Pressure Flow Studies in Men and Women

Sylvester E. Onyishi, MD, Christian O. Twiss, MD*

KEYWORDS

• Urodynamics • Pressure flow study • Urinary obstruction • Detrusor underactivity

KEY POINTS

- There are well-established pressure flow criteria for urinary obstruction in men.
- The pressure flow criteria for female urinary obstruction are not well established because of differences in female voiding dynamics compared with men; typically, other information such as radiographic data and clinical symptoms are needed to facilitate the diagnosis.
- Detrusor underactivity remains a poorly studied clinical condition without definitive urodynamic diagnostic criteria.

INTRODUCTION

Pressure flow urodynamics study is a well-established diagnostic tool for evaluating bladder outlet obstruction in men. Nomograms such as the Abrams-Griffiths nomogram, the Passive Urethral Resistance Relation, and the ICS nomogram have been established and accepted for use in male voiding dysfunction. Parameters obtained from these nomograms, such as the Bladder Outlet Obstruction Index (BOOI), Qmax (maximum flow), and PdetQmax (detrusor pressure at maximum flow), have accepted cutoff values for defining bladder outlet obstruction (BOO) in men with benign prostatic hyperplasia (BPH) due to the high prevalence of BPH and the associated symptoms. Because of differences in the anatomy of lower urinary tract and voiding dynamics between the sexes, established criteria for urodynamic obstruction in men do not apply to women, and there are currently no widely accepted cutoff values for defining BOO in women.

Another cause of lower urinary tract symptoms (LUTS) that cannot be distinguished from BOO purely based on symptoms and uroflow study is detrusor underactvity (DU). Although this is not as prevalent in men as BOO, it accounts for a significant proportion of men with LUTS and is common in women with urinary retention.[1] According to the International Continence Society (ICS), DU is defined as a detrusor contraction of inadequate magnitude and/or duration to effect complete bladder emptying in the absence of urethral obstruction.[2] DU may arise de novo and coexist with BOO, and it can be a complication of long-standing untreated BOO. DU can only be diagnosed via pressure flow studies.

In this report, we strive to highlight the role of pressure flow studies (PFS) in diagnosis of BOO and DU and determine what is known about the urodynamic criteria to diagnose these conditions in men and women.

BASICS OF PFS

PFS are the essential urodynamic studies used to evaluate the voiding or emptying characteristics of the lower urinary tract by monitoring the detrusor pressure and uroflow simultaneously. Detrusor contractility and bladder outlet resistance are the 2 main parameters determined from PFS. Three

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Division of Urology, University of Arizona College of Medicine, PO Box 245077, 1501 North Campbell Avenue, Tucson, AZ 85724, USA
* Corresponding author.
E-mail address: ctwiss@surgery.arizona.edu

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fundamental voiding states may be identified in PFS:

1. Low detrusor pressure and high flow rate, which signifies the unobstructed state
2. High detrusor pressure and low flow rate, which signifies the obstructed state
3. Low detrusor pressure and low flow rate, which is indicative of detrusor underactivity

It is important to note that borderline cases with coexistence of obstruction and impaired contractility are possible and that the above classifications are not absolute. The nomograms described below have been devised to interpret PFS based on the plot of the detrusor pressure at maximum urinary flow (PdetQmax) versus the maximum urinary flow rate (Qmax). Typical unobstructed and obstructed PFS are shown in **Fig. 1**.[3] Intravesical and abdominal pressures are measured using catheters with pressure transducer, whereas the detrusor pressure is calculated by subtracting the abdominal pressure from the intravesical pressure.

MEASURING URODYNAMIC OBSTRUCTION

PFS in Men

In men, Qmax of less than 10 has been used as the cutoff to suggest obstruction.[4] About 90% of men with a Qmax less than 10 have obstruction.[4] On the other hand, 25% to 30% of men with decreased flow rate do not have obstruction.[4] Thus, decreased flow rate by itself is not sufficient to accurately diagnose outlet resistance, as it may be indicative of obstruction, impaired bladder contractility, or a combination of both. Simultaneous measurement of detrusor pressure and flow rate during voiding helps distinguish the causes of reduced flow rate by simultaneously assessing detrusor and outlet function as they relate to voiding.

To this end, several well-established nomograms and concepts have been advanced to categorize the voiding pattern in men as obstructed, equivocal, or unobstructed. These are (1) the Abrams-Griffiths nomogram, (2) the Urethral Resistance Factor (URA), (3) the Passive Urethral Resistance Relation (PURR), and (4) the Linear Passive Urethral Resistance Relation (LinPURR).[5–8]

The Abrams-Griffiths Nomogram

The data for the Abrams-Griffiths nomogram (**Fig. 2**) were originally obtained via PFS of 117 men age 55 and older evaluated for possible BPH.[8,9] By plotting PdetQmax on Y axis and Qmax on X axis, 3 zones are generated, representing obstructed, unobstructed, and equivocal micturition. The boundaries for the zones were created by a combination of theoretical and empiric observations. Specifically, patients were classified clinically as obstructed or unobstructed based on clinical criteria established in the earlier work of Abrams and colleagues[10–12] before undergoing pressure flow studies. In addition, the pressure flow plots were represented as obstructed or unobstructed based on separate sets of empiric criteria previously established by Bates and colleagues[13] and Griffiths.[14] The nomogram was then constructed by comparing the 2 methods of assessment, clinically and from pressure flow plots.

This nomogram has been used in studying the outcome of prostatectomy performed for BOO. Jensen and colleagues[15] noted significant improvement in pressure flow parameters after prostatectomy in obstructed patients but not in unobstructed patients using this nomogram. The improvements in pressure flow parameters were noted to correlate with subjective improvement in LUTS. Other investigators subsequently duplicated these findings.[9,16] Thus, the utility of the nomogram is primarily in making an accurate diagnosis of male BOO and identifying patients who are likely to benefit from surgical intervention.

One of the early criticisms of the Abrams-Griffiths nomogram was the lack of a quantitative measure of obstruction. This eventually led to the formulation of the Abrams-Griffiths (AG) number from this nomogram. The Abrams-Griffiths nomogram and the AG number form the basis of the ICS nomogram as discussed later. Another issue is that the Abrams-Griffiths nomogram by its nature does not permit the diagnosis of impaired contractility with or without coexisting BOO.

The Concept of the Urethral Resistance Factor

In a separate work, Griffiths and colleagues[17] derived a single parameter called *urethral resistance factor* (URA) for quantifying urethral resistance. This was derived from the pressure flow plots of men with obstruction caused by BPH. This model was largely based on the conceptualization of the urethra as an active tube with an effective cross-sectional area. Flow is initiated in such a tube once the minimum pressure, termed *urethral opening pressure* (Puo) is reached or slightly exceeded. Once Puo is reached, voiding occurs, assuming that the urethra remains relaxed during voiding. Based on this concept, the authors generated a series of curves of constant resistance (**Fig. 3**) and noted that these closely follow the pressure flow plots under relaxed conditions.