Urethral function in overactive bladder syndrome

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CHAPTER 4

ADDITIONAL VALUE OF TRIPLE-SENSOR URETHRAL CATHETER IN DEMONSTRATING URETHRAL PRESSURE VARIATIONS DURING FILLING CYSTOMETRY

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INTRODUCTION

Urodynamic evaluation is often performed in the work-up of patients with lower urinary tract symptoms (LUTS). During filling cystometry, urethral pressure variations (UPV) can be observed if continuous intra urethral pressure measurement is performed. Continuous intra urethral pressure is technically not easy to measure, since the closed urethra during filling phase has no lumen like the bladder, the vagina or the rectum. In the period 1978-1996 various studies have described urethral pressure variations, and discussed whether this is an entity on its own, apart from detrusor overactivity[1-4]. The International Continence Society (ICS) defined urethral instability (URI) in 1981 as a condition in which there is an involuntary fall in urethral pressure during filling phase, resulting in urinary leakage in the absence of detrusor activity. This definition was abandoned shortly after because this is a rare phenomenon. In a recent review was concluded that studies on this subject have a diversity in measurement techniques and materials [5]. Urodynamic catheters with variation of one to six sensors in the urethra have been used in the literature[6-9]. In the studies performed with multiple urethral pressure sensors, all sensors registered the urethral pressure variations simultaneously, they have however been best recognized at the point of maximal urethral pressure[9]. Recently, a think tank session of the ICI-RS was dedicated to urethral pressure variations urethral instability[10]. This session was followed by a summarizing report based on literature review and discussions during this ICI-RS meeting[11]. This report also concluded that UPV certainly is associated with LUTS and thus, future research on this topic is relevant.

If clinical relevance of urethral pressure variations is to be further examined, a consensus about the definition of URI is necessary and the demonstrating of this condition has to be widely applicable. Therefore, research is needed to demonstrate if measurement with a single urethral sensor catheter is as representative as measurement with a multi sensor urethral catheter in diagnosing UPV. Continuous urethral pressure measurement is usually performed with the use of a dual air-balloon sensor urodynamic catheter with only one sensor in the urethra. In our centre, urodynamic studies have been performed with both the "standard" dual sensor catheter, as with a catheter with three urethral sensors. The purpose of this study is to compare the results of continuous urethral pressure measurements with a single urethral sensor catheter and a triple urethral sensor catheter in demonstrating UPV during filling cystometry.

MATERIALS AND METHODS

This prospective observational intervention study was performed at the outpatient urology department of Leiden University Medical Centre. Between May 2016 and July 2018, seventy-five consecutive patients enrolled in this study. All adult female patients, mentally fit to consent and requiring urodynamic evaluation for analysis of their LUTS were asked to participate in this study. Ethical committee approval was granted and all patients provided written informed consent. Declaration of Helsinki was followed. All patients had a normal urine microscopy before urodynamic investigation. All patients underwent two series of filling and voiding cystometry. One series was performed with the regular dual-air balloon sensor urodynamic catheter (Laborie T-DOC® air-charged dual sensor catheter, distance from bladder sensor to urethral sensor 6cm, shore hardness 65±5D, 7Fr), positioned at maximum urethral pressure. The other series was performed with a urodynamic catheter with three urethral sensors (Unisensor, UniTip catheter, three urethral sensors 7mm apart, distance from bladder sensor to middle urethral sensor 7cm, shore hardness of 65D, 8Fr), with the midurethral pressure sensor positioned at the maximum urethral pressure. It was decided at random which type of catheter was used for the first filling series, the second measurement series was performed with the other type. Cystometry was carried out in a semi-upright sitting position with a continuous filling rate of 30-50ml/min. All urodynamic investigations were performed by the same specialized nurse according to ICS standard good urodynamic practices and terms 2016. During filling cystometry, the sensory markers first sensation of filling (FSF), normal desire (ND) and strong desire (SD) and maximal filling capacity (MMC) were marked. Pelvic floor electromyography (EMG) was performed with surface patch electrodes. In the measurement with single urethral sensor catheter, UPV was defined as an urethral pressure drop exceeding 30 cmH2O. Although to date pressure variations larger than 15 cm H2O have appeared to be most clinically relevant, we deliberately used a relatively higher cut-off value to rule out movement artefacts. In the measurement with the triple urethral sensor catheter, UPV was defined as an urethral pressure drop present in at least two out of three sensor measurements, with a pressure drop exceeding 30 cmH2O in at least one sensor measurement. Confidence intervals for correlation were calculated to a sample size of 75 patients.

RESULTS

The patients' mean age was 54 years with a range of 19-90 years. The median volumes during filling cystometry measured with both catheters are shown in Table 4.1.

The prevalence of UPV is 37.3% (28 out of 75 patients). In 8 patients UPV was seen in both single and triple urethral sensor catheters, in 18 patients only in the triple urethral sensor catheter and in 2 patients only in the single urethral sensor catheter. Examples of urodynamic tracings showing the 30cm H2O pressure drop with each of the two catheter types in the same patient are shown in figure 4.1 and 4.2 respectively. An overview of the prevalence of UPV in measurements with both catheters is shown in table 4.2. The triple sensor catheter detected a significant larger amount of UPV (26/28) compared to dual air-balloon catheter (10/28, p-value <0.001). Detrusor overactivity (DO) was seen in 13 patients (17.3%) and a combination of UPV and DO in 4 patients (5.3%). As shown in Table 4.3, there are no significant differences in volumes during filling cystometry between patients with and without UPV. As shown in table 4.4, neither was there a significant difference in median volumes during filling cystometry between patients who underwent the first measurement with single sensor catheter compared to triple sensor catheter.

Table 4.1 Median volumes during filling cystometry

N=75	Dual microtip Median (IQR)	Missing	Triple sensors Median (IQR)	Missing	P-value*
FSF	97 ml (55 – 214)	2	123 ml (67 – 198)	0	0.790
ND	245 ml (121 – 386)	6	198 ml (133 – 316)	6	0.013
SD	303 ml (167 – 455)	11	264 ml (169 – 411)	9	0.030
MMC	334 ml (210 – 502)	10	327 ml (195 – 499)	7	0.493

* Wilcoxon signed ranks test

Table 4.2 UPV in dual microtip versus triple sensor catheter (30cmH2O)

		Triple sensor No UPV	UPV	Total
Dual microtip (one urethral sensor)				
	No UPV	47	18	65
	UPV	2	8	10
	Total	49	26	75

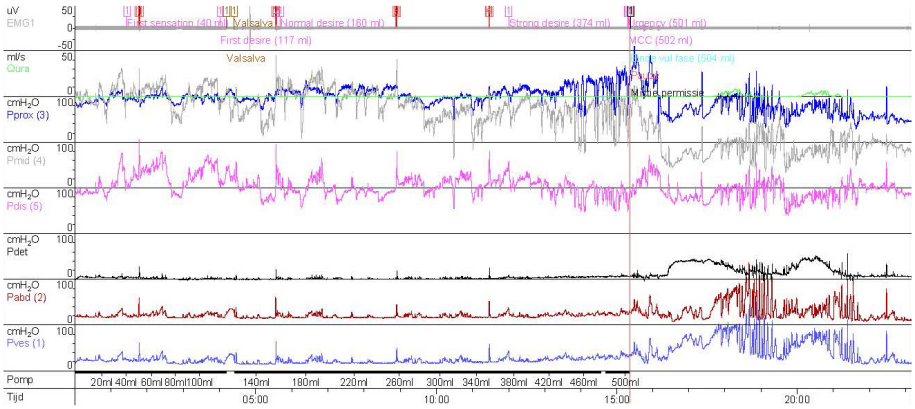

Figure 4.1 Sample tracing UPV with 3 urethral sensor catheter

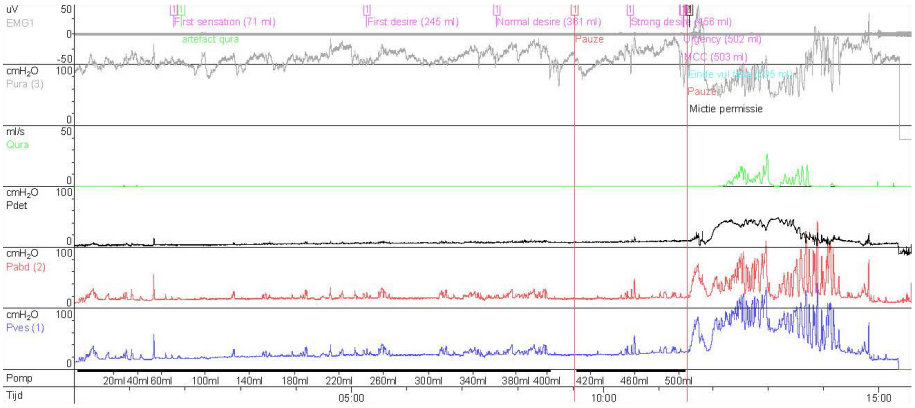

Figure 4.2 Sample tracing UPV single urethral sensor catheter

Table 4.3 Median volumes during filling cystometry compared in patients with and without UPV

		UPV (n=28)	Missing	No UPV (n= 47)	Missing	P-value*
FSF	*1 sensor*	90ml (65 – 309)	0	99ml (51 – 205)	2	0.434
	3 sensors	115ml (65 – 193)	0	124ml (69 – 201)	0	0.935
SD	*1 sensor*	349ml (181 – 501)	2	272.5ml (155 – 433)	9	0.346
	3 sensors	322ml (169 – 501)	1	249ml (169 – 369)	8	0.300
MMC	*1 sensor*	463ml (209 – 524)	2	323ml (210 – 491)	8	0.328
	3 sensors	412ml (202– 550)	1	299ml (195 – 481)	6	0.284

*Mann- Whitney U test

Table 4.4 Median volumes during filling cystometry compared in order of measurements

		1-3 (N= 20)	Missing	3-1 (N=55)	Missing	P-value*
FSF	*1 sensor*	99 (56 – 263)	1	95 (53 – 213)	1	0.624
	3 sensors	135 (74 – 232)	0	113 (63 – 176)	0	0.229
ND	*1 sensor*	226 (121 – 375)	2	264 (120 – 415)	4	0.779
	3 sensors	226(150 – 525)	4	194 (125 – 311)	2	0.196
SD	*1 sensor*	251 (137 – 403)	2	312 (183 – 471)	9	0.442
	3 sensors	273 (176 – 588)	4	260 (162 – 408)	5	0.487
MMC	*1 sensor*	319 (206 – 487)	3	400 (213 – 503)	7	0.681
	3 sensors	308 (196 – 599)	4	342 (195 – 498)	3	0.603

*Mann- Whitney U test

DISCUSSION

In the present study, we found two things. First, despite the use of a relatively high cut-off value for the definition of UPV, the prevalence still was 37%. This is much more common than the prevalence of DO. Opponents of UPV in the past have argued that UPV is a physiological phenomenon prior to voiding reflex in DO or as a result of voluntary holding to suppress the desire to void [8, 12, 13]. However, the prevalence of both conditions in the same measurement series was even more rare in this series. The relatively high prevalence and the presence in healthy asymptomatic females have also been used as arguments against a pathophysiological entity[14]. In other words, on the one hand the definition of URI was abandoned because of the rarity of the condition, and on the other hand URI is rejected because of the high prevalence when detected apart from urinary incontinence. At the same time is accepted that DO can be demonstrated in asymptomatic patients. Since the urethra is not a closed reservoir like the bladder and since it's not filled with liquid at rest, it is difficult to understand what is measured. Besides, the urethra has a different shape of cross-section from point to point. The possibility of movement artefacts can never be completely excluded, but is demonstrated too consistent to be labelled as artefact only. By performing pelvic floor EMG - not showing any movements when UPV occurred- we have tried to exclude the movement artifacts to the best of our ability, but off course there might be better methods to do so. By performing two measurement series, one with each catheter, in the same patient, we made the patients their own control. To reduce the risk of bias, we have performed the measurements with the different catheter types in random order, however this doesn't exclude the within-patient

variability of pressure measurement completely. However, there were no significant differences in the two measurements within the same patients and between patients undergoing three urethral-sensor measurement first or single urethral-sensor measurement first.

It is time to evaluate the complete functional unit of bladder and urethra together in the analysis of LUTS.

Second, we found that there is additional value in measurement with triple urethral sensor catheter for the demonstration of UPV during filling cystometry. The use of three urethral sensors reduces the chance of measurement artifacts due to movement of the catheter. The direction of the three sensors are the same, so we hypothesized that if there is any movement of the catheter, it will be registered in all leads.

Before the start of the study it was considered that there could be advantages as well as disadvantages in using the triple sensor urethral catheter. An advantage is that the chance of missing UPV because of dislocation of the catheter is minimized since the presence of two other sensors being able to so. A possible disadvantage is that the triple sensor urethral catheter is a reusable one, with a slightly larger diameter (8Fr versus 7Fr) and maybe a slight greater degree of stiffness (65D versus 65±5D). The use of a triple urethral sensor catheter during filling cystometry was non-inferior to the single urethral sensor catheter in first sensation of filling and bladder capacity, thus demonstrating the possible disadvantage of use not to be present.

The advantage has been proven true, since the triple sensor urethral catheter detected UPV significantly better. This observation is not so favorable for the applicability in daily practice. In many centers, continuous urethral pressure measurement is not performed at all, let alone with a custom-made triple urethral sensor catheter. On the other hand, the majority of previous studies are performed with a standard dual micro tip catheter, with a similar prevalence as seen here. The larger the pressure variation, the greater the chance that the dual sensor will demonstrate it as well. Therefore, we suggest to start with standard measurement of continuous urethral pressure measurement with a standard single urethral sensor catheter and to refer patients for measurement with a multi urethral sensor catheter when no abnormalities are demonstrated but clinical suspicion of UPV still is present.

The cut-off value for UPV we used were pressure variations of 30cm H2O or more. In the literature a diversity of cut-off values and categories have been used to describe UPV. Definitions have been used with a fixed

cut-off value between 10-30 cm H2O[3, 7, 15], dependent on pattern, peak-to-peak time[16-18] and as percentage or difference with maximum urethral pressure[4, 19-21]. While the air balloon measurements have less variability than other measurement types, there are no normal ranges for the technology used, maybe varying pressure amounts may need to be adjusted for which type of sensor is used, although no significant differences between the two measurements in the same patient occurred in this series. As long as there is no definition of UPV within terms of ICS, this is still a matter of debate as well. Because the aim of this study was primarily to investigate the applicability and outcomes of the two different urodynamic catheters, a relatively high fixed cut-off point was used.

CONCLUSION

In this study we found that UPV is a quite common phenomenon, demonstrated in one third of all patients during filling cystometry. Although the clinical consequences have yet to be established, these results underline the importance of further research to urethral function. Currently, measurement of urethral pressure during filling cystometry is not defined within ICS standard good urodynamic practices and terms. The single urethral sensor catheter is useful for a start, but detection of UPV is significantly better with triple urethral sensor catheter. There is an additional value in measurement with triple urethral sensor catheter during filling cystometry.

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