.0
X	20.0	11.0
Y	31.0	22.0
Z	41.0	31.0
AA	30.0	23.0
AB	36.0	20.5
AC	42.0	38.0
AD	77.0	27.0

lity, $\geqslant 30^\circ$ movement with strain. All participants were diagnosed with genuine stress urinary incontinence during the urodynamic testing.

Comparison of the profilometry measurements revealed that the averages of the MUCP and mnPTR were significantly lower with the fiberoptic cathether (FST) than with the microtip catheter (Table 1). There was no significant difference in the FUL as measured by the two types of catheter.

Comparing the mean of the MUCP measurements patient by patient (Table 2), one can see that the FST measurement was always less than the microtip measurement (Fig. 1). Using MUCP less than or equal to 20 cmH_2O as the definition of low-pressure urethra (LPU), 10 women were diagnosed with LPU using the microtip catheter; this was confirmed by the FST catheter. However, the FST catheter diagnosed an additional 5 women with LPU (patients D, F, Q, R, W; Table 2).

Discussion

The lower FST urethral measurements are probably due to the averaging of the pressure along the entire circumference at the transducer. The frequency response requirements of a transducer are higher when measuring cough spikes than when determining pressure changes during bladder filling [7]. Lower PTRs could result from a lower frequency response of the FST compared to the microtip catheter, but this is unlikely because the MUCPs were also lower during the resting urethral pressure profiles.

Both catheter types measured intravesical and intra-abdominal pressures during bladder filling, enabling a diagnosis of genuine stress incontinence or detrusor instability to be made. If non-surgical therapy is planned, or if the MUCP is greater than 20 cmH_2O, there appears to be no significant difference between the two systems. The importance of the urethral profilometry remains controversial. Awad [8] found that MUCP does differentiate well between women with GSI and controls. Because no standardized definition of intrinsic sphincteric deficiency (ISD) exists, many surgeons rely on the MUCP to diagnose low-pressure urethra or ISD [9,10]. Because the chance that a retropubic urethropexy will fail to correct urinary incontinence is higher in a woman with ISD than in one with GSI and 'normal' urethral closure pressures, many women with ISD will be advised to undergo the more obstructive sling urethropexy [11]. However, a sling procedure is associated with a higher morbidity rate, including urinary retention and de novo detrusor instability [12], and so the diagnosis of ISD must be made carefully. In our small series, 20% of the women would have been diagnosed with LPU using the fiberoptic catheter, but not with the microtip catheter.

As most of the published research regarding profilometry was done using microtip transducers, the established definitions reflect those transducers. This comparison is not intended to establish which is the more accurate, but simply points out that the profilometry measurements between the two catheters are different. In order to use the fiberoptic catheters to diagnose low-pressure urethra via the use of MUCP, a new scale will need to be established and correlated to clinical outcome. Leak-point pressures were not measured during the course of this study, and so no conclusions can be made regarding the reproducibility of Valsalva leak-point pressure (VLPP) between the two catheters.

Conclusions

The FST-200 catheters measure lower urethral pressures during urethral profilometry than do the Millar microtip catheters, resulting in lower urethral closure pressures and pressure/transmission ratios. Thus it is possible that low-pressure urethra might be overdiagnosed using the fiberoptic catheters.

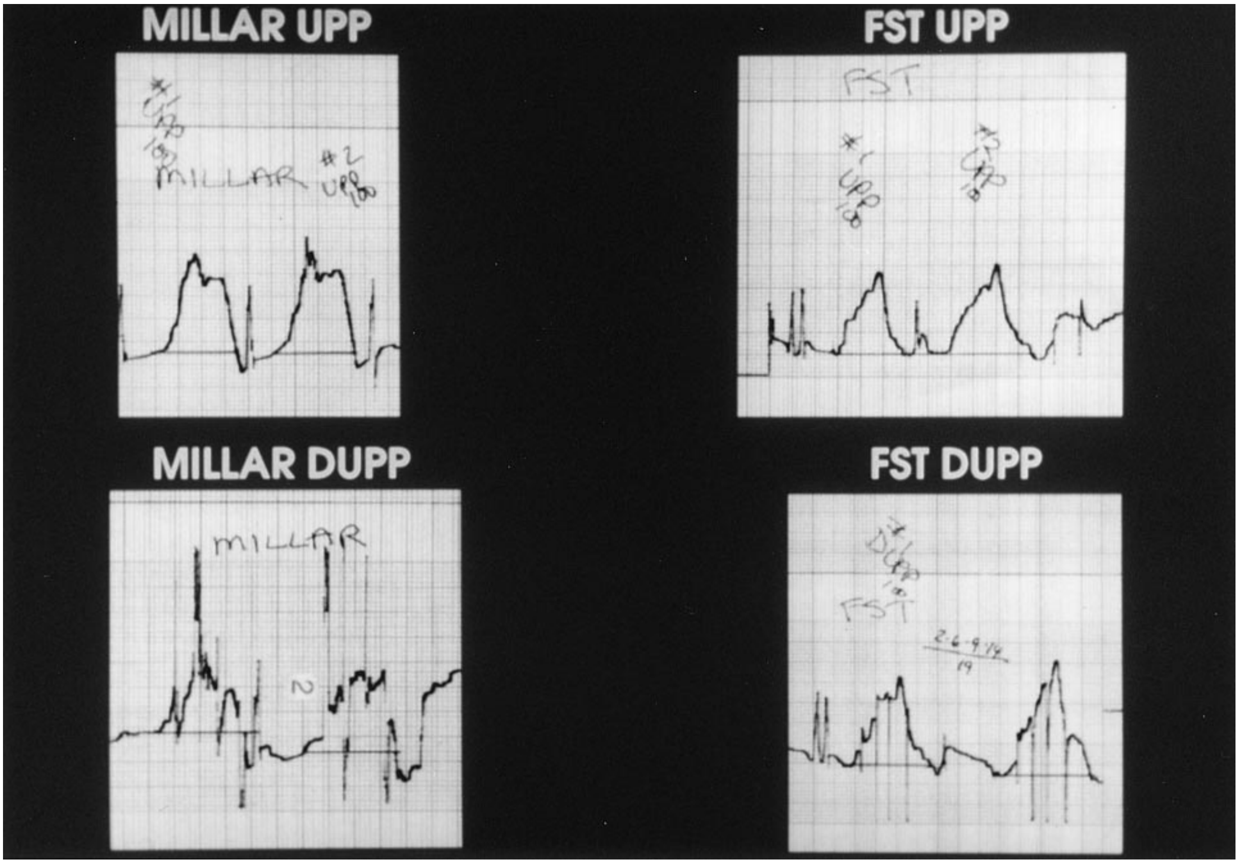

Fig. 1. Four urethral pressure profiles from one patient. UPP, urethral pressure profile; DUPP, dynamic or cough profile; Millar, microtip catheter; FST, fiberoptic catheter.

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EDITORIAL COMMENT: This study compares microtransducer with fiberoptic catheters for urethral profilometry. In this series the measurements with the fiberoptic catheter for urethral pressure were lower than those obtained with the microtransducer catheter. Even though fiberoptic catheters have been sold extensively over the last few years, this is the first study in the literature that compares these two types of catheter for this purpose. The most important point derived from this study is the realization that 20% of patients would have been diagnosed with low-pressure urethra. If this had been the only criterion for the diagnosis of intrinsic sphincter deficiency, it is likely that these patients would have received the wrong operation, such as a sling procedure, with its higher morbidiy, instead of a Burch procedure. New modalities need to be tested clinically before they are applied to clinical situations in order to avoid such potential errors in patient management.