International Journal of Urology Sciences

ISSN Print: 2664-9306
ISSN Online: 2664-9314
Impact Factor: RJIF 5.22
IJUS 2024; 6(1): 10-13
www.urologyjournal.net
Received: 08-06-2024
Accepted: 10-07-2024

Dr. Snigdh Garg
Chengalpattu Medical College & Hospital, Chengalpattu, Tamil Nadu, India

Dr. S Sudhakaran
Chengalpattu Medical College & Hospital, Chengalpattu, Tamil Nadu, India

Dr. S Senthilkumar
Chengalpattu Medical College & Hospital, Chengalpattu, Tamil Nadu, India

Dr. G Ramesh
Chengalpattu Medical College & Hospital, Chengalpattu, Tamil Nadu, India

Dr. P Sangameswaran
Chengalpattu Medical College & Hospital, Chengalpattu, Tamil Nadu, India

Dr. K Senthilkumar
Chengalpattu Medical College & Hospital, Chengalpattu, Tamil Nadu, India

Corresponding Author:
Dr. Snigdh Garg
Chengalpattu Medical College & Hospital, Chengalpattu, Tamil Nadu, India

Use of DeltaQ to differentiate detrusor underactivity from bladder outflow obstruction

Snigdh Garg, S Sudhakaran, S Senthilkumar, G Ramesh, P Sangameswaran and K Senthilkumar

DOI: https://doi.org/10.33545/26649306.2024.v6.i1a.9

Abstract
Introduction: Detrusor underactivity (DUA) and Bladder Outflow Obstruction (BOO) are prevalent conditions that present as lower urinary tract symptoms (LUTS) in elderly men but they are discriminated only by the pressure-flow component of a urodynamic examination (UDE) which has its own complications. The objective of this study was to evaluate DeltaQ (Q_{max}-Q_{avg}) which is conveniently obtained from uroflowmetry, in differentiating DUA from BOO in men presenting with LUTS.
Materials and Methods: A prospective study was conducted after ethical clearance and 80 men over 50 years of age undergoing evaluation of LUTS on out-patient or in-patient basis in Department of Urology at Chengalpattu Medical College & Hospital and satisfying inclusion and exclusion criteria were enrolled in the study. Every enrolled patient filled IPSS Questionnaire (with/without assistance), got Serum Prostate Specific Antigen (PSA), Urine Routine Examination and Urine Culture and Sensitivity done, underwent Ultrasonography (USG) for assessment of Prostate size and post void residual urine (PVR) followed by a Uroflowmetry (UFM). Finally, patients underwent a Urodynamic Examination (UDE) as per International Continence Society (ICS) standards.
Results: Amongst the 80 patients, 56 had BOO and 24 had DUA as per UDE criteria. DeltaQ was observed to be higher in the BOO group (9.02±3.64 mL/s) as compared to DUA group (5.63±2.76 mL/s) and this was significant (p <0.001). Area under curve (AUC) in ROC for ability to diagnose DUA for DeltaQ was 0.82.
Conclusion: DeltaQ can be used to differentiate DUA from BOO in men presenting with LUTS. Since DeltaQ can be obtained from uroflowmetry, it is a useful, simple and cost-effective parameter for diagnosing DUA in men with LUTS.

Keywords: Detrusor underactivity, bladder outflow obstruction, uroflowmetry, deltaq

Introduction
Although the prevalence of lower urinary tract symptoms (LUTS) is about 62% in men at any age, this prevalence increases consistently with age, reaching 80.7% in men over 60 [1,2]. Detrusor underactivity (DUA) and Bladder Outflow Obstruction (BOO) are the two most prevalent conditions that present as voiding LUTS in elderly men [3,4,5,6]. However, because of the clinical similarity of symptoms of DUA and BOO, they are discriminated only by the pressure-flow component of a urodynamic examination (UDE) [7], which is the standard for diagnosis. DUA is defined as BCI (Bladder contractility index = P_{det} @ Q_{max} + 5 Q_{max}) ≤ 100 cm H_2O with BOOI (Bladder outflow obstruction index= P_{det} @ Q_{max} - 2 Q_{max}) ≤ 20 cm H_2O and BOO is defined as BOOI ≥ 40 cm H_2O. Nevertheless, the patient discomfort and potential complications from catheterization of UDE deter the patient regardless of its clinical utility. Indeed, the reported complication rate from UDE ranges from 4% to 45%, predominantly urinary tract infection and haematuria [8]. Since uroflowmetry (UFM) was first introduced in 1957 by Von Garrelts, it has been used as a simple, non-invasive test in which key parameters are maximum flow rate (Q_{max}), average flow rate (Q_{avg}) and voided volume (VV). The objective of this study was to analyse DeltaQ (Q_{max}-Q_{avg}) [9] obtained from Uroflowmetry in differentiating Detrusor Underactivity (DUA) from Bladder Outflow Obstruction (BOO) in men presenting with lower urinary tract symptoms (LUTS). Thus, in

addition to saving time, this variable could offer a simple, inexpensive, and convenient method for clinicians to distinguish DUA and BOO in men presenting with LUTS.

Materials and Methods

Approval for conducting this study was obtained from the Institutional Ethics Committee. A prospective study was designed and all men over 50 years of age undergoing evaluation of LUTS on out-patient or in-patient basis in Department of Urology at Chengalpattu Medical College & Hospital from Jan 2024 to Jun 2024 and satisfying inclusion and exclusion criteria were included in the study after obtaining informed consent. Every enrolled patient had to fill IPSS Questionnaire (with/without assistance), get Serum Prostate Specific Antigen (PSA), Urine Routine Examination and Urine Culture and Sensitivity done, undergo Ultrasonography (USG) for assessment of Prostate size and post void residual urine (PVR) followed by a Uroflowmetry (UFM). Finally, patient had to undergo a Urodynamic Examination (UDE) as per International Continence Society (ICS) standards.

Inclusion Criteria

- Males with age over 50 years having LUTS who are evaluated on out-patient/in-patient basis in Department of Urology at Chengalpattu Medical College & Hospital
- ≥8 points in International Prostatic Symptom Score (IPSS)
- Serum prostate-specific antigen (PSA) ≤4 ng/dL
- No hematuria or pyuria
- No alpha blocker, anticholinergics or beta agonists that could influence detrusor function for a minimum eight weeks before evaluation

Exclusion Criteria

- Patients with central or peripheral neurogenic disease including cerebral vascular accident and spinal cord disease and severe cardiovascular disease
- History of urinary tract abnormalities, strictures or lithiasis
- Surgeries of the pelvic floor or bladder, chronic pelvic pain
- Patients unable to complete uroflowmetry or voiding study
- Patients having diagnosis other than DUA or BOO on UDE

Results

A total of 124 patients were initially selected for the study but after screening tests 80 patients were enrolled for the study, with 56 diagnosed with Bladder Outlet Obstruction (BOO) and 24 with Detrusor Underactivity (DUA) on UDE. The variables compared between these groups are presented in Table 1.

Table 1: Comparison of variables between BOO & DUA patients

Variables	Total (n=80)	BOO (n=56)	DUA (n=24)	*p* value
Age (years)	64.18±8.24	64.32±8.78	64.02±8.11	0.8865
IPSS	16.22±6.80	16.47±6.35	15.89±6.88	0.7160
Serum PSA (ng/mL)	2.02±1.08	1.98±1.02	2.25±0.98	0.2758
Prostate Size (g)	26.78±14.45	27.65±13.98	25.32±15.02	0.5060
PVRU (mL)	98.74±64.21	73.93±60.46	114.02±85.55	0.0194
Q_{max} (mL/s)	12.22±4.24	14.85±4.19	10.67±3.27	0.0001
Q_{avg} (mL/s)	5.37±1.83	5.83±1.75	5.04±2.02	0.0813
DeltaQ (mL/s)	6.85±3.17	9.02±3.64	5.63±2.76	0.0001
BOOI (cm H_2O)	35.42±12.45	57.43±15.89	14.76±5.01	0.0001
BCI (cm H_2O)	102.42±14.68	126.05±13.92	78.79±15.43	0.0001

The mean age was 64.18 years (±8.24) with no significant difference between BOO and DUA groups (p = 0.8865). Similarly, no significant differences were found in IPSS, Serum PSA, Prostate Size or Q_{avg} between the groups.

However, significant differences were observed in Postvoid Residual Urine (PVRU), maximal flow rate (Q_{max}), DeltaQ, and Bladder Outlet Obstruction Index (BOOI) and BCI. Specifically, BOO patients had significantly lower PVRU (p = 0.0194) and higher Q_{max} (p = 0.0001) compared to DUA patients. DeltaQ was also notably higher in the BOO group (9.02±3.64 mL/s) compared to the DUA group (5.63±2.76 mL/s) with a p-value of 0.0001. BOOI was significantly higher in BOO patients (p = 0.0001) and BCI was significantly lower in DUA patients (p= 0.0001).

Table 2: Multivariate logistic regression analysis of variables

Variable	Coefficient B	p value	95% Confidence Interval
DeltaQ (mL/s)	1.426	0.0001	1.204-1.648
PVRU (mL)	0.876	0.026	0.869- 0.883
Q_{max} (mL/s)	0.651	0.238	0.631-0.671

Multivariate logistic regression analysis identified DeltaQ and PVRU as significant predictors for differentiating BOO from DUA. DeltaQ was the strongest predictor with a coefficient B of 1.426 (95% CI: 1.204-1.648, p = 0.0001). PVRU also showed statistical significance (p = 0.026) with a coefficient B of 0.876 (95% CI: 0.869-0.883). Q_{max} did not show significant predictive value ($p > 0.05$) (Table 2).

Table 3: Receiver operating curve characteristics for variables

Variable	Area under curve (AUC)
DeltaQ (mL/s)	0.82
PVRU (mL)	0.73
Q_{max} (mL/s)	0.714

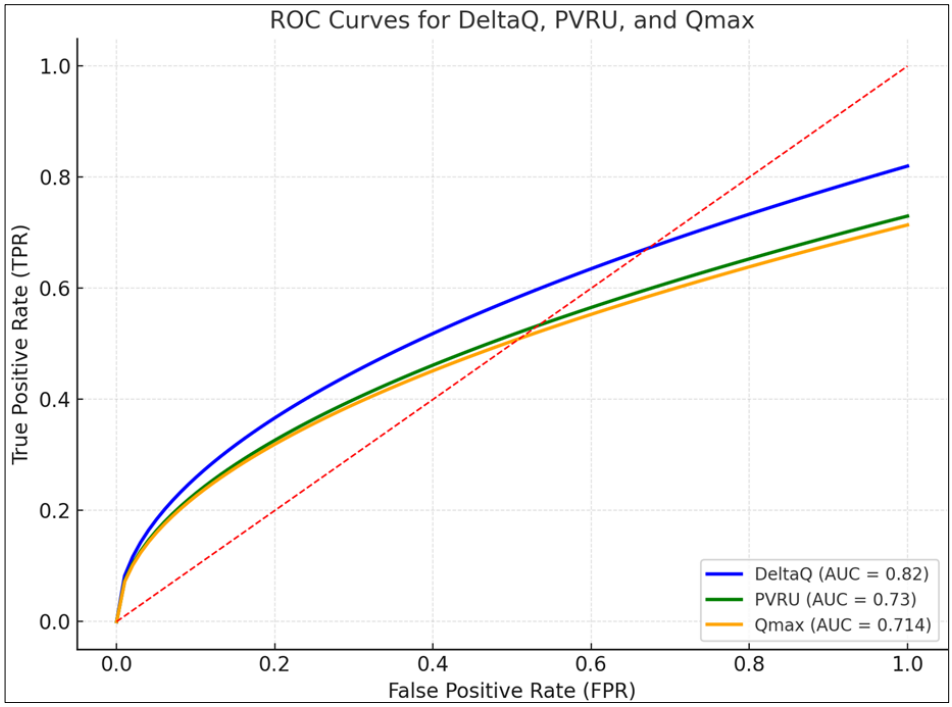

Image 1: ROC for DeltaQ

The ROC curve analysis demonstrated that DeltaQ had Area Under the Curve (AUC) of 0.82, indicating strong diagnostic capability for distinguishing between BOO and DUA (Table 3, Image 1). The AUC for PVRU and Qmax were 0.73 and 0.714, respectively, suggesting limited discriminative ability. From the ROC curve a sensitivity of 80% and specificity of 72% was obtained considering DeltaQ of 7.08 mL/s as cut-off value.

Discussion

Our study aimed to identify non-invasive predictors for differentiating BOO from DUA in patients presenting with lower urinary tract symptoms (LUTS). DUA is defined as BCI (Bladder contractility index = P_{det} @ Q_{max} + 5 Q_{max}) ≤ 100 cm H_2O with BOOI (Bladder outflow obstruction index= P_{det} @ Q_{max} - 2 Q_{max}) ≤ 20 cm H_2O and BOO is defined as BOOI ≥ 40 cm H_2O [10]. Although urodynamic study remains the gold standard investigation to differentiate DUA from BOO (as shown by BOOI & BCI having p = 0.0001 in this study as well) [11], various attempts have been made to identify variables which can reliably differentiate these entities.

The central hypothesis was that DeltaQ would differ significantly between BOO and DUA patients due to the distinct pathophysiological mechanisms underlying these conditions. In patients with BOO, the bladder faces an obstruction at the outlet, which leads to increased detrusor pressure during voiding. This pressure enables a higher maximal flow rate (Q_{max}), while the average flow rate (Q_{avg}) remains relatively lower, resulting in a larger DeltaQ.

Conversely, in patients with DUA, the detrusor muscle is underactive, meaning it cannot generate sufficient pressure during voiding. This leads to both a reduced Q_{max} and Q_{avg}, resulting in a smaller DeltaQ. Therefore, the hypothesis posited that DeltaQ would be higher in BOO patients and lower in DUA patients, reflecting the differential detrusor function and obstruction levels.

The findings from our study strongly support this hypothesis. DeltaQ was significantly higher in BOO patients (9.02±3.64 mL/s) compared to DUA patients (5.63±2.76 mL/s), with a p-value of 0.0001, indicating a statistically significant difference. The high Area Under the Curve (AUC) value of 0.82 for DeltaQ in the Receiver Operating Characteristic (ROC) analysis further underscores its diagnostic utility.

This difference in DeltaQ aligns with the hypothesis that a normal or hyperactive detrusor, as seen in BOO, produces a higher Q_{max} despite the presence of an obstruction, while an underactive detrusor, as seen in DUA, leads to a more uniformly low flow rate, reducing DeltaQ. These findings corroborate the initial assumption that DeltaQ could be a distinguishing feature between these two conditions.

Lee KS *et al* [9] evaluated 517 men with LUTS and concluded that DeltaQ was a reliable and useful tool to differentiate DUA from BOO. They reported AUC of 0.806 for DeltaQ and suggested cut-off of 6.65 mL/s with sensitivity of 71.3% and specificity of 70.3%. The findings in our study corroborates with this study and reinforces the fact that urodynamic parameters, particularly DeltaQ, can be a reliable indicator for these situations.

The significance of PVRU as a predictor in this study also reinforces its clinical relevance. Higher PVRU in DUA patients, as observed in this study, may be attributed to impaired bladder emptying due to reduced detrusor contractility. However, the relatively lower AUC of PVRU compared to DeltaQ suggests that while useful, it may not be as strong a standalone diagnostic tool. Yono M *et al* conducted a study to assess the variability of PVR and BVE (bladder voiding efficiency) determinations in patients with underactive bladder (UAB). They concluded that measurement of PVR was unreliable because of wide variation in the same individual. The variation of BVE was much smaller than PVR [12]. Oelke *et al* performed a retrospective analysis of 822 male patients to construct a nomogram using bladder outlet resistance and detrusor contractility in order to classify BOO and DU simultaneously. They concluded that higher age, bladder capacity, and PVR as well as lower voiding efficiency indicate DU [13]. Ghirca M *et al* conducted a retrospective study including 91 patients and concluded that findings such

as absence of bladder obstruction, post-void residual urine, Q_{max}, together with BCI value, helps in setting the proper management of underactive bladder [14]. Kalil JS *et al* retrospectively evaluated 22 patients to differentiate Detrusor Underactivity (DU) from Bladder Outlet Obstruction (BOO) and concluded that isolated symptoms, classified by IPSS and PVR, could not differentiate patients with DU from those with BOO, but it was possible using urodynamic data [15]. Takahashi R *et al* examined 909 men who underwent PFS and concluded that **t**hree factors (older age, smaller prostate volume and fewer urgency symptom evaluated by IPSS) were the predictive factors to differentiate DU from BOO, which might be useful for estimating the probability of DU in clinical practice without a PFS [16].

The limitations of this study include the relatively small sample size, single centre-based design, inherent biases and confounders. Future studies with multiple centres, larger cohorts and prospective designs are necessary to validate these findings and further refine the diagnostic criteria for BOO and DUA. Moreover, while this study focused on non-invasive predictors, the integration of these parameters with other diagnostic modalities, such as imaging and patient-reported outcomes, could enhance diagnostic accuracy.

Conclusion

The validation of this hypothesis has significant clinical implications. By identifying DeltaQ as a key differentiator, clinicians can use uroflowmetry, a non-invasive and widely accessible test, to screen for BOO and DUA with greater accuracy. This reduces the reliance on invasive urodynamic studies (UDS), which, while considered the gold standard, are associated with patient discomfort and potential complications.

Furthermore, the hypothesis-driven exploration of DeltaQ provides a foundation for future research. It suggests that other non-invasive parameters could also be explored for their potential to differentiate between urological conditions, thus broadening the toolkit available for clinicians in the diagnostic process.

In summary, the hypothesis that DeltaQ is a significant predictor of BOO versus DUA has been substantiated by our findings. This supports the use of DeltaQ in clinical practice as a simple yet effective tool for differentiating between these common causes of LUTS, potentially improving patient outcomes through more targeted treatment strategies.

References

1. Martin SA, Haren MT, Marshall VR, Lange K, Wittert GA, Members of the Florey Adelaide Male Ageing Study. Prevalence and factors associated with uncomplicated storage and voiding lower urinary tract symptoms in community-dwelling Australian men. World J Urol. 2011;29:179-184.
2. Kupelian V, Wei JT, O'Leary MP, Kusek JW, Litman HJ, Link CL, *et al*. Prevalence of lower urinary tract symptoms and effect on quality of life in a racially and ethnically diverse random sample: the Boston Area Community Health (BACH) Survey. Arch Intern Med. 2006;166:2381-2387.
3. Laniado ME, Ockrim JL, Marronaro A, Tubaro A, Carter SS. Serum prostate-specific antigen to predict the presence of bladder outlet obstruction in men with urinary symptoms. BJU Int. 2004;94:1283-1286.`
4. Resnick NM, Yalla SV, Laurino E. The pathophysiology of urinary incontinence among institutionalized elderly persons. N Engl J Med. 1989;320:1-7.
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 the outcome after transurethral resection of the prostate with a minimum 10-year urodynamic follow-up. BJU Int. 2004;93:745-750.
6. Jeong SJ, Kim HJ, Lee YJ, Lee JK, Lee BK, Choo YM, *et al*. Prevalence and clinical features of detrusor underactivity among elderly with lower urinary tract symptoms: a comparison between men and women. Korean J Urol. 2012;53:342-348.
7. Gratzke C, Bachmann A, Descazeaud A, Drake MJ, Madersbacher S, Mamoulakis C, *et al*. EAU guidelines on the assessment of non-neurogenic male lower urinary tract symptoms including benign prostatic obstruction. Eur Urol. 2015;67:1099-1109.
8. Porru D, Madeddu G, Campus G, Montisci I, Scarpa RM, Usai E. Evaluation of morbidity of multi-channel pressure-flow studies. Neurourol Urodyn. 1999;18:647-652.
9. Lee KS, Song PH, Ko YH. Does uroflowmetry parameter facilitate discrimination between detrusor underactivity and bladder outlet obstruction? Investig Clin Urol. 2016;57(6):437-441.
10. Abrams P. Bladder outlet obstruction index, bladder contractility index and bladder voiding efficiency: three simple indices to define bladder voiding function. BJU Int. 1999;84:14-15.
11. Chapple CR, Osman NI. Underactive Bladder Versus Bladder Outlet Obstruction: Don't Get Tricked! Eur Urol Focus. 2022;8(2):388-390.
12. Yono M, Ito K, Oyama M, Tanaka T, Irie S, Matsukawa Y, *et al*. Variability of post-void residual urine volume and bladder voiding efficiency in patients with underactive bladder. Low Urin Tract Symptoms. 2021;13(1):51-55.
13. Oelke M, Rademakers KL, van Koeveringe GA; FORCE Research Group, Maastricht & Hannover. Unravelling detrusor underactivity: Development of a bladder outlet resistance-bladder contractility nomogram for adult male patients with lower urinary tract symptoms. Neurourol Urodyn. 2016;35(8):980-986.
14. Ghirca MV, Chibelean C, Frunda EA, Mártha O. A hólyagkontraktilitási index meghatározásának fontossága a csökkent hólyagműködés kezelésében [The importance of Bladder Contractility Index in the management of underactive bladder]. Orv Hetil. 2017;158(31):1222-1227.
15. Kalil J, D'Ancona CAL. Detrusor underactivity versus bladder outlet obstruction: clinical and urodynamic factors. Int Braz J Urol. 2020;46(3):419-424.
16. Takahashi R, Takei M, Namitome R, Yamaguchi O, Eto M. Symptoms and noninvasive test parameters that clinically differentiate detrusor underactivity from bladder outlet obstruction without a pressure-flow-based diagnosis in men with lower urinary tract symptoms. Neurourol Urodyn. 2021;40(1):303-309.