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ICS Teaching Module: Analysis of Voiding, Pressure Flow Analysis (Basic Module)

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Aims: To present the evidence background for an ICS teaching module for the urodynamic analysis of voiding. **Methods:** Literature analysis and expert opinion are combined to collate an outline and explanation of a preferred and good urodynamic practice. **Result:** Patient's preparation, pathophysiology, technique and principles of pressure flow analysis are summarized in this manuscript. **Conclusions:** This manuscript serves as scientific background for a slides set, made available on the ICS website to teach the basic and practical elements of pressure flow analysis. *Neurourol. Urodynam. 35:36–38, 2016.* © 2014 Wiley Periodicals, Inc.

Key words: bladder outlet obstruction; diagnosis; pressure flow analysis; review; teaching module; underactive detrusor; voiding

INTRODUCTION

The ICS Urodynamics Committee presents the teaching module Analysis of Voiding; Pressure Flow Analysis-basic module to serve as a standard education of Good Urodynamic Practice for everyone involved in indicating, performing, and analyzing urodynamic testing in general and more specifically, performing analysis of voiding. The teaching module consists of a presentation, in combination with this manuscript. This manuscript serves as a scientific background review; the evidence base, for the ICS Power Point presentation; available via http://www.icsoffice.org/eLearning/. The presentation explains normal physiology, testing requirements, pressure flow analysis methods, and introduces the nomograms. The presentation and this manuscript uses experts opinion where evidence is, especially for the clinical practice aspects, unavailable and is marked with:[eo] (experts' opinion).

PREPARATION OF THE PATIENT

Urodynamic testing requires an optimally informed patient, after adequate relevant medical history, systematic symptoms analysis, laboratory, and clinical (neuro-gyneco-urological) exam and, preferably, at least one, not-catheterized (free) flowmetry with post-void residual determination.[1–3] Pressure flow analysis is the element of urodynamic testing to diagnose voiding dysfunction. Although voiding is, plausibly, negatively influenced by the shift of the autonomic system to sympatical dominance in the situation of mental stress, there is not very much evidence, that voiding in laboratory circumstances is unacceptably unrepresentative.[eo] Some indirect evidence exists that differences between office and home are not large in (elderly) male,[4,5] as long as the bladder is not uncomfortably full.[6] Perceivably, it is patient friendly to ensure adequate draping, normal seating (or standing, if preferred by the –male patient) and maximum possible privacy during voiding as well as quiet, relaxing circumstances with as little number as possible persons involved during urodynamic testing.[eo]

Infection prophylaxis necessitates sterile catheterization but for this short time catheterization in the noncompromised patient prophylactic antibiotics is unnecessary.[7,eo] Laxatives are also unnecessary and might cause unwanted bowel (over) activity and fecal urgency during the test, but is advantageous to ask the patient to arrive with an empty bowel if possible.[eo] If high incidences of urinary tract infections after urodynamic testing are observed in a given practice, the first step should be that the procedures are changed so that strict antisepsis is followed.[eo] Thin (6–8F) double lumen or micro tip with lumen catheters for intravesical filling and pressure recording are advised[2] with adequate fixation alongside the meatus over the penis or a labium.

PATHOPHYSIOLOGY

Voiding is an autonomic reflex that is, in the normal situation, initiated through voluntary and conscious pelvic floor relaxation. The detrusor dome, when parasympatically activated delivers the energy to void. The bladder outlet or bladderneck (or autonomic sphincter) relaxes as a result of inhibition of sympathic input and allows emptying. The normal outlet controls the flow by passive distension and through its visco-elasticity. The outlet collapses when the intravesical pressure is too low to overcome the forces that close the outlet.[8] Typically, reduced patency of the bladder outlet through an enlarged prostate or a urethral stricture, is limiting the (maximum) flowrate and driving the detrusor muscle to higher power contraction, thus higher intravesical pressures, during voiding.

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Clinical nomograms to quantify pressure flow analysis results in a standard manner are available for symptomatic elderly male with an enlarged prostate.[9–11] All of those methods give very consistent results.[12,13] Women (and young men) voiding dynamics differs from elderly men because there is no prostate to act as a stable nozzle and pressure flow nomograms are more difficult to construct. Time based pressure and flow graphs allow judgement of the voiding; post processing with pressure and flow on an X-Y graph is possible on all contemporary urodynamic equipment, and allows precise appreciation of bladder outlet obstruction (BOO) and outlet dynamics throughout voiding. Nevertheless, good quality and plausibility control as well as an evaluation of clinical representativity are necessary.[2]

TECHNIQUE AND INTERPRETATION

Technique

Pressure flow starts after permission to void and hesitancy can be recognized if that permission is precisely marked. More important, permission to void indicates the end of storage phase and differentiates between detrusor overactivity (DO) and detrusor voiding contraction; DO to be diagnosed only in the storage phase.

Pressure flow analysis relies on the simultaneous recording of pressures and flow. Pressures in the storage phase are interpreted as pattern; DO or reduced compliance, and there is no evidence that the absolute pressures play a role. In pressure flow analysis however, the absolute pressures, referred to atmospheric pressure, are relevant for the clinical interpretation with the nomograms (v.i.).

There is no specific evidence for the preferred position during pressure flow testing. Plausibly women shall perform best while comfortably sitting, however, many women never really sit on the toilet, or are used to squat.[14,15] Sitting uncomfortably and voiding in a manner that does not adequately represent the usual way of voiding may likely occur on a videourodynamic equipment, because of the restrictions of the equipment. More in general: in the semi recumbent, supine, or gynecological position, voiding can hardly be as usual, however, direct comparative evidence is lacking.[eo] As in adults, position is of influence for storage phase results, but the relevance of voiding position seems not studied in children and is not mentioned in the standard.[16,17] Free flow in men is, in group-wise comparisons, influenced by position, however, individuals might have a preferred position and the possibility to allow the patient preferred position seems relevant.[18–20] To include the lag-time from meatus to flow recording is necessary in any way,[21] but a very short meatus to flowmeter distance is beneficial.[eo]

If the patient's position is changed during the test, external pressure transducers (if used) must be adjusted to the height of the symphysis pubis again.

Interpretation

Analysis of bladder outlet obstruction is done on the second, passive phase of micturition, usually from the moment maximum of flow when detrusor and outlet act in a steady state and are in balance.[9,10] Before maximum flow, pelvic floor relaxation and outlet distension dynamics are predominant, but after maximum flow, the true passive outlet resistance is obtained. Pressure at maximum flow in combination with corresponding maximum flow gives a clinically relevant grading of bladder outlet obstruction when used in a formula.[11] This grading number is presented, and subsequently adopted, as the ICS-obstruction number.[22,23]

Likewise, maximum of detrusor contraction (or contractility) can be calculated with the ICS contraction number.[22] Detrusor contraction power during voiding can also be calculated throughout the entire voiding[24] and relates to bladder outlet obstruction and affectivity of voiding.[25] Both analysis methods give similar results.[26]

Analysis of female micturition is less standardized but follows the principles as mentioned here above. There is usually more flowrate and pressure variation during the time of one female voiding. Most women however, empty with high peak flowrates and because high flowrate rules out static outlet obstruction, outlet dynamics is the cause of variation here. Relatively high detrusor pressure during voiding is also in women regarded as a sign of (static) bladder outlet obstruction.[27] This is captured in a nomogram that integrates maximum of (not catheterized) free flowrate with a minimum cut-off pressure, to be observed during voiding cystometry or with observations during radiography.[28,29] Although frequently used, in variations of application, this nomogram has never been ICS-standard. Pressure at maximum flow is at present accepted as the most relevant parameter.[30]

Pressure flow voiding can occur in a manner that does not represent the patients' usual behaviour. Comparison with free flowmetry and asking the patients' opinion in this regard are valuable.[eo]

Artefacts arise when the (intravesical pressure recording) catheter is slipping out during voiding. This can be suspected already from the pressure recording during voiding and also from the pressures response on cough testing after voiding.[2] All artefacts that are known from uroflowmetry are to be expected, and should be controlled for, also in pressure flow cystometry.[2,31]

Very low pressure-voiding, inability to void, or to inability to initiate a full voiding reflex as usual, limits the applicability of pressure flow analysis. Especially in shy voiders, it can become a problem to objectively diagnose the bladder outlet properties, or the real ability of the detrusor muscle to generate sufficient pressure. However, if (little) fluid leaves the bladder during a weak or incomplete voiding reflex, serious bladder outlet obstruction is relatively unlikely when this happens with low pressure, although the level of uncertainty of this diagnosis is high.

CONCLUSIONS

Pressure flow analysis is the golden standard for the analysis of voiding. For male patients, precise and clinically relevant limits for bladder outlet obstruction are available. For female and children, the limits are less precisely defined however, on the basis of what can be expected from normal lower urinary tract physiology, closely linked to the methods and nomograms that are calibrated for male patients. Strict adherence to antisepsis and a patient-centred approach before, during and after testing limits unwanted effects and enhances representativity. Adherence to good urodynamic practice standards, with adequate reference to atmospheric pressure ensures optimal quality of analysis and diagnosis. This ICS educational module provides the background for the basic education of the analysis of voiding in patient with lower urinary tract symptoms.

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