Clinical research

A pilot study: a new non-invasive method that differential diagnosis of under active bladder

Mehmet Yoldas[1,2]

[1]Ministry of Health, Republic of Turkey
[2]Health Directorate, University of Health Sciences, Tepecik Training and Research Hospital, Izmir, Turkey

Corresponding author:
Mehmet Yoldas MD
Ministry of Health
Republic of Turkey
Health Directorate
University of Health Sciences
Tepecik Training and
Research Hospital
Izmir, Turkey
E-mail: yoldas_2297@
hotmail.com

Submitted: 19 September 2021
Accepted: 22 January 2022

Arch Med Sci Aging 2022; 5: e1–e6
DOI: https://doi.org/10.5114/amsa.2022.118074

Abstract

Introduction: We have tried to define any criteria between under active bladder (UB) and bladder outlet obstruction (BO) from voiding efficiency (VE) without using pressure flow studies.
Material and methods: In male patients uroflowmetry data, post-void residual (PVR) urine data and subsequent pressure flow studies (PFS) were examined retrospectively. Bladder outlet obstruction index (BOI) and bladder contractility index (BCI) were calculated using patients' PFS values. Patients with BCI < 100 and BOI < 20 were grouped as the UB group and BCI > 100 and BOI > 40 with obstruction were grouped as the BO group.
Results: Forty-four patients in UB and 49 in BO groups, totally 93 patients were examined. According to Qmax value there is no statistically significant difference between the two groups (p = 0.38). Average VE was 63.6 ±2.43% and 46.2 ±2.63% for UB and BO groups, respectively, and the difference was statistically significant (p < 0.001). UB can be diagnosed with at least 95% sensitivity and 88% specificity in men.
Conclusions: Non-invasive uroflowmetry and VE measurements were also shown to differentiate between UB and BO patients, presenting with identical clinic data, besides PFS.

Key words: bladder outlet obstruction, under active bladder, voiding efficiency, pressure flow study.

Introduction

Reduced detrusor contraction (Detrusor underactivity/Under active bladder) means prolonged voiding at low pressure, without any obstruction from the urodynamic and clinical point of view. This has been named by several terms so far. In his last study published in 2015, Chapple has defined as active bladder (UB) and a symptom complex including prolonged voiding time with or without a feeling of complete bladder emptying, difficulty in initiating voiding, diminished sense of bladder filling and a slow voiding flux [1]. UB may interfere with BO, which also leads to lower urinary tract (LUT) symptoms. This interference leads to failure of the planned surgery in these patients. Significant chronic retention or surgical treatment was not determined in the 10-year follow-up of these patients as it is learned from follow-up studies [2].

UB is generally seen in patients aged over 80 in both genders, although identified more precisely in men, in terms of standardization.

A Korean study reported higher frequencies for UB in men (40.2%) than in women (12%) aged over 80 [3].

There are studies reporting symptom recovery after prostate surgery in these patients [4]. Some others claimed that only slight clinical recovery would be seen [5].

A low urine flow rate is a common feature among the patients with UB and BO. Voiding pressure-flow study can be used for differentiation in cases that are indeterminate [2]. Because of the invasive nature of the pressure-flow study, a non-invasive method is needed. There may be a correlation between the detrusor contraction index and the ratio of micturition volume and average physiological bladder capacity. This ratio, also known as voiding efficiency (VE), was addressed in the articles on pressure-flow studies and UB in the literature, nevertheless it is an insufficiently studied topic.

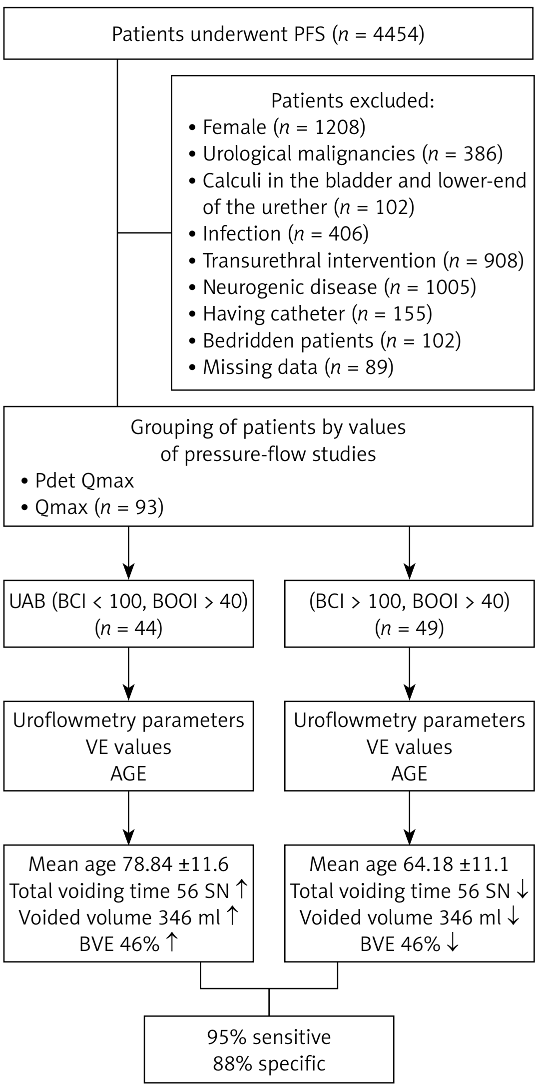

Figure 1. Algorithm

Material and methods

Clinical data of the patients and the algorithm

In the study, data of 4454 patients who underwent PFS in the period between January 2007 and January 2015 was examined. Male patients having a minimum of 2 uroflowmetry and post-void residual urine measurements were enrolled. Female patients (*n* = 1208), with urological malignancies that may affect LUT symptoms (bladder cancer, prostate cancer, etc.) (*n* = 386), calculi in the bladder and lower-end of the ureter (*n* = 102), an active infection and asymptomatic bacteriuria (*n* = 406), transurethral intervention history (*n* = 908), previous LUT symptoms due to neurogenic causes (*n* = 1005), catheter before and after urodynamics or performing clean intermittent catheterization (CIC) (*n* = 155), and decayed and bedridden patients suffering from mobilization problems (*n* = 102), and those with missing data (*n* = 89) were excluded from the study. A total of 93 patients with complete data and failed to comply with the exclusion criteria were included in the study.

Detailed urological history and physical examination data were evaluated for all patients.

Uroflowmetry measurements (Aymed urodynamic systems, Istanbul, Turkey) were performed at least two times before urodynamic testing and residual urine volume after uroflowmetry was assessed by suprapubic ultrasound measurement (LOGIQ C2, GE medical systems, Jiangsu, China). Those with uroflowmetry measurement ≥ 150 ml were included in the evaluation (Figure 1).

Uroflowmetry and measurement of post-void residual urine

All patients had at least 2 uroflowmetry measurements performed prior to urodynamic evaluation and the average was calculated. They were asked to come to test with a full bladder. Uroflowmetry was performed while the patient was standing comfortably and alone. Uroflowmetry data including, maximum urinary flow rate (Qmax), voided volume were noted. For each patient, post-void residual urine volume was determined by ultrasonography (US) by multiplying distances at sagittal, transverse and vertical axis of the bladder by 3.14/6 and noted for all patients [6].

Urodynamic evaluation

With all patients planned for urodynamics, drugs that can affect LUT symptoms were discontinued 3 days in advance, in accordance with the International Continence Society guidelines [7]. Urinary culture and antibiogram were done in all cases to exclude any possible risk of infection.

Patients with a negative culture were eligible for pressure flow studies, with prior quinolone prophylaxis. In pressure flow studies, two-way 6 fr urodynamics catheter (Mediana, ADS, Ankara, Turkey) and 12 fr rectal balloon catheter (UD-CATH, Aymed, Istanbul, Turkey) were used. Pressure flow studies started with an empty bladder while the patient was in the sitting position and in a quiet room, alone.

Bladder contractility index (BCI) was determined during pressure-flow studies, by adding 5 times the maximum urinary flow (Qmax) value following the voiding command, to the detrusor pressure at the moment of maximum flow volume following the voiding command (5 Qmax + PdetQmax). The values ≤ 100 were defined as under active bladder (UB) [8].

Bladder outlet obstruction index (BOI) however, also known as the Abrams-Griffiths (AG) number, was also determined during pressure-flow studies, by subtracting twice the maximum flow value following the voiding command, from the value of detrusor pressure during the moment of maximum flow (PdetQmax) – 2Qmax). BOI was considered positive for the values ≥ 40 [9].

Statistical analysis

SPSS 15.0 (Statistical Package for the Social Sciences) (SPSS Inc, Chicago, IL, USA) statistical package was used in the statistical analysis of the data. Kolmogorov-Smirnov goodness-of-fit test was used to assess compliance with the normal distribution of data. Descriptive statistics of the data were calculated. Significance of differences between the groups was determined by Mann-Whitney *U*-test. Statistical significance was accepted as $p < 0.05$. Cut-off values of the statistically significant parameters were evaluated by the ROC curve.

Results

A total of 93 patients with eligible and complete data were grouped into 2 groups as UB (BOI < 40 and BCI < 100; $n = 44$) and BO (BOI > 40 and BCI > 100; $n = 49$) groups. Mean age was 64.18 ±1.66 years for the BO group and 78.54 ±1.68 years for the UB group. Mean age was higher in the UB group, with a statistically significant difference between two groups ($p < 0.001$) (Table I).

In the analysis of the two groups with regard to uroflowmetry parameters; mean time to start voiding after the command was 11.95 ±1.82 s in the UB group and 10.89 ±1.06 s in the BO group and there was no statistically significant difference between the groups ($p = 0.731$). Mean value for maximum urinary flow was 10.46 ±0.59 ml/s in the UB group and 11.36 ± 0.70 ml/s in the BO group, with a non-significant difference between the groups ($p = 0.387$). The mean flow rate was noted as 7.59 ±0.43 and 6.53 ±0.40 ml/s, respectively for UB and BO, again with a non-significant difference ($p = 0.061$).

Measurement of post-void residual urine volume showed that mean volume was 381.47 ±45.53 ml in the UB group and 296.93 ±45.0 ml in the BO group, with a non-significant difference between the groups ($p = 0.208$). Mean voided volume was 666.90 ±38.84 ml in the UB group and 213.46 ±13.67 in the BO group, with a statistically significant difference between the groups ($p < 0.001$). With regard to bladder voiding efficiency, the UB group performed at 66.02 ±2.43% and the BO group at 45.53 ±2.63% efficiency ($p < 0.001$).

In short, the UB group performed voiding at high efficiency while the BO group at lower efficiency levels (Table I).

In the pressure-flow study; first sensation of bladder filling (early desire to void) was detected at mean volumes of 150.8 ±64.77 ml in the UB group, although not detected in 6 patients, and 117.7 ±64.52 ml in the BO group. The first desire to void occurred at average bladder filling of 243.5 ±100.62 ml in the UB group and 177.1 ±83.86 ml in the BO group. A strong desire to void (urgency) occurred at average bladder filling of 355.6 ±130.66 ml in the UB

Table I. Demographic, uroflowmetry and post-void residual urine data of the patients

Parameters	UB group	BO group	*P*-value
Number of patients	44	49	
Mean age [years]	78.54 ±11.6	64.18 ±11.1	< 0.001
Uroflowmetry parameters:			
Time to start voiding after the command [s]	11.95 ±1.82	10.89 ±1.06	0.731
Maximum urinary flow [ml/s]	11.36 ±0.70	10.46 ±0.59	0.387
Mean urinary flow [ml/s]	7.59 ±0.43	6.53 ±0.40	0.061
Post-void residual urine volume [ml]	381.4 ±45.53	296.93 ±25.57	0.208

Table II. Urodynamic data of the patients

Bladder sensation during filling	**UB group**	**BO group**
First sensation of bladder filling (early desire to void)	150.8 ±64.77 ml Absent in 6 patients	117.7 ± 64.52 ml Absent in 1 patient
First desire to void	243.5 ±100.62 ml	177.1 ±83.86 ml
Strong desire to void (urgency)	355.6 ±130.66 ml	294.4 ±145.78 ml
Maximum bladder capacity	544.7 ±167.45 ml	355.1 ±133.48 ml
Pressure-volume studies:		
Qmax [ml/s]	4.2 ±3.96	6.5 ±3.98
PdetQmax [cm H_2O]	34.1 ±21.31	101.1 ±40.02
Bladder contractility index (PdetQmax + 5Qmax)	48.8 ±27.21	132.5 ±37.83
A-G number (PdetQmax – 2Qmax)	20.0 ±8.82	88.0 ±40.69

group and 294.4 ±145.78 ml in the BO group. Maximum bladder capacity was on average 544.7 ±167.457 ml in the UB group and 355.1 ±133.48 ml in the BO group. All parameters were determined to be higher in the patients of the UB group.

Qmax values measured during pressure-flow studies was on average 4.2 ± 3.96 in the UB group and 6.5 ±3.98 ml/sn in the BO group. Average vesical pressure values recorded at maximum measured flow were 34.1 ±21.31 cm H_2O in the UB group and 101.1 ±40.02 cm H_2O in the BO group. Vesical pressure values were higher in the BO group, as expected (Table II).

Discussion

Bladder's ability to contract is well known to decrease with increasing age in both genders, causing pathologies resulting in UB and BO as well as causing LUT symptoms. Age-dependant impairment in UB is closely related with structural impairment of detrusor muscle. Structural changes are related with intense band decreases, decreased density of axonal connections, decreased collagen/muscle ratio, changes in muscarinic receptors, as determined by ultrastructural studies by electron microscopy [10]. BO secondary to benign prostatic hyperplasia is well known to increase with age. Clinical features and prognosis of UB are not clearly defined and any diagnosis method has not been developed yet except for the gold standard of urodynamics. Its prevalence in the elderly population is unclear [11]. Surgery for BO, diagnosed with urodynamic testing, was shown to increase the success rate in e.g. transurethral resection of the prostate (TUR-P).

Qmax values measured during pressure-flow studies were on average 4.2 ±3.96 in the UB group and 6.5 ± 3.98 ml/sn in the BO group. The difference between the two groups was that the urodynamic catheter provided faster flow in the BO group. Average vesical pressure values recorded at maximum measured flow were 34.1 ±21.31 cm H_2O in the UB group and 101.1 ±40.02 cm H_2O in the BO group. Vesical pressure values were higher in the BO group, as expected (Table II). Bladder capacities were higher in the UB group during urodynamics – 544.7 ±167.45 ml in the BU group and 355.1 ±133.48 ml in the BO group, respectively.

Many studies reported up to date have emphasized the need for urodynamic diagnosis of BO and 3 different states were set as obstructive, intermediate and non-obstructive [12]. These studies are mostly based on post-operative observations of the patients who underwent an operation for BO and having previously had TUR-P. Besides, Pdet/Qmax values decreased postoperatively in the obstructive group, decreased insignificantly in the equivocal group and remained unchanged in the non-obstructive group [13–15].

UB and BO present with the same clinical symptoms and uroflowmetry findings although they are totally opposite clinical entities requiring completely different treatment. Surgery is usually the treatment of choice for BO, while rather unusual for UB, where medical treatment (cholinergic agonists, cholinesterase inhibitors, etc.), clean intermittent catheterization and conservative approach are more prominent. Urodynamic testing, which is the gold standard method, is an invasive diagnostic method used for differential diagnosis in these two clinical entities. In this context, with a view to differentiate between these two types of clinical cases, we attempted to use non-invasive VE for differential diagnosis. To the best of our knowledge, such a study has not been performed so far. VE was defined for the first time by Abrams in 1979 as the bladder contractility against urethral resistance and interpreted as a percentage figure representing the degree of bladder emptying [13]. Subsequent studies of Abraham indicated a combination nomogram of 6 groups according to the BCI and the BOI and noted that including VE to this nomogram would be more appropriate to decide both surgical and medical treatment modalities and to interpret the progression of the disease. In 1995, Bosch has evaluated the correlation and variation of this percentage value with aging, bladder contractility and urethral resistance [16], but voiding efficiency was calculated after urodynamic testing and was not utilized as a differential diagnostic tool.

A Korean study evaluated the relationship between clinical pictures of UB and BO with age and gender, and reported a higher increase in prevalence of UB with aging when compared to BO in the male group, and as for the female group, this relation was opposite, prevalence of BO was increasing more with age, as compared to UB [3]. Mean age of our study group which consisted of only male patients was higher in the UB group as compared to the BO group. UB displayed a more an accelerated increase with age than BO did, which was also compatible with the Korean study. Patients over 85 years of age constituted 40% of the UB group and 26% of the BO group. Interestingly, BO showed a decrease after the age of 75 (Figure 2). We interpret this fact as BO might cause some kind of compensation as a result of increased effort against increased resistance in the bladder and prevent UB development at advanced ages. In accordance with this interpretation, decreased UB incidence, conversely increased BO incidence was shown among females aged over 75 years in the Korean study [3]. Additionally, we think that UB has a closer correlation with aging but BO pathogenesis is multifactorial.

Our patients in the UB group displayed higher values for voided volume, total voiding time and VE percentage than those in the BO group. For the patients of UB and BO groups respectively, average values for VE were 66.02 ±2.43% and 45.53 ±2.63% ($p < 0.001$).

To conclude, patients in the UB group voided more volumes in a longer time period and more efficiently. Even if it is not exactly the same with our study, in the study by Bosch, relationship of VE with age, urethral resistance and bladder contractility were evaluated and a closer and directly proportional relationship was determined between urethral resistance and VE [16]. A nomogram with the VE values was established in the study by Bosch and suggested to be used for analysing potential retention risks of these patients in the future, but long-term results were not covered in this study. Unlike our study, post-void residual urine volume was measured by catheterization in the study of Bosch. They checked if the bladder was completely emptied or not by instilling with an opaque material; hence much more realistic values were obtained, but the measurements were performed just after the pressure-flow studies. In our study VE was used for differential diagnosis of two opposite entities: UB and BO. VE values achieved were statistically significant with $p <$ 0.001 in both groups. In another study by Abrams, a columnar nomogram divided into 9 groups was established with Q max and Pdet/Qmax values obtained by flowmetry measurements in separate columns and this was utilized to estimate whether medical, surgical or conservative approach is needed. It was also mentioned that addition of VE to this nomogram would provide a stronger estimation of correlation [13].

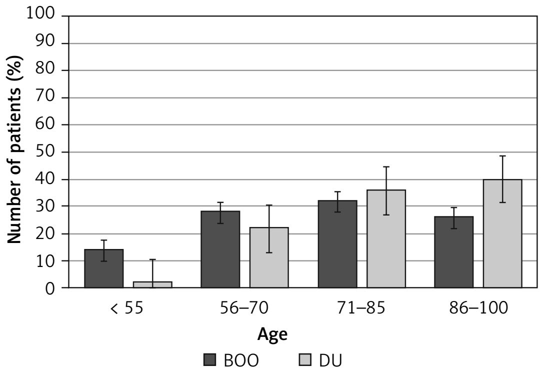

Figure 2. Patient groups by age

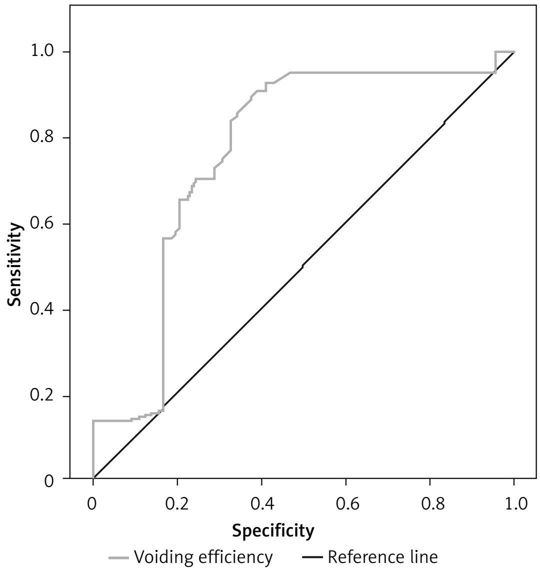

Figure 3. ROC curves for voiding time, voided volume and voiding efficiency

It is apparent that voiding time increases with increased voided volume for UB and BO groups, having equal average flow rates in the uroflowmetry measurements. Voided volume was found considerably higher in the UB group. We realized that our patients in the UB group had larger bladder capacity, which is the main factor affecting voided volume and voiding time. In another approach, we can mention that patients with BO pathology have smaller bladder capacity and thus void in lesser volumes and for a shorter time.

A statistically significant difference was detected between the two groups for VE. In the analysis of determining the cut-off by ROC curve, the area under the curve of maximum diagnostic value was for BVE, it was 0.771 ±0.052. As the best cut-off points, separate ROC curve analysis for VE with 93% sensitivity and 60% specificity (Figure 3).

Limitations of our study may be mentioned as that BOI between 20 and 40 was not examined in our study and also that the cut-off was taken as 40 (AG-number) as in the Korean study.

In conclusion, in this retrospective study on 93 male patients, we intended to develop an alternative non-invasive diagnostic tool instead of invasive pressure-flow testing, which is recognized as the gold standard for differential diagnosis between UB and BO patients that present with identical clinical pictures. UAB can be diagnosed with at least 93% sensitivity and 60% specificity in men over the age of 80, with uroflowmetry measurements of 46% voiding efficiency however, longer-term prospective studies with larger populations are obviously needed in the follow-up of these patients, in terms of retention and upper urinary tract involvement rates.

Conflict of interest

The authors declare no conflict of interest.

References

1. Chapple CR, Osman NI, Birder L, et al. The underactive bladder: a new clinical concept? Eur Urol 2015; 68: 351-3.
2. Thomas AW, Cannon A, Bartlett E, Jones JE, Abrams P. The natural history of lower urinary tract dysfunction in men: minimum 10-year urodynamic follow-up of untreated detrusor under activity. BJU Int 2005; 96: 1295-300.
3. Jeong SJ, Kim HJ, Lee YJ, et al. Prevalence and clinical features of detrusor under activity among elderly with lower urinary tract symptoms: a comparison between men and women. Korean J Urol 2012; 53: 342-8.
4. Han DH, Jeong YS, Choo MS, et al. The efficacy of transurethral resection of the prostate in the patients with weak bladder contractility index. Urology 2008; 71: 657-61.
5. Thomas AW, Cannon A, Bartlett E, Ellis-Jones J, Abrams P. The natural history of lower urinary tract dysfunction in men: the influence of detrusor underactivity on 23 the outcome after transurethral resection of the prostate with a minimum 10-year urodynamic follow-up. BJU Int 2004; 93: 745-50.
6. Hakenberg OW, Ryall RL, Langlois SL, Marshal VR. The estimation of bladder volume by sonocystography. J Urol 1983; 130: 249-51.
7. Schafer W, Abrams P, Liao L, et al. Good urodynamic practices: uroflowmetry, filling cystometry, and pressure-flow studies. Neurourol Urodyn 2002; 21: 261-74.
8. Abrams P. Bladder outlet obstruction index, bladder contractility index and bladder voiding efficiency: three simple indices to define bladder voiding function. BJU Int 1999; 84: 14-5.
9. Tubaro A, La Vecchia C; Uroscreening Study Group. The relation of lower urinary tract symptoms with life-style factors and objective measures of benign prostatic enlargement and obstruction: an Italian survey. Eur Urol 2004; 45: 767-72.
10. Hotta H, Morrison JF, Sato A, Uchida S. The effects of aging on the rat bladder and its innervation. Jpn J Physiol 1995; 45: 823-36.
11. Taylor JA 3rd, Kuchel GA. Detrusor underactivity: clinical features and pathogenesis of an underdiagnosed geriatric condition. J Am Geriatr Soc 2006; 54: 1920-32.
12. Abrams P, Buzelin JM, GriBths D et al. The urodynamic assessment of lower urinary tract symptoms. Proceedings of 4th International Consultation on BPH, FCI, 1998: 323-77.
13. Abrams P, Griffiths D. The assessment of prostatic obstruction from urodynamic measurements and from residual urine. Br J Urol 1979; 51: 129-34.
14. Schafer W. Basic principles and clinical application of advanced analysis of bladder voiding function. Urol Clin N Am 1990; 17: 553-66.
15. Griffiths DJ, van Mastrigt R, Bosch R. Quantification of urethral resistance and bladder function during voiding, to the with special reference to the effects of prostate size reduction on urethral obstruction due to benign prostatic hyperplasia. Neuroural Urodynam 1989; 8: 29-52.
16. Bosch JL, Kranse R, van Mastrigt R, Schroder FH. Dependence of male voiding efficiency on age, bladder contractility and urethral resistance: development of a voiding efficiency nomogram. J Urol 1995; 154: 190.