

Role of Urodynamic Studies in Management of Benign Prostatic Obstruction: A Guide for Interventional Radiologists

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ABSTRACT

Urodynamic testing is the most accurate representation of bladder outlet obstruction physiology. As prostate artery embolization becomes an increasingly common therapy for benign prostatic obstruction, knowledge of urodynamic assessment and reports can assist the interventional radiologist in selecting appropriate patients. This review summarizes the role of urodynamic studies in the management of benign prostatic obstruction, including patient selection, interpretation of urodynamic studies, and their potential to predict patient outcomes.

ABBREVIATIONS

BOO = bladder outlet obstruction, BOOI = Bladder Outlet Obstruction Index, BPO = benign prostatic obstruction, LUTS = lower urinary tract symptoms, PAE = prostate artery embolization, PVR = postvoid residual, Qmax = maximum flow rate, TURP = transurethral resection of the prostate

The development of lower urinary tract symptoms (LUTS) is common in men > 40 years old. The high prevalence of various pathophysiologic factors contributing to LUTS, including obesity, diabetes, and smoking, has led the American Urological Association and European Association of Urology to develop diagnostic algorithms for evidence-based care (1,2). Medical and surgical treatment of LUTS is often directed toward treatment of benign prostatic obstruction (BPO) even though this is not a confirmed primary cause of symptoms in a large percentage of patients. Transurethral resection of the prostate (TURP), considered to be a gold standard therapy for treating BPO, fails to resolve symptoms in

almost one quarter of patients (2). Diagnostic evaluations before invasive therapy can help to improve patient selection and predict treatment success (3–5). As an important component of the American Urological Association and European Association of Urology diagnostic algorithms, urodynamic studies provide detailed insight into the functional mechanisms that result in LUTS, identify risk factors for adverse outcomes, and improve diagnostic accuracy by providing objective pathophysiologic explanations for symptoms (1,2).

Prostate artery embolization (PAE) has emerged as a promising new treatment for men with symptomatic benign prostatic hyperplasia (6,7). Although collaborative patient selection by interventional radiologists and urologists is important for ensuring optimal outcomes, interventional radiologists should understand the basic principles of urodynamic testing to identify possible candidates for LUTS therapies. The goal of this review is to provide an overview of urodynamic testing to guide patient selection for PAE in the management of benign prostatic hyperplasia–related LUTS.

PATIENT SELECTION FOR URODYNAMIC STUDIES

The American Urological Association/Society of Uroynamics, Female Pelvic Medicine & Urogenital Reconstruction guidelines on urodynamic studies in men (8)

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recommend that urodynamic studies, in particular, pressure-flow studies, be considered to determine the presence of BPO if invasive and potentially irreversible treatments are considered. The European Association of Urology has published separate guidelines on assessment of nonneurogenic male LUTS and suggests that pressure-flow studies be performed for specific indications or when evaluation of the underlying pathophysiology of LUTS is warranted (1). In addition, urodynamic testing is recommended for all patients in the following 3 situations: (a) patients with a neurologic diagnosis that may contribute to LUTS, (b) before retreatment in patients with symptom recurrence after previous surgical intervention, and (c) patients with equivocal results on noninvasive testing (1,2,8).

URODYNAMIC STUDY EVALUATION

Urodynamic study evaluation is an interactive diagnostic study of the lower urinary tract comprising numerous tests that provide functional information about bladder filling, urine storage, and emptying (8). Noninvasive and invasive evaluations are included that can be performed independently or together. Although a multichannel urodynamic study remains an optimal test to evaluate BPO, it is invasive and not performed routinely in all patients presenting with LUTS. However, noninvasive urodynamic studies should be performed in patients before any invasive therapy (1). The basic goals of urodynamic studies are outlined in [Table 1](#).

NONINVASIVE URODYNAMIC STUDIES

Uroflowmetry and postvoid residual (PVR) measurements are the 2 most common noninvasive urodynamic tests performed in men with LUTS. The tests can be performed individually or as part of a more comprehensive multichannel urodynamic study. Uroflowmetry measures the rate of urine flow over time. Commercially available flowmeters use either weight transduction or a rotating disc to measure the flow rate. Variables captured during noninvasive uroflowmetry include maximum flow rate (Q_{max}), average flow rate, voided volume, flow time, and time to maximum flow. Uroflowmetry is often interpreted in combination with a PVR measurement to assess how urine flow (or obstruction thereof) affects bladder emptying. Because bladder

volume and voided volume have a substantial impact on the flow rate, a voided volume of > 150 mL has been recommended for improved reliability (1,2,9). It is common for men with notable BPO to produce voided volumes of < 150 mL (10). In such cases, both the American Urological Association and the European Association of Urology suggest repeat testing or further evaluation with a pressure-flow urodynamic study to more accurately identify the cause of LUTS (1,8).

Q_{max} is a useful variable for diagnosis and after procedures because of its negative correlation with grade of outlet obstruction (11). The flow curve generated during uroflowmetry is broadly classified as either continuous or intermittent. A normal flow pattern has a classic bell-shaped configuration ([Fig 1](#)) with Q_{max} reaching the first 30% of the tracing within 5 seconds from the start of flow (12). Patients with bladder outlet obstruction (BOO) may produce a continuous flow pattern, but it often assumes a flattened or plateau appearance ([Fig 2](#)) rather than a bell-shaped curve. An intermittent or interrupted pattern ([Fig 3](#)) can occur secondary to abdominal straining during voiding or secondary to fluctuations in detrusor muscle contractility. Although uroflowmetry cannot distinguish between obstruction and impaired contractility as the cause for a decreased flow rate, approximately 90% of men with a $Q_{max} < 10$ mL/s demonstrate BOO during pressure-flow studies compared with only 48% of men with a $Q_{max} > 15$ mL/s (11). Given that surgical treatment failures are higher for patients with $Q_{max} > 10$ mL/s, the American Urological Association suggests that pressure-flow studies be performed to confirm the presence of BOO before invasive treatments (1).

PVR measures the volume of urine remaining in the bladder after urination and is an objective assessment of bladder emptying. This assessment can be performed either by direct catheterization or through ultrasound-based bladder scans. PVR tends to be a poor correlate to symptom score, and there is no absolute consensus on a normal value (1,13,14). Most men without urinary retention have a PVR of < 50 mL, and $> 90\%$ of men have a PVR of < 100 mL (8). The International Continence Society defines chronic urinary retention as a nonpainful bladder that remains palpable at conclusion of voiding. There appears to be little standardization in the duration or PVR volume necessary for diagnosis and treatment of chronic urinary retention; however,

Table 1. Basic Aims of Urodynamic Studies in Male Lower Urinary Tract Symptoms

- Reproduce the patient's symptoms during urodynamic testing to obtain objective information to make an accurate diagnosis of primary cause of LUTS
- Distinguish BPO from other causes of LUTS
- Evaluate bladder storage and emptying, which can impact treatment success or complications
- Determine if serious or irreversible damage to upper and lower urinary tract has already occurred or is at risk

BPO = benign prostatic obstruction; LUTS = lower urinary tract symptoms.

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