ORIGINAL ARTICLE

Use of the Uroflow Study in the Diagnosis of Bladder Outlet Obstruction in Elderly Men

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Summary

The uroflow and pressure-flow data of 67 men aged 65 years or more were compared. At best, the uroflow study applying the Liverpool nomogram (25th percentile) and Bristol nomogram (OSD) diagnosed bladder outlet obstruction with sensitivity of 62.5% and 62.5% and specificity of 48.8% and 74.4% respectively. Using the 50th percentile of the Liverpool nomogram as the cut-off resulted in a negative predictive value of 100.0% allowing about 10% of men to have this diagnosis ruled out. We conclude that the uroflow study is inaccurate in diagnosing bladder outlet obstruction in elderly men. However, it can be used to rule out this condition in the small subset of men with maximum flow rates above the 50th percentile of the Liverpool nomogram.

Key Words : Uroflowmetry, Urodynamics, Bladder outlet obstruction, Benign prostatic hyperplasia, Urinary incontinence, Singapore

Introduction

Bladder outlet obstruction is an important medical condition in elderly men. It is most commonly due to benign prostatic hypertrophy. It may produce "irritative" or "storage"[1] symptoms such as frequency, nocturia, urgency and urge incontinence. It may also produce "obstructive" or "voiding"[1] symptoms like hesitancy, poor stream, intermittent stream, sensation of incomplete emptying, straining and need for manual compression when voiding. In addition to these troublesome symptoms, men with bladder outlet obstruction are predisposed to developing acute retention or urine, bladder calculi, obstructive uropathy involving the upper urinary tract and renal impairment. It is a source of significant morbidity in older men. With appropriate treatment, symptomatic relief can be achieved and more serious complications averted.

Lower urinary tract symptoms are quite common in community-dwelling elderly men[2]. "Storage" symptoms have been reported in 10 to 40%[2] and "voiding" symptoms in up to 20% of these men[3]. However, it is accepted that 25 to 30% of men with these lower urinary tract symptoms do not actually have bladder outlet obstruction[4]. This figure is probably even higher in older men with other co-morbid illness like neurological disease. In these men, such symptoms are very often due to detrusor instability secondary to neurological disease (e.g. stroke, parkinsonism). Inappropriate treatment in this group of patients results in poorer outcome. Additionally, surgery in men with bladder outlet obstruction diagnosed by urodynamic criteria have been shown to have a better outcome than in those who are not [5-7]. As such, effort towards obtaining objective diagnosis of bladder outlet conditions should be undertaken when specific treatment is planned for elderly men with lower urinary tract symptoms.

The uroflow study has been widely used in the evaluation of elderly men with lower urinary tract symptoms. Most commonly, low maximum flow rates have been used in the attempt to identify men with bladder outlet obstruction. However, investigators have estimated that 25% of men with low flow rates are unobstructed [8]. To compound the issue, it was demonstrated that 7 to 25% with high flow rates turned out to have obstruction [9,10]. This has resulted in a consensus that if precise information is needed, the uroflow study cannot stand alone [1].

It must be remembered that while the pressure-flow urodynamic study has the best ability to define the presence of bladder outlet obstruction [11], it is nevertheless invasive in nature. On the other hand, the uroflow study is non-invasive, simple to conduct and more widely available. As such, we went on to investigate the usefulness of established uroflow nomograms using maximum flow rate corrected for the voided volume (as flow rates are expected to be lower with smaller voided volumes). The main objective was to quantify the actual extent of the limitation of the uroflow study in the diagnosis of bladder outlet obstruction in elderly men. A secondary aim was to determine if these nomograms could aid in ruling in or out this diagnosis to any meaningful degree. The ultimate intention was to attempt to develop our own guidelines for the use of the uroflow study in the diagnosis of bladder outlet obstruction in elderly men with lower urinary tract symptoms. We are unaware of any published data from South-East Asia on this subject relating specifically to elderly men alone. With this in mind, we report our available data here.

Materials and Methods

Men aged 65 years and above who were undergoing urodynamic evaluation for lower urinary tract symptoms at the Continence Clinic of the Department of Geriatric Medicine in Tan Tock Seng Hospital, a 1000-bedded acute care general hospital in Singapore were studied. They were either patients of our department or patients referred by continence clinics in the community supervised by geriatricians. Of the 191 men studied, only 67 (35.1%) men could void 50 ml or more in the uroflow study. Only this subset of elderly men was included for analysis. The work-up included a focused history and neurological examination.

The Dantec Menuet urodynamic equipment was used. In a single session, the uroflow study was conducted followed by the pressure-flow study (filling and voiding cystometry). For the latter, patients were catheterised per urethrally with a size 10 Nelaton catheter and a fine epidural catheter introduced together. The bladder was filled with normal saline at an infusion rate of 30 ml/min. At maximum bladder capacity, the Netalon catheter was withdrawn and the patient voided with the epidural catheter in place recording the bladder pressure.

The uroflow data of these 67 men were obtained and compared with their corresponding pressure-flow data. In analysing the uroflow data, the Bristol nomogram [12] and Liverpool nomogram [13] were used to classify the maximum flow rate corrected for the voided volume (Figure 1).

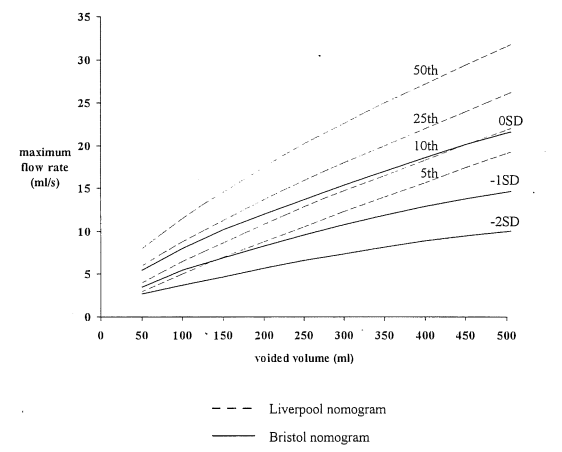

Fig. 1: x-v graph of maximum flow rate and voided volume (with cut-offs for nomograms shown)

The sensitivity and specificity of the various cut-offs in these 2 nomograms in the diagnosis of bladder outlet obstruction were computed. We know that the positive predictive values (PPV) and negative predictive value (NPV) vary with different prevalence rates of the condition being studied. As such, the PPV and NPV for our study population (prevalence of bladder outlet obstruction being 35.8%) were obtained. In addition, the corresponding PPV and NPV when the prevalence of bladder outlet obstruction is 70% was also calculated applying the following formulas based on the Bayes' theorem [14].

$$PPV = \frac{\text{sensitivity X prevalence}}{\text{sensitivity X prevalence + (1-specificity) X (1-prevalence)}}$$

$$NPV = \frac{\text{specificity X (1-prevalence)}}{\text{(1-sensitivity) X prevalence + specificity X (1-prevalence)}}$$

The figure of 70% was arbitrarily decided upon as there is some agreement among investigators that 25% to 30% of men undergoing evaluation for lower urinary tract symptoms do not actually have bladder outlet obstruction [4]. With the help of receiver operating characteristic (ROC) curve analysis, the cut-offs offering the best balance of sensitivity and specificity for both nomograms were determined.

To define bladder outlet obstruction, the pressure-flow criteria of Abrams and Griffiths[15] was applied. Specifically, this was :

Unobstructed : mean slope of pressure-flow plot < 2 $H_2O/ml\ s^{-1}$ and detrusor pressure as flow ceases at end of voiding < 40 cmH_2O

Obstructed : mean slope of pressure-flow plot > 2 $cmH_2O/ml\ s^{-1}$ or detrusor pressure as flow ceases at end of voiding > 40 cmH_2O.

This criteria was chosen among a few other pressure-flow criteria as it is widely accepted and has shown the ability to select out patients with a better outcome after prostatic resection [5]. Impaired detrusor contractility was defined as voided volume of 50% or less of the bladder volume [16,17]. More sophisticated methods of quantifying detrusor contractility, particularly Watts Factor (WF) [18] were avoided as there is as yet no prevailing consensus as to which methods are most appropriate for clinical use.

Only descriptive statistics were used with the help of SPSS 6.0 in our data analysis.

Results

The median age (range) was 75 years (65-94). The number of men with overt neurological disease (e.g. cerebrovascular disease, parkinsonism) and diabetes mellitus were 28 (41.8%) and 18 (26.9%) respectively. Six (9.0%) men had a previous transurethral resection of the prostate (TURP). In the uroflow study, the median maximum flow rate (range) was 9.2 ml/s (2.6-23.7). A scattergram of the maximum flow rates against whether the men were unobstructed or not in the study population is shown in Figure 2. The corresponding median voided volume (range) was 106 ml (50-460). Twenty four (35.8%) men satisfied the pressure-flow criteria for bladder outlet obstruction. Twenty (29.9%) men had impaired detrusor contractility as defined in this study.

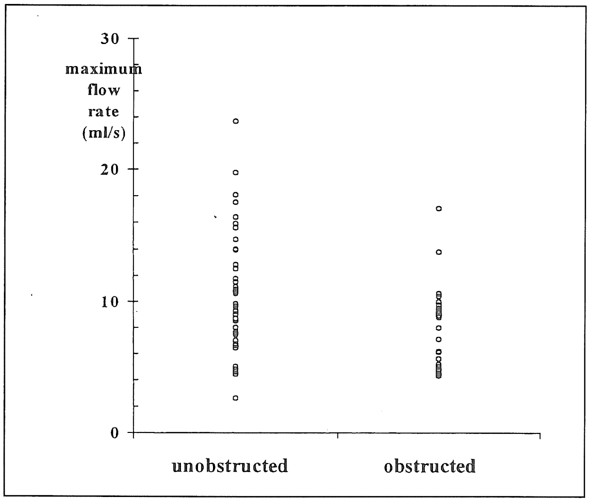

Fig. 2: Scatter plot of maximum flow rates in uroflow study against whether unobstructed or obstructed in study population

The sensitivity, specificity, PPV and NPV for the diagnosis of bladder outlet obstruction using various cut-offs in the Bristol and Liverpool nomograms are shown in Tables I and II. The receiver operating

Table I
Analysis of the diagnostic ability of the Bristol nomogram in the diagnosis of bladder outlet obstruction

			Prevalence of bladder outlet obstruction 35.8%		70.0%	
Cut-off	**Sensitivity**	**Specificity**	**PPV**	**NPV**	**PPV**	**NPV**
OSD	62.5%	74.4%	57.7%	78.0%	85.1%	46.0%
- 1SD	8.3%	90.7%	33.3%	63.9%	67.6%	29.8%
- 2SD	4.2%	100.0%	100.0%	65.2%	100.0%	30.9%

Table II
Diagnostic ability of the Liverpool nomogram in the diagnosis of bladder outlet obstruction

			Prevalence of bladder outlet obstruction 35.8%		70.0%	
Cut-off (percentile)	**Sensitivity**	**Specificity**	**PPV**	**NPV**	**PPV**	**NPV**
50th	100.0%	16.3%	40.0%	100.0%	73.6%	100.0%
25th	62.5%	48.8%	40.5%	70.0%	74.0%	35.8%
10th	37.5%	83.7%	56.3%	70.6%	84.3%	36.5%
5th	20.8%	88.4%	50.0%	66.7%	80.7%	32.4%

characteristic (ROC) curves for these 2 nomograms are shown in Figure 3. From this analysis, the cut-offs located closest to the top left hand corner of the graph would give the best balance of sensitivity and specificity. For the Bristol nomogram, the OSD cut-off obtained the optimal sensitivity of 62.5% and specificity of 74.4%. For the Liverpool nomogram, the 25th percentile cut-off did the same with sensitivity of 62.5% and specificity of 48.8%. The predictive values for the prevalence rates of 35.8% (obtained in the study) and 70.0% for bladder outlet obstruction were also computed and compared in Tables I and II.

To address the issue as to whether diagnostic accuracy was better when the uroflow study was performed in men without overt neurological disease, diabetes mellitus and previous TURP, sub-group analysis was performed comparing this subset of men with the others. The sensitivity and specificity in the diagnosis of bladder outlet obstruction using the OSD of the Bristol

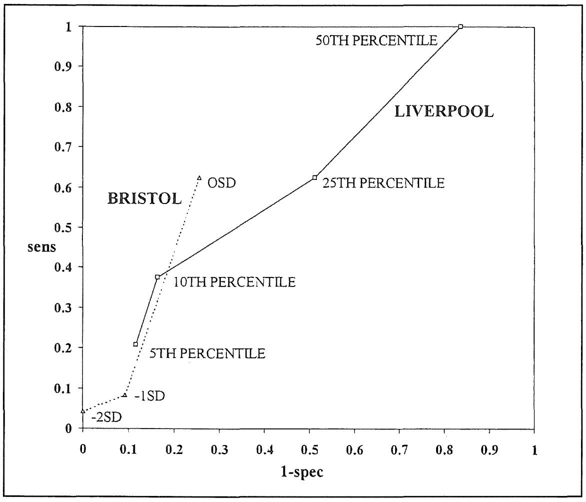

Fig. 3: ROC curve analysis for the Bristol and Liverpool nomograms in the diagnosis of bladder outlet obstruction

nomogram and 25th percentile of the Liverpool nomogram were computed for both groups and are presented in Table III.

Using the 50th percentile of the Liverpool nomogram as the cut-off for prevalence of 35.8%, the NPV for the diagnosis of bladder outlet obstruction was 100.0%, with a PPV of only 40.0% (Table 2). Only 7 men (10.4%) had maximum flow rates above the 50th percentile. For a prevalence of 70%, the PPV would be 73.6% while retaining a NPV of 100.0%. However, in the latter case, only 3 men (4.5%) would have had maximum flow rates above the 50th percentile.

The 5th percentile of the Liverpool nomogram only achieved a PPV of 50.0% in the diagnosis of bladder outlet obstruction. Among those with maximum flow rates below this cut-off but had no obstruction, 40% had impaired detrusor contractility. The -2SD of the Bristol

Table III
Comparison of diagnostic accuracy of the uroflow study in men without overt neurological disease, diabetes mellitus and previous TURP (n = 24) versus other (n = 43)

			Prevalence of bladder outlet obstruction 35.8%		70.0%	
	sensitivity	**specificity**	**PPV**	**NPV**	**PPV**	**NPV**
Bristol Nomogram (OSD) :						
(1) without neurological disease, DM and previous TURP	62.5%	87.5%	73.6%	80.8%	92.1%	50.0%
(2) others	62.5%	66.7%	51.1%	76.1%	81.4%	43.3%
Liverpool nomogram (25th percentile) :						
(1) without neurological disease, DM and previous TURP	62.5%	62.5%	48.2%	74.9%	79.5%	41.7%
(2) others	62.5%	40.7%	37.0%	66.1%	71.1%	31.7%

nomogram did achieve a PPV of 100.0% but as only 1 patient had a maximum flow rate less than this cut-off, meaningful analysis was not possible.

Discussion

The prevalence of bladder outlet obstruction in our study population was 35.8%. This is much lower than more widely accepted figure of 70 to 75% [4]. We postulate that the reason for this is that compared with other studies, our elderly patients are more frail and have a high prevalence of neurological disease (41.8%) and diabetes mellitus (26.9%). Neurological disease (esp cerebrovascular disease and parkinsonism) are well known to be associated with detrusor instability [19] which may present with lower urinary tract symptoms indistinguishable from those caused by bladder outlet obstruction. Detrusor instability is the commonest cause of urinary incontinence [20] (and other lower urinary tract symptoms) in the elderly. The fact that more than 40% of our patients had overt neurological disease probably contributed to a situation where these symptoms were related to detrusor instability from neurological disease in many of our patients. As such, the number of patients with true bladder outlet obstruction were "diluted", resulting in a lower prevalence of this condition in our study population.

From the results obtained, it is clear that the ability of the uroflow study alone to diagnose bladder outlet obstruction in our local elderly men is quite limited. These results complement those obtained in studies done previously in Caucasian populations [8,21,22]. While sensitivity and specificity is commonly assessed, it is usually the PPV and NPV which are important to the clinician. In this case, a "positive" result indicates a maximum flow rate value failing below the chosen cut-off in the Bristol and Liverpool nomograms, and a "negative" result being a value falling above the cut-off. The PPV of the OSD of the Bristol nomogram and the 25th percentile of the Liverpool nomogram in the diagnosis of bladder outlet obstruction were both below 60%. The corresponding NPV were below 80%. These results are applicable for a prevalence rate of bladder outlet obstruction of 35.8%. With a prevalence rate of 70%, the PPV and NPV would only be up to about 85% and 45% respectively. It is clear that the predictive values obtained do not appear to be high enough to be relied upon in clinical practice if a precise diagnosis is desired.

Sub-group analysis demonstrated a trend towards improvement in the predictive values in men without overt neurological disease, diabetes mellitus or previous TURP compared with the other men. This improvement was in the order of about 7 to 22%. This is not surprising as men without neurological disease and diabetes mellitus tend to have a narrower range of diagnostic possibilities accounting for the lower urinary tract symptoms compared with men who have these conditions. However, these improved predictive values are still not good enough for precise diagnosis of bladder outlet obstruction in clinical practice.

As it was possible to obtain a NPV of 100% in the diagnosis of bladder outlet obstruction using the 50th percentile of the Liverpool nomogram, this condition could be ruled out confidently in our study population when this cut-off for maximum flow rate was utilised. This has potential clinical application in that men fulfilling this criteria may not need to go on to invasive pressure-flow studies. In the presence of clinical features of detrusor instability, these men could proceed with bladder relaxant drug therapy (e.g. with oxybutynin) without too much concern about these men harbouring undiagnosed bladder outlet obstruction along with its attendant risk of developing urinary retention with such drug therapy. However, it is important to note that only 5 to 10% of men who could void 50 ml or more in the uroflow study (depending on the prevalence of obstruction) could benefit from this diagnostic ability as only this proportion of men obtained maximum flow rates above the 50th percentile of the Liverpool nomogram in our study.

For the purpose of ruling in bladder outlet obstruction, our data does not suggest that the nomograms can do this accurately. The 5th percentile of the Liverpool nomogram fell far short of achieving a PPV of 100% (only 50%) with impaired detrusor contractility accounting for almost half of cases with such low maximum flow rates below this cut-off in those without bladder outlet obstruction. There is not enough data on the performance of the -2SD of the Bristol nomogram. However, we are pessimistic that it would do better than the Liverpool nomogram. This would be in agreement with other investigators who have found that with the uroflow study could not differentiate between bladder outlet obstruction and impaired detrusor contractility [23] in men with low flow rates.

It must be highlighted that only 35% of the original group of elderly men undergoing urodynamic evaluation could void 50 ml or more in the uroflow study. This is not surprising as it is well-known that many elderly men cannot void adequate amounts of urine in the uroflow study. This is of importance as uroflow studies with low voided volumes are generally regarded as unreliable. We chose to include men with uroflow studies with an arbitrary minimum voided volume of 50 ml as both uroflow nomograms used corrected maximum flow rates down to this volume. Whether running a urine flow clinic[1] and performing more than one uroflow study for each patient over a period of several hours can improve the diagnostic accuracy is uncertain. A very recent study showed that using 4 voids compared with a single void in the uroflow study, an increase in the specificity and PPV was obtained but this was accompanied by a decrease in the sensitivity and NPV for the diagnosis of bladder outlet obstruction in middle-aged and elderly men [24]. In any case, this practice does not seem to be practical or feasible for many of our frail elderly men who depend on carers to bring them to the clinic, except perhaps if the use of a geriatric day hospital was available for these men. Home-based uroflowmetry using a portable instrument is the latest addition to the methods of studying free flow urinary rates. Its reliability has been reported [25] though its utility in the diagnosis of bladder outlet obstruction has yet to be shown to be any better than that of the conventional uroflow study.

Conclusion

Based on the findings of our study, we conclude that the uroflow study applying 2 established nomograms that utilise the maximum flow rate is indeed quite limited in its ability to diagnose bladder outlet obstruction accurately in our elderly men. The predictive values using these nomograms obtained are only between 35 to 85%. This translates to a relatively low level of accuracy in diagnosis in clinical practice. This limitation largely remains even when men with neurological disease, diabetes mellitus and previous TURP were excluded. In the small subset of elderly men with maximum flow rates above the 50th percentile in the Liverpool nomogram, the diagnosis can be ruled out with reasonable certainty. We recommend that the uroflow study be used to rule out bladder outlet obstruction in elderly men using the criteria of maximum flow rates above the 50th percentile of the Liverpool nomogram.

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