Original Research Paper

Volume - 16 | Issue - 04 | April - 2026 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Surgery

IS 'VOIDING TIME' AN EFFICACIOUS SURROGATE MARKER TO DETECT BLADDER OUTLET OBSTRUCTION (BOO) IN MEN WITH LOWER URINARY TRACT SYMPTOMS (LUTS) DUE TO BENIGN PROSTATIC HYPERPLASIA(BPH)-A PROSPECTIVE CASE CONTROLLED COHORT EFFICACY STUDY.

Iqbal Singh*	M.Ch (Urology), D.N.B (GUSurg), MTS, DNB (Surg), Fellowship (Robotics & Minimally Invasive Urology), WFUMTS, NC, USA. Professor (Senior Consultant Urologist) & Head Department of Surgery, University College of Medical Sciences, (University of Delhi) & GTB Hospital, Delhi-110095. India *Corresponding Author
Himanshu Agrawal	Department of Surgery, University College of Medical Sciences (University of Delhi) & GTB Hospital, Delhi-95. India.
Natasha Panesar	Primary DNB Resident, Deen Dayal Upadhyay Hospital, Hari Nagar, New Delhi -64. India.
Mukul	Department of Surgery, University College of Medical Sciences (University of Delhi) & GTB Hospital, Delhi-95. India.

ABSTRACT **Objective:** The aim of this study was to evaluate and assess the diagnostic sensitivity and efficacy of using voiding time as a predictor for detecting bladder outlet urinary obstruction in men with Lower Urinary Tract Symptoms (LUTS) due to Benign Prostatic Hyperplasia (BPH). **Methods:** After obtaining IEC and written informed consent a prospective cohort study was conducted at a tertiary care teaching institute as per protocol. Men aged 50 years and older, diagnosed with BPH and LUTS, were enrolled with focussed urological assessment included the using. International Prostate Symptom Score (IPSS) and uroflow parameters (maximum flow rate (Qmax), voiding time, voided volume, and post-void residual (PVR) volume). Pressure-flow studies were performed on select of patients for ruling out an overactive bladder. Voiding time was used as a surrogate test marker which was evaluated and compared with traditional uroflow parameters. **Results:** This study involved 20 participants, with a mean age of 63.85 years, a mean IPSS score of 18.00, a mean Qmax of 11.90 mL/s with a mean voiding time of 30.25 seconds. A significant correlation was found between prolonged voiding time and the presence of bladder outlet obstruction (BOO). Voiding time showed increased sensitivity for detecting early BOO, particularly in patients with normal or near-normal Qmax. **Conclusions:** The Voiding time parameter serves as surrogate but sensitive and reliable diagnostic marker for identifying urinary obstruction in select male patients with BPH-related LUTS, complementing traditional uroflow parameters. Its incorporation into clinical practice could enhance early detection and improve patient outcomes.

KEYWORDS : Benign Prostatic Hyperplasia, Lower Urinary Tract Symptoms, Uroflow, Voiding Time.

INTRODUCTION

Lower Urinary Tract Symptoms (LUTS) are a diverse group of urinary disorders affecting the overall quality of life in aging men[1]. LUTS can be categorized into storage and voiding symptoms, including frequency, urgency, nocturia, weak urinary stream, and incomplete bladder emptying. LUTS are frequently associated with Benign Prostatic Hyperplasia (BPH), a common condition in which the prostate gland enlarges and compresses the urethra, leading to urinary flow obstruction. BPH affects up to 90% of men over the age of 80, with the prevalence increasing with age, contributing to discomfort, sleep disturbances, and social limitations[2]. The diagnosis of LUTS traditionally involves uroflow test that measures maximum flow rate (MFR-Qmax), average flow rate (AFR) and voided volume which predicts urinary outflow obstruction [3]. However the traditional measures like Qmax have their limitations, in detecting early-stage or mild urine outflow obstructions. In BPH, the bladder may compensate for such obstructions by increasing muscle activity to maintain normal flow rates despite underlying bladder dysfunction[4]. The present study aims to evaluate the potential of using "voiding time(VT)" as a surrogate of uroflow marker to predict the onset and detection of early bladder outlet obstruction. Using VT, total duration of urination, could provide a more comprehensive view of urinary function and serve as a critical marker for identifying obstructions that are not evident through traditional methods. This study explores the sensitivity of using VT versus Qmax to predict BOO in order improve early diagnosis and treatment of LUTS and BPH and its applicability in resource-limited settings which has been scarcely reported in the English literature which forms the basis of the current study.

PATIENTS AND METHODS

This study was conducted as a prospective observational and analytical investigation at the Outpatient and Inpatient Surgical Clinics, University College of Medical Sciences and Guru Teg Bahadur Hospital, a tertiary care teaching institute over the study period of 18 months from May' 2023 to Nov'2024. After obtaining prior written informed consent in (bilingual) and Local Institutional Ethics Committee approval of study protocol, selected patients were enrolled in to the present study as per protocol criteria.

The study protocol was registered with the Thai Clinical Trials Registry (TCTR20250707009, dated 07.07.2025 (https://www.thaiclinicaltrials.org/show/TCTR20250707009). The study population comprised adult male patients presenting with lower urinary tract symptoms (LUTS) attributable to benign prostatic hyperplasia (BPH). A total of 170 participants were enrolled and divided into two equal cohorts: 85 symptomatic cases and 85 age-matched controls. Men aged 45 years or older with LUTS clinically attributable to BPH, who were able to comprehend the study protocol and provide informed consent, were included. Patients were excluded if they had LUTS due to causes other than BPH, such as neurogenic bladder or urethral stricture, or had a history of prostate malignancy or any cancer within the preceding five years. Additional exclusion criteria included recent use (within three months) of medications known to affect voiding dynamics (androgens, anti-androgens, diuretics, cholinergics or anticholinergics), presence of symptomatic urinary tract infection, chronic inflammatory conditions, or significant renal impairment defined as serum creatinine ≥2.0 mg/dL. Patients unable to comply with study requirements were also excluded.

Participants were stratified based on the International Prostate Symptom Score (IPSS). The case group consisted of symptomatic patients with IPSS ≥8, indicating moderate to severe LUTS. The control group included age-matched men with IPSS <8, representing absent or mild symptoms. This stratification enabled comparison of voiding time across differing symptom severities and assessment of its diagnostic performance. All enrolled participants underwent a standardized baseline assessment. A detailed clinical history was obtained, including duration and nature of urinary symptoms, past medical history, medication history, and relevant personal history. Physical examination included general examination and focused urological assessment. Laboratory investigations included hemogram, liver function tests, kidney function tests, serum electrolytes, random blood sugar, and serum prostate-specific antigen (PSA) levels. A mid-stream urine sample was collected for microscopy and culture to exclude UTI. Uroflow was performed under standardized conditions using a calibrated uroflow meter. Patients were instructed to void when they felt a normal desire to urinate, ensuring adequate bladder filling. The following parameters were recorded: maximum flow rate (Qmax),

average flow rate (AFR), voided volume (VV), and voiding time (VT). Voiding time was defined as the total duration from initiation to completion of urine flow, automatically recorded by the uroflow device. In parallel, post-void residual (PVR) urine volume was measured post-voiding by USG. Participants also maintained a voiding diary, documenting frequency and pattern of micturition. All subjects underwent ultrasound of kidney, ureters, and bladder (USG-KUB) with assessment of prostate volume. IPSS questionnaires were administered as per protocol for evaluation which allowed correlation of voiding time with established objective and subjective markers of bladder outlet obstruction.

Outcome Criteria: The primary outcome was the sensitivity of voiding time in detecting urinary obstruction, using peak flow rate (Qmax) and average flow rate (AFR) as reference (gold-standard) parameters. Secondary outcomes included assessment of voiding time differences between symptomatic and control groups and evaluation of its potential applicability as a low-cost diagnostic tool in resource-limited settings.

Sample Size Computation: The sample size for the study was determined based on a study by Pahouja et al. [5], which reported the sensitivity of voiding time (VT) for predicting obstruction as 85%. The sample size was calculated using the formula:

$$\text{Sample Size (N)} = \frac{(Z_{1-\alpha/2})^2 * S * (1-S)}{W^2 * P}$$

Wherein the sensitivity (SSS) was set at 0.85, the proportion of subjects with the target condition (PPP) was 0.433 (43.3%), the width of the confidence interval (WWW) was 0.125 (12.5%), and the type I error (α\alpha) was 5%, leading to Z1−α/2=1.96Z_{1-\alpha/2} = 1.96Z1−α/2=1.96. Substituting these values into the above formula, the required sample size was calculated to be approximately 75 participants. Considering the potential loss of patients to follow-up, the attrition rate was estimated to be up to 10%. Therefore, with a 95% confidence interval, the proposed sample size for study was adjusted to 85 patients per group.

Statistical Analysis: Data were coded and entered into Microsoft Excel, and statistical analysis was performed using SPSS version 23.0 (IBM Corp., USA). Continuous variables were expressed as mean ± standard /median/ interquartile range, while categorical variables were summarized as frequencies and percentages. Group comparisons were performed using appropriate parametric or non-parametric tests. Diagnostic performance of voiding time was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy, using Qmax and AFR as reference standards. Receiver Operating Characteristic (ROC) curve analysis was conducted to determine the area under the curve (AUC). Correlation between voiding time and uroflow parameters was analyzed using correlation and regression models. A p-value <0.05 was considered statistically significant.

OBSERVATIONS AND RESULTS

A total of 170 participants were included in the study, comprising 85 cases (men with LUTS due to BPH; IPSS ≥8) and 85 age-matched controls (IPSS <8). The mean age of patients in the case group was 58.85 ± 7.24 years, which was significantly higher than that of the control group (56.01 ± 8.93 years), and this difference was statistically significant ($p = 0.024$). This reflects the increasing prevalence and severity of LUTS with advancing age. Baseline clinical demographic parameters are depicted in Table-I, which demonstrated that the case group had significantly higher prostate volume, post-void residual urine (PVR), and serum PSA levels, consistent with greater BOO and symptom severity when compared to versus the controls.

Comparison of Uroflow Parameters: Significant differences were observed between the two groups for all uroflow parameters. The case group demonstrated markedly reduced Qmax and AFR, along with a substantially prolonged voiding time, indicating significant bladder outlet obstruction. Mean Qmax was 9.33 ± 1.41 and 17.76 ± 2.76 ml/s in case versus controls respectively ($p < 0.0001$). The mean AFR was 5.51 ± 1.40 and to 8.99 ± 1.49 ml/s ml/s in cases vs controls ($p < 0.0001$) and the mean voiding time was 41.02 ± 10.76 and 22.61 ± 4.71 seconds in cases versus controls respectively ($p < 0.0001$) as depicted in Table-II.

Diagnostic Performance of Voiding Time: When Qmax was used as the reference standard, voiding time demonstrated a sensitivity of 76.7%, specificity of 98.5%, and an overall diagnostic accuracy of 85.3%. Using AFR as the reference standard, sensitivity increased to 100%, with specificity of 76.3% and diagnostic accuracy of 83.5% as depicted in Table-III).

Secondary Outcomes(Correlation Analysis): A strong and statistically significant inverse correlation was observed between voiding time(VT) and both uroflow parameters. The Qmax vs VT, correlation coefficient was $\rho = -0.86$($p < 0.0001$) and the AFR vs VT, correlation coefficient was $\rho = -0.93$($p < 0.0001$). Regression analysis showed that VT decreased by approximately 2.24 seconds per 1 ml/s increase in Qmax and by 5.09 seconds per 1 ml/s increase in AFR which confirmed and demonstrated that VT was a robust surrogate marker of uroflow as depicted in Table-IV).

Stratification by Symptom Severity: VT increased progressively in direct proportion with higher IPSS scores. Patients with IPSS ≥8 exhibited significantly prolonged VT versus those with IPSS <8, indicating worsening BOO and increased symptom severity.

DISCUSSION

The present study was designed to evaluate the diagnostic utility of voiding time (VT) as a uroflowm parameter for detecting urinary obstruction in men with Lower Urinary Tract Symptoms (LUTS) secondary to Benign Prostatic Hyperplasia (BPH). Our findings demonstrated that VT was significantly prolonged in symptomatic patients and shows a strong inverse correlation with established uroflow parameters, particularly maximum flow rate (Qmax) and average flow rate (AFR). These observations reinforce the growing recognition of VT as a clinically meaningful, non-invasive marker of BOO.

In this study, patients in the LUTS-BPH group exhibited significantly lower Qmax and AFR values, along with markedly prolonged VT, versus age-matched controls. The diagnostic performance analysis showed that VT achieved high sensitivity (76.7-to 100%), depending on the reference standard, with excellent diagnostic accuracy when compared with Qmax. This highlights VT's potential to identify obstruction even when conventional uroflow parameters alone may not fully reflect the degree of functional impairment. More specifically, the strong inverse correlations observed between VT and Qmax ($\rho = -0.86$) and between VT and AFR ($\rho = -0.93$) demonstrated that prolonged VT reliably mirrored the deteriorating urinary flow. These findings support earlier observations by Memon et al [6], who demonstrated that VT closely correlated with severity of LUTS and may serve as a surrogate marker of the intensity BOO. Our results were consistent with prior studies emphasizing the limitations of relying solely on Qmax for diagnosing BOO.

Mallik et al. [9] highlighted the substantial variability in Qmax values across populations and clinical settings, which can reduce its sensitivity for detecting early or mild obstruction. Similarly, Cicione et al [10] underscored the importance of adjunctive parameters such as post-void residual volume (PVR), reinforcing the need for a multiparametric approach to LUTS evaluation. The present findings further align with the work of Shah et al. [11] and Okeke et al. [12], who demonstrated that VT provides additional diagnostic information, particularly in patients with borderline or equivocal Qmax. These studies collectively suggest that VT is especially useful in identifying subtle or evolving obstruction that might otherwise be underestimated. Additionally, Billah et al [13] had also reported a strong association between increasing grades of prostatomegaly and obstructed urinary flow findings, that parallel our observation that prolonged VT's often accompany higher prostate volumes and increased urinary outflow obstruction severity thereby reinforcing the relevance of VT's in reflecting the mechanical and functional consequences of prostatic enlargement.

The clinical importance of early and accurate detection of obstruction in BPH has been well established by Gemma et al. [7] who emphasized that timely relief of obstruction leads to improved symptom control and prevention of complications. In this context, the ability of VT to detect early or mild BOO provides a meaningful advantage, enabling earlier intervention.

Age-related trends observed in our cohort were consistent with the

findings of Reddy et al. [8], which highlighted the increasing burden of LUTS and obstruction with advancing age. Given that older men are disproportionately affected by BPH and its complications, incorporating a simple parameter like VT into routine assessment could have significant clinical impact. Furthermore, Apata et al [14] and Memon et al [6] have suggested that improving diagnostic sensitivity at the primary evaluation stage can translate into better patient outcomes. In this regard, voiding time offers a practical and cost-effective addition to uroflow, particularly in resource-limited settings. The findings of Creta et al [15], who demonstrated the role of uroflow in guiding surgical decision-making for BPH, further support the integration of VT into initial diagnostic workflows. Prolonged VT may assist in identifying patients that are more likely to benefit from early escalation of therapy medical or surgical and may assist in risk stratification during follow-up.

By complementing traditional uroflow parameters, voiding time provides a more holistic assessment of voiding dysfunction, capturing the dynamic aspect of bladder emptying rather than focusing solely on peak flow values. The results of this study suggest that voiding time is a valuable adjunct to conventional uroflow study for evaluating LUTS due to BPH. Its simplicity, reproducibility, and non-invasive nature make it particularly attractive in settings where advanced urodynamic investigations, such as pressure-flow studies, are unavailable or impractical. Incorporating VT into routine practice may improve diagnostic accuracy, facilitate early detection of obstruction, and help prevent progression to complications such as acute urinary retention or hydronephrosis. Beyond tertiary care, voiding time has potential applicability in primary care and peripheral healthcare settings, empowering clinicians to identify high-risk patients earlier and initiate timely referral or treatment. This aligns with broader efforts to decentralize BPH care and improve accessibility. Future research should focus on large, multicentre studies to validate these findings across diverse populations. Longitudinal studies evaluating the relationship between VT and long-term outcomes, such as treatment response, quality of life, and need for surgical intervention which would further clarify its role. Additionally, subgroup analyses in patients with comorbidities such as diabetes or neurological disorders may provide further insights into the diagnostic scope of VT. A brief review of similar published studies and their comparison with the present study is depicted in Table-V.

Limitations: Despite its strengths, the present study had certain limitations. Although adequately powered, the single-centre design and modest sample size could have impacted and limit generalizability. A larger, multicentre cohort could have provided more robust estimates of diagnostic accuracy. Pressure-flow studies were performed only in a subset of patients due to protocol restrictions; universal urodynamic assessment could have offered more definitive validation of VT against the gold standard for bladder outlet obstruction. The quality-of-life measures, erectile function, effects of medical therapy, and co-morbid conditions were not evaluated as part of the study protocol, which could have increased the clinical utility of the current study. Finally, the current study did not assess long-term outcomes of patients, diagnosed using voiding time. Future longitudinal studies are required to determine whether routine use of VT alone or in combination with other parameters influences physician decision-making and improves patient-centred outcomes.

Conclusions: Despite these limitations the present study suggested the utility of 'voiding time' as an overall sensitive and reliable diagnostic parameter that could complement traditional uroflow study in screening and detecting urinary obstruction in a select population of men with LUTS due to BPH. The ability of 'voiding time' to detect early-stage or mild obstructions that could be missed by an isolated equivocal Qmax value makes 'voiding time' as a possible valuable tool in the management of LUTS. Incorporating voiding time into routine clinical practice could improve the early detection and treatment of BPH may ultimately enhance patient outcomes and quality of life.

List of Abbreviations:

BPH: Benign Prostatic Hyperplasia; PVR: Post Void Residue; VT: Voiding Time; AVR: Average Flow Rate; Qmax/MFR: Maximum Flow Rate; IPSS: International Prostate Symptom Score; BOO: Bladder Outlet Obstruction; LUTS: Lower urinary tract symptoms

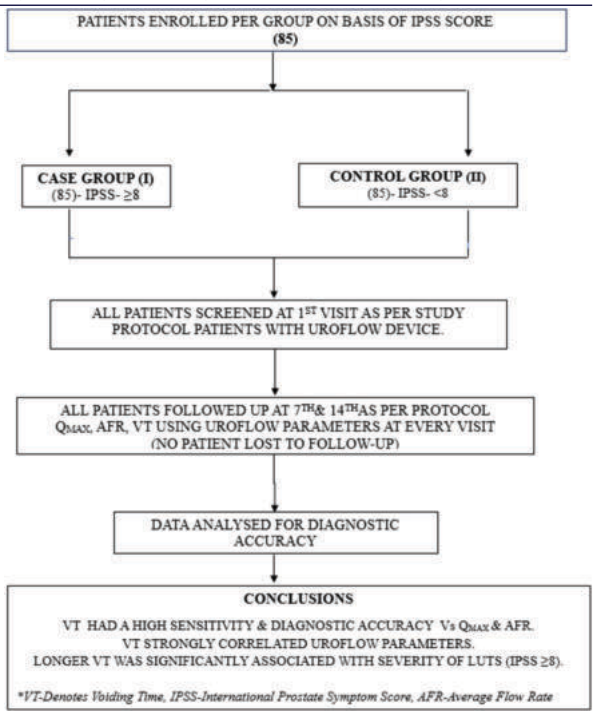

Fig-I: Depicts the Flow of the Current Study Protocol.

Table-I: Depicting Demographic and Baseline Clinical Characteristics.

TABLE-I: DEMOGRAPHIC AND BASELINE CLINICAL CHARACTERISTICS			
PARAMETER	CASE GROUP (N = 85)	CONTROL GROUP (N = 85)	P-VALUE
Mean age (years)	58.85 ± 7.24	56.01 ± 8.93	0.024
IPSS score	≥ 8	< 8	—
Prostate volume	Higher	Lower	<0.05
Post-void residual (ml)	Higher	Lower	<0.0001
Serum PSA (ng/ml)	Higher	Lower	<0.05

Table-II: Depicting the Comparison of Uroflow Parameters (Case vs Control Groups).

TABLE-II: COMPARISON OF UROFLOW PARAMETERS IN BOTH GROUPS			
PARAMETER	CASE GROUP (MEAN ± SD)	CONTROL GROUP (MEAN ± SD)	P-VALUE
Qmax (ml/s)	9.33 ± 1.41	17.76 ± 2.76	<0.0001
AFR (ml/s)	5.51 ± 1.40	8.99 ± 1.49	<0.0001
Voiding time (sec)	41.02 ± 10.76	22.61 ± 4.71	<0.0001

Table-III: Depicting the Diagnostic Performance of Voiding Time.

TABLE-III: DIAGNOSTIC PERFORMANCE OF VOIDING TIME		
DIAGNOSTIC PARAMETER	COMPARED TO QMAX	COMPARED TO AFR
Sensitivity (%)	76.7	100
Specificity (%)	98.5	76.3
PPV (%)	98.8	65.0
NPV (%)	73.3	100
Diagnostic accuracy (%)	85.3	83.5

Table-IV: Depicting the Correlation of Voiding Time with Uroflow Parameters.

TABLE-IV: CORRELATION OF VOIDING TIME WITH UROFLOW PARAMETERS			
PARAMETER COMPARED	CORRELATION COEFFICIENT (P)	P-VALUE	INTERPRETATION
Voiding time vs Qmax	−0.86	<0.0001	Strong inverse correlation
Voiding time vs AFR	−0.93	<0.0001	Very strong inverse correlation

Table-V: Depicting the Summary of Salient Features of Reviewed Articles.

TABLE-V : SUMMARY OF REVIEWED ARTICLES			
AUTHOR	TYPE	STUDY AIM	SALIENT CONCLUSIONS
Gemma et al, 2024 [7]	ORS	Managing LUTS(BPH)with medications & surgical interventions to relieve obstruction & improve QOL.	BPH therapy should focus on alleviating LUTS by preventing urinary retention, UTI & Vesical stones, while enhancing patient's QOL
Shah et al, 2024[11]	CSS	51 men evaluated with IPSS & uroflow to assess flow rate (Qmax).	Weak negative correlation between IPSS &Qmax, suggested, Qmax was most relevant uroflow parameter to assess symptom severity in LUTS-BPH.
Sandhu et al[16]	RS	Study in men with LUTS (BPH) compared symptom-based diagnoses over organ-specific causes.	LUTS based approach was more useful vs prostate size in guiding BPH therapy in men
Creta et al, 2024 [15]	CSS	Patients underwent uroflow to assess (BOO) & LUTS. Patients who required surgery (open prostatectomy or TURP) were followed up.	UFL was essential in diagnosing BOO in BPH, Post-treatment assessments showed effectiveness of TURP and open prostatectomy, with differences in outcomes based on the method used.
Jeh et al, 2024[17].	CSS	UDS to classify patients as obstructed or non-obstructed, followed by a formula combining (PV+MFR+VV).	Combined(Mean PV+MFR+VV) was effective in predicting IPP (Infravesical Prostatic Protrusion) compared to UDS.
Yu et al[18].	SR	UFL in diagnosing and treating LUTS in men with BPH	UFL was inconsistent in clinical guidelines for managing LUTS.
Udo et al, 2024[19].	RS	354 BPH men were reviewed for PV, PSA & uroflow (Qmax) to analyze effect of age on these parameters.	PV and PSA levels increased with age and were insufficient for estimating BPH severity. UFL was more useful for assessing BPH symptoms.
Fang et al, 2024[20].	CSS	BPH men underwent IPSS, QOL,UFL, PVR and pressure-flow UDS to assess BOO.	IPP and other ultrasound parameters were significant reliable predictors of BOO in BPH to correlate these parameters with severity of BOO.
Singh et al, 2014 [21].	RCT	1,058 men with BPH.Tadalafil (titrated doses) versus placebo using UFL, PVR, and IPSS	Tadalafil improved bladder capacity and voiding efficiency but did not significantly affect uroflow (Qmax) while significantly improving obstructive symptoms (IPSS) versus placebo.
Neri et al, 2024[22].	CSS	238 men underwent IPSS, PV & Qmax to measure severity.	UFL is a valuable tool in monitoring LUTS(BPH) correlated well with symptom severity, PV,PSA levels, and ED in older men with LUTS.
Present Study 2026	RCT	85	VT had high sensitivity & diagnostic accuracy vs Qmax, AFR, VT strongly correlated with uroflow parameters. Longer VT was significantly associated with severity of luts (ipss ≥8).

CSS: Cross Sectional Study; OS: Observational study; RCT: Randomised Controlled Study, SR: Systematic Review;
RS: Review Study; IPSS: International Prostate Symptom Score; BOO: Bladder outlet obstruction; UFL: Uroflow; PV: Prostate volume; PVR:Post void residue; MFR: Mean/Average flow rate; Qmax: Maximal flow rate; ED: Erectile dysfunction. VT-Voiding Time; QOL: Quality of Life.

Ethical Statements

A. Acknowledgements: None

B. Funding Statement: The authors (s) received no specific funding for this study.

C. Author Contributions: The authors confirm their contribution as follows: Study conception, Design & Supervision: IS ; Data collection: M, HA, IS ; Draft manuscript preparation: IS, HA, NP, M ; Data Analysis& Statistics & References: NP, M ; Review of the results & approval of the final version of the manuscript: All authors.

D. Availability of Data and Materials: The data that support the findings of this study are available from the corresponding author (IS) upon reasonable request.

E. Ethics Approval: The Institutional Ethics Committee – Human Research (IEC-HR) of University College of Medical Sciences, University of Delhi, Delhi – 110095, vide No IECHR-2023-59-70 dated 30.04.2023, approved the study protocol from ethical angle. All patients participating in the study gave written and informed consent.

F. Conflicts of Interest: The authors (s) individually declare that they have no conflicts of interest for the present study.

REFERENCES:

1. Cabeza M. Current Understanding of Androgen Signaling in Prostatitis and its Treatment: A Review. Current Medicinal Chemistry. 2024;31(27):4249-4266.
2. Cameron AP, Yang CC, Bradley CS, et al. Symptoms of Lower Urinary Tract Dysfunction Research Network (LURN): An introduction to the Urinary Urgency Phenotyping Protocol LURN II. Neurourology and Urodynamics. Online July 29, 2024.
3. Ganesan V, Agarwal D. Medical Advancements in BPH Treatments. Current Urology Reports. 2024;25(5):93-98.
4. Hashim H, Tarcan T, Acar O, Malde S, Wein A, Abrams P. Evaluation of new treatments for benign prostatic obstruction: ICI.RS 2023. Neurourology and Urodynamics. 2024;43(6):1409-1419.
5. Pahouja G, Patel P, Martinez EB, Mueller E, McVary KT. Voiding Time for the Evaluation of LUTS in Men - A Potential Option for Addressing Disparity Related Access to Urodynamic Testing. Urology. 2022;169:162-166. doi:10.1016/j.urology.2022.05.058
6. Memon AH, Chandio MA, Bhellar ZH, Rehman HU, Akhtar S, Bhurt A. Role of Uroflowmetry in Patients of BPH Presenting with LUTS: Uroflow in BPH. Pakistan J of Health Sci. Published online November 30, 2024:40-45. doi:10.54393/pjhs.v5i11.2409
7. Gemma L, Pecoraro A, Sebastianelli A, et al. Impact of minimally invasive surgical procedures for Male LUTS due to BPH on ejaculatory function: a systematic review. Prostate Cancer Prostatic Dis. 2024;27(3):404-tctr 421. doi:10.1038/s41391-024-00795-2
8. Reddy SVK, Shaik AB. Non-invasive evaluation of BOO in BPH: a clinical correlation study. Arab J Urol. 2019;17(4):259-264. doi:10.1080/2090598X.2019.1660071
9. Mallik PAU. Evaluation of LUTS suggestive of BPH by Uroflow & AUA Symptom Score. KYAMC Journal. doi:10.3329/KYAMCJ.V13I1.59881
10. Cicione A, Lombardo R, Nacchia A, et al. Post-voided residual urine ratio as a predictor of BOO in men with LUTS: development of a clinical nomogram. World J Urol. 2023;41(2):521-527. doi:10.1007/s00345-022-04259-x
11. Shah RS, Mishra K, Sah S, et al. Correlation between the Visual Prostate Symptom Score and IPSS in Patients with Symptomatic BPH. Journal of Nobel Medical College. 2024;13(1):55-59. doi:10.3126/jonmc.v13i1.68105
12. Okeke CJ, Jeje EA, Obi AO, Ojewola RW, Ogunjimi MA, Tijani KH. Correlation between Bladder Wall Thickness and Uroflowmetry in West African Patients with BPH. Nigerian Journal of Clinical Practice. 2023;26(7):986. doi:10.4103/njcp.njcp_850_22
13. Billah DMA, Monowar-UL-Haque PDM, Akter DT, et al. Correlation of Different Grades of Intravesical Prostatic Protrusion with Uroflow Parameters in Patients with Symptomatic BPH. Archives of Nephrology and Urology. 2024;7(1):1-8.
14. Apata KO, Jeje EA, Tijani KH, Ogunjimi AM, Ojewola RW, Adeyomoye AA. Correlation between the IPSS and sonographic parameters in patients with symptomatic BPH. Journal of Clinical Sciences. 2023;20(1):1. doi:10.4103/jcls.jcls_21_22
15. Creta M, Russo GI, Bhojani N, et al. Bladder Outlet Obstruction Relief and Symptom Improvement Following Medical and Surgical Therapies for LUTS Suggestive of BPH: A Systematic Review. Eur Urol. 2024;86(4):315-326. doi:10.1016/j.eururo.2024.04.031
16. Sandhu JS, Bixler BR, Dahm P, et al. Management of LUTS Attributed to BPH: AUA Guideline Amendment 2023. J Urol. 2024;211(1):11-19. doi:10.1097/JU.0000000000003698
17. Jeh S, Choi M, Kang C, et al. The epidemiology of male LUTS associated with BPH: Results of 20 years of Korean community care & surveys. Investig Clin Urol 2024; 65(1) : 69-76. doi:10.4111/icu.20230249
18. Yu WR, Jiang YH, Jhang JF, Kuo HC. Urine biomarker could be a useful tool for differential diagnosis of a lower urinary tract dysfunction. Tzu Chi Medical Journal. 2024 Apr 1;36(2):110-9.
19. Udo CO, Robinson ED, Ijeruh OY, Nwankwo NC, Ugwoegbu JU, Emecheta OG, et al. Correlation between prostate volume and LUTS:a hospital-based study. J Global Radiol. 2024 May 2;10(1).
20. Fang H, Li Y, Wang S, Liu S, Qiao Y, Li Y, Shan S. Clinical value of neutrophil to lymphocyte ratio and ultrasonic parameters in the diagnosis of BOO in BPH. French J Urol 2024 Jun 1;34(6):102643.
21. Singh DV, Mete UK, Mandal AK, Singh SK. A comparative randomized prospective study to evaluate efficacy & safety of combination of tamsulosin and tadalafil vs. tamsulosin or tadalafil alone in patients with LUTS due to BPH. J Sex Med. 2014 Jan;11(1):187-96.
22. Neri DA, Venturini BA, Massuqueto E, de Abreu GE, Portugal MM, Costa J, et al. Agreement between two uroflowmetry tests in children with LUTS. J Ped Urol. 2024 Sep 3.