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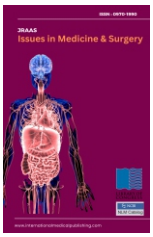

Research Article

Section: General Surgery

Efficacy of Using Voiding Time as A Uroflow Parameter for Detecting Urinary Obstruction in Men with Lower Urinary Tract Symptoms Due to Benign Prostatic Hyperplasia

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HIGHLIGHTS

- BPH causes urinary obstruction.
- LUTS: urgency, weak stream.
- Voiding time non-invasive tool.
- Prolonged time shows severity.
- Early diagnosis improves outcomes.

Key Words:
Voiding time
Uroflowmetry
Urinary obstruction
Lower urinary tract symptoms
Benign prostatic hyperplasia
Peak urinary flow rate
Urodynamic studies
Non-invasive diagnostic tool
Urinary flow parameters

ABSTRACT

Introduction: Benign Prostatic Hyperplasia (BPH) is a common condition in aging men characterized by prostate enlargement that causes bladder outlet obstruction, leading to Lower Urinary Tract Symptoms (LUTS) such as frequency, urgency, weak urine stream, and incomplete bladder emptying. Accurate assessment of urinary obstruction is essential for appropriate management; however, conventional diagnostic tools like pressure-flow studies are invasive and expensive. Therefore, identifying a simple, non-invasive, and cost-effective parameter such as voiding time may provide an alternative diagnostic approach. **Aim & Objective:** To evaluate the role of voiding time as a uroflowmetric parameter for detecting urinary obstruction in men with LUTS secondary to BPH and to determine its correlation with the severity of obstruction assessed by urodynamic and clinical parameters. **Materials & Methods:** A cohort of men diagnosed with BPH presenting with LUTS underwent uroflowmetry to record voiding time along with other parameters such as peak urinary flow rate (Qmax). These findings were compared with urodynamic study results and clinical assessments to analyze the correlation between voiding time and the degree of urinary obstruction. **Results:** The study demonstrated a significant association between prolonged voiding time and increased severity of urinary obstruction. Patients with longer voiding times exhibited reduced Qmax values and higher obstruction grades on urodynamic evaluation. **Conclusion:** Voiding time shows potential as a simple and practical indicator for detecting urinary obstruction in men with BPH-related LUTS. Its use could facilitate early diagnosis and timely management, improving patient outcomes and quality of life. Larger-scale studies are warranted to further validate its diagnostic utility.

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INTRODUCTION

Lower Urinary Tract Symptoms (LUTS) are a set of urinary problems resulting from dysfunction in the bladder and urethra, often categorized into storage symptoms (frequent urination, urgency, nocturia, and incontinence) and voiding symptoms (difficulty starting urination, weak urinary stream, hesitancy, and incomplete bladder emptying) [1]. LUTS are particularly common in aging men, with about 30-50% of men over 50 experiencing these symptoms, and the prevalence increases with age [2]. By the age of 80, nearly 80% of men report some form of LUTS. These symptoms can significantly impair quality of life, causing discomfort, sleep disturbances, and social and physical limitations. Additionally, chronic symptoms may lead to mental health issues such as stress and anxiety [3].

A major cause of LUTS in older men is Benign Prostatic Hyperplasia (BPH), a non-cancerous enlargement of the prostate gland. BPH compresses the urethra, causing urinary obstruction. It affects roughly half of men aged 50 to 60 and up to 90% of men over 80 [4]. While not all men with BPH experience symptoms, about 50% will develop significant LUTS that require medical attention, including difficulty urinating, weak stream, incomplete bladder emptying, and frequent urination. If left untreated, BPH can lead to urinary retention, bladder dysfunction, and kidney damage, making early detection essential for effective treatment [5].

Uroflowmetry is a commonly used non-invasive test to assess urinary function by measuring the rate of urine flow. Parameters like maximum flow rate (Qmax) and voided volume are often used, but they have limitations, especially in detecting early or mild obstructions [6]. For instance, early-stage obstructions may not show a significant reduction in Qmax due to compensatory bladder muscle activity. Additionally, Qmax results can vary based on factors like hydration and bladder contractility, reducing their diagnostic reliability [7].

To address these limitations, voiding time, the total duration of urination from start to finish, has been proposed as a potentially more sensitive marker for urinary obstruction. Voiding time may be particularly useful in cases of BPH, where the enlarged prostate restricts urine flow, forcing the bladder to work harder and resulting in a prolonged voiding time [8]. Research suggests that voiding time may better reflect the severity of urinary obstruction than Qmax alone, especially in early or mild cases. Unlike Qmax, voiding time is less influenced by factors like voided volume, making it more consistent even in patients with low urine output [8].

Incorporating voiding time into uroflowmetry assessments could enhance diagnostic accuracy, providing additional insight into urinary function [9]. When combined with traditional parameters like Qmax, voided volume, and average flow rate, voiding time offers a more comprehensive evaluation of urinary obstruction, leading to earlier detection and more personalized treatment options for men with BPH and LUTS [10].

MATERIAL & METHODS

The study aims to assess the sensitivity of "Voiding Time" (VT) as a uroflow parameter for detecting urinary obstruction in men with Lower Urinary Tract Symptoms (LUTS) due to Benign Prostatic Hyperplasia (BPH), using Peak Flow Rate (PFR) or Average Flow Rate (AFR) as the reference standard. Ethical approval has been obtained for the study from the ethical approval committee of the Institute. The primary objective is to evaluate VT's sensitivity in identifying urinary obstruction in men with BPH-related LUTS. The secondary objective is to provide a solution for areas lacking access to standard urodynamic testing, facilitating diagnosis and treatment in primary care centers. This prospective observational study, conducted at UCMS & GTB Hospital from May 2023 to November 2024, will involve 85 patients who meet the inclusion criteria of adult males aged 45 and above, presenting with LUTS due to BPH. The study will compare VT to standard uroflowmetry parameters, measuring sensitivity, specificity, and diagnostic accuracy. Data will be analyzed using SPSS, with statistical significance set at $p<0.05$.

RESULTS

Table 1 compares two groups, Control and Case, based on age. The Case group has a slightly higher mean age (58.8 vs. 56). The median age is also higher in the Case group (59 vs. 52). A p-value of 0.024 indicates a statistically significant difference between the groups. Table 2 compares the distribution of age groups between case and control groups. It shows the number of participants in each age group, the percentage of cases and controls in each group, and the total count. The p-value (0.057) indicates a marginal statistical difference between the two groups for age distribution. Table 3 shows the distribution of Prostatomegaly grades based on Digital Rectal Examination (DRE) in case and control groups. In Grade 1, a significant majority of controls (92.5%) were diagnosed compared to only 7.5% in the case group ($p < 0.0001$). Grade 2 and 3 show a higher prevalence in cases. Table 4 compares two groups (Case and Control) based on a particular measurement. The "Mean" values are 0.91 for the Case group and 0.66 for the Control group, indicating a higher average in the Case group. The "Standard Deviation" (Std Dev) shows more variability in the Case group (0.37) compared to the Control group (0.24). Both groups consist of 85 participants, and the "P-Value" is less than 0.0001, suggesting a statistically significant difference between the two groups. Table 5 compares two groups, "Case" and "Control." The mean score for the "Case" group is 38.6 with a standard deviation of 8.13, while the "Control" group has a mean of 30.56 with a standard deviation of 3.77. The p-value is <0.0001, indicating a

statistically significant difference between the groups. Table 6 compares the case and control groups. The case group has a higher mean value (35.71) compared to the control group (25.18). The standard deviation is greater in the case group (7.91 vs. 4.86), indicating more variation. The p-value (<0.0001) suggests a statistically significant difference between the groups. Table 7 compares the "Case" and "Control" groups based on their mean, standard deviation, and count values. The "Case" group has a mean of 9.33 with a standard deviation of 1.41, while the "Control" group has a mean of 17.76 with a standard deviation of 2.76. The p-value is <0.0001, indicating a statistically significant difference between the groups. Table 8 compares the "Case" and "Control" groups based on a specific parameter. The mean for the "Case" group is 5.51 with a standard deviation of 1.40, while the "Control" group has a mean of 8.99 and a standard deviation of 1.49. The p-value is <0.0001, indicating a statistically significant difference between the two groups.

Table 9 compares the mean values of a parameter between the case and control groups. The case group has a higher mean (41.02) and standard deviation (10.76) than the control group (22.61 and 4.71, respectively). The P-value (<0.0001) indicates a statistically significant difference between the groups. Table 10 compares the mean values of a certain parameter between the Case and Control groups. The Case group has a mean of 211.89 with a standard deviation of 23.62, while the Control group has a mean of 196.41 with a standard deviation of 11.65. Both groups have 85 participants, with a p-value of <0.0001, indicating a statistically significant difference between the groups. Table 11 compares diagnostic metrics (sensitivity, specificity, PPV, NPV, and diagnostic accuracy) of a test when compared to two methods: Qmax and AFR. The test shows high sensitivity and specificity when compared to Qmax, with excellent PPV and reasonable NPV. AFR shows perfect sensitivity and NPV but lower PPV.

Table 1: Descriptive Statistics for Age in Control and Case groups

Group	Control	Case
Count	85	85
Mean	56	58.8
Std Dev	8.9	7.2
Min	46	46
25%	50	54
Median	52	59
75%	61	64
Max	81	78
P-Value	0.024	

Table 2: Age Group Distribution: Case vs Control

Age Group	Case	Control	Total	Case %	Control %	P-Value
41-50	12	21	33	36.4	63.6	0.057
51-60	34	37	71	47.9	52.1	
61-70	31	19	50	62	38	
71-80	8	5	13	61.5	38.5	
81-90	0	3	3	0	100	

Table 3: Distribution of Prostatomegaly Grades: Case vs Control

Prostatomegaly DRE (Grade)	Case	Control	Total	Case %	Control %	P-Value
1	4	49	53	7.5	92.5	<0.0001
2	59	36	95	62.1	37.9	
3	22	0	22	100	0	

Table 4: Descriptive Statistics for S.PSA(ng/ml) in Control and Case groups

Group	Case	Control
Mean	0.91	0.66
Std Dev	0.37	0.24
Count	85	85
P-Value	<0.0001	

Table 5: Descriptive Statistics for Prostate Vol.(cc) in Control and Case groups

Group	Case	Control
Mean	38.6	30.56
Std Dev	8.13	3.77
Count	85	85
P-Value	<0.0001	

Table 6: Descriptive Statistics for Average Post Void Volume (cc) in Control and Case groups

Group	Case	Control
Mean	35.71	25.18
Std Dev	7.91	4.86
Count	85	85
P-Value	<0.0001	

Table 7: Descriptive Statistics for Average Qmax(ml/sec) in Control and Case groups

Group	Case	Control
Mean	9.33	17.76
Std Dev	1.41	2.76
Count	85	85
P-Value	<0.0001	

Table 8: Descriptive Statistics for Average AFR (ml/sec) in Control and Case

Group	Case	Control
Mean	5.51	8.99
Std Dev	1.4	1.49
Count	85	85
P-Value	<0.0001	

Table 9: Descriptive Statistics for Average Voiding Time (sec) in Control

Group	Case	Control
Mean	41.02	22.61
Std Dev	10.76	4.71
Count	85	85
P-Value	<0.0001	

Table 10: Descriptive Statistics for Average Voided Volume (ml) in Control and Case groups abscess

Group	Case	Control
Mean	211.89	196.41
Std Dev	23.62	11.65
Count	85	85
P-Value	<0.0001	

Table 11: Diagnostic Performance Comparison of Average Voiding Time

Metric	Compared to Qmax	Compared to AFR
Sensitivity	0.76699	1
Specificity	0.985075	0.762712
Positive Predictive Value (PPV)	0.9875	0.65
Negative Predictive Value (NPV)	0.733333	1
Diagnostic Accuracy	0.852941	0.835294

DISCUSSION

Lower urinary tract symptoms (LUTS) are common among men, especially those over 40, affecting up to 41% of individuals [11]. LUTS can significantly impact quality of life, with benign prostatic obstruction (BPO) and overactive bladder (OAB) being prevalent causes. In benign prostatic hyperplasia (BPH), LUTS are categorized into voiding symptoms (e.g., slow stream, intermittency, terminal dribbling) and storage symptoms (e.g., frequency, nocturia, urge incontinence). Despite the global burden of LUTS, there are disparities in diagnosis and treatment, particularly in rural and underdeveloped areas due to limited healthcare infrastructure and specialist shortages [12].

Uroflowmetry is commonly used to assess LUTS severity, particularly for diagnosing urinary obstruction. It measures flow rate, voided volume, peak flow rate (Qmax), and other metrics such as voiding time, average flow rate, and time to maximum flow [13]. Qmax is considered the gold standard for diagnosing urinary obstruction. However, due to the technical and financial demands of uroflowmetry, alternative, cost effective methods, such as measuring voiding time (VT), are being explored, particularly in low-resource settings [14].

Voiding time (VT), a simpler and cost-effective parameter, has gained attention as a potential diagnostic tool. VT can be measured with a basic stopwatch, making it accessible in primary care and rural areas without specialized equipment [15]. It can be used as a proxy for other uroflowmetry parameters like Qmax, offering a practical solution for diagnosing LUTS in men with BPH. Studies have demonstrated a significant correlation between VT and uroflowmetry parameters, indicating its potential as a reliable diagnostic tool in resource-limited environments [16].

A study assessed the sensitivity of VT compared to uroflowmetry for diagnosing urinary obstruction in men with LUTS due to BPH [17]. The study found a significant correlation between VT and uroflowmetry parameters, highlighting the high sensitivity of VT in detecting urinary obstruction. These findings suggest that VT is a practical, cost-effective alternative in areas with limited resources, offering similar insights to uroflowmetry at a fraction of the cost [18].

However, VT's accuracy may be affected by factors like interrupted flow, terminal dribbling, or anxiety, and further studies are needed to validate its efficacy across diverse populations [19].

The study also aimed to analyze VT in relation to International Prostate Symptom Score (IPSS) to assess its effectiveness in distinguishing between mild and moderate-to-severe LUTS [20]. The study found that VT significantly differed between groups with mild and moderate-to-severe symptoms, with a mean VT of 22.61 seconds in the control group and 41.02 seconds in the case group. These results align with previous studies that observed increased voiding time in individuals with more severe LUTS [21].

The study further examined other parameters like prostatomegaly grade, prostate volume, post-void residual volume (PVR), average Qmax, and average AFR. Significant differences were observed between case and control groups in these parameters, further supporting the association between LUTS severity and prostate-related conditions. The findings emphasized the role of parameters like Qmax, AFR, and PVR in assessing LUTS severity and the value of VT as a potential diagnostic tool [22].

Overall, the study demonstrated that VT could be a valuable diagnostic alternative to uroflowmetry, particularly in resource-limited settings. The results indicated that VT showed high sensitivity and specificity when compared to Qmax, with improved sensitivity when compared to AFR. While VT is not without limitations, such as operator-dependent variations and potential biases, it presents a practical and cost-effective tool for diagnosing bladder outlet obstruction (BOO) due to BPH in settings with limited access to advanced urological services. The study suggests that VT could be incorporated into clinical practice as a reliable marker for urinary obstruction, addressing healthcare disparities and improving access to care in underserved regions [23].

Despite limitations such as small cohort size and potential biases in measuring VT, the study supports the utility of VT as a valuable tool for diagnosing LUTS in BPH patients, offering a cost-effective and accessible alternative to traditional uroflowmetry in low-resource environments. Future studies with larger sample sizes, multicenter data, and exploration of longitudinal outcomes could further validate VT's diagnostic accuracy and its potential role in clinical practice [24].

CONCLUSION

Voiding Time (VT) shows a strong inverse correlation with key uroflowmetry parameters (Qmax and AFR), making it a reliable indicator of urinary obstruction. Its high sensitivity (76.7%-100%) and specificity (76.3%-98.5%) highlight its diagnostic utility. VT offers a cost-effective alternative to advanced uroflowmetry, particularly in resource-limited settings. It effectively differentiates LUTS severity levels and has excellent diagnostic accuracy (AUC: 0.95 for Qmax). The study demonstrates that VT can complement traditional uroflowmetry metrics in diagnosing urinary obstruction due to BPH, bridging diagnostic gaps and improving BPH management, especially in under-resourced healthcare environments.

LIMITATIONS & FUTURE PERSPECTIVES

The study was limited by its single-centre design, relatively small sample size, and short duration, which may restrict generalizability. Future research could focus on multicenter studies with larger cohorts to validate findings, evaluate long-term outcomes, and explore innovative diagnostic and management strategies for appendicular perforation, improving patient prognosis and reducing complications.

CLINICAL SIGNIFICANCE

Timely detection and management of acute appendicitis are crucial to prevent perforation, reducing morbidity and mortality. The study identifies high-risk groups, such as males and individuals at age extremes, highlighting the need for targeted preventive strategies and clinical vigilance. Delayed presentation significantly increases perforation risk, under-scoring the importance of early healthcare access and dawa-reness campaigns. Postoperative complications, including surgical site infections and prolonged ileus, emphasize the need for thorough preoperative risk assessment and tailored postoperative care. Recognizing the distal third of the appendix as the most common perforation site aids surgeons in effective intraoperative planning and management.

AUTHOR INFORMATION

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AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteria outlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

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CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

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All necessary consent & approval was obtained by authors.

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DATA AVAILABILITY

All data generated and analyzed are included within this research article. The datasets utilized and/or analyzed in this study can be obtained from the corresponding author upon a reasonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in thewriting or editing of the manuscript, and no images were altered or manipulated using AI & LLM.

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This article serves as an important educational tool for the scientific community, offering insights that may inspire future research directions. However, they should not be relied upon independently when making treatment decisions or developing public health policies.

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