Comparison of Ultrasonographically Measured Intravesical Prostatic Protrusion and Prostate Volume in the Evaluation of Bladder Outlet Obstruction

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Abstract

Objective: The aim of this cross sectional study is to define the relationship between songraphically measured intravesical prostatic protrusion and prostatic volume and to determine which one of these two is better predictor of bladder outlet obstruction due to prostatic enlargement.

Methods: This study was carried out in the department of Radiology and Imaging, BIRDEM (Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorder) Dhaka during the period of 1st July 2007 to June 2008.A total of 104 patients of clinically suspected as enlarged prostate were enrolled in this study. Transabdominal sonography including uroflowmetry examination was done in all these patients.

Results: The validity of prostate volume (PV) in identifying bladder outlet obstruction (BOO) and their relationship with BOO index >40 sensitivity 78.6%, specificity 16.7%, accuracy 50.0%, positive and negative predictive values were 52.4% and 40.0% respectively where as the validity of Intravesical prostatic protrusion (IVPP) revealed sensitivity 85.7%, specificity 75.0%, accuracy 80.8%, positive and negative predictive values were 80.0% and 81.8% respectively.

Conclusion: This study suggests that intavesical prostatic protrusion ismore sensitive, specific and accurate than prostatic volume in bladder outlet obstruction.

[Shaheed Syed Nazrul Islam Med Col J 2021, Jan; 6 (1):86-94]

Keywords: Benign Prostatic Hyperplasia, Prostate volume (PV), Intravesical prostatic protrusion (IVPP), bladder outlet obstruction (BOO)

Introduction

Prostatic enlargement is the commonest cause of bladder outlet obstruction (BOO) in older men.[1] Approximately 50% to 60% for men in their 60s, and is 80% to 90% for men in their 70s and 80s develop symptoms from benign prostatic hyperplasia (BPH).[2] There is no consensus or clear practical guide lines to define the presence and severity of obstruction, other than the pressure flow study[3].Pressure flow study and trans rectal ultrasound are invasive, costly and time-consuming procedures, precluding routine use at most centers.

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International Prostate Symptoms Score (IPSS) is a simple tool in the evaluation of benign prostatic enlargement and worsening score may warrant intervention. However, its poor correlation with BOO is a major drawback. PVR may reflect the severity of BOO but the presence of bladder dysfunction confounds its value.[4] The existence of BOO represents physical obstruction at the bladder neck.[5]

On transabdominal ultrasound IPP represents the median and lateral lobes of the prostate protruding into the bladder, causing a ball-valve type of obstruction, which increases urethral resistance. In addition, the presence of median lobe enlargement causes dyskinetic movement during micturition.[6]

A number of studies have been reported combining noninvasive investigations. Bladder outlet obstruction number may be calculated with an easy to use expression composed of prostate size, maximum urinary flow and relative residual volume. In 50 percent of men with prostatism, bladder outlet obstruction will diagnose obstruction with a reliability of more than 90 percent.[7] IPP is a simple and useful clinical predictor for evaluating the success of a voiding trial following acute retention of urine. The degree of IPP influences the outcome[8].IPP is a more effective predictor of BOO to identify those patients at risk and directs the clinician in offering a more proactive treatment strategy. The strong correlation of maximum flow is not surprising since it is related to urodynamic flow and the bladder outlet obstruction index is derived from maximum urine flow. In practice many urologists continue to use simple office tests to estimate the likelihood of bladder outlet obstructions.[9]

In this study with a single operator, we have also demonstrated that IPP correlates the best with BOO, when compared PV. A multitude of studies correlated prostate size with BOO and the relationship between IPP and BOO has been defined.

Methods

This cross sectional study was done on 108 patients older than 50 years of age who were referred to Radiology and Imaging Department, Bangladesh institute of research and rehabilitation in diabetes, endocrine and metabolic disorders(BIRDEM) from 1st June 2007 to 31st May 2008, for routine trans-abdominal ultrasonogram of KUB region and prostate with PVR. This group of patients had lower urinary tract symptoms and suspected clinically as enlarged prostate. Informed consent was taken from every patient. Then the patients were evaluated by detailed history. The present study was carried out using a real time ultrasound equipments and prostate volume, intravesical prostate protrusion and post voidal residue was measured.

After ultrasonogram two patients were excluded from the study for catheterization and again two patients were excluded as their uroflowmetry report could not be collected. Finally 104 patients were included for the study.

Uroflowmetry was done in the urology department and the maximum urine flow rate (Qmax) was recorded accordingly. Maximum urine flow rate (Qmax) and post void residue of each case were correlated with prostate volume and intravesical prostatic protrusion. The patients with optimally filled bladder (200-300 ml of urine) by in built software of ultrasonograph machine.

Uroflowmetry was performed by having a person urinate in standing position into a special funnel that was connected to a measuring instrument. The measuring instrument calculated the amount of urine rate of flow in seconds and length of time until

completion of the void. This information was converted into a graph and interpreted by a concern physician.

Results

A total of 104 men age ranged from 52 to 72 years suspected clinically as enlarged prostate were included in the study, who were referred in the department of Radiology and Imaging of BIRDEM and underwent transabdominal ultrasonogrum including uroflowmetry examination was done during 1st June 2007 to 31st May 2008.

The mean age was 62.9 years with standard error of mean (SE) ± 0.49 years with ranged from 52-72 years [Table I]

Prostate volume was measured in this study and found the mean±SE was 67.42±2.34cc ranged from 21 to 120 cc measured by ultrasonographically. According to prostate volume the patients were divided into three groups: ≤ 20 cc; 21 – 40 cc; and > 40 cc. 71.2% of the patients was found > 40 cc of the prostate volume, 28.8% was between 21 – 40 cc and none was found ≤ 20 cc. [Table II]

Mean±SE of post void residual determined by transabdominal ultrasonography was 103.44±10.02 cc varied from 0 to 240 cc and majority 40(38.5%) of the patients having PVR was found > 40 cc. [Table III]

Mean±SE intravesical prostatic protrusion measured by transabdominal ultrasound scan was 15.19±0.98 mm varied from 2 to 35 mm and majority 57(54.8%) of the patients having IPP was found >10 mm [Table IV].

It was observed that the mean±SE value of maximum urine flow (Q max) was determined by uroflowmetry was 14.08±0.80 mL/s varied from 2 to 30 mL/s and majority (38.5%) of the Qmax value was found up to 10 mL/s. [Table V]

BOOI was calculated using the equation, p BOOI = anti $\log_{10}$ (2.16-0.48 log Qmax + 0.17 log TPV + 0.02 log PVR) -50 and the mean±SE of these index was 53.81±3.93 varied from 5 to 162 and majority (53.8%) of the bladder outlet obstruction index was found >40 (obstruction) followed by 26.9% was between 20 – 40 (equivocal obstruction) and 19.2% was < 20 (no obstruction). [Table VI]

Table VII shows prostate volume was measured by ultrasonographically and bladder outlet obstruction index (BOOI) was calculated using the equation. Obstruction (BOOI >40) was seen in 56 patients, out of which 59.5% had prostate volume (PV) >40cc and rest 40.0% PV between 21 – 40cc. Equivocal (BOOI 20 - 40) was seen in 28 patients, out of which 25.7% had PV >40cc and 30.0% PV between 21 – 40cc. No obstruction (BOOI ≤ 20) was seen in 20 patients, out of which 14.9% had PV >40cc and 30.0% PV between 21 – 40cc.

The intravesical prostatic protrusion (IPP) [Table VIII] obstruction as define by BOOI >40 was seen in 80.0% of grade 3 IPP and only 42.1% of grade 2 IPP. A BOOI of 20 – 40 indicates equivocal was seen 20.0% of grade 3 IPP, 21.1% of grade 2 IPP and 48.0% of grade 1 IPP. A BOOI of <20 (indicating no obstruction) was not found in any patient with of grade 3 IPP, 36.8% of grade 2 IPP and 52.0% of grade 1 IPP.

A positive significant correlation (r=0.3012, p=0.042) was found PV and BOOI in the present study. The validity of prostate volume (PV) in identifying bladder outlet obstruction (BOO) and their relationship with BOO index >40 sensitivity 78.6%, specificity 16.7%, accuracy 50.0%, positive and negative predictive values were 52.4% and 40.0% respectively [Fig 1].

The validity of Intravesical prostatic protrusion (IVPP) in identifying bladder outlet obstruction and their relationship with BOOI>40 sensitivity 85.7%, specificity 75.0%, accuracy 80.8%, positive and negative predictive values were 80.0% and 81.8% respectively [Table IX].

The prostate volume (PV) sensitivity 51.0%, specificity 38.0%, positive predictive value 65.0% and negative predictive value 42.0% with BOO index >40 [Table X].[9]

A highly positive significant correlation ($r=0.5278$, $p<0.001$) was found between intravesical prostatic protrusion and bladder outlet obstruction index.It was observed from the receiver operating characteristic (ROC) curves analysis Intravesical prostatic protrusion (IPP) had the best area under curve (0.815) compared to prostate volume (0.435) [Table XI].

Table I: Age distribution of the patients (n=104)

Age in years	No. of patients	Percentage
≤55	8	7.7
55-60	24	23.1
61-65	40	38.5
66-70	24	23.1
>70	8	7.7
Total	104	100.0

Mean ±SE 62.9±0.49 Years; Range (min, max) (52-72) Years

Table II: Distribution of patients according to prostate volume of the patient (n=104)

Prostate volume (cc)	No. of patients	Percentage
≤20	0	0.0
21-40	30	28.8
>40	74	71.2
Total	104	100.0

Mean ±SE 67.42±2.34 CC; Range (min, max) (21-120) CC

Table III: Distribution of patients according to post void residual urine (n=104)

Post void residual (PVR) cc	No. of patients	Percentage
≤10-20	12	11.5
21-40	12	11.5
>40	40	38.5
Nil/O	40	38.5
Total	104	100.0

Mean ±SE 103.44±10.02 CC; Range (min, max) (0-240) CC

Table IV: Distribution of patients according to intravesical prostatic protrusion (IPP) (n=104)

Intravesical prostatic protrusion (IPP)	No. of patients	Percentage
≤5	33	31.7
5-10	14	13.5
>10	57	54.8
Total	104	100.0

Mean ±SE 15.19±0.98 mm
Range (min, max) (2-35) mm

Table V: Distribution of patients according to Qmax (n=104)

Qmax (mL/s)	No. of patients	Percentage
Up to 10	40	38.5
11-20	36	34.6
>20	28	26.9
Total	104	100.0

Mean ±SE 14.08±0.80 mL/s
Range (min, max) (2-30) mL/s

Table VI: Distribution of patients according to predicted bladder outlet obstruction index (BOOI) (n=104)

Predicted bladder outlet obstruction index (BOOI)	No. of patients	Percentage
<20	20	19.2
20-40	28	26.9
>40	56	53.8
Total	104	100.0

Mean ±SE 53.81±3.93
Range (min, max) (5-162)

Table VII: Distribution of prostate volume accordingly to bladder outlet obstruction index (BOOI) (n=104)

Prostate Volume (cc)	BOOI <20		BOOI 20-40		BOOI >40		Total		Percentage
	n	%	n	%	n	%	n	%	
≤20	0	0.0	0	0.0	0	0.0	0	0.0	19.2
21-40	9	30.0	9	30.0	12	40.0	30	28.8	26.9
>40	11	14,9	19	25.7	44	59.5	74	71.2	53.8
Total	20	19.2	28	26.9	56	53.8	104	100	100.0

Table VIII: Distribution of intravesical prostatic (IPP) according to bladder outlet obstruction index (BOOI) (n=104)

IPP grade mm	BOOI <20		BOOI 20-40		BOOI >40		Total	
	n	%	n	%	n	%	n	%
≤5	13	52.0	12	48.0	0	0.0	25	24.0
>5-10	7	36.8	4	21.1	8	42.1	19	18.3
>10	0	0.0	12	20.0	48	80.0	60	57.5
Total	13	52.0	12	48.0	0	0.0	25	24.0

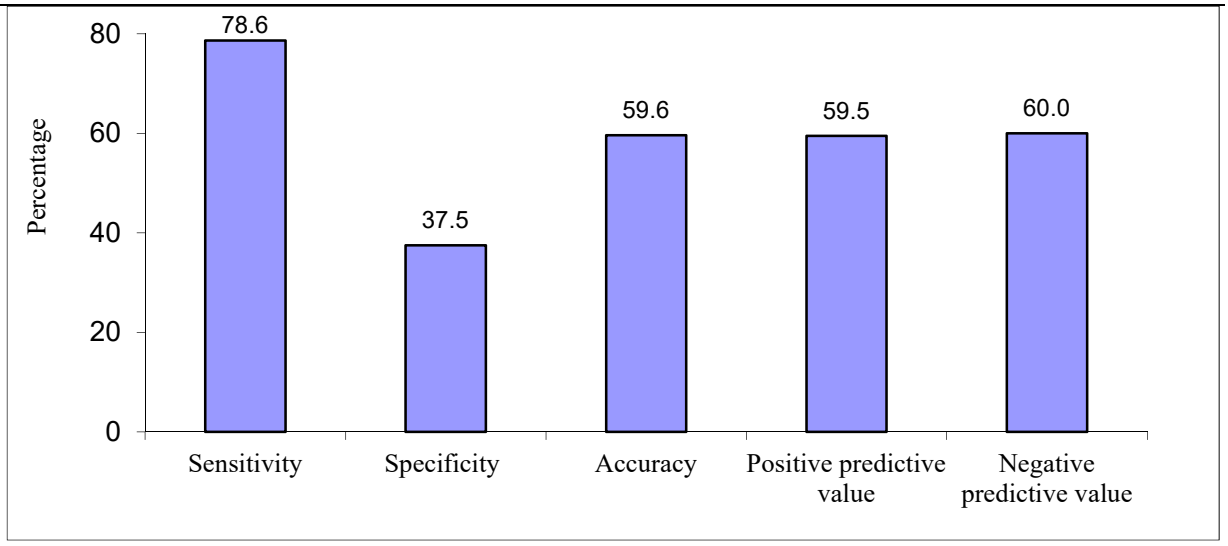

Figure 1: Bar diagram showing the sensitivity, specificity, positive and negative predictive values of theprostate volume in identifying bladder outlet obstruction.

Table IX: Sensitivity, specificity, accuracy, positive and negative predictive values of prostate volume (PV) and intravesical prostatic protrusion (IPP) (n=104).

Parameter	Sensitivity (%)	Specificity (%)	Accuracy (%)	Positive predictive value (%)	Negative predictive value (%)
IPP	85.7	75.0	80.8	80.0	81.8
PV	78.6	37.5	59.6	59.5	60.0

Table X: Prostate volume and intravesical prostatic protrusion area under the curve (n=104)

	Prostate volume (PV)	Intravesical prostatic protrusion (IPP)
Area under curve	0.435 (0.320 -0.549)	0.815 (0.720 – 0.909)

Based on the above receiver-operator characteristic (ROC) curves Intravesical prostatic protrusion (IPP) had the best area under curve compared to prostate volume (PV). (Figure 1)

Specificity 37.5
Accuracy 59.6
Positive predictive value 59.5
Negative predictive value 60.0

Table XI: Correlation co-efficient and area under curve (AUC) by receiver operator-curve (ROC) of prostate volume (PV) and intravesical prostatic protrusion (IPP) with BOOI (n=104).

	BOOI vs. IPP	BOOI vs. PV
Correlation	0.5278	0.3012
ROC (AUC)	0.815	0.435

Discussion

Evaluation and selection criteria for treatment of benign prostatic enlargement included the International Prostate Symptoms Score (IPSS), uroflowmetry and postvoid residual urine (PVR) or urodynamic study. Urodynamic study is the gold standard in the diagnosis of BOO.[10] Lim et al correlated anatomical configuration of the prostate gland to the presence of BOO.[11]

This cross sectional study was carried out with an objective to define the relationship between sonographically measured intavesical prostatic protrusion and prostatic volume and to determine which one of these two is better predictor of bladder outlet obstruction due to prostatic enlargement and elucidate the correlation, accuracy, sensitivity and specificity of intravesical prostatic protrusion(IPP) and prostate volume (PV) measured at sonography in the determination of bladder outlet obstruction (BOO).

The present study findings discussed and compared with previously published relevant studies.The median age of the patients with enlarged prostatewas 66 years ranged from 52 to 88 years[11]. Similarly Ockrimhas observed in their study on 384 patients, the mean age was 64±12.3 years ranged from 56 to 73 years[7].The result obtained in the present study is consistent with the above mentioned studies.

Mean±SE of PV was 67.42±2.34 cc ranged from 21 to 120 cc. According to prostate volume 71.2% of the patients was found > 40 cc of the prostate volume, 28.8% was between 21 – 40 cc and none was found ≤ 20 cc. In a study the median prostate volume (PV) 52 cc ranged from 8 to 125 cc measured by transabdominal ultrasound scan and majority (45.3%) of the prostate volume (PV) belongs to 21–40cc followed by 37.9% prostate volume (PV) >40 cc and only 16.8% prostate volume (PV) was <20 cc.[11] It was observed in one study on 384 patients, the mean prostate volume was 35±23.5 ccranged from 20 to 42 cc.[9] The present study results is higher than the above may be due to lack of exposure to health awareness in our population.

Post void residual mean±SEwas 103.44±10.02 cc varied from 0 to 240 cc. Ockrim measured the mean±SD of post void residual was 61±81.9 cc varied from 10 to 80 cc.[9]

Mean±SE value of maximum urine flow (Q max) was 14.08±0.80 mL/s varied from 2 to 30 mL/s and majority (38.5%) of the Qmax value was found up to 10 mL/s. Ockrim found on 384 consecutive patients who had mean±SDQ max value was 13.18±6.19 mL/s range from 9 – 18.[9]

The mean±SE of BOOI was 53.81±3.93 varied from 5 to 162 and majority (53.8%) was found >40 (obstruction) followed by 26.9% was between 20 – 40and 19.2% was < 20 (no obstruction).The mean value bladder outlet obstruction index (BOOI) was 42 ±36.4 range from 18 to 62 on Okrim's study.[9]

Obstruction (BOOI >40) was seen in 56 patients, out of which 59.5% had prostate volume (PV) >40cc and rest 40.0% PV between 21 – 40cc. Equivocal (BOOI20 - 40) was seen in 28 patients, out of which 25.7% had PV >40cc and 30.0% PV between 21 – 40cc. No obstruction (BOOI ≤ 20) was seen in 20 patients, out of which 14.9% had PV >40cc and 30.0% PV between 21 – 40cc. Lim et al., seen in terms of PV obstruction was in 67.0% of patients with volume >40ml and 60.0% of those with volume 20 -40 ml, which nearly support the present study.[9]

In this study BOOI of 20 – 40 indicates equivocal was seen 20.0% of grade 3 IPP, 21.1% of grade 2 IPP and 48.0% of grade 1 IPP. A BOOI of <20 (indicating no obstruction) was not found in any patient with of grade 3 IPP, 36.8% of grade 2 IPP and 52.0% of grade 1 IPP. Obstruction according to IPP, which was defined by BOOI >40 was seen in 71.0% of grade 3 prostate and 53.0% of grade 2 prostate, which is support the present study.[9]

A positive significant correlation (r=0.3012, p=0.042) was found between prostate volume and bladder outlet obstruction index.It was also observed identical correlation(r=0.314, p=0.507) between PVBOOI.[9]

In the current study, receiver operating characteristic (ROC) curves analysis IPP had the best area under curve (0.815) compared to prostate volume (0.435). It has recently observed in their ROC curve analysis IPP more accurate than PV in predicting (Area under ROC curve IPP=0.833 and PV =0.724) bladder outlet obstruction[12]. Based on ROC curve Lim et al. observed IPP (AUC IPP=0.772 and PV=0.637) had the best area under curve compared to PV, these results closely agree with the results of present study.[11]

The prostate volume (PV) sensitivity 51.0%, specificity 38.0%, positive predictive value 65.0% and negative predictive value 42.0% with BOO index >40.[9] Accuracy of IPP in identifying bladder outlet obstruction and the relationship with BOO index >40 sensitivity 46.0%, specificity 65.0%, positive predictive value 72.0% and negative predictive value 46.0%.[9]

Conclusion

The present study adopted an approach by transabdominal ultrasonogram to evaluate IPP and post voidal residue (PVR). The procedure being simple, noninvasive and cost-benefit, makes reliable and acceptable to doctors and patients. From the result of the present study, it was conceived that ultrasonographically measured Intravesical prostatic protrusion (IPP) is a better predictor than prostate volume (PV) in bladder outlet obstruction. This study will serve as a platform for future larger scale validation. Further study is

required including the determination of the optimal intravesical prostatic protrusion cut off level for predicting bladder outlet obstruction with larger number of cases.

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