African Journal of Urology

ORIGINAL RESEARCH Open Access

Correlation of intravesical prostatic protrusion with severity of lower urinary symptoms among patients with benign prostatic hyperplasia

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Abstract

Background: Benign prostate hyperplasia (BPH) is characterized by an increase in the number of epithelial and stromal cells in the periurethral area of the prostate. Lower urinary tract symptoms (LUTS) often develop as a manifestation of bladder outlet obstruction (BOO) due to benign prostate enlargement. When the prostate enlarges, protrusion into the bladder often occurs as a result of morphological changes of the gland. Prostatic protrusion into the bladder can be measured with ultrasound as intravesical prostatic protrusion (IPP). There are studies that have shown IPP as a reliable predictor of bladder obstruction index (BOOI) as measured by pressure flow studies. IPP is thereby reliable in assessing the severity of BOO in patients with BPH. The severity of symptoms in patients with BPH can be assessed through several scoring systems. The most widely used symptoms scoring system is the International Prostate Symptoms Score (IPSS). The aim of this study is to determine the correlation of IPP with IPSS in men with BPH at our facility.

Methods: The study was a cross-sectional observational study that was conducted at the Division of Urology, Department of Surgery, in our facility. The study was conducted on patients greater than 50 years LUTS and an enlarged prostate on digital rectal examination and/or ultrasound. All consenting patients were assessed with the International Prostate Symptoms Score (IPSS) questionnaire, following which an abdominal ultrasound was done to measure the intravesical prostatic protrusion (IPP), prostate volume (PV) and post-void residual (PVR) urine. All the patients had uroflowmetry, and the peak flow rate was determined. The data obtained were entered into a proforma. The results were analyzed using Statistical Package for Social Sciences (SPSS) software package version 20.

Results: A total of 167 patients were seen during the study period. The mean age was 63.7 ± 8.9 years, with a range of 45–90 years. The mean IPSS was 18.24 ± 6.93, with a range of 5–35. There were severe symptoms in 49.1%, while 43.1% had moderate symptoms and 7.8% had mild symptoms. The overall mean IPP was 10.3 ± 8 mm. Sixty-two patients (37.1%) had grade I IPP, 21 patients (12.6%) had grade II IPP and 84 patients (50.3%) had grade III IPP. The mean prostate volume and peak flow rate were 64 g ± 34.7 and 11.6 ml/s ± 5.4, respectively. The median PVR was 45 ml with a range of 0–400 ml. There was a significant positive correlation between the IPP and IPSS ($P = 0.001$). IPP also had a significant positive correlation with prostate volume and post-void residual and a significant negative correlation with the peak flow rate ($P < 0.01$).

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Conclusion: Intravesical prostatic protrusion is a reliable predictor of severity of LUTS as measured by IPSS, and it also shows good correlation with other surrogates of bladder outlet obstruction.

1 Background

Benign prostate hyperplasia is a condition intimately related to aging [1]. Histologically, it is a hyperplastic process that develops in the transition zone resulting from an increase in cell number. Microscopic evaluation reveals a nodular growth pattern that is composed of varying amounts of stroma and epithelium. Stroma is composed of varying amounts of collagen and smooth muscle [2]. The enlarged prostate can lead to bladder outlet obstruction which manifests clinically as LUTS. The size of the prostate is not a reliable predictor of the severity of LUTS [3, 4].

Pressure flow studies remain the gold standard to diagnose bladder outlet obstruction [5]. However, they are invasive, because catheterization is required to measure detrusor and urethral pressure, and they are uncomfortable for patients because of pain and voiding difficulty. Another important limitation of pressure flow study is the need for expensive equipments which are not readily available in many parts of the developing world. Thus, the need for a noninvasive, reliable and cost-effective alternative has lead to suggestion of surrogates like intravesical prostatic protrusion (IPP). Ultrasonographic measurement of IPP is able to detect bladder outlet obstruction in patients with benign prostate hyperplasia quickly and noninvasively [6]. Intravesical prostatic protrusion is the distance in millimeters between the tip of the prostate median lobe and bladder neck in the midsagittal plane, using a suprapubically positioned ultrasound scanner.

The intravesical prostatic protrusion distance can be divided into three grades: grade I: 0–4.9 mm, grade II: 5–10 mm, and grade III: more than 10 mm [7]

Studies have shown that IPP is a reliable predictor of bladder outlet obstruction index (BOOI) as measured by pressure flow studies [8, 9].

The severity of lower urinary tract symptoms can be measured reliably with a number of validated questionnaires like International Prostate Symptoms Score (IPSS), Boyarsky score, Madsen score, Iversen score and Danish prostatic symptom score. The IPSS is recommended as the symptom scoring instrument to be used for the baseline assessment of symptom severity in men presenting with lower urinary tract symptom [10].

The present study will aim to determine the correlation between intravesical prostatic protrusion (IPP) and International Prostate Symptoms Score (IPSS).

2 Methods

The study was conducted at the Division of Urology, Department of Surgery, in our center, between September 2015 and August 2016. Approval was obtained from the health research ethics committee (HREC) prior to the commencement of the study. A written informed consent was obtained from all participants. All adult males greater than 50 years, presenting with LUTS and an enlarged prostate on DRE or ultrasound, were included in the study. Patients on medical therapy for BPH, BPH coexisting with urethral stricture, suspected prostate cancer and those with neurogenic bladder were excluded.

All enrolled patients were evaluated at the time of initial visit using the IPSS questionnaire. A digital rectal examination was done on each patient to assess the prostate size and characteristics. Uroflowmetry was done using ARK Meditech System Uroflowmetry Machine: Urol 010 Model. The abdominal ultrasound was done using a Mindray Digital Ultrasonic Diagnostic Imaging System: Model DP-20 with an abdominal probe frequency of 3.5 MHz by the same radiologist in the radiology department. IPP was measured when the bladder contained about 100–200 ml of urine. This was measured as the distance in millimeters between the tip of the prostate median lobe and bladder neck in the midsagittal plane and divided into three grades (grade I: 0 − 4.9 mm; grade II: 5.0–10.0 mm; and grade III: greater than10.0 mm). The prostate volume and post-void residual urine were also determined.

The data obtained were recorded in a proforma and entered into statistical software. Statistical Package for Social Sciences (SPSS) software version 20 was used for data analysis. The correlation between IPP and IPSS was determined using Spearman correlation coefficient. The correlation between IPP and the surrogates of BOO (prostate volume, Qmax and PVR) was also determined using Spearman correlation coefficient. The correlation between the surrogates of BOO and IPSS was determined using Pearson's correlation coefficient. Statistical significance (*P*) value was set at 0.05. Statistical significance (*P*) value was set at 0.05.

3 Results

A total of 167 patients met the inclusion criteria. The mean age was 63.7 ± 8.9 years, with a range of 45–90 years. The peak age group was 60–69 years as

Table 1 Age distribution of 167 men with BOO secondary to BPH

Age (years)	Frequency	Percentage
40–49	12	7.1
50–59	36	21.6
60–69	73	43.7
70–79	40	24.0
80–89	4	2.4
90–99	2	1.2
Total	167	100

Table 2 Distribution of the study population according to IPP grading

IPP grading	Frequency	Percentage
Grade I (< 5 mm)	62	37.1
Grade II (5–10 mm)	21	12.6
Grade III (> 10 mm)	84	50.3
Total	167	100

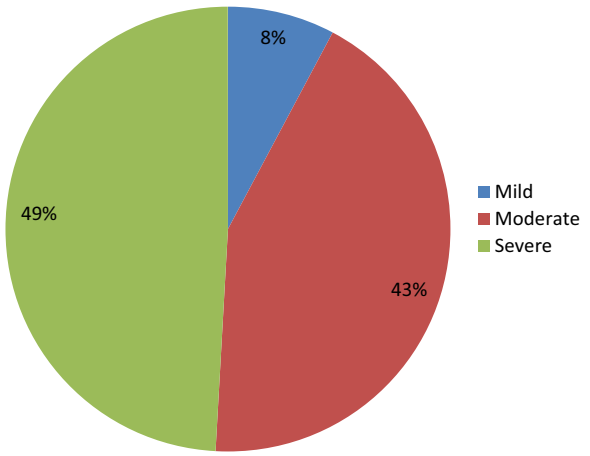

Fig. 1 A pie chart showing the frequency of severity of symptoms based on IPSS

shown in Table 1. Majority (50.3%) had grade III IPP as shown in Table 2.

The mean IPSS was 18.24 ± 6.93, with a range of 5–35. Eighty-two patients (49.1%) had severe symptoms; others are shown in Fig. 1.

The quality of life assessments showed that majority of the patients were unhappy with their symptoms (47.9%) as shown in Fig. 2.

Eighty-two patients (49.1%) had severe symptoms of which 23 patients (12.8%), nine patients (5.45%) and 50

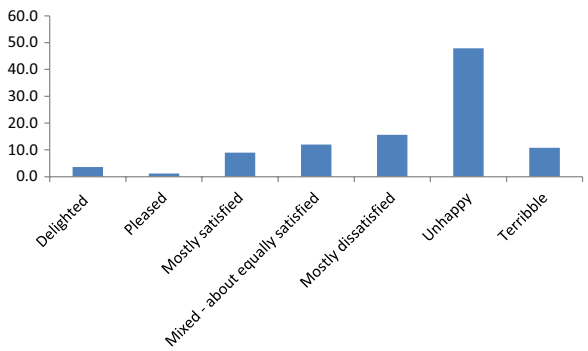

Fig. 2 A bar chart showing the quality of life assessment of the patients ($n = 167$)

Table 3 Demographics and clinical characteristics of individual IPP category

	Grade I	Grade II	Grade III	Total
Mean age (years)	61.65 ± 7.5	65 ± 9.3	65 ± 9.6	63.7 ± 8.9
Mean IPP (mm)	2.1 ± 1.9	7.8 ± 1.0	18.7 ± 4	10.2 ± 8.0
Mean IPSS (total)	16.23 ± 6.9	17.1 ± 6.7	20 ± 6.6	18.24 ± 6.93
Mean IPSS (storage)	7.61 ± 3.6	8.86 ± 2.7	9.5 ± 3.2	8.7 ± 3.3
Mean IPSS (voiding)	8.48 ± 4.2	8.29 ± 4.8	10.5 ± 4.9	9.4 ± 4.7
Mean QoL	4.06 ± 1.2	4.19 ± 1.4	4.48 ± 1.2	4.3 ± 1.3
Mean PV (g)	46.9 ± 21.4	64.1 ± 41.3	72.2 ± 37.2	64 ± 34.7
Mean Qmax (ml/s)	13.4 ± 5.2	13.8 ± 6.0	9.7 ± 4.8	11.6 ± 5.4
Median PVR (ml)	18	13.8	100	45

patients (29.9%) had grade I, grade II and grade III IPP, respectively. Seventy-two patients (43.1%) had moderate symptoms of which 28 patients (16.8%), 12 patients (7.2%) and 32 (19.2%) patients had grade I, grade II and grade III IPP, respectively. Thirteen patients (7.8%) had mild symptoms of which 11 patients (6.6%) and two patients (1.2%) had grade I and grade III IPP, respectively.

The mean IPP was 10.2 ± 8 mm, with a range of 0–28.2 mm. See Table 3 for the distribution of individual IPP category.

There was a positive correlation between the IPP versus IPSS storage, IPSS voiding, IPSS (total) and quality of life scores. The correlations were weak but statistically significant (Table 4).

The mean prostate volume was 64 g ± 34.7, with a range of 18.6–176.8 g. Most (117 patients) had prostate volumes ≥ 40 g, of which 21.6%, 10.2%, and 38.3% had grades I, II and III IPP, respectively (Table 5).

The mean Q max was 11.6 ml/s ± 5.4 with a range of 2–21 ml/s. Seventy-seven (46.1%) patients had flow < 10 ml/s of which 12%, 5.4%, and 28.7% had grades

Table 4 The correlation of grade of IPP with IPSS and quality of life

Variable	Spearman's correlation coefficient	*P* value
IPPS (storage)	0.245**	0.001
IPSS (voiding)	0.187*	0.016
IPSS (total)	0.255**	0.001
QoL	0.169*	0.029

**Correlation is significant at the 0.01 level

*Correlation is significant at the 0.05 level

I, II, and III IPP, respectively. Most of the patients with grade III IPP had Q max < 10 ml/s (Table 5).

The median PVR was 45 ml with a range of 0–400 ml. only 14.4% had PVR ≥ 200 ml, most of them with grade III IPP.

Intravesical prostatic protrusion had positive correlation with prostate volume and post-void residual. Intravesical prostatic protrusion also had a negative correlation with the Q max. The correlations were all statistically significant (Table 5).

There was a positive correlation between the IPSS (voiding, storage and total) and post-void residual urine; this was found to be statistically significant. There was negative correlation between the IPSS (voiding, storage and total) and Qmax. This was also found to be statistically significant (Table 6).

However, there was no correlation between the prostate volume and the IPSS (voiding, storage and total) (Table 6).

4 Discussion

A total of 167 patients were evaluated for BOO secondary to BPH during the study period. The mean age was 63.7 years ± 8.9 years, with a range of 45–90 years. The mean age is similar to the findings of Udeh et al. [11] in north central Nigeria who reported a mean age of 65.6 ± 9.84 years, and Badmus et al. [12] in south western

Table 5 Distribution of prostate volume, Q max and PVR among different grades of IPP and their correlation with IPP

Variable	IPP, number (%)				Correlation with IPP	
	Grade I	Grade II	Grade III	Total	r_s^*	*P* value
Prostate volume						
< 40 g	26(15.6%)	4(2.4%)	20(12%)	50(29.9%)	0.328	0.000
40– 100 g	36(21.6%)	13(7.8%)	48(28.7%)	97(58.1%)		
> 100 g	0	4(3%)	16(9%)	20(12%)		
Q max						
< 10 ml/s	20(12%)	9(5.4%)	48(28.7%)	77(46.1%)	− 0.291	0.000
10–15 ml/s	14(8.4%)	0	26(15.6%)	40(24%)		
> 15 ml/s	28(16.7%)	12(7.2%)	10(6.0%)	50(29.9%)		
PVR						
< 50 ml	40(24%)	13(7.8%)	26(15.6%)	83(49.7%)	0.422	0.000
50–199 ml	14(8.4%)	6(3.6%)	40(24%)	60(35.9%)		
≥ 200 ml	4(2.4%)	2(1.2%)	18(10.8%)	24(14.4%)		

Correlation is significant at the 0.01 level

r_s^*: Spearman's correlation coefficient

Table 6 The correlation of prostate volume, Qmax and PVR with IPSS and QoL

		Prostate volume	Q max	Post-void residual urine
IPSS (storage)	Pearson correlation	0.057	− 0.181	0.225
	P value	0.464	0.019	.004
IPSS (voiding)	Pearson correlation	0.104	− 0.254	0.262
	P value	0.180	0.001	0.001
IPSS (total)	Pearson correlation	0.099	− 0.260	0.285
	P value	0.205	0.001	0.000
QoL	Pearson correlation	0.019	− 0.119	0.308
	P value	0.810	0.127	0.000

P < 0.05 is significant

Nigeria who reported a mean age of 64.4 ± 8.88 years. Similar findings have also been reported by other studies [13, 14]. Most of the patients in this study presented in the seventh decade. The peak age of presentation is similar to the findings of Udeh and Movsav et al. [11, 15].

The mean IPSS was 18.24 ± 6.93, which was within moderate score on IPSS. Severe symptoms on IPSS were found in 49.1%, while 43.1% had moderate symptoms and 7.8% had mild symptoms. There are studies (in patients with BPH ± IPP) that have reported the mean IPSS both in the moderate [14, 16] and severe range [17, 18]. The preponderance of severe symptoms can be partly explained by fact that the Urology clinic in our hospital is a referral center; patients are more likely to be referred to the Urologists if their symptoms are bothersome (moderate to severe score on IPSS). A population-based study is likely have more patients with mild symptoms compared to hospital-based studies. Ezeanyika et al. [19] in a population-based study in Nsukka, Nigeria, on males without apparent symptoms of ill health reported 74.65% as having mild symptoms on IPSS, while 23.58% and 1.77% had moderate and severe symptoms, respectively. Another possible explanation as to why most patients present with moderate to severe symptoms is that many men often attribute the changes in urinary pattern to inevitable consequence of aging, they eventually present to the Urologist when the symptoms become bothersome as noted by Oranusi et al. [20].

The QoL score showed that most patients were unhappy with their symptoms (46.1%). There was also a strong positive correlation between the IPSS and QoL. This is similar to the findings of Adegun et al. [21]. They further suggested that the QoL should serve as the basis of treatment rather than the IPSS.

The mean IPP in this study was 10.3 mm which was within grade III IPP. This is similar to the findings of Agbo [22] and Sidgel et al. [23] who reported mean IPP of 12.9 mm and 14.6 mm, respectively. About half of the patients (50.3%) had grade III IPP. This is comparable with the findings of Reis et al. [13] and Eze et al. [24] in which grade III IPP constituted 59.5% and 59.4% of their study populations, respectively. However, there are other studies with preponderance of IPP grade I and grade II. [25, 26] Kuei et al. [26] in a study of Asian population reported 66.1%, 18.8% and 15.2% for grade I, grade II and grade III, respectively. The mean prostate volume in that study was 40 ml. The geographical location and smaller mean prostate volume may explain why there was preponderance of grade I IPP.

In this study, there was a significant positive correlation between the IPP and IPSS, IPSS sub scores and QoL. This finding is supported by several studies that have reported a significant positive correlation between the IPP and IPSS [22, 24, 27, 28]. However, there are other studies that did not reveal any correlation between IPP and IPSS [23, 29]. This can be attributed to a number of factors. It has been noted that different bladder volumes affect the degree of protrusion of the prostate into the bladder, which eventually affect the grading of IPP [30]. Too little urine allows more protrusion of the prostate into the bladder, while a full bladder will reduce the protrusion of the prostate into the bladder. Yuen et al. [30] in a study to determine the effect bladder volume on prostatic protrusion concluded that IPP should be measured between 100 and 200 ml. Sidgel et al. [23] used a different bladder volume to measure the IPP (150–250 ml), while Hou et al.[29] did not mention the bladder volume at which IPP was measured. Measurement of IPP is also operator dependent, Hou et al. [29] was not explicit whether they used a single radiologist or otherwise.

There are several studies that shown IPP as a reliable predictor of BOOI as measured by pressure flow studies [8, 9]. Chia et al.[8] considered IPP to be a useful parameter to predict BOO because of its good correlation with conventional pressure flow studies. Chia et al. [8] also found that 75% of men with significant BOO had IPP greater than 10 mm, whereas only 8% of men with no significant BOO had IPP greater than 10 mm. Keqin Z et al.[9] found that IPP was positively correlated with bladder outlet obstruction index. IPP greater than 10 mm appeared more often in the obstructed patients.

This study revealed a significant positive correlation between IPP and other parameters of BOO (PV, Qmax and PVR).

Lee et al.[28] in a prospective study of 114 men with BOO secondary to BPH, found a positive correlation between IPP and prostate volume. Both IPP and PV had a significant positive correlation with BOOI; however, IPP had a better correlation with BOOI than prostate volume. Han et al.[31] also reported significant positive correlation between IPP with prostate volume ($r = 0.534$, $P < 0.01$). Gyawali et al.[32] had a different outcome, in a prospective study of 60 men with LUTS; found that IPP had no correlation with PV. This study however had a smaller sample size.

The mean Qmax in this study was 11.6 ml/s. Most men with grade III IPP had flow < 10 ml/s. There was a significant negative correlation between the IPP and Qmax. Similarly Han et al. found out that the degree of IPP is negatively correlated with the Qmax (-0.364, $P < 0.01$)[31]. Liber et al.[33] in a sample of 322 men residing in Olmsted county, reported significant correlation between IPP and higher obstructive symptoms and Qmax ($r = -0.18$, $P < 0.01$). However, Sidgel et al.[23] in a prospective study of 50 patients with BPH reported IPP had a positive correlation with Qmax, but it was not

statistically significant. This outcome of Sidgel et al. could have been affected by the small sample size.

In this study, IPP had a significant positive correlation with PVR urine. This has also been reported from other studies [28, 29].

In this study, both the Qmax and PVR urine had a significant correlation with the IPSS. Barry MJ and Girman CJ [34], Bosch et al.[35] and Din et al.[36] have reported weak but significant correlations between Qmax and symptom scores, while Singla et al.[37] and Kolman C et al.[38] both reported significant positive correlation between PVR urine and IPSS.

In this study, there was no correlation between prostate volume and IPSS. There are studies that have reported similar findings [39, 40]. Symptoms severity is determined by other factors and not necessarily the size of the prostate alone.

Apart from predicting symptoms severity, IPP can also be useful predictor for successful trial without catheter (TWOC). A TWOC is more likely to fail in patients with IPP larger than 10 mm [41]. Patients with grade III IPP can be identified earlier as such patients are more likely to require surgical intervention [42].

5 Conclusion

Intravesical prostatic protrusion is a reliable predictor of severity of LUTS as measured by IPSS. Patients with grade III IPP are likely to present with severe symptoms. IPP also shows good correlation with other surrogates of BOO (prostate volume, Qmax and post-void residual urine).

Abbreviations

BPE: Benign prostatic enlargement; BPH: Benign prostate hyperplasia; BOO: Bladder outlet obstruction; DRE: Digital rectal examination; IPSS: International Prostate Symptoms Score; QoL: Quality of life; IPP: Intravesical prostatic protrusion; PV: Prostate volume; PVR: Post-void residual; LUTS: Lower urinary tract symptoms; Qmax: Peak flow rate; SPSS: Statistical package for the social sciences; PFR: Peak flow rate.

Acknowledgements

Not applicable.

Authors' contributions

B.K.H. contributed to project development, manuscript writing, data collection, data analysis and editing. M.A (Ahmed), A. B and H.Y.M helped with project development and editing. M.A.T contributed to data collection, data analysis, and editing. M.A (Awaisu), A.T. L, N.O, K.I.A, L. L and A. S helped with data collection and editing. All authors have read and approved the manuscript.

Funding

None.

Availability of data and materials

Raw data are available at the request of the author.

Ethical approval and consent to participate

This study was approved by the health research ethics committee (HREC) of Ahmadu Bello University Teaching Hospital Zaria (Reference number: ABUTHZ/HREC/N09/2015). A written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

None.

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Received: 23 April 2020 Accepted: 14 December 2020
Published online: 07 January 2021

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