Original Article

Correlation of Prostate Volume and Intravesical Protrusion of Prostate with Uroflowmetry in Evaluation of Benign Prostatic Hyperplasia

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Abstract:

Background: Uroflowmetry is considered as the best available noninvasive reference test to diagnose bladder outlet obstruction (BOO) due to Benign Prostatic Hyperplasia (BPH).

Objective: The present study was aim to evaluate the diagnostic usefulness of ultrasonography in patients of Benign prostatic hyperplasia (BPH).

Materials and Methods: This cross sectional study was carried out in the Department of Radiology & Imaging and Department of Urology at Sir Salimullah Medical College and Mitford Hospital, Dhaka from July 2009 to June 2010 conducted on elderly patients presented with Lower Urinary Tract Symptoms (LUTS) suggestive of Benign Prostatic Hyperplasia. International prostate symptoms score (IPSS), Digital rectal examination (DRE), Uroflowmetry (Q_{max}), serum prostate specific antigen (PSA) measurements and transabdominal ultrasound scan were performed to evaluate this study.

Results: A total number of 50 elderly men were recruited in this study with a mean age of 62.14±9.98 years. High degree of negative correlation between the Q_{max} and prostate volume (PV) was found ($r = -0.656$; $p = 0.001$). High degree of negative correlation between the Q_{max} and intravesical prostatic protrusion (IPP) was found ($r = -0.748$; $p = 0.001$).

Conclusion: The role of sonography in the evaluation of patients with BPH is found significant as prostate volume (PV) & intravesical prostatic protrusion (IPP) correlates well with Q_{max}.

Keywords: *Benign Prostatic Hyperplasia, BPH, intravesical protrusion, uroflowmetry*

Introduction

Benign Prostatic Hyperplasia (BPH) is a common cause of Bladder Outlet Obstruction (BOO) in men older than 50 years[1]. It is a quite common problem in elderly population of Bangladesh[2]. It affects approximately 50% of men 60 years old and some estimate the prevalence to be approximately 80% by 80 years worldwide[3]. However, the prevalence of clinically enlarged prostate in above 50 years is 39.5% in this country[2]. In the United States approximately 300,000 men annually undergo surgical treatment to relieve bladder outlet obstruction caused by BPH[4].

Pressure-flow studies are the gold standard for BOO determination[5]. However, this method is an invasive and expensive procedure with limited availability. Therefore, attempts have been made to diagnose BOO through noninvasive methods that can be divided into two categories: non-urodynamically based measurements and noninvasive urodynamics[1]. Non-urodynamically based measurements include symptoms, post-void residual urine (PVR), Prostate specific antigen (PSA) and ultrasound derived measurements, such as prostate volume and intravesical prostatic protrusion (IPP). Among noninvasive urodynamics uroflowmetry is most commonly used by the urologists[1].

In Uroflowmetry Q_{max}, Q_{avg}, maximum flow rate, voiding time are measured[6]. Of these Q_{max} and Q_{avg} are the two most important parameters to detect prostatic obstruction. Q_{max} <15ml/sec is considered obstructive prostate[7]. Transabdominal sonographic scanning of the bladder and prostate is a useful diagnostic tool. In ultrasound study we measure prostate size/ volume, intravesicular prostatic protrusion (IPP) and post-void residual of urine (PVR)[8]. IPP and prostatic volume, bladder wall thickness measured through abdominal ultrasound are noninvasive. The IPP assessed by transabdominal sonography is a better predictor of bladder outlet obstruction than the other variables assessed[9]. However, there have been some questions regarding the acceptability of pressure flow studies due to the perceived invasiveness, cost and morbidity of the test. Therefore, attempts have been made to diagnose BOO by noninvasive methods. Transabdominal sonography is a non-invasive, available and cheaper imaging technique. In a resource limited country like Bangladesh, it is justified to evaluate the scopes of transabdominal sonography in diagnosis of prostatic obstruction comparing with uroflowmetry.

In this present study ultrasound parameters were correlated with uroflowmetry (Q_{max}) and try to find out whether ultrasound parameter is sensitive in detecting obstructive prostate or not and thus establishing abdominal ultrasonography of prostate as an effective modality in detecting obstructive prostate.

Materials and Methods

This cross sectional study was carried out on ambulant elderly male patients more than or equal to 50 years of age presented with clinical symptoms of obstructive voiding difficulty suggestive of BPH who were attended in the Department of Urology at Sir Salimullah Medical College & Mitford Hospital, Dhaka from 1st July 2009 to 30th June 2010, for a period of one year. Patient on indwelling catheter, previous prostate or pelvic surgery, neurologic problem like cerebrovascular disease or neuropathy, raised PSA (prostate specific antigen) > 4ng/ml or urethral pathology like stricture, stone or carcinoma were excluded from this study. In uroflowmetry patient who voided a volume of equal or <150 ml were excluded from the study. All these information were collected in a pre-designed structured data collection sheets. The initial evaluation of the patients consisted of history taking, physical examination and some relevant investigations. The physical examination including DRE was done to exclude tumor and neurological examination was done to exclude any neurological deficit and neurologically related bladder dysfunction. The bladder was assessed by transabdominal ultrasonography at the Department of Radiology and Imaging with a curvilinear 3.5 MHz probe (Siemens G 60S and with Toshiba Justvision 400). The extent of IPP was measured by moving the ultrasound probe both horizontally and longitudinally and assessing the bladder neck for protrusion of the prostate into the bladder[10]. IPP was measured in millimeter (mm) as a vertical distance from the tip of the protrusion to the circumference of the bladder at the base of the prostate gland. Patients were divided into two groups according to the severity of the protrusion. Intravesical protrusion of prostate less than or equal to 10 mm was regarded as grade-I and more than 10 mm protrusion was regarded as grade-II[11]. Prostatic volume (PV) was measured by using the formula for elliptical volume (Transverse Diameter X Antero-posterior Diameter X Cephalocaudal Diameter X 0.52), which is built in the machine[12]. Patients with a minimum Prostate volume of 25 mL (1+ enlarged prostate) were recruited in the study[5]. Patients were again divided into two groups depending on the prostatic volume measured in milliliter (mL). Patients with prostatic volume between 25-49 mL were included in grade I and 50-75 mL was included in grade II. If the prostate volume lies in between 75-100 ml and more than 100 ml then grade of prostate enlargement falls into grade-III and grade IV respectively[5]. Uroflowmetry was done to measure the peak urinary flow rate (Q_{max}). A cutoff value of $Q_{max} \leq$ 15 ml/s was taken in the study[7]. Accordingly patients were divided into obstructed (≤15mL/s) and nonobstructed (>15ml/s) groups. Serum PSA was also measured to exclude prostatic malignancy. Prior to the commencement of this study, the research protocol was approved by the local ethical committee of Sir Salimullah Medical College. Informed consent was taken from each patient. Statistical analysis was performed by SPSS version 17 using McNemar's test and kappa statistics. Scatter plot together with Pearson's correlation coefficients were used to assess the relationship between IPP and PV with Qmax. Receiver operator characteristic (ROC) curves were produced to visualize, and calculation of the area under the curve (AUC) was used to describe the diagnostic characteristics of the index tests to diagnose BOO due to BPH.

Results :

A total number of 69 patients who had clinically suspected obstructive voiding problem, included consecutively in this study. After uroflowmetry ten patients were excluded from the study as they could not void the required amount (> 150 ml) of urine and again nine patients were excluded due to nonavailability of uroflowmetry report. Finally 50 patients were included for the study. The mean age of the subjects was 62.14±9.98 ranging from 50 to 88 years. Majority of patients were of age groups 50 to 70 years (Table 1).

Patients having Grade - II (50-75 cc) prostate had obstructive Q_{max} (≤ 15 ml/s) in 27.6% of cases and non-obstructive Q_{max} (> 15 ml/s) in 9.5% cases. In patients having grade-I (25- 49 cc) prostate had obstructive Q_{max} in 72.4% cases and non-obstructive Q_{max} in 90.5% cases. So there is significant correlation of increased prostate volume with obstructive Q_{max} (p = 0.001) (Table 2). Patients having Grade-II (>10mm) IPP had obstructive Q_{max} (≤ 15ml/s) in 55.2% of cases and non-obstructive Q_{max} (> 15ml/s) in only 4.8% cases. In patients with Grade-I (≤ 10 mm) IPP had obstructive Q_{max} in 44.8% cases and non-obstructive Q_{max} in 95.2% cases. So, in this table it is evident that IPP had significant impact on Q_{max}, the more the IPP the less the Q_{max} (Table 3). Pearson's correlation test showed r = -0.656, p = 0.001, which signifies high degree of negative correlation between the Q_{max} and PV (Figure I). Pearson's correlation test showed r = - 0.748, p = 0.001, which signifies high degree of negative correlation between the Q_{max} and IPP (Figure II). ROC has shown an area of 0.860 and 0.836 under the Curve in Intravesicular Prostatic Protrusion (IPP) and Prostate Volume (PV) respectively.

Table 1: Distribution of age of the patients (n=50)

Age (in year)	No. of patients	Percentage
≤ 50	7	14.0
51-60	18	36.0
61-70	15	30.0
>70	10	20.0
Total	**50**	**100.0**
Mean ± SD (Range)	62.14 ± 9.98	(50-88)

Table 2: Distribution of Prostate volume (PV) by Peak Urinary Flow Rate (Q_{max}) (n = 50)

Prostate volume (cc)	Q_{max} (ml/s)		Total
	Obstructive (≤15ml/s)	Non obstructive (>15ml/s)	
Grade II (50-75 cc)	8 (27.6)	2 (9.5)	10 (20.0)
Grade I (25-49 cc)	21 (72.4)	19 (90.5)	40 (80.0)
Total	**29(100.0)**	**21(100.0)**	**50 (100.0)**

* p value = 0.001 done by McNemar's test.

* Figure within parentheses denoted corresponding percentage

* Kappa = 0.161

Table 3: Distribution of Intravesical protrusion of Prostate (IPP) by Peak Urinary Flow rate (Q_{max}) (n = 50).

IPP (mm)	Q_{max} (ml/s)		Total
	Obstructive (≤15ml/s)	Non obstructive (>15ml/s)	
Grade II (>10 mm)	16 (55.2)	1 (4.8)	17 (34.0)
Grade I (≤10 mm)	13 (44.8)	20 (95.2)	33 (66.0)
Total	**29(100.0)**	**21(100.0)**	**50 (100.0)**

* p value = 0.002 done by McNemar's test.

* Figure within parentheses denoted corresponding percentage.

* Kappa = 0.467

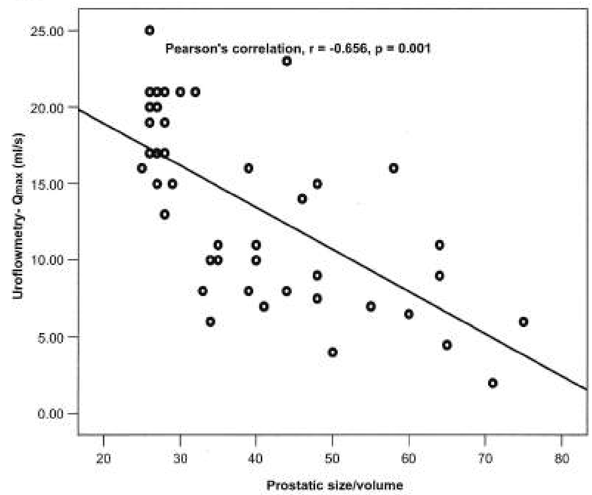

Figure I: Correlation of prostate volume with Q_{max}

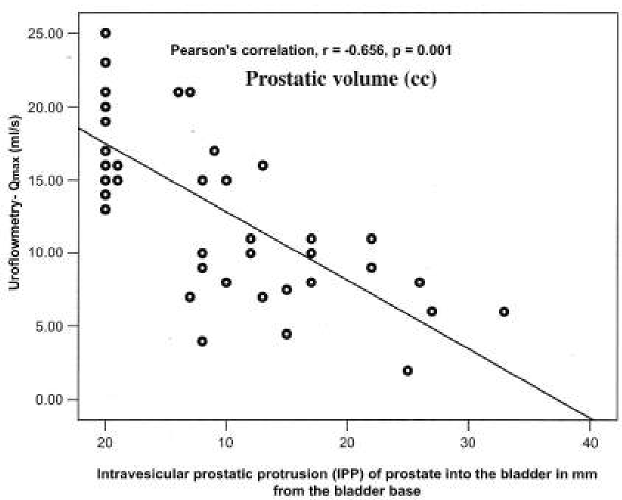

Figure II: Correlation of IPP with Q_{max}

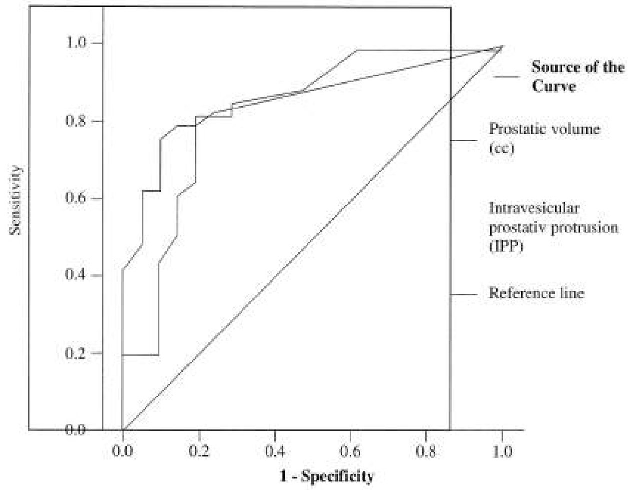

Figure III: Receiver operating characteristic curves of investigated noninvasive tests commonly used to predict BOO due to BPH

Discussion

Bladder outlet obstruction (BOO) is a common cause of lower urinary tract symptoms (LUTS) in men and women[5]. BOO is determined by urodynamically assessing the pressure-flow relation during voiding. Since the 1960s much work has been done to standardize the urodynamic definitions of obstruction in men and more recently women. However, urodynamic testing voiding pressure-flow analysis remains the gold standard for the diagnosis of BOO and the etiology of LUTS[7]. The pressure-flow relation is much better defined in men than in women, but research work suggests that although the definition of obstruction may differ between men and women, the concept of the pressure-flow relation to diagnose obstruction holds true for both genders[13]. The features of the gland such as the size as defined by prostatic volume and configuration as defined by IPP are considered to further define the contribution of anatomic components of the diagnosis of BOO. IPP is easily measured and it correlates with urodynamically proven BOO[14].

In the present study it was found that IPP had significant impact on lower urinary tract function as observed by decreased peak urinary flow rate (Q_{max}). Pearson correlation test between IPP and Q_{max} showed r =-0.748, P<0.001 (Figure I) and in case of correlation between Q_{max} and prostatic volume (PV), Pearson correlation test showed r=-0.664, P<0.001 (Figure II). These tests revealed high degree of negative correlation of Qmax with both IPP and PV which indicate when IPP and PV raise the Q_{max} decreases. But negative correlation of IPP is more than PV with obstructed Q_{max} (Q_{max}< 15ml/s) which signifies higher degree of bladder outlet obstruction. In a study conducted by Chia et al[19] showed that IPP correlated well with the severity of obstruction as defined by the higher BOO index (P<0.001). Lim et al[14] demonstrated that PSA, PV and IPP correlate well with one another. Although all three indices had good correlation with BOO index, IPP was the best. Keqin et al[15] also found significantly lower peak urinary flow rate (Q_{max}) in the significant IPP group. IPP degree was negatively correlated with Q_{max} (r= -0.284). These findings are consistent with the present study. In patients having Grade-II IPP (>10mm) 55.2% found obstructive and 4.8% found non obstructive with Q_{max} (p=0.002).

The accuracy of transabdominal ultrasound as the standard clinical tool for a rapid, simple and non-invasive screening of the prostate volume has been described[16,17,18]. In the present study it was found that mean prostate volume was 37.52±15.98 ml, ranging from 25 to 75 ml. In majority of cases (80%) prostatic volume was between 25 ml to 49 ml. Patients having Grade - II (50-75 cc) prostate had obstructive Qmax (≤ 15 ml/s) in 27.6% of cases and non-obstructive Qmax (> 15 ml/s) in only 9.5% cases. In patients having grade-I (25- 49 cc) prostate had obstructive Qmax in 72.4% cases and non-obstructive Q_{max} in 90.5% cases. So there is significant correlation of increased prostate volume with obstructive Q_{max} (p=0.001). The findings of van Venrooij and coworkers (1995) are consistent with the present study.[19] A significant correlation was found between size of the prostate and grade of obstruction in their study.

In the present study kappa statistic was calculated as a measure of agreement. It was found that IPP had the moderate amount of agreement (kappa = 0.467) with the reference test (Qmax, uroflowmetry) than PV which had a poor agreement with the reference test (kappa =0.161). Receiver operator characteristic (ROC) curves were produced to visualize, and calculation of the area under the curve (AUC) was used to describe the diagnostic characteristics of the index tests to diagnose BOO due to BPH. In the current study it was observed from the receiver operating characteristic (ROC) curves analysis Intravesical prostatic protrusion (IPP) had the best area under curve (0.860) compared to prostate volume (0.836). Mariappann et al[20] has 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. Based on ROC curve Lim et al[14] 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.

Conclusion

Low Q_{max} has stronger correlation with IPP than PV in patients with BPH. Thus these indices can be used initially to assess patients with LUTS suggestive of BPH being noninvasive way to stratify patients for further management.

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