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Comparative Analysis Of Intravesical Prostatic Protrusion And Prostate Volume In Bladder Outlet Obstruction

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Abstract

Introduction: *Benign Prostatic Enlargement Is A Prevalent Cause Of Bladder Outlet Obstruction (BOO) In Men Over 50 Years Presenting With Lower Urinary Tract Symptoms (LUTS). While Urodynamic Study Is The Gold Standard For Diagnosing BOO, Its Invasive Nature Limits Its Routine Clinical Application. This Study Aimed To Evaluate The Utility Of Intravesical Prostatic Protrusion (IPP) As A Non-Invasive Clinical Predictor For BOO.*

Methods: *This Cross-Sectional Study Was Conducted At The Department Of Urology, Dhaka Medical College And Hospital, From January 2009 To December 2010. The Study Included 60 Consecutive Male Patients Aged 50 Years And Above With Lower Urinary Tract Symptoms Indicative Of Benign Prostatic Enlargement*

Result: *Among The Participants, Approximately 21.67% Had No Obstruction (BOO Index <20), While Around 28.33% Had An Equivocal BOO Index (BOO Index 20-40). The Majority Of Patients (50%) Had Definite Obstruction, As Indicated By A BOO Index >40. The Age Distribution Analysis Showed No Significant Association Between Age And BOO Index. The Mean Ages For The No Obstruction, Equivocal, And Obstruction Groups Were 69.7 ± 7.9 Years, 66.8 ± 9.2 Years, And 70.2 ± 10.5 Years, Respectively. There Was A Statistically Significant Difference In Prostate Volume Among The Three Groups, With A Greater Proportion Of Patients In The Obstructed Group Having A Volume >40 Ml. The Study Also Revealed A Linear Correlation Between IPP And BOO Index, As Well As Between PV And BOO Index.*

Conclusion: *The Study Underscores The Importance Of IPP As A Robust, Non-Invasive Clinical Predictor For BOO. IPP Measurement, Which Can Be Easily Obtained With Transabdominal Ultrasound, Should Be Given More Emphasis In The Evaluation Of Benign Prostatic Enlargement And In The Decision-Making Process For Appropriate Treatment Strategies.*

Keywords: *Bladder, Obstruction, Prostate, Protrusion, Intravesical*

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I. INTRODUCTION

Benign Prostatic Hyperplasia (BPH) is a common urological condition characterized by the nonmalignant enlargement of the prostate gland. It is prevalent in men, especially those over 50 years of age, and can lead to Lower Urinary Tract Symptoms (LUTS) due to Bladder Outlet Obstruction (BOO).[1] The pathophysiology of BPH and its progression to BOO is multifactorial, involving dynamic and static components. The dynamic component is related to the tone of the smooth muscle in the prostate and the prostatic urethra, while the static component is associated with the increase in prostate size.[2] The evaluation of BOO in BPH patients is crucial for determining the appropriate therapeutic intervention. Traditionally, parameters such as Prostate Specific Antigen (PSA), International Prostate Symptoms Score (IPSS), and Prostate Volume (PV) have been used to assess the severity of BPH and BOO.[1] However, recent studies have suggested that Intravesical Prostatic Protrusion (IPP), a parameter that can be measured using transabdominal ultrasound, may be a better predictor of BOO.[2–5] IPP refers to the degree of enlargement of the prostate into the bladder, which can be categorized into grades I, II, and III. Studies have shown that IPP correlates well with BOO and can predict the outcome of treatment in BPH patients.[6] Moreover, the measurement of IPP is non-invasive, cost-effective, and can be easily performed during routine ultrasound examination of the prostate. On the other hand, PV is another significant factor in the evaluation of BPH. An increase in PV is directly related to the severity of BPH and BOO. However,

the correlation between PV and BOO is not as strong as that between IPP and BOO.[2] Moreover, PV can be influenced by factors such as age and the use of medications for BPH. In recent years, there has been a growing interest in comparing the effectiveness of IPP and PV in evaluating BOO in BPH patients. A comparative analysis of these two parameters can provide valuable insights into their roles in the diagnosis and management of BPH and BOO. The prevalence of significant IPP in patients presenting with acute urinary retention (AUR) due to BPH has been studied, and a significant correlation between IPP and PV has been found.[7] The role of MRI in assessing the treatment response of BPH following prostatic artery embolization (PAE) has also been investigated, with semi-automatic software analysis of MRI features showing a significant reduction in PV and IPP after treatment.[8,9] The use of diffusion tensor imaging (DTI) to assess the structural connectivity of the brain in men with BPH with chronic BOO has been explored, revealing significant associations between preserved white matter integrity of specific white matter tracts and the severity of LUTS.[10] This suggests that the brain's structural connectivity may play a role in the pathophysiology of BPH and BOO. In conclusion, the evaluation of BOO using non-invasive parameters such as IPP and PV can significantly improve patient comfort and diagnostic accuracy. This study aims to shed light on these parameters' comparative effectiveness, contributing to better diagnostic practices in urology.

II. METHODS

This cross-sectional study was conducted at the Department of Urology, Dhaka Medical College and Hospital, from January 2009 to December 2010. The study included 60 consecutive male patients aged 50 years and above with lower urinary tract symptoms indicative of benign prostatic enlargement. Patients underwent various examinations and tests, including digital rectal examination, urinalysis, ultrasound, and measurement of post-void residual urine and serum prostate-specific antigen (PSA) levels. Patients meeting the inclusion criteria and not meeting the exclusion criteria were included in the study. The inclusion criteria were elderly males aged 50 years and above, presenting with lower urinary tract symptoms, an enlarged prostate on digital rectal examination, and ultrasonography showing an enlarged prostate with intravesical prostatic protrusion. The exclusion criteria were carcinoma of the prostate, patients with diabetic cystopathy or neurological bladder with voiding dysfunction, patients who had undergone prostatic surgery before, patients who refused to give informed consent, and patients who had received radiation in the pelvis or perineum. The key variables examined in the study were the Bladder Outflow Obstruction Index (BOOI) as the independent variable, and Prostate Volume (PV) and Intravesical Prostatic Protrusion (IPP) as dependent variables. Patients were categorized into three groups based on their BOOI, indicating the presence or absence of obstruction. The IPP and PV levels were compared among the three groups. Data were collected from patient history, clinical examinations, investigation results, and Urodynamic tracings. Statistical analysis was performed using the Statistical Package for Social Science (SPSS, version 12), including descriptive statistics, Chi-square tests, and Spearman's correlation coefficient. The significance level was set at 0.05, with $P<0.05$ considered statistically significant. Ethical approval was obtained prior to the study, and written informed consent was obtained from all patients. Patient privacy and confidentiality were maintained throughout the study.

III. RESULTS

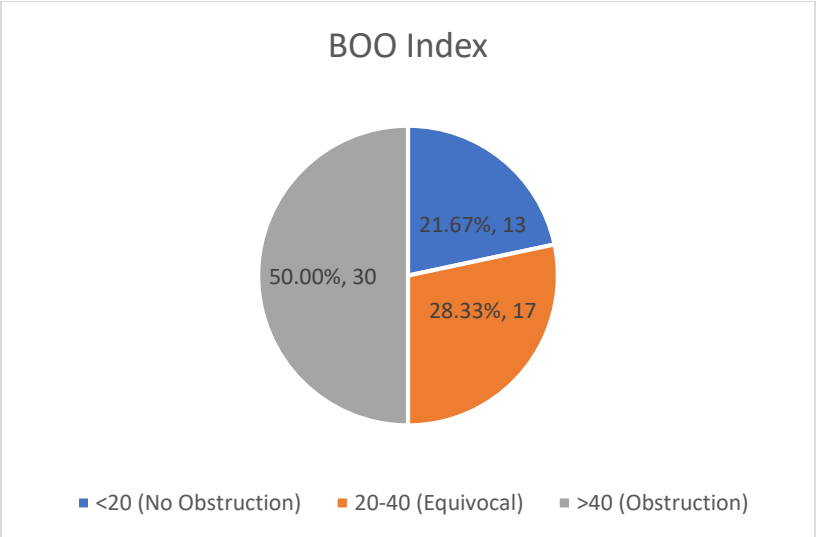

Figure 1: Distribution of participants by BOO Indexing (N=60)

Among the study participants, 21.67% had a BOO index of less than 20, indicating no obstruction. Approximately 28.33% of patients had a BOO index ranging from 20 to 40, indicating an equivocal or uncertain obstruction status. The majority of patients, accounting for 50% of the sample, had a BOO index greater than 40, indicating definite obstruction.

Table 1: Age Distribution of the participants (N=60)

Age (years)	**BOO Index**			p-value
	No obstruction (n = 13)	Equivocal (n = 17)	Obstruction (n = 30)	
<60	2(15.4)	6(35.3)	6(20.0)	0.486
60 – 70	5(38.5)	5(29.4)	7(23.3)	
≥70	6(46.2)	6(35.3)	17(56.7)	
Mean ± SD	69.7 ± 7.9	66.8 ± 9.2	70.2 ± 10.5	

#**Chi-square (χ^2) Test** was employed to analyze the data;

The p-value indicates the statistical significance of the association between age and BOO index. Among participants aged less than 60 years, 15.4% had no obstruction, 35.3% had an equivocal BOO index, and 20.0% had definite obstruction. In the 60-70 age group, 38.5% had no obstruction, 29.4% had equivocal BOO index, and 23.3% had definite obstruction. For participants aged 70 years and above, 46.2% had no obstruction, 35.3% had equivocal BOO index, and 56.7% had definite obstruction. The mean age ± standard deviation for the no obstruction group was 69.7 ± 7.9 years, for the equivocal group was 66.8 ± 9.2 years, and for the obstruction group was 70.2 ± 10.5 years. The p-value of 0.486 suggests that there is no statistically significant association between age and BOO index among the participants.

Table 2: Comparison of International prostate symptom score (IPSS) score among groups (N=60)

IPSS score	**BOO Index**			p-value
	No obstruction (n = 13)	Equivocal (n = 17)	Obstruction (n = 30)	
≤19	8(61.5)	15(88.2)	20(66.7)	0.081
>19	5(38.5)	2(11.8)	10(33.3)	
Mean ± SD	19.1 ± 1.4	17.2 ± 1.8	18.5 ± 3.0	

#**Chi-square (χ^2) Test** was employed to analyze the data;

Majority (88.2%) of patients in 'Equivocal group', 61.5% in 'No obstruction' and 66.7% in 'Obstructed group' had international prostate symptom score (IPSS) score less than 19. However, no significant difference was observed among the three groups in terms of IPSS (19.1 ± 1.4 vs. 17.2 ± 1.8 vs. 18.5 ± 3.0, p = 0.081).

Table 3: Comparison of Quality of life index among groups (N=60)

Quality of life index	**BOO Index**		
	No obstruction (n = 13)	Equivocal (n = 17)	Obstruction (n = 30)
Mild	3(23.1%)	3(17.6%)	1(3.3%)
Moderate	10(76.9%)	13(76.5%)	22(73.3%)
Severe	0	1(5.9%)	7(23.3%)

More than three-quarters (76.9%) of patients had moderate impairment and 23.1% mild impairment of QOL in 'No obstruction' group. More than three-quarters (76.5%) of patients had moderate impairment, 17.6%

had mild impairment and 5.9% had severe impairment of QOL in 'Equivocal' group. Nearly three-quarters (73.3%) of patients had moderate impairment, 3.33% had mild impairment and 23.3% had severe impairment of QOL in 'Equivocal' group.

Table 4: Comparison of prostate volume among groups (N=60)

Prostate volume	**BOO Index**			p-value
	No obstruction (n = 13)	Equivocal (n = 17)	Obstruction (n = 30)	
≤40 ml	9(69.2)	10(58.8)	9(30.0)	**0.030**
>40 ml	4(30.8)	7(41.2)	21(70.0)	

#**Chi-square (χ^2) Test** was employed to analyze the data;

Twenty-one (70%) of 30 in 'Obstructed group', 7(41.2%) in 'Equivocal group' and 4(30.8%) in 'No obstruction' had prostate volume more than 40 ml. The difference among the three groups with respect to prostate volume was statistically significant (p = 0.030)

Table 5: Comparison of Intravesical prostate protrusion among groups (N=60)

IPP grade (mm)	**BOO Index**			p-value
	No obstruction (n = 13)	Equivocal (n = 17)	Obstruction (n = 30)	
Grade-I (<5)	7(53.8)	3(17.6)	3(10.0)	**0.003**
Grade-II (5 – 10)	4(30.8)	10(58.8)	10(33.3)	
Grade-III (>10)	2(15.4)	4(23.5)	17(56.7)	

#**Chi-square (χ^2) Test** was employed to analyze the data;

A higher proportion of 'Obstructed group' (56.7%) exhibited Grade-III prostate protrusion, compared to 'Equivocal' group (23.5%) which was again higher than the 'No obstruction' group (15.4%) (p = 0.003).

Table 6: Distribution of urodynamic study results based on prostate volume (PV) intravesical prostatic protrusion (IPP) grade

Index	**No Obstruction**	**Equivocal**	**Obstruction**	**Total**
	(BOOI ≤20)	**(BOOI 20–40)**	**(BOOI >40)**	**n=60**
PV (ml)				
<40	9(32.1)	10(35.7)	9(32.1)	28
>40	4(12.5)	7(21.9)	21(65.6)	32
IPP (mm)				
≤5	7(53.9)	3(23.1)	3(23.1)	13
>5–10	4(16.7)	10(41.7)	10(41.7)	24
>10	2(8.7)	4(17.4)	17(73.9)	23

Obstruction as defined by BOOI >40 was seen in 73.9% of grade 3 prostate and only 23.1% of grade 1 prostate in IPP. In terms of PV, obstruction was seen in 65.6% of patients with volume >40 mL and 32% of those with volume <40 mL.

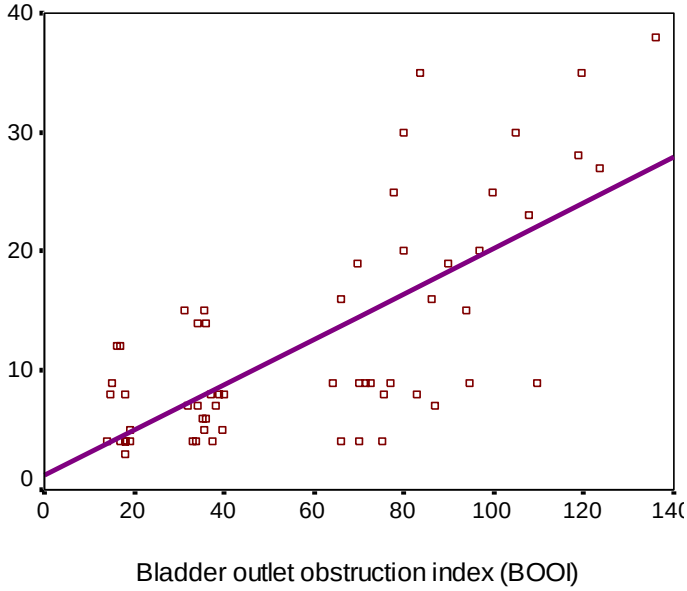

Figure 2: Relationship between BOOI and IPP

Figure 2 shows the correlation of intravesical prostatic protrusion (IPP) with bladder outlet obstruction index (BOOI).

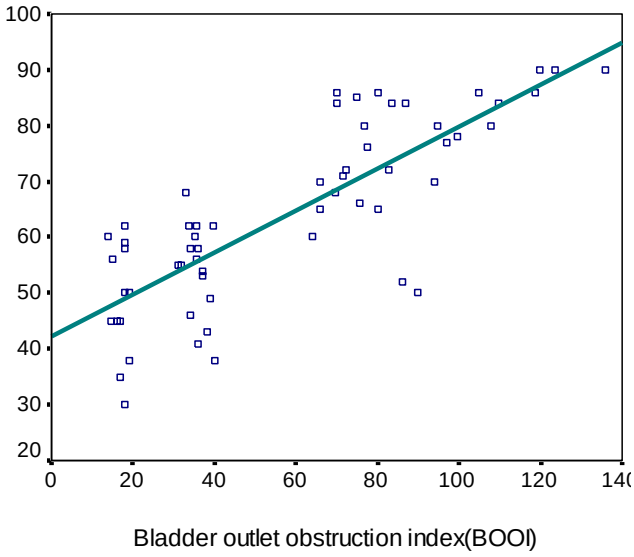

Figure 3: Relationship between BOOI and prostate volume

Figure 3 shows the correlation of prostate volume (PV) with bladder outlet obstruction index (BOOI).

Table 7: Correlation between independent and dependent variables

Dependent variables	Independent variable	**Correlation coefficient (r)**	**95% CI**	**p-value**
IPP	BOOI	0.807	0.440 – 1.823	< 0.001
PV	BOOI	0.707	0.756 – 1.544	< 0.001

All the independent variables like IPP and PV were found to be linearly correlated with BOOI ($r = .807$, $p<0.001$, $r=0.707$, $p < 0.001$ respectively). More than 80% of the variation in BOOI can be explained with increase in IPP, while 70.7% of the variations in IPP can be explained by PV.

IV. DISCUSSION

Bladder outlet obstruction (BOO), predominantly instigated by benign prostatic enlargement, is a widespread issue in men over 50 years of age who exhibit lower urinary tract symptoms (LUTS). The challenge lies in pinpointing the optimal treatment strategy for these individuals. Despite being the gold standard for diagnosing BOO, urodynamic study is not routinely utilized due to its invasive nature. Consequently, a variety of noninvasive clinical indices have been explored to provide comparable insights, with the overarching aim of directing more aggressive therapies to those patients who would most benefit from such interventions.[4,5,11] The International Prostate Symptom Score (IPSS) is a straightforward tool utilized in the assessment of benign prostatic enlargement. A deteriorating score may suggest the need for intervention. However, its limited correlation with BOO undermines its utility.[12] Given that BOO is a dynamic event significantly influenced by both the physical obstruction of the prostate and bladder function, it is judicious to incorporate an anatomical evaluation in any assessment.[13] In this context, the size and configuration of the prostate gland, as determined by prostate volume (PV) and intravesical prostatic protrusion (IPP) respectively, are considered crucial factors.[14] Our study was designed to juxtapose IPP and PV in the evaluation of BOO. The average ages of the 'No obstruction', 'Equivocal', and 'Obstruction' groups were 69.7 ± 7.9 years, 66.8 ± 9.2 years, and 70.2 ± 10.5 years respectively, aligning with the findings of Lim et al. (2006) and Keqin et al..[4,15] Our study found that the severity of symptoms, as measured by IPSS, was ≤ 19 in 88.2% of patients in the 'Equivocal' group, 61.5% in the 'No obstruction' group, and 66.7% in the 'Obstruction' group. However, no significant difference was observed among the three groups in terms of IPSS, which is consistent with the findings of Lim et al., Keqin et al., and Wadie et al.[4,15,16] In our study, approximately three-quarters of patients in all three groups experienced moderate impairment of quality of life (QOL) due to benign prostatic hyperplasia, which is similar to the findings of Lim et al. (2006) and Keqin et al. (2007).[4,15] When comparing prostate volume among the three groups, we found that 70% of the 'Obstructed group', 41.2% of the 'Equivocal group', and 30.8% of the 'No obstruction' group had a prostate volume greater than 40 ml. This difference was statistically significant and aligns with the study by Lim et al. (2006).[4] Interestingly, some patients with a small prostate volume presented with obstruction, which could be explained by the presence of high IPP. These patients, who have a small prostate gland with high IPP, are expected to be unobstructed by size criteria. However, the high IPP due to a protruding median lobe can cause obstruction by creating a 'ball-valve' effect during voiding.[17] In our study, we found that a higher proportion of the 'Obstructed group' exhibited Grade-III prostate protrusion compared to the 'Equivocal' and 'No obstruction' groups, which corresponds with the study of Lim et al. (2006).[4] Furthermore, dependent variables such as IPP and PV were found to be linearly correlated with BOOI, suggesting that prostate configuration (IPP) may be more important than prostate size (PV and PSA). This is in line with the study by Lim et al. (2006) and Keqin et al. (2007).[4,15] In the context of evolving non-invasive clinical predictors for BOO, IPP stands up well against PV. IPP measurement can easily be obtained with the transabdominal ultrasound scan in the outpatient setting, eliminating the need for a transrectal probe or blood taking. This suggests that a greater emphasis on IPP is warranted in the evaluation of benign prostatic enlargement and decision-making in offering surgical options.[4,15] The superior correlation of IPP with the bladder outlet obstruction index compared to prostate volume can be explained by the fact that, in addition to being indirectly related to prostate volume, IPP also indicates the presence of the median lobe without lateral lobe enlargement.[3] Interestingly, some patients had an increased prostate volume but did not present with obstruction. This observation can be explained if there were no intravesical prostatic protrusion and just bilateral lateral lobes, the strong bladder contraction could force open a channel between the lobes. This highlights the complex interplay between prostate size, configuration, and bladder function in the pathogenesis of BOO.[4,15]

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

V. CONCLUSION

In conclusion, our study underscores the significance of intravesical prostatic protrusion (IPP) as a robust, non-invasive clinical predictor for bladder outlet obstruction (BOO). It stands out in comparison to traditional measures such as prostate volume (PV), especially in the context of patients presenting with lower urinary tract symptoms (LUTS). The findings suggest that IPP, which can be easily measured using transabdominal ultrasound in an outpatient setting, should be given more emphasis in the evaluation of benign prostatic enlargement and in

the decision-making process for appropriate treatment strategies. Furthermore, the study highlights the complex interplay between prostate size, configuration, and bladder function in the pathogenesis of BOO. Future research should continue to validate these findings in larger and more diverse patient populations, with the aim of enhancing patient care and treatment outcomes in benign prostatic enlargement.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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