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Bladder Outlet Obstruction Nomogram for Women With Lower Urinary Tract Symptomatology

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The aim of our study was to construct a bladder outlet obstruction nomogram for women with lower urinary tract symptoms. A urodynamic database of 600 consecutive women was reviewed. Bladder outlet obstruction, utilizing strict diagnostic criteria, was diagnosed in 50 (8.3%) patients. A comparison of patient characteristics, uroflowmetry, and detrusor pressure-uroflow studies was carried out between the obstructed patients (mean age, 64.4 ± 17.6 years) and 50 age-matched unobstructed controls (mean age, 64.8 ± 10.7 years). Maximum flow rates were significantly higher in free uroflow studies (free Qmax) than in pressure-flow studies (Qmax), in both obstructed (9.3 ± 3.7 versus 5.7 ± 3.6 mL/s, respectively. $P = 2.6\ 10^{-6}$) and unobstructed (25.6 ± 11.2 versus 11.8 ± 5.9 mL/s, respectively. $P = 8.7\ 10^{-12}$) patients. Comparison of detrusor pressure at maximum flow (pdet.Qmax) and maximum detrusor pressure during voiding (pdet.max) values did not reveal significant differences, in both obstructed (39.3 ± 18.4 versus 49.7 ± 25.5 cm H_2O, respectively) and unobstructed (16.5 ± 8.4 versus 20.6 ± 9.2 cm H_2O, respectively) patients. Further statistical analysis was carried out to construct bladder outlet obstruction nomogram. The nomogram classifies any pair of values of free Qmax and pdet.max into one of the following four zones: no obstruction, mild obstruction, moderate obstruction, and severe obstruction. Of the 50 obstructed women, 34 (68%) were classified by the nomogram as mildly, 12 (24%) as moderately, and 4 (8%) as severely obstructed. A positive correlation was found between subjective severity of the symptoms (assessed by the AUA Symptom Index score) and the four nomogram zones. In conclusion, the nomogram makes it possible to differentiate between obstructed and unobstructed women and between various degrees of obstruction. We believe the nomogram may also serve as an instrument to assess treatment outcomes. *Neurourol. Urodynam. 19:553–564, 2000.*

Key words: female; bladder outlet obstruction; urodynamics; nomogram

INTRODUCTION

The prevalence of bladder outlet obstruction in women is not well known and in all probability has been underestimated. Previous studies reported a 2.7–23% prevalence rate among women referred for evaluation of lower urinary tract symptoms [Rees et al., 1976; Farrar et al., 1976; Massey and Abrams, 1988; Chassagne et al., 1998; Nitti et al., 1999; Groutz et al., 2000a]. The most likely reason for this wide

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variation in reported prevalence is the lack of standard diagnostic definitions, or nomograms, for the evaluation of female bladder outlet obstruction.

Some previous studies suggested pressure-flow criteria for diagnosing bladder outlet obstruction [Diokno et al., 1984; Axelrod and Blaivas, 1987; Chassagne et al., 1998]. Others combined free uroflowmetry and pressure-flow studies [Farrar et al., 1976; Massey and Abrams, 1988; Groutz et al., 2000a], and still others use clinical definitions. All these methods are flawed for a number of reasons. First, none of the studies compared women with well-defined clinical parameters of obstruction to normal women. Second, recent data suggest that the presence of a 7-F transurethral catheter may have a profound effect on uroflow, falsely increasing the prevalence of urethral obstruction in women undergoing pressure-flow studies [Groutz et al., 2000b]. None of the previous studies took this into account. Finally, arbitrary cut-off values may fail to diagnose obstructed patients with “normal” uroflows or those who are unable to void with urethral catheter in place.

In men, the most widely accepted method of diagnosing bladder outlet obstruction is analysis of detrusor pressure-uroflow studies. Two pressure-flow parameters, maximum flow rate (Qmax) and detrusor pressure at maximum flow (pdet.Qmax), have been used in various male bladder outlet obstruction nomograms [Abrams and Griffiths, 1979; Schafer, 1985; Griffiths et al., 1997]. These nomograms are not applicable to women because normal voiding detrusor pressure is significantly lower in women than in men.

The aim of the present study was to construct a bladder outlet obstruction nomogram for women with lower urinary tract symptoms.

MATERIALS AND METHODS

Patients and Investigations

A urodynamic database of 600 consecutive women referred for evaluation of lower urinary tract symptoms was reviewed. Bladder outlet obstruction, defined by strict inclusion criteria specified below, was diagnosed in 50 patients. These patients were compared with 50 age-matched unobstructed controls (20 unobstructed urodynamically normal patients and 30 unobstructed, sphincteric-incontinent patients). All patients underwent detailed clinical evaluation, which included a complete history and physical examination, urinary questionnaire, the American Urological Association (AUA) symptom index score, 24-hour voiding diary, 24-hour pad test, urine culture, non-invasive uroflowmetry (free-flow), post-void residual urine volume, video urodynamics, and urethrocystoscopy. Before urodynamic evaluation, all patients voided in private using a standard toilet and the free-flow was recorded. Free-flow measurements were repeated at least twice to ensure consistency. Uroflow pattern and maximum free-flow rate (free Qmax) were manually inspected. Only the best free-flow pattern was analyzed.

Multi-channel video urodynamics were performed using a 7-F double-lumen transurethral catheter through which room temperature, radiographic contrast was infused at a medium filling rate (75–100 mL/min), with rectal pressure monitoring. Bladder filling was discontinued at functional bladder capacity (defined as the largest voided volume in a 24-hour voiding diary) or before this if the patient experienced a strong desire to void. Subsequently, patients were asked to void with the 7-F transurethral catheter in place. Pressure-flow studies, in the sitting position, with simultaneous video fluoroscopy of the bladder outlet and perineal surface electromyography measurements were undertaken. Maximum flow rate (Qmax), detrusor pressure at maximum measurable flow (pdet.Qmax), and maximum detrusor pressure during voiding (pdet.max) were manually inspected.

Definitions

Bladder outlet obstruction was defined by one or more of the following inclusion criteria among women with persistent obstructive and/or irritative lower urinary tract symptoms:

1. Free Qmax $\leq$ 12 mL/s in repeated free-flow studies, combined with a sustained detrusor contraction and pdet.Qmax $\geq$ 20 cm H_2O in the pressure-flow study. Typical pressure-flow study is presented in Fig. 1.
2. Obvious radiographic evidence of bladder outlet obstruction in the presence of a sustained detrusor contraction of at least 20 cm H_2O and poor Qmax, regardless of free Qmax. Typical video urodynamic findings are presented in Fig. 2A,B.
3. Inability to void with the transurethral catheter in place despite a sustained detrusor contraction of at least 20 cm H_2O. Typical video urodynamic findings are presented in Fig. 3A,B.

Statistical Analysis

A comparison of patient characteristics and various urodynamic parameters (free uroflowmetry and pressure-flow studies) was made between obstructed and unobstructed cases. Results were analyzed statistically by Student's *t*-test and χ^2 test. Values of $P < 0.01$ were considered significant. Data are presented as mean ± SD or percentage according to the variables.

Free Qmax, Qmax, pdet.Qmax, and pdet.max were first analyzed separately and then compared in obstructed and unobstructed patients. Two parameters were chosen to construct the nomogram: free Qmax and pdet.max. The free Qmax (free-flow study) was preferred over the Qmax (pressure-flow study) because many of the unobstructed patients had low Qmax values owing to the adverse effect of the transurethral catheter. The pdet.max was preferred over the pdet.Qmax because separate analysis of these parameters failed to reveal any statistically significant difference. Furthermore, pdet.Qmax cannot be plotted in cases of urinary retention because there is no measurable flow, whereas the pdet.max during an attempt to void enables analysis of these cases as well. The use of pdet.max may therefore enable analysis of severely obstructed patients with urinary retention.

Initial analysis showed that the data fall naturally into three clusters (Fig. 4): 1) a group of patients with low pressures and high flow, all of whom were classified as unobstructed by the inclusion criteria; 2) a group with high pressures and low flow, all of whom were classified as obstructed; and 3) a densely clustered group with low to intermediate values of pressure and flow rate. Cluster analysis by complete linkage with squared Euclidean distances, based on standardized variables [Norussis, 1988], was carried out to tighten the boundaries of the third group.

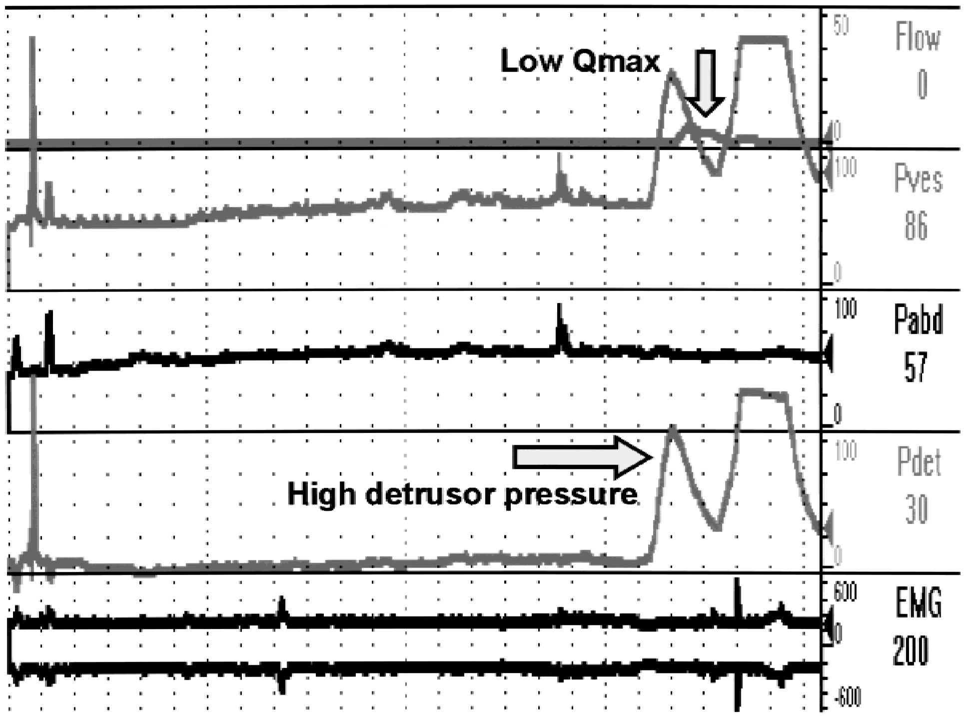

Fig. 1. A 59-year-old woman with a long-term history of intermittent obstructive symptoms. Repeated uroflow measurements revealed poor flow rates (free Qmax: 6 mL/s). Pressure-flow study revealed low flow rate (Qmax: 6.3 mL/s) and high detrusor pressures (pdet.Qmax: 76 cm H_2O; pdet.max: 138 cm H_2O). Cystoscopic evaluation revealed erythematous tissue at the bladder neck, which was biopsied with a cold cup.

RESULTS

Patient Characteristics

Of the 600 consecutive women in the database, 50 (8.3%) met our criteria of bladder outlet obstruction. The mean age and parity of the obstructed patients were 64.4 ± 17.6 years and 1.8 ± 1.5, respectively. The unobstructed control group comprised 20 women with lower urinary tract symptoms, but whose urodynamic study was normal, and 30 other women with sphincteric incontinence. Patient characteristics, non-invasive uroflow measurements and pressure-flow studies were similar among these two unobstructed sub-sets. The mean age and parity of the 50 unobstructed controls were 64.8 ± 10.7 years and 2.1 ± 1.5, respectively. Comparison of the obstructed and unobstructed women according to the various subsets is presented in Table I. The etiologies of bladder outlet obstruction are presented in Table II. Previous anti-incontinence surgery and severe genital prolapse were the most common etiologies, accounting for 40% of the cases.

Symptoms

The mean AUA symptom index score was significantly higher in obstructed than in unobstructed patients (18.8 ± 8.2 versus 11.6 ± 7.2, respectively. P =

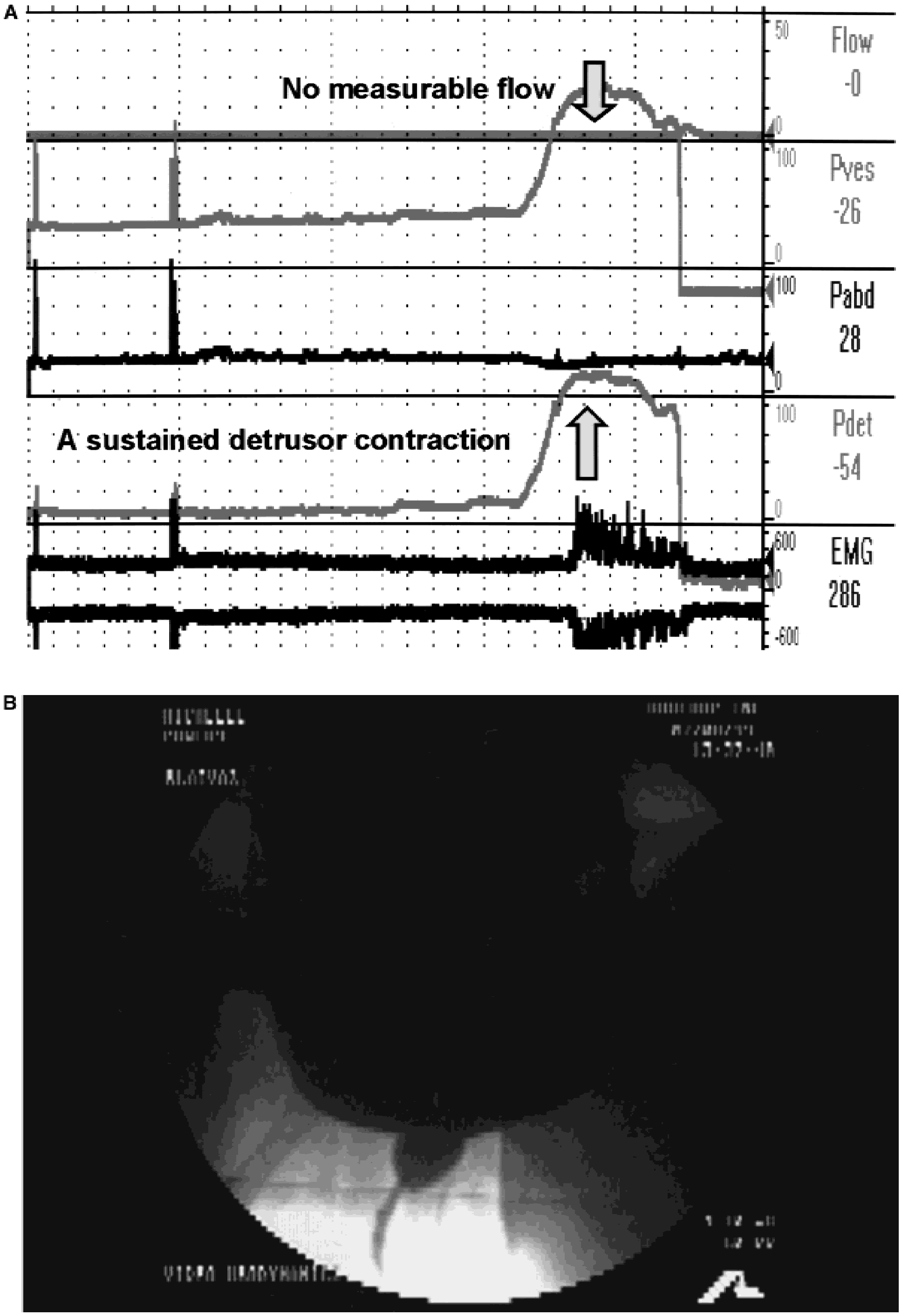

Fig. 2. A 27-year-old woman with a 2-year history of intermittent obstructive symptoms. Repeated uroflow measurements yield varied results with some "normal" flow rates (free Qmax: 18–24 mL/s; uroflow pattern: continuous) and some low uroflows (free Qmax: <12 mL/s). However, a pressure-flow study **(A)** with simultaneous imaging of the bladder outlet **(B)** revealed distal urethral obstruction. Final diagnosis of urethral diverticulum was made by magnetic resonance imaging.

A

B

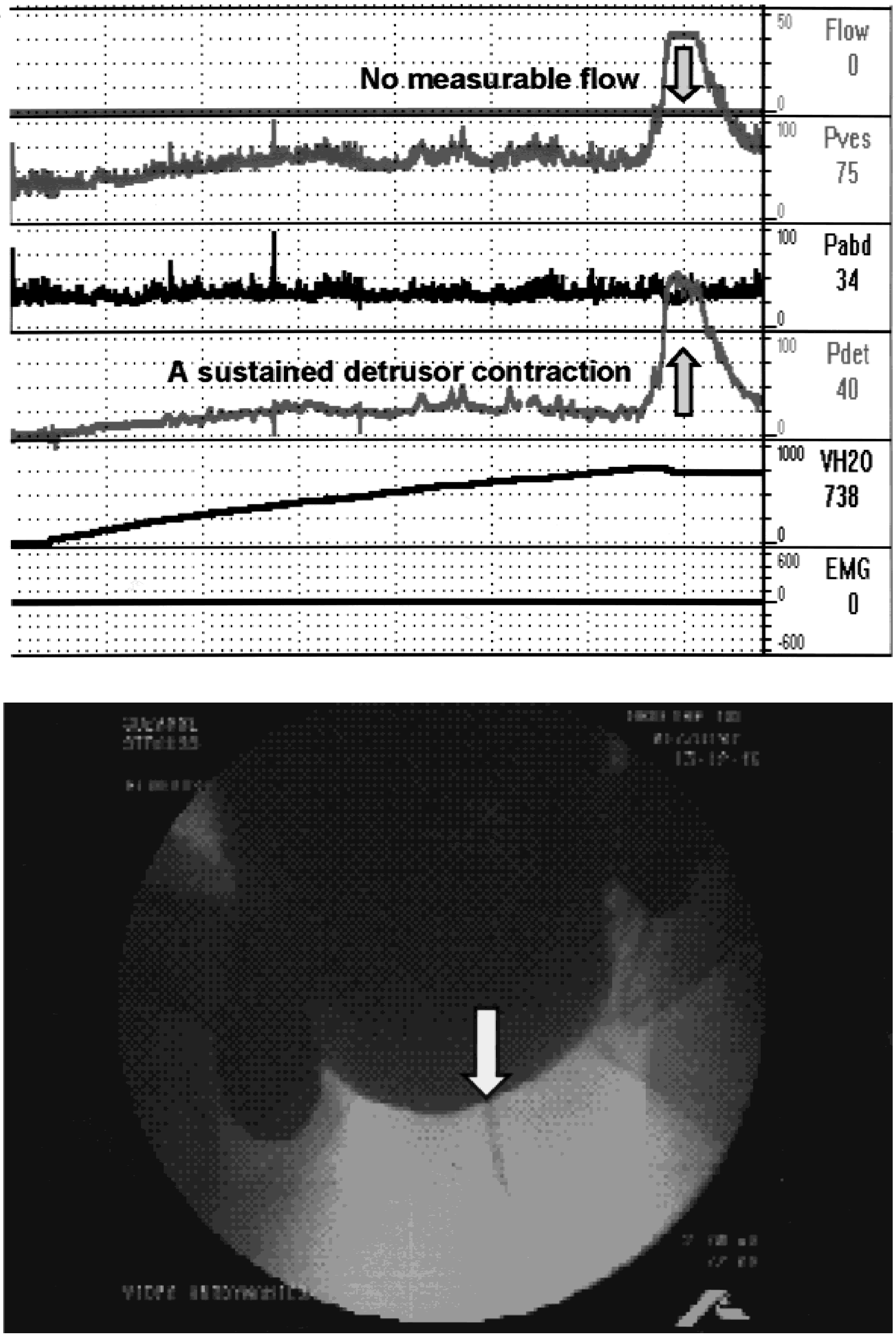

Fig. 3. A 51-year-old woman with intermittent obstructive symptoms. Repeated uroflow measurements revealed poor flow rates (free Qmax: 4 mL/s; uroflow pattern: interrupted). During the pressure-flow study, she was unable to void despite a sustained detrusor contraction over 100 cm H_2O **(A)**. Simultaneous fluoroscopic imaging of the bladder outlet revealed primary bladder neck obstruction **(B)**, which was treated by transurethral resection of the vesical neck and proximal urethra.

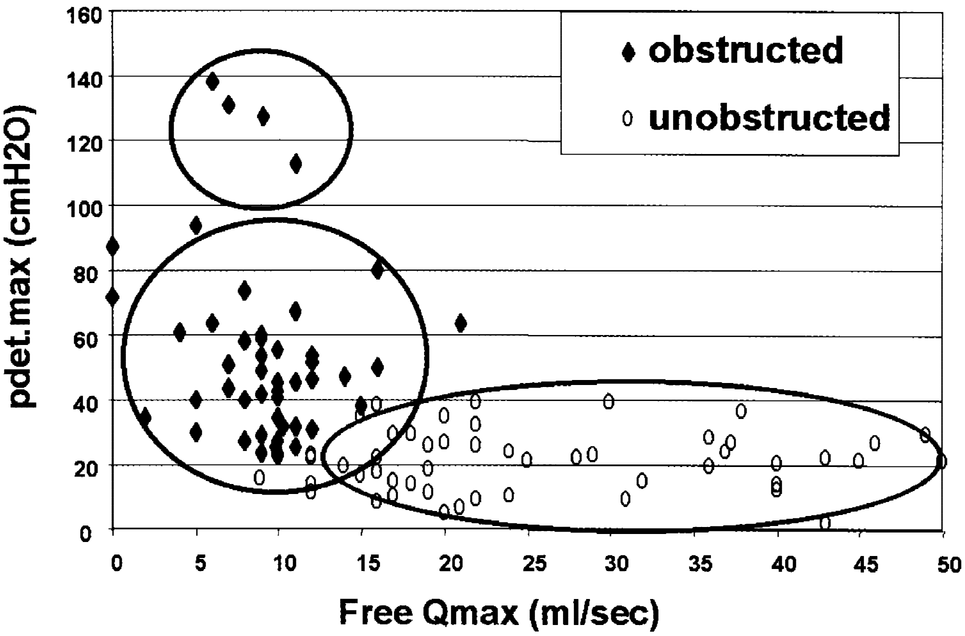

Fig. 4. Distribution of free Qmax/pdet.max plots according to the clinical diagnosis.

0.00001). Mixed obstructive and irritative symptoms were the most common symptoms among the obstructed patients, followed by isolated irritative symptoms (58 and 32% of the obstructed patients, respectively). Isolated obstructive symptoms were much less common, reported by only five (10%) of the obstructed patients.

Non-invasive Uroflowmetry

The non-invasive uroflow study was repeated at least twice to ensure consistency. Only the best free-flow pattern was analyzed. Two obstructed patients had urinary retention and were unable to void spontaneously. Of the 48 obstructed patients who were able to void spontaneously, 43 (90%) had free Qmax ≤12 mL/s (mean, 8.9 ± 2.3 mL/s). Five (10%) other patients had free Qmax >12 mL/s (mean, 16.4 ± 2.4 mL/s); however, pressure-flow study with simultaneous fluoroscopic imaging of the bladder outlet revealed definitive obstruction. Comparison of the free-flow parameters in obstructed versus unobstructed patients is presented in Table 1.

Detrusor Pressure-Uroflow Studies

Eight (16%) of the obstructed patients were unable to void with urethral catheter in place, despite a sustained detrusor contraction with a mean pdet.max of 70.9 ± 31.4 cm H_2O. Comparison of the pressure-flow parameters in obstructed versus unobstructed patients is presented in Table 1. Maximum flow rates were significantly higher in free uroflow studies (free Qmax) than in pressure-flow studies (Qmax), in both obstructed (9.3 ± 3.7 versus 5.7 ± 3.6 mL/s, respectively; $P = 2.6\ 10^{-6}$) and unobstructed (25.6 ± 11.2 versus 11.8 ± 5.9 mL/s, respectively; $P = 8.7\ 10^{-12}$) patients. Comparison of pdet.Qmax and pdet.max values did not reveal significant

TABLE I. Patient Characteristics, Free-Uroflow, and Pressure-Flow Studies in Obstructed Versus Unobstructed Patients

	Main urodynamic diagnosis			
	Bladder outlet obstruction			
Data (mean ± SD)	Able to void (n = 42)	Unable to void (n = 8)	Normal (n = 20)	Sphincteric incontinence (n = 30)
Age (y)	65.4 ± 16.5	59.4 ± 21.8	67.6 ± 11	62.9 ± 10.2
Parity	1.8 ± 1.5	1.8 ± 1.3	1.7 ± 1.4	2.5 ± 1.5
Free uroflowmetry				
free Qmax (mL/sec)	9.9 ± 3.2	8.2 ± 3.6	24.4 ± 8.8	26.4 ± 12.5
Voided volume (mL)	159 ± 96	153 ± 93	250 ± 113	321 ± 125
Post-void residual (mL)	66 ± 87	150 ± 161	30 ± 49	27 ± 33
Pressure-flow studies				
Qmax (mL/s)	6.7 ± 3.0		13.3 ± 6.3	10.8 ± 5.5
pdetQmax (cm H_2O)	39.3 ± 18.4		17.9 ± 7.5	15.5 ± 8.8
pdet.max (cm H_2O)	49.7 ± 25.5	70.9 ± 31.4	22.2 ± 9.2	19.5 ± 8.9
Voided volume (mL)	180 ± 100		312 ± 131	340 ± 146
Post-void residual (mL)	204 ± 173	339 ± 144	103 ± 100	83 ± 101

differences in both obstructed (39.3 ± 18.4 versus 49.7 ± 25.5 cmH2O, respectively) and unobstructed (16.5 ± 8.4 versus 20.6 ± 9.2 cm H_2O, respectively) patients.

Bladder Outlet Obstruction Nomogram

Three major clusters of free Qmax/pdet.max plots were identified: 1) low pressure/high flow, 2) high pressure/low flow, and 3) low to intermediate pressure/flow values (Fig. 4). The third cluster was further divided into two groups: one with mostly obstructed, but some clinically unobstructed patients according to the inclusion criteria, and another in which all patients were previously classified as clinically obstructed. These clusters form a four-zone nomogram that classifies any pair of values of free Qmax and pdet.max into unobstructed (zone 0), mildly obstructed (zone I), moderately obstructed (zone II), and severely obstructed (zone III).

The boundaries between the four zones are as follows (Fig. 5):

- Between unobstructed and minimally obstructed: a line with slope 1.0 and intercept 7 cm H_2O; i.e., running through the points (0,7) and (50,57).
- Between minimally and moderately obstructed: a horizontal line at pdet.max of 57 cm H_2O.
- Between moderately and severely obstructed: a horizontal line at pdet.max of 107 cm H_2O.

Of the 50 obstructed women, 34 (68%) were re-classified by the nomogram as mild, 12 (24%) as moderate, and 4 (8%) as severe obstruction (Fig. 6). None of the obstructed women was reclassified as unobstructed. Of the 50 unobstructed women, 40 (80%) were likewise classified by the nomogram. However, four (8%) clinically unobstructed women had plots compatible with mild obstruction and six other (12%) had marginal plots, just near or over the dividing line between the no-obstruction and mild-obstruction zones.

Patients who were classified by the nomogram as severely obstructed had significantly higher AUA symptom index scores than moderately and mildly obstructed

TABLE II. Etiologies of Bladder Outlet Obstruction Among the Obstructed Women

Etiology	Bladder outlet obstruction No.	%
Previous anti-incontinence surgery	10	20
Severe genital prolapse	8	16
Severe prolapse and previous surgery	2	4
Urethral stricture or narrowing	9	18
Primary bladder neck obstruction	3	6
Urethral diverticulum	3	6
Learned voiding dysfunction	2	4
Detrusor-external sphincter dyssynergia	2	4
Idiopathic	11	22
Total	50	100

patients (29.8 ± 2.7 versus 19.7 ± 9.4 and 17.2 ± 7.1, respectively; $P = 0.002$). Similarly, patients who were classified by the nomogram as mildly obstructed had significantly higher AUA symptom index scores than unobstructed patients (17.2 ± 7.1 versus 11.6 ± 7.2, respectively; $P = 0.0006$). Moderately obstructed patients had higher AUA scores than mildly obstructed patients, although owing to the number of patients, statistical significance was not established.

DISCUSSION

Bladder outlet obstruction nomograms on the basis of pressure-flow data are routinely used in the evaluation of obstructive uropathy in men. Three widely ac-

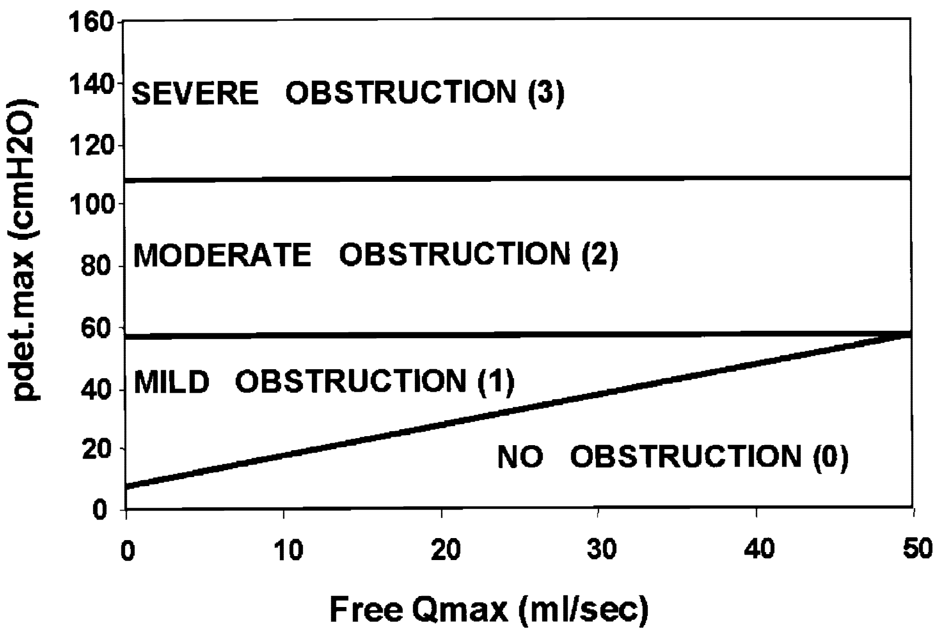

Fig. 5. Bladder outlet obstruction nomogram for women.

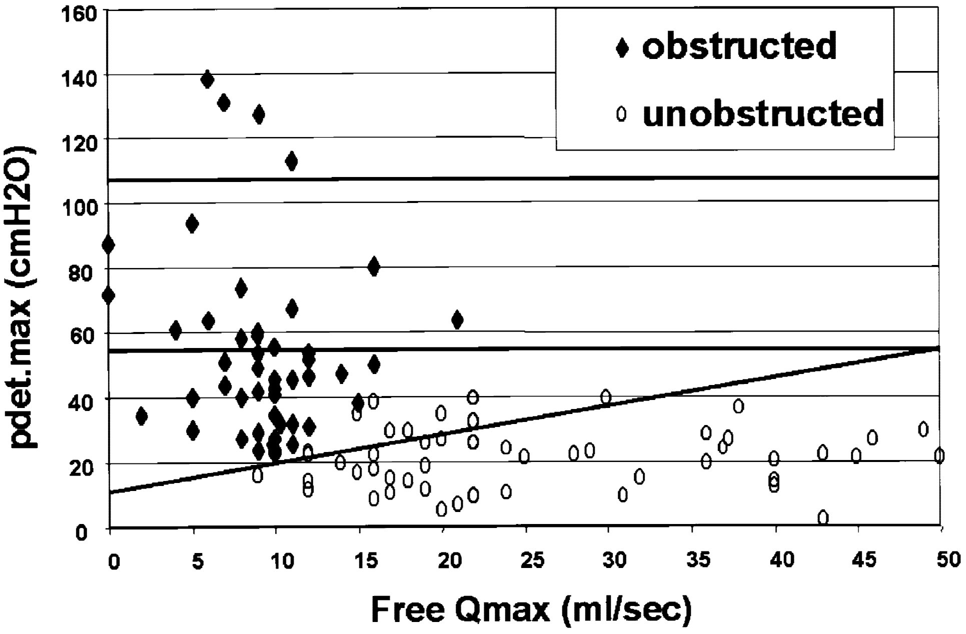

Fig. 6. Distribution of free Qmax/pdet.max plots by four zones.

cepted nomograms, the Abrams-Griffiths [Abrams and Griffiths, 1979], the linPURR nomograms [Schafer, 1985], and the International Continence Society [Griffiths et al., 1997], use the pressure-flow values of Qmax and pdet.Qmax to differentiate between obstructed and unobstructed men. These nomograms are not applicable to women, because normal voiding detrusor pressure is significantly lower in women than in men. To the best of our knowledge, the present study is the first to present a bladder outlet obstruction nomogram for women with lower urinary tract symptoms.

No standard definitions exist for the diagnosis of bladder outlet obstruction in women. Recently, Chassagne et al. [1998] analyzed pressure-flow parameters of 35 "clinically obstructed" and 124 stress-incontinent women. According to their analysis, Qmax $\leq$15 mL/s and pdet.Qmax >20 cm H_2O are reasonable pressure-flow parameters to define female bladder outlet obstruction. However, relying on a history of only obstructive symptoms for inclusion is too restrictive. Many patients with bladder outlet obstruction present with various lower urinary tract symptoms and correlation between obstructive symptoms and objective urodynamic findings is poor [Dwyer and Desmedt, 1994; Clarke, 1997; Groutz et al., 1999, 2000c]. In our series, only five of the obstructed patients (10%) had isolated obstructive symptoms. Approximately one third had irritative symptoms, and the remainder had mixed obstructive and irritative symptomatology.

Moreover, strict urodynamic cut-off values will fail to diagnose patients who are unable to void with urethral catheter in place or those with "normal" uroflows despite the existence of a relative obstruction. These patients may be diagnosed by using simultaneous fluoroscopic imaging of the bladder outlet during pressure-flow study. More recently, Nitti et al. [1999] proposed video urodynamic criteria for diagnosing bladder outlet obstruction in women. Obstruction was defined as radiographic evidence of obstruction in the presence of a sustained detrusor contraction of any magnitude. Strict pressure-flow criteria were not used. Twenty-three percent of their patients met the radiographic criteria for bladder outlet obstruction. Obstructed cases had significantly higher voiding pressures, lower flow rates, and higher post-void residual volumes than the unobstructed cases. However, in 11.8% of the patients, Qmax was >15 mL/s and in 10.5% of the patients pdet.Qmax was <20 cm H_2O. The authors concluded that pressure-flow studies alone may fail to diagnose obstruction, whereas the use of video urodynamic criteria facilitates diagnosis of obstruction, even when it is not clinically suspected.

We prefer to define bladder outlet obstruction in women by combining free-flow measurements, pressure-flow studies, and voiding cystourethrography. Non-invasive uroflowmetry ("free flow") is widely used as a screening tool in male voiding disorders. However, non-invasive uroflowmetry, without synchronous measurement of detrusor pressure during voiding, cannot distinguish between bladder outlet obstruction, impaired detrusor contractility, and normal. We therefore analyzed the pressure-flow parameters to distinguish between bladder outlet obstruction, i.e., low flow and a high detrusor pressure, and an underactive detrusor, i.e., detrusor contractility of inadequate magnitude and/or duration to affect complete bladder emptying. In addition, pressure-flow studies were performed with simultaneous video fluoroscopy of the bladder outlet to detect obstructed patients with "normal" uroflows. Contrary to previous studies, patients who were unable to void with a urethral catheter in place were also enrolled, and obstruction was defined by the presence of a sustained detrusor contraction of more than 20 cm H_2O during an attempt to void. We believe our combined criteria, using both free-flow and pressure-flow parameters with simultaneous video fluoroscopy of the bladder outlet, provide optimal clinical definitions for bladder outlet obstruction in women. We used these criteria to identify a large series of 50 definitely obstructed and 50 definitely unobstructed women. Analysis of these patients enabled us to construct a nomogram for women with lower urinary tract symptoms.

Two parameters have been chosen to construct the nomogram: free Qmax and pdet.max. In any statistical model, it is of utmost importance to select variables for inclusion by clear scientific rationale. The free Qmax (free-flow study) was preferred over the Qmax (pressure-flow study), traditionally used in male nomograms, because of the adverse effect of the transurethral catheter in women undergoing pressure-flow studies [Groutz et al., 2000b]. The pdet.max was preferred over the pdet.Qmax, used in male nomograms, because separate analysis of these parameters failed to reveal significant differences. Moreover, pdet.Qmax cannot be plotted in cases of urinary retention because there is no measurable flow, whereas pdet.max during an attempt to void enables analysis of these obstructed patients as well. In addition, in a recently published study, the reproducibility for pdet.Qmax was found to be relatively poor [Kortmann et al., 2000]. We therefore assume that it may be easier for the average physician to read and interpret pdet.max rather than pdet.Qmax and that the quality of both parameters in relation to bladder outlet obstruction in women is similar. The suggested female bladder outlet obstruction nomogram consists of four zones: no obstruction, mild, moderate, and severe obstruction. Further analysis confirmed a positive correlation between subjective severity of the symptoms and the four nomogram zones.

In conclusion, bladder outlet obstruction in women appears to be more common than was previously recognized, occurring in 8.3% of our patients. We suggest a nomogram that enables differentiation between obstructed and unobstructed women and between various degrees of bladder outlet obstruction. We believe the nomogram may also serve as an instrument to assess treatment outcomes, either after potentially obstructive procedures (such as anti-incontinence surgery) or after corrective surgical interventions (such as urethrolysis). However, one should bear in mind that a nomogram should not be used to dictate treatment, rather it should be considered as a tool to facilitate diagnosis. Specific treatment plans should be based on overall judgment, taking into consideration the clinical status and all objective findings.

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REFERENCES

Abrams PH, Griffiths DJ. 1979. The assessment of prostatic obstruction from urodynamic measurements and from residual urine. Br J Urol 51:129–34.

Axelrod SL, Blaivas JG. 1987. Bladder neck obstruction in women. J Urol 137:497–9.

Chassagne S, Bernier PA, Haab F, Roehrborn CG, Reisch JS, Zimmern PE. 1998. Proposed cutoff values to define bladder outlet obstruction in women. Urology 51:408–11.

Clarke B. 1997. The role of urodynamic assessment in the diagnosis of lower urinary tract disorders. Int Urogynecol J 8:196–200.

Diokno AC, Hollander JB, Bennett CJ. 1984. Bladder neck obstruction in women: A real entity. J Urol 132:294–8.

Dwyer PL, Desmedt E. 1994. Impaired bladder emptying in women. Aust NZ J Obstet Gynaecol 34:73–8.

Farrar DJ, Osborne JL, Stephenson TP, Whiteside CG, Weir J, Berry J, Milroy EJG, Turner Warwick R. 1976. A urodynamic view of bladder outflow obstruction in the female: factors influencing the results of treatment. Br J Urol 47:815–22.

Griffiths D, Hofner K, vanMastrigt R, Rollema HJ, Spangberg A, Gleason D. 1997. Standardization of terminology of lower urinary tract function: pressure-flow studies of voiding, urethral resistance, and urethral obstruction. Neurourol Urodynam 16:1–18.

Groutz A, Gordon D, Lessing JB, Wolman I, Jaffa AJ, David MP. 1999. Prevalence and characteristics of voiding difficulties in women: are subjective symptoms substantiated by objective urodynamic data? Urology 54:268–72.

Groutz A, Blaivas JG, Chaikin DC. 2000a. Bladder outlet obstruction in women: definition and characteristics. Neurourol Urodynam 19:213–20.

Groutz A, Blaivas JG, Sassone AM. 2000b. Destrusor pressure-uroflow studies in women: The effect of a 7F transurethral catheter. J Urol 164:109–140.

Groutz A, Blaivas JG, Fait G, Sassone AM, Chaikin DC, Gordon D. 2000c. The significance of the American Urological Association symptom index score in the evaluation of women with bladder outlet obstruction. J Urol 163:207–11.

Kortmann BBM, Sonke GS, Wijkstra H, Nordling J, Kallestrup E, Holm NR, de la Rosette JJMCH. 2000. Intra- and inter-investigator variation in the analysis of pressure-flow studies in men with lower urinary tract symptoms. Neurourol Urodynam 19:221–32.

Massey JA, Abrams PH. 1988. Obstructed voiding in the female. Br J Urol 61:36–9.

Nitti VW, Tu LM, Gitlin J. 1999. Diagnosing bladder outlet obstruction in women. J Urol 161:1535–40.

Norussis MJ. 1988. SPSS/PC+ Advanced Statistics V2.0, SPSS Inc, Chicago IL, P. B1-B39, B70-B89.

Rees DLP, Whitfield HN, Islam AKMS, Doyle PT, Mayo ME, Wickham JEA. 1976. Urodynamic findings in adult females with frequency and dysuria. Br J Urol 47:853–60.

Schafer W. 1985. Urethral resistance? Urodynamic concepts of physiological and pathological outlet function during voiding. Neurourol Urodynam 4:161–201.