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ICS teaching module on urodynamics for lower urinary tract symptoms in men

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ABSTRACT

Aims: To present the body of evidence about the urodynamic assessment and diagnosis of male lower urinary tract symptoms (LUTS) and to serve as a scientific background review and evidence base for the presentation available on the International Continence Society (ICS) website on Urodynamics in male LUTS.
Methods: This teaching module was developed by the Urodynamics Committee of the ICS as a clinical practice tool. The module examines the indications, pre-test preparation, urodynamics technique, key findings, and interpretation, of urodynamics in adult men presenting with refractory voiding or storage LUTS. The module is based on evidence, clinical practice guidelines, existing ICS Standardization documents, and consensus formation by the members of the Working Group, and review by the members of the ICS Urodynamics and Standardization Steering Committees. The module is complemented by educational material on the ICS website.
Results: Invasive urodynamics should be considered in select men before surgery to quantify obstruction and the detrusor voiding contraction, as well as identify relevant storage abnormalities that might impact therapeutic strategy or prognosis. Initial evaluation frames the urodynamics question, informs technique, stratifies risk of infection, and provides input for interpretation of results. Adherence to the ICS standard technique of urodynamics and quality control, with clear annotations on the tracings, are crucial. Analysis includes scrutiny of the traces, and calculation of the ICS-Bladder Outflow Obstruction Index and ICS-Detrusor Contraction Index. When indicated, video-urodynamics can be used to locate the site of obstruction.
Conclusion: Urodynamics is useful in select men with LUTS and is usually offered only when invasive therapies are being considered. Combining information from urodynamics with clinical data is recommended.

1. Introduction

Lower urinary tract symptoms (LUTS) are common in men with an age-associated increase in risk [1]. Symptoms can chiefly be categorized as voiding and storage LUTS although some men present with post-micturition symptoms such as dribbling of urine [1]. A majority of men can be managed on the basis of clinical assessment supported by non-invasive testing [2]. Some men might require invasive urodynamics to make a diagnosis or prognosticate the outcome of treatment [2]. Generally, invasive testing is reserved for select men who are refractory to conservative treatments and drug therapy. This module of the Urodynamics Committee of the International Continence Society (ICS) examines the indications, preparation, technique, key findings and interpretation of invasive urodynamics in adult men with LUTS. This document complements existing ICS Standardization Reports [3–5] and ICS Modules on Cystometry and Pressure Flow Study [6,7] and has been reviewed by the ICS Urodynamics and Standardization Steering Committees.

2. Indications

Invasive urodynamics prior to prostate surgery is not routinely recommended by clinical practice guidelines [2,8]. This guidelines

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position is underpinned by findings of the UPSTREAM Trial (*vide infra*) [9]. Invasive urodynamic investigations are recommended by the European Association of Urology in some specific situations: in men aged <50 or >80 years; in those considering invasive treatment who cannot void > 150 mL or with bothersome, predominantly voiding LUTS with a post void residual > 300 mL; in men with bothersome predominantly voiding LUTS and Q_{max} > 10 mL/s; in those who have had previous unsuccessful (invasive) treatment for LUTS [2]. Furthermore, invasive urodynamic tests may be considered in individual patients for specific indications before invasive treatment or when further evaluation of the underlying pathophysiology of LUTS is warranted. According to the American Urological Association, invasive urodynamic investigations should be considered when the patient's condition is not sufficiently suggestive of obstruction (e.g., peak urinary flow >10 mL/s) [8]. The reason to consider these tests is that an unsatisfactory outcome following bladder outlet surgery is more likely in the absence of obstruction, the presence of detrusor underactivity (DU), or if storage abnormalities are responsible for symptoms. Distinct from the European Guidelines, this guideline advises invasive urodynamics in men with retention to differentiate detrusor muscle weakness or detrusor sphincter dyssynergia from bladder outflow obstruction (BOO).

Thus, according to the most commonly used guidelines, invasive urodynamic tests should be used or at least considered in several situations before surgery, to quantify the obstruction, assess the presence and the possible clinical impact of both detrusor over- or under-activity, explore other findings (such as reduced bladder compliance or bladder sensation, abnormal urethral function) that may impact on the therapeutic strategy that follows. Although the majority of recommendations are based on weak evidence or expert opinions, the role of urodynamics before surgery in male patients with LUTS remains fundamental to investigating the whole function of the lower urinary tract during filling and voiding phases, with the possibility to impact on the treatment or, at least, improve patients' counseling, with particular regard to conditions (e.g., detrusor overactivity or DU) possibly reducing surgery success rates.

3. Preparation

3.1. Initial evaluation

The initial evaluation should include the urodynamic question in which the clinical assessment of all information regarding the patient is of great importance in understanding the nature of LUTS, its severity, and correlation with other pathologies. This will also allow the urodynamicist to reproduce patient's symptoms during the test. Ideally patients should attend the test with a completed frequency volume chart (FVC) or a bladder diary. Illiteracy and aging can adversely impact compliance with diaries. Nevertheless, information provided by the diary supports the patient's symptoms. Validated symptom score questionnaires are also recommended. Symptom scores quantify the severity and type of LUTS. However they are not disease specific and do not replace urodynamics in diagnosing BOO [10]. The International Prostate Symptom Score (IPSS) is probably the most frequently used tool [2]. The International Consultation on Incontinence Questionnaire on Male LUTS is a more elaborate questionnaire with bother scores for each symptom [11]. Physical examination including digital rectal examination (DRE) is an integral part of the patient's assessment. However, it is also known that DRE is not reliable in determining prostate size [12]. Documentation of prostate size and morphology can inform treatment decisions. It can be accomplished by transabdominal ultrasonography, transrectal ultrasonography, computed tomography, or magnetic resonance imaging. DRE also includes a focused neurourological examination, assessment of perineal sensation, anal tone, and the bulbocavernosal reflex that can indicate the presence of neurological disease. Urinalysis must be included in evaluation to identify conditions such as urinary tract infections (UTI), non-visible or visible hematuria, or diabetes mellitus. Prostate specific antigen is a good predictor of prostate volume as well as the risk of LUTS progression [13,14].

Other tests such as voiding cysto-urethrogram (VCUG), are not recommended in the routine diagnostic work-up of men with LUTS. However, if some other conditions such as vesico-ureteral reflux, bladder diverticula, or urethral stricture are suspected it can be combined with urodynamics in a videourodynamics study. Urethrocystoscopy may be indicated in men with LUTS presenting with microscopic or gross hematuria, or if there is suspicion of urethral stricture or bladder cancer. Cystoscopy is not recommended as a test for making a diagnosis of bladder outlet obstruction [15].

3.2. Choosing urodynamics type

The objective of urodynamics (UDS) is to determine the function of the lower urinary tract and its correlates with LUTS. It also allows to identify potential risk factors for complications and adverse outcomes as well as to provide information for shared decision-making with the patient.

Filling cystometry and pressure flow studies are the most widely used tests in LUTS. Nevertheless, non-invasive urodynamics has a role in LUTS assessment. Urinary flow rate testing is a widely used non-invasive urodynamic test. However, it is neither sensitive nor specific for BOO or DU. As an initial test for assessment of male LUTS its evidence is weak but prior to medical or surgical intervention in LUTS patients the evidence is strong [16].

Pressure flow studies are used to diagnose BOO but it also allows for the determination its severity. It also allows to determine DU which is highly prevalent in the LUTS population [17]. Due to the invasive nature of urodynamics, it is recommended only if conservative and medical treatment have failed. Recent evidence has shown the LUTS patient who will benefit from surgery based on clinical and urodynamic parameters [18]. Gathering anatomical and functional parameters together with video urodynamics is useful in LUTS patients. However, its evidence is lacking. Patients with complex presentation such as prior LUTS surgery are probably the ones who will benefit the most from video urodynamics. In young men with refractory voiding symptoms, these techniques can reassure that the obstruction is at the bladder neck before invasive therapy is offered.

3.3. Avoiding infection

All patients should be screened for symptoms of UTI and if found, urodynamics should be postponed until resolution. The patient can be screened with a dipstick urinalysis or urine culture before the test. Symptomatic UTI or even sepsis can follow invasive urodynamics and it is important to know who will benefit from antibiotic prophylaxis. Guidelines do not recommend routine antimicrobial prophylaxis prior to UDS for patients without any risk factors for UTI. In the context of adult men with non-neurogenic LUTS, risk factors include age over 70, immunosuppressive medication, elevated PVR, indwelling catheter or clean intermittent catheterization as well as a history of joint implants or prosthetic devices [19]. The antimicrobial choice depends on local resistance patterns and should be administered as a single dose within an hour prior to urodynamics [19]. Laxatives are also unnecessary and might cause unwanted bowel (over) activity and fecal urgency during the test. However, whenever possible, it is advantageous to ask the patient to arrive with an empty bowel [20].

4. Urodynamics technique

4.1. Position

Filling can be completed with the patient in a sitting or standing position, and the pressure-flow study should be completed in the patient's usual voiding position [5]. Any transition from sitting to standing should be completed before the patient reaches a strong desire to void, so that the transition does not affect pressures during the voiding [3,4]. If possible, the patient should be allowed to void in privacy [3].

4.2. Catheters

Thin double-lumen catheters (7-8F) are recommended ([4]). Water-filled catheters are the ICS standard, but air-charged catheters can also be used [3,6,21]. Use of two small caliber (5F) catheters is an acceptable alternative, as the filling line can be removed prior to voiding [5]. Catheters should be fixed close to the urethral meatus and anus with adhesive tape without occluding the urethral meatus.

4.3. Filling

The recommended fill rate is 10% of the patients maximum voided volume per minute [3,22]. Room or body temperature saline is recommended for filling [6]. The timing for the verbal sensory thresholds of first sensation of bladder filling, first desire to void and strong desire to void should be recorded during filling [22,23]. When appropriate, a cough stress test is performed during filling [5]. Filling ends when the patient reaches a strong desire to void and permission is given, or if incontinence leads to a significant volume of leakage [5]. Based on pre-urodynamics evaluation, the urodynamicist might choose to refill (often with a slower rate) to allow filling cystometry to continue. Once the patient experiences a strong desire to void, the pump is stopped and the patient is asked to try to delay voiding until any abnormal pressure rise settles to its baseline. Occasionally, it might be acceptable to allow a patient who is unable to wait for a phasic contraction to subside, to void. Caution must be exercised in interpreting such a voiding pressure-flow tracing. Pressure data are recorded at a minimum data rate of 10 Hz.

4.4. Pressure-flow study

The pressure-flow study begins with permission to void [3]. Voiding should occur into a flow measurement system that records volume and flow rate. Flow and pressure data are recorded at a minimum data rate of 10 Hz, and any flow delay should be considered [3,24]. Post void residual volume is measured via transabdominal ultrasound or as captured by the urodynamics system provided the bladder was emptied at the start of the filling [3].

4.5. Quality assurance

Initial resting pressures should be within appropriate ranges [24]. The fine trace pattern on both intravesical and abdominal pressure channels should match and be 'live' (Fig. 1). Cough tests should be performed before and during filling cystometry and before as well as after the voiding pressure-flow study to confirm proper catheter positioning and fidelity of the recording system [3,24].

4.6. Artifacts (brief)

Pressure artifacts can be caused by patient movement, gut activity, and catheter slippage or kinking [8–10]. Other artifacts may include spikes on the flow curve [4]. Artifacts should be identified and addressed at the time of the study (Fig. 2 and Fig. 3). A valid change in p_{det} must always be matched by a corresponding change in p_{ves}.

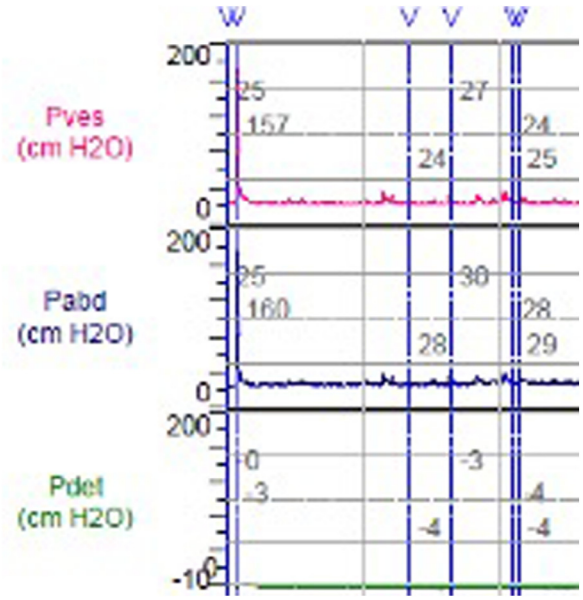


Fig. 1. Example tracing of P_{ves}, P_{abd} and P_{det} prior to bladder filling. Baseline P_{ves} and P_{abd} were identical at 25 cm-H2O. A cough (left) produced nearly equal P_{ves} (157 cm-H2O) and P_{abd} (160 cm-H2O), indicating a good pressure measurement match (Courtesy JS).

4.7. Repeat cycles

While a single cycle of testing is often enough, there should be low threshold for repeat cycles of testing. Some indications might be significant artifacts [24], large incontinence leakage [3], unrepresentative flow, serious technical flaws, or the need for additional specific tests triggered by the initial cycle of testing.

4.8. Electromyography and video

Electromyography (EMG) can be recorded with perineal patch electrodes and a sampling rate of 1–20 kHz [22]. Meticulous attention to technique is crucial to avoid artifacts with EMG testing which is common [4]. Video-urodynamics uses X-ray fluoroscopy to capture images of structural changes and behavior of the urethra and bladder during both filling and voiding [22]. In men, the striated sphincter is radiologically located at the lower border of the symphysis pubis and hence video must be positioned to include the entire length of the symphysis and beyond (to identify the occasional passable urethral stricture).

4.9. Scaling, labeling, plots

For the filling phase, bladder volume intravesical pressure, abdominal and detrusor pressures should be plotted vs time at an appropriate scale to allow for identification of any detrusor overactivity and calculation of compliance [23]. All the pressure channels must be identically scaled, and such that the traces remain visible throughout the study. For the voiding phase, flow rate (mL/s) should be plotted versus detrusor pressure (cmH_2O) [4].

4.10. Documentation

Documentation of the urodynamic technique should include the following: patient position, catheter sizes, filling method, fill rate, fluid type and temperature, pressure measurement technique [3].

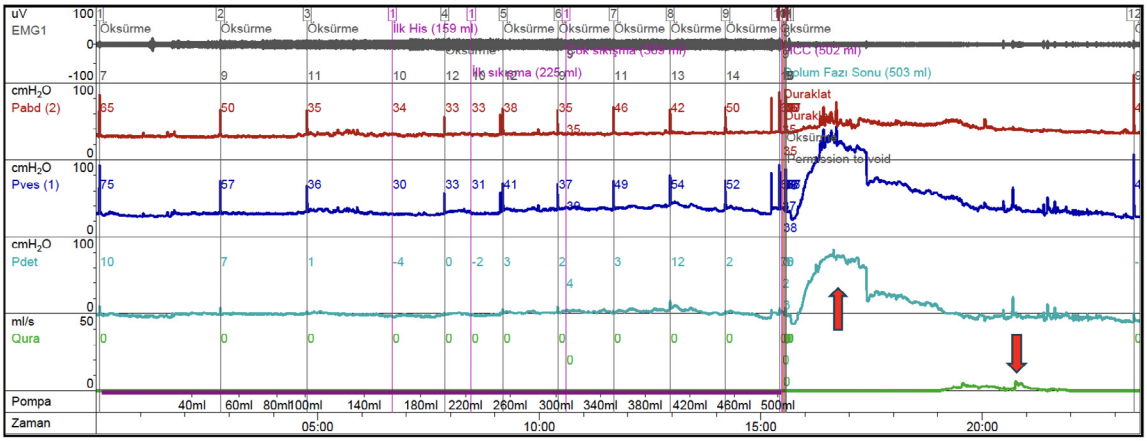


Fig. 2. Patient urinates out of the flowmeter in the beginning of voiding (red arrow on the left) resulting in misinterpretation of Q_{max} (red arrow on the right). This error should be noticed by the observer and the pressure flow study should be repeated. Of note, this error can only be identified at the time of test by the investigator and cannot be corrected post-test (Courtesy TT). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

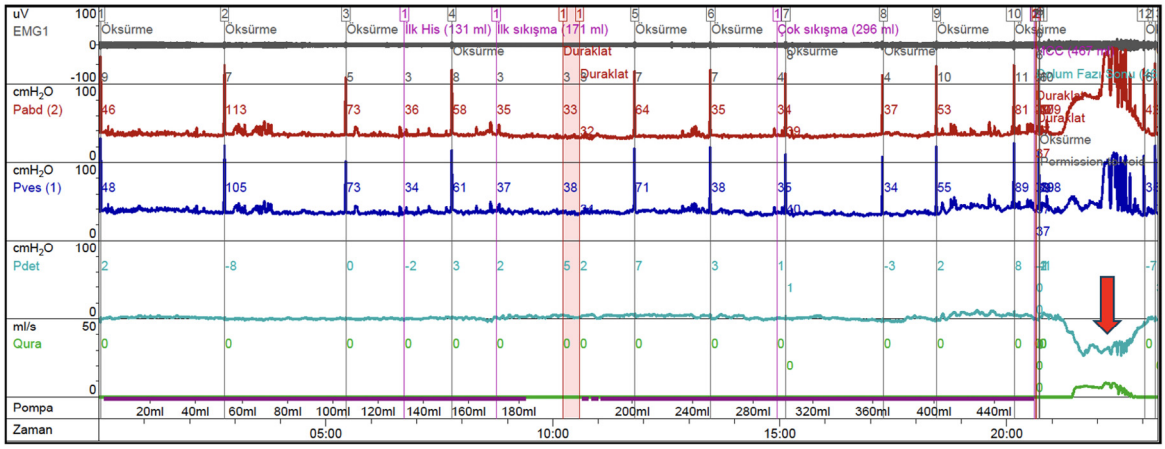


Fig. 3. Vesical and abdominal transducers are switched. Good calibration leads to good quality cough tests during cystometry. The error is only recognizable during emptying due to detrusor pressure decrease (red arrow)! (Courtesy TT). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

5. Key findings

The diagnosis of the key urodynamic findings in the evaluation of male LUTS should follow the ICS standards [23]. The ICS standard invasive urodynamic testing starts with cystometry. Cystometry may reveal abnormal storage phase findings such as abnormal sensations, abnormal capacity, detrusor overactivity (DO), detrusor overactivity incontinence (DOI), and reduced bladder compliance as described before [5]. Cystometry is always followed by a pressure flow study (PFS) to analyze the voiding phase (Fig. 4).

The analysis of the voiding phase in a patient with poor flow aims to differentiate BOO from DU. For this purpose, nomograms, ICS-Bladder Outflow Obstruction Index (ICS-BOOI) and ICS-Detrusor Contraction Index (ICS-DCI) are defined [4]. BOOI (BOOI = $p_{detQmax}$ - $2Q_{max}$) >40 is at present a commonly accepted cut-off to diagnose BOO in men. The current ICS-SUFU Standardization document suggests using the classes: no BOO (BOOI <20), intermediate BOO (BOOI 20–40), moderate BOO (BOOI 40–80), and severe BOO (BOOI >80) [4]. Detrusor Contraction Index (ICS-DCI) is equal to $p_{detQmax}$ +5 Q_{max}. Values greater than 150 cmH_2O are reported to represent a strong detrusor voiding contraction; values from 100 to 150 cmH_2O, a normal contraction; values from 50 to 99 cmH_2O a weak, and values below 50 cmH_2O, a very weak contraction [4].

The diagnosis of BOO by PFS does not indicate the site of obstruction (e.g. at the bladder neck or prostate or at the striated sphincter caused by dysfunctional voiding or dyssynergia) which can be revealed by video-urodynamic studies or surface electromyography, although the latter is generally recognized as less reliable [4,25].

The diagnosis of BOO in men with urinary retention or UAD may be challenging when there is reduced or no detrusor contraction during PFS [26]. Therefore, the yield of PFS diminishes in patients who cannot void with an acceptable volume and flow during the study. PFS cannot define BOO in the absence of a detrusor contraction or with a detrusor contraction of very low magnitude or very brief duration [26]. Still, a group of patients who cannot void during PFS will be able to void successfully after prostatectomy [26].

According to the ICS-SUFU standard urodynamic testing, uroflowmetry and measurement of PVR should always precede invasive UDS [4]. Two previously published ICS basic teaching modules have discussed uroflowmetry [27] and measurement of PVR [28] in detail.

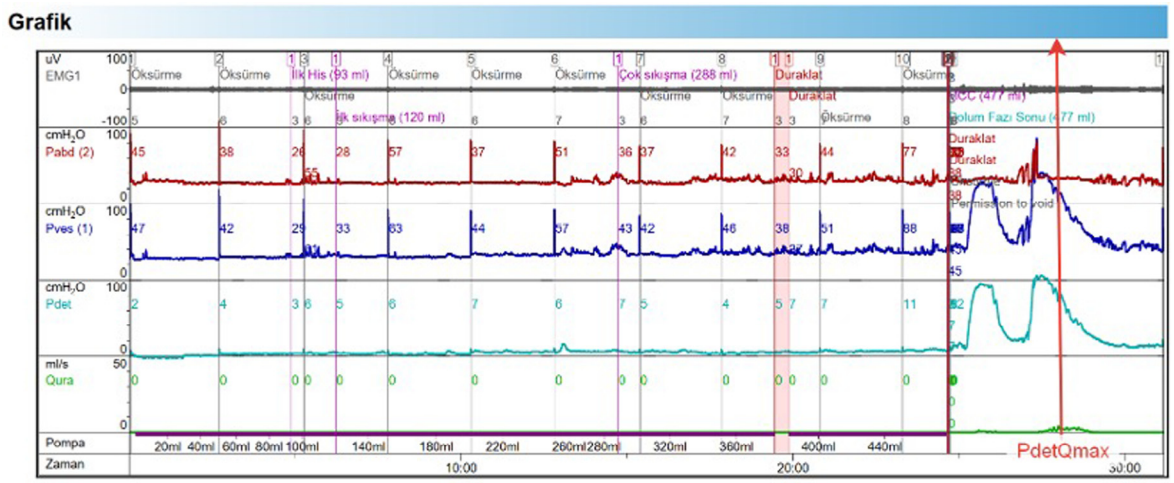


Fig. 4. Cystometry and pressure flow study on a male patient with LUTS in sitting position. CMG reveals normal findings. After the strong desire to void, the pump is stopped at 450 ml and the patient is given the permission to void. A cough test is repeated just before voiding to ensure good calibration. The patient voids 163 ml with a Q_{max} of 4 ml/s and a $P_{det@.Qmax}$ of 73 cmH2O and a PVR of 314 ml. The study ends with a final cough test after the detrusor pressure normalizes. The ICS-BOOI is calculated as 65 and the ICS-DCI as 93. (Courtesy TT).

6. Interpretation

In the UPSTREAM study, a large cohort of men who were considering whether to have surgery to treat bladder outlet obstruction was randomized to undergo routine tests alone (symptom score, bladder diary, flow rate tests, urinalysis) or to have these tests as well as urodynamics [29]. For both arms there was a similar overall improvement in symptoms, and the proportion of men undergoing surgery was similar [9]. On this basis, it is clear that urodynamics does not need to be undertaken routinely in all cases. A couple of vital messages need to be understood, however. Selective use of urodynamics in men with refractory LUTS remains vital. The study found a significant proportion of men experienced a deterioration in symptoms after surgery, which obviously needs to be avoided so far as possible [30]. Secondary analysis identified predictive factors from the baseline testing which could anticipate symptom deterioration, and which of the patients should have urodynamics testing based on their symptom presentation [18,31]. The strongest factor predicting good outcome from surgery is the ICIQ MLUTS voiding subscale, with an optimal cut-off point of >8. Surgery also has a greater chance of a good outcome in men with age <74 yr, Q_{max} <9.8 ml/s, IPSS >16, IPSS QoL score >4, and ICIQ total score >18. Where UDS results are available, surgery is most successful with a BOOI of >47.6 and/or BCI (ICS-DCI) of >123.0 [18]. If Q_{max} is 13 or greater, UDS should strongly be considered [31]. The study also found that symptom scores need to evaluate both severity and bother of each individual symptom, and include an assessment of highly influential symptoms such as incontinence or post micturition dribble. On that basis, the ICIQ-MLUTS symptom score has important advantages over IPSS [32].

Another key message is the importance of doing all the key assessments to a good professional standard, and interpreting them appropriately. Unfortunately, many patients struggle to comply with the demands of symptom score completion, bladder diary completion [33] and flow rate testing [34]. Furthermore, the quality of testing is sometimes substandard in a surprisingly large proportion of clinical units [35]. Given the vital nature of the basic assessments for predicting treatment outcomes and thereby justifying treatment recommendations, it is clear that urodynamic assessment could provide a way to get meaningful evaluation of an individual patient where the other tests fail to offer the information needed. The study also established that men are willing to undergo urodynamic testing given the possibility of additional information for guiding their treatment [36]. Hence, whilst most did not like the thought of the test, or found it uncomfortable, short term discomfort was considered minor relative to the lifelong consequences of surgery. The value of proper assessment and a cautious approach to decision-making is underlined by the value many men place on good information about their urinary tract problem, though clearly, individuals may differ [37].

For men with refractory storage-dominant LUTS, urodynamics can identify any significant underlying obstruction, especially high-flow obstruction, that might not be otherwise apparent. This has two implications. First, there could be a higher risk of requiring catheterization following botulinum toxin injection in men who have not been subjected to prostate surgery [38]. Identification and treatment of such obstruction prior to botulinum toxin injection might avoid retention. Second, treatment of underlying obstruction might result in sustained relief of storage symptoms obviating the need for therapy for refractory overactive bladder [39].

7. Conclusion

This is the first ICS module of its kind and complements existing ICS Standardization Reports [3–5] and ICS Modules on Cystometry [7] and Pressure Flow Study [6] to give an overview of the indications, initial evaluation, technique, salient findings, and interpretation, of urodynamics in men. Urodynamics is useful in select men with LUTS. Adequate pre-test preparation, choice of appropriate technique, attention to detail, and quality assurance are important to ensure valid test results that can be meaningfully interpreted to optimize patient care.

Ethics approval

The authors declare that this study did not involve Humans or Animals.

Declaration of competing interest

The authors have no conflicts to declare.

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Data availability

No data was generated as a part of this work.

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