Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

To Know the Correlation of Prostate Size on Ultrasound with International Prostate Symptom Score and Uroflowmetry in Benign Prostatic Hyperplasia

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Abstract

Introduction: Benign prostatic hyperplasia (BPH) is an extremely common condition in elderly men and is a major cause of bladder outflow obstruction. An enlarged prostate may also be incidentally found on imaging of the pelvis or on rectal examination. Lower urinary tract symptoms (LUTSs) are one of the commonest presentations in urology clinics. Clinical diagnosis of BPH is made by the assessment of international prostate symptom score (IPSS), prostate size or volume, and reduced urinary flow rate. Uroflowmetry is one of the simplest and non-invasive urodynamic investigations used in the measurement of urinary flow rate using a flowmeter for the evaluation of obstructive LUTS. The IPSS is widely used to assess the severity of LUTS in men with bladder outlet obstruction and to evaluate the response to medical or surgical therapy for benign prostatic obstruction.

Materials and Methods: This prospective study was conducted on patients with LUTS to evaluate: (1) Prostate size on ultrasound, (2) correlate prostate size with IPSS, and (3) correlate prostate size with uroflowmetry. A total of 60 patients were included in the study attending the outpatient department of general surgery in Government Doon Medical College between June 2018 and September 2019.

Result: Our study states that maximum flow rate and prostate volume show a positive significant correlation having $P < 0.01$. Considering all the three grades of BPH, a positive correlation was found between prostate volume and maximum flow rate. A significant correlation was found between mean prostate volume and maximum flow rate signifying that the higher the prostate volume, the lower the maximum flow rates. The statistical analysis of prostate volume versus IPSS showed strongly significant correlation between the two parameters. Mean prostate volume was higher in patients with PSS of 18–35. It denotes that higher the prostate volume higher is severity index in patients with BPH.

Conclusion: On the basis of data, which were obtained after evaluation of 60 patients with BPH, it can be concluded that prostate volume and its relationship with peak flow of output can help predict the degree and cause of obstruction. The higher the prostate volume, the higher the possibility of the cause to be obstructive due to BPH. Uroflowmetry, IPSS, and ultrasound are non-invasive, easy, and cheap investigation in evaluation of LUTS, mainly due to BPH.

Key words: Hyperplasia, Prostate, Ultrasound

INTRODUCTION

Benign prostatic hyperplasia (BPH) is an extremely common condition in elderly men and is a major cause of bladder outflow obstruction. Although the term prostatomegaly is often used interchangeably with BPH, strictly speaking, prostatomegaly may refer to any cause of prostatic enlargement. By the age of 60, 50% of men have BPH, and by 90 years of age, the prevalence has increased to 90%. As such, it is often thought of essentially as a "normal" part of aging.

Although a degree of prostatomegaly may be completely asymptomatic, the most common presentation is lower urinary tract symptoms (LUTSs) including:

- Poor stream despite straining
- Hesitancy, frequency, and incomplete emptying of the bladder
- Nocturia

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www.ijss-sn.com

Month of Submission : 04-2020
Month of Peer Review : 05-2020
Month of Acceptance : 05-2020
Month of Publishing : 06-2020

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Clinical diagnosis of BPH is made by the assessment of IPSS, prostate size or volume, and reduced urinary flow rate. Histopathologically, BPH is characterized by an increased number of epithelial and stromal cells in the periurethral transitional zones of the prostate. Ultrasound of the prostate is the investigation that enables us to visualize the prostate gland directly and is one of the most common diagnostic modalities performed nowadays. It can be done using the suprapubic abdominal approach as well as transrectal approach. Among several methods, the diameter method is the most commonly used method for the determination of prostate volume. It comprises measurement of height (H), width (W), length (L), and volume (V) and is calculated using the formula ½ (H × L × W).

Uroflowmetry is one of the simplest and non-invasive urodynamic investigations used in the measurement of urinary flow rate using a flowmeter for the evaluation of obstructive LUTSs. Urodynamic studies in patient with LUTSs are used for objective assessment of urinary bladder outlet behavior. However, to decide what is abnormal, it seems mandatory to agree on what can be considered normal. Although urodynamic studies are frequently used to evaluate voiding disorders in an elderly men with LUTS suggestive of BPH. The measuring instrument calculates the amount of urine, flow rate in milliliter per second, and length of time until completion of voiding. This information is plotted on a graph and interpreted by the treating doctor.

The international prostate symptom score (IPSS) is widely used to assess the severity of LUTSs in men with bladder outlet obstruction and to evaluate the response to medical or surgical therapy for benign prostatic obstruction. The IPSS is a written screening tool comprising seven symptom questions.

AIMS AND OBJECTIVES

The aim of this study is to evaluate:
1. Prostate size on ultrasound.
2. Correlate prostate size with IPSS.
3. Correlate prostate size with uroflowmetry.

MATERIALS AND METHODS

This study was conducted on patients with LUTS.

Study Design

This was a prospective study.

Duration of Study

The study duration was from June 2018 to December 2019.

Place of Study

The study was conducted at the Department of General Surgery, Government Doon Medical College, Dehradun, Uttarakhand.

Sample size: 60

Inclusion Criteria

The following criteria were included in the study:
1. Patients presenting with LUTS.
2. Age > 50 years.
3. Prostate size ≥ 20 g on Ultrasound

Exclusion Criteria

The following criteria were excluded from the study:
1. Patients who had undergone previous urinary tract or pelvic surgeries/trauma.
2. Patients who had a history of prostatic surgery, prostatic carcinoma, urethral stricture, vesical calculus, or neurogenic bladder.
3. Patients who had systemic disorders that could influence bladder function, such as neurological disorders (CVA and spinal abnormalities) and diabetes.
4. Patients whose pre-voided urine volume was <180 ml.
5. Patients unable to go for uroflowmetry

There were 60 individuals in the age group of 50–80 years with LUTSs. All these patients were subjected to a detailed history taking, physical examinations, international prostatic symptom score (IPSS) assessment, digital rectal examinations (DREs), ultrasound, and uroflowmetry. Written informed consent was obtained from all the patients who participated in the study after explaining the patient's diagnosis, the nature, and purpose of the study.

All included patients were evaluated using IPSS questionnaire and personnel interview with the patient, before treatment on the following symptoms, which they experienced over the past 1 month.
1. Incomplete emptying
2. Frequency
3. Intermittency
4. Urgency
5. Weak stream
6. Straining
7. Nocturia due to urinary symptoms.

The IPSS is the ideal instrument, which can be used to grade baseline symptoms severity. The IPSS is based on the answers to seven questions, which concern urinary symptoms. Each question is assigned points from 0 to 5, which indicate increasing severity of the particular symptom and a total score, which ranges from 0 to 35. Digital rectal examination was done and size of the prostate

was estimated along with its consistency and fixity of rectal mucosa with the gland. In addition, examination of external genitalia was done to exclude meatal stenosis or a palpable urethral mass. The patients with prostatic carcinoma and who have undergone previous prostatic surgery were excluded from the study.

All the patients underwent transabdominal sonography for the estimation of prostate volume, pre-void urine volume, and post-void assessment for the residual urine. The prostate gland was evaluated transabdominally after adequate bladder distension. The prostate gland assessed for volume, echo texture, morphology, focal lesions, and median lobe parenchymal calcification. The prostate volume was calculated using prostate ellipsoid formula: Anteroposterior × Transverse × Craniocaudal × 0.52. The grading of the prostate gland enlargement was done as follows:

- Grade I: 21–30 cc.
- Grade II: 31–50 cc
- Grade III: 51–80 cc
- Grade IV: 80 cc and above.

The urinary bladder was assessed for various abnormalities such as pre-void urine volume, wall thickness, mucosal regularity, calculi, diverticulitis, tumor, and post-void assessment for the residual urine. The patients were advised to come with empty bladder soon after the uroflowmetry. Post-void residual urine was determined using transabdominal ultrasound measurement using the formula for elliptical volume (transverse dimension × anteroposterior dimension × cephalocaudal dimension × 1/2).

Uroflowmetry was performed in all patients with full bladders and voiding volume, peak flow rate, average flow rate, hesitance time, and voiding time were recorded. Adequate privacy was provided and patients were asked to void when they felt a normal desire to void. The machine gave the result as peak flow rate, voiding time, voiding volume, and time to peak flow. The test involved normal urination and so patients did not experience any discomfort.

The data of the patients were analyzed and the patients were divided as per their symptom severities as was assessed by IPSS. The results of uroflowmetry, as were obtained from these patients, were compared using various statistical techniques. Pearson's correlation coefficient was used to assess correlation between various variables.

RESULTS

In the current study, the total number of patients taken for study was 60. In our study, patients age ranged between 50 and 79 years with a mean age of 62.18. Maximum number of patients were in the age group of 60–69 years [Table 1]. Lower socioeconomic patients showed maximum incidence of 36 (60%) [Table 2]. Maximum number of patients 25 (41.7%) in our study were having Grade 2 BPH [Table 3]. On USG, majority of our cases were Grade-2 (43.3%) and Grade 1 (40.0%) [Table 4]. As shown in Table 5, maximum

Table 1: Distribution of patients according to age group

Age group (years)	Number of patients	%
50–59	22	36.7
60–69	27	45.0
70–79	11	18.3
Total	60	100
Mean±SD	62.18±6.76	
Median	62	
Min-Max	50–78	

Table 2: Distribution of patients according to socioeconomic status

Socioeconomic status	Number of patients	%
High class	5	8.3
Middle class	19	31.7
Lower class	36	60
Total	60	100

Table 3: Distribution of patients according to prostate on DRE

Size	Number of patients	%
Grade 1	24	40.0
Grade 2	25	41.7
Grade 3	11	18.3
Total	60	100

Table 4: Distribution of patients according to prostate volume on ultrasound

Prostate volume	Number of patients	%
Grade 1 (21–30 cc)	24	40.0
Grade 2 (31–50 cc)	26	43.3
Grade 3 (51–80 cc)	10	16.7
Total	60	100
Mean	38.02±12.52	
Median	35 cc	
Min-Max	23–68 cc	

Table 5: Distribution of patients according to international prostate symptom score

IPSS score	Number of patients	%
−7	19	31.7
8−19	31	51.7
20−35	10	16.7
Total	60	100
Mean±SD	12.62±7.43	
Median	10	
Min-Max	3–30	

number of patients 31 (51.7%) were having IPSS score between 8 and 19.

In this study on uroflowmetry, the mean interval time was 8.83 s and ranged between 0 and 42 s, mean voided volume was 209.80 ml, and mean max. flow rate was 10.14 ml/s while mean voiding time was 66.92 s [Table 6]. In Q_{max} < 10 ml/s range 28 (46.67%) and in 10–15 ml/s 27 (45%) patients were there [Table 7]. In Grade 1, total patients were 24 and majority were in Q_{max} 10–15 ml/s range while in Grade 2, total patients were 26 and majority were in Q_{max} < 10 ml/s [Table 8]. In our study, Q_{max} < 10 ml/s group, the mean prostate volume was observed as 44.04 cc, in 10–15 ml/s group, it was 33.93 cc [Table 9].

In IPSS ≤ 7 group, patients were 19, out of which maximum were in Q_{max} 10–15 ml/s range while in IPSS 8–19 group, total patients were 31 and majority were in Q_{max} < 10 ml/s range [Table 10]. In the IPSS ≤ 7 group, the mean maximum flow rate was observed as 13.68 ml/s, in 8–19 group, it was 9.17 ml/s, and in 20–35 group, it was 6.40 ml/s [Table 11]. If we correlate IPSS score with prostate volume, majority 24 (77.4%) were in IPSS score 8–19 and they were having Grade 2 prostate volume [Table 12]. In the IPSS ≤ 7 group, the mean prostate volume was observed as 30.21 cc, in 8–19 group, it was 36.45 cc, and in 20–35 group, it was 57.70 cc in our study [Table 13].

Table 6: Distribution of mean uroflowmetry

Uroflowmetry	Mean±SD	Median	Min-Max
Interval time	8.83±8.41	7.50	0–42
Voided volume	209.80±82.61	180	105–518
Max. flow rate	10.14±3.93	10	3–20
Flow time	45.73±14.79	46	19–88
Voiding time	66.92±34.57	58.50	20–198

Table 7: Distribution of patients to maximum flow rate

Max. flow rate (ml/s)	Number of patients	%
<10	28	46.67
10–15	27	45
>15	5	8.33
Total	60	100
Mean±SD	10.14±14.79	
Median	10	
Min-Max	3–20	

DISCUSSION

The study which was done on 60 patients was designed to determine the relationship among parameters of uroflowmetry and ultrasound findings and IPSS. Patients were distributed according to age which ranged between 50 and 78 years. The mean of patients in this study was 2.18 ± 6.76 years. Most of the patients (45%) were in the group of 60–69 years. Mebust *et al.*, in their study, displayed almost similar results with patients who had an average age of 69 years, for benign prostatic hyperplasia.[1] Similarly, Iqbal *et al.* and Saleem *et al.* reported patients with mean ages of 63.4 and 65.6 years, respectively.

The patients of BPH who visited our hospital were studied. Socioeconomic status was categorized into three categories according to their monthly income. Lowest frequency of patients 5 (8.3%) was found in higher-class patients and highest frequency of 36 (60.0%) patients was found in the lower-class patients. In this study, 60 patients were distributed according to prostate size, categorizing 24 (40%) patients as Grade I, 26 (43.3%) patients as Grade II, and 10 (16.7%) patients as Grade III. The maximum being in Grade II. The mean prostatic size having a range of 23–68 cc was found out to be 38.02 cc which is almost equal to 40.l cc in 354 patients and 41 cc in 25 patients in the studies by Vesely *et al.* and Dicuio *et al.,* respectively.[2,3]

Depending on clinical suspicion of BPH, digital rectal examination serves an important role. It not only confirms our clinical diagnosis of BPH but also gives an idea of the clinical grade of the enlarged prostate. In this study, on DRE, 24 (40.0%) patients were diagnosed as Grade l BPH, while 25 (41.7%) were diagnosed as Grade II, and 11 (18.3%) patients were diagnosed as Grade III BPH. Almost all these findings of DRE were radiologically confirmed by ultrasonography. Therefore, it can be stated that DRE is a very efficient tool in the diagnosis as well as

Table 8: Correlation between prostate volume and maximum flow rate

Max. flow rate (ml/sec)	Prostate volume			*P* value
	Grade 1 (21–30cc)	Grade 2 (31–50 cc)	Grade 3 (51–80 cc)	
	Number of patients (%)	Number of patients (%)	Number of patients (%)	
<10	3 (12.5)	17 (65.4)	8 (80)	<0.001
10–15	16 (66.7)	9 (34.6)	2 (20)	
>15	5 (20.8)	0 (0)	0 (0)	
Total	24 (100)	26 (100)	10 (100)	

Table 9: Distribution of mean prostate volume according to maximum flow rate

Prostate volume	<10 ml/sec	10–15 ml/sec	>15 ml/s	*P* value
	Mean±SD	Mean±SD	Mean±SD	
	44.04±12.58 cc	33.93±10.38 cc	26.40±10.70 cc	0.001

Table 10: Correlation between maximum flow rate and IPSS

Max. flow rate (ml/s)	IPSS score			*P* value
	≤7	8–19	20–35	
	Number of patients (%)	Number of patients (%)	Number of patients (%)	
<10	2 (10.5)	17 (54.8)	9 (90)	
10–15	13 (68.4)	13 (41.9)	1 (10)	
>15	4 (21.1)	1 (3.2)	0 (0)	
Total	19 (100)	31 (100)	10 (100)	<0.001

IPSS: International prostate symptom score

Table 11: Distribution of mean flow rate according to IPSS

Max. flow rate (ml/sec)	IPSS score			*P* value
	≤7	8–19	20–35	
	Mean±SD	Mean±SD	Mean±SD	
	13.68±3.25 ml/s	9.17±2.82ml/s	6.40±2.88ml/s	<0.001

IPSS: International prostate symptom score

Table 12: Correlation between prostate volume and IPSS

Prostate volume	IPSS score			*P* value
	≤7	8–19	20–35	
	Number of patients (%)	Number of patients (%)	Number of patients (%)	
Grade 1	17 (89.5)	7 (22.6)	0 (0)	<0.001
Grade 2	0 (0.0)	24 (77.4)	2 (20)	
Grade 3	2 (10.5)	0 (0)	8 (80)	
Total	19 (100)	31 (100)	10 (100)	

IPSS: International prostate symptom score

Table 13: Distribution of mean prostate volume according to IPSS

Prostate volume	IPSS score			*P* value
	≤7	8–19	20–35	
	Mean±SD	Mean±SD	Mean±SD	
	30.21±11.11 cc	36.45±6.38 cc	57.70±8.78 cc	<0.001

grading of BPH. Basawaraj *et al.*[4] in his study had subjected patients to ultrasonography and graded in according to their prostate volume. Maximum number of patients had a prostate volume measuring 31–50 cc (35.7%) followed by patients having prostate volume more than 50 cc (19.8%). The largest prostate volume was 91 cc with mean being 36.98 cc ± 18.05 and median value of 33 cc. In our study, maximum number of patients were having prostate size measuring 31–50 cc (43.3%) followed by patients having prostate volume 21–30 cc (40.0%).

The lowest prostate volume is 23 cc and largest prostate volume is 68 cc, having a mean of 38.02 12.55 cc and median value of 35 cc. Therefore, both the studies have almost similar values, thereby focusing on the correlation between prostate volume and grading of the disease taking severity of symptoms into consideration.

IPSS score was brought into use by the American Urology Association and European.

Urology Association to evaluate the severity of BPH.[5] IPSS is used to evaluate therapeutic response in men with LUTSs. Basawaraj *et al.*[4] found that 21.4% of patients were having mild symptoms (IPSS score < 7), 37.3% of patients were having moderate symptoms (IPSS 8–9), and 41.3% of patients were having severe symptoms (IPSS 20–35). In the present study, it was found that 31.7% of patients were having mild symptoms (IPSS score ≤ 7), 51.7% of

patients were having moderate symptoms (IPSS 8–9), and 16.7% of patients were having severe symptoms (IPSS 20–35). The mean was found out to be 12.62 ± 7.43 with a median value of 10 and range being 3–30.

In our study, the mean voided volume was found out to be 209.80 ± 82.61 ml with a range 105–518 ml. The mean maximum flow rate is 10.14 ± 3.93 ml/s with a range 3–20 ml/s. The mean flow time is 45.73 ± 14.79 ml/s with a range 19–88 ml/s. The mean voiding time is 66.92 ± 34.57 s with a range 20–198 s. In our study, maximum numbers of patients (46.67%) were having maximum flow rate < 19 ml/s followed by 45% of patients having maximum flow rate between 10 and 15 ml/s. Only 8.33% were found to have a maximum flow rate >15 ml/s. Mean maximum flow rate was 10.14 ± 3.93 with a range 3–20. The findings are almost comparable to 9.67 ± 3.26 ml/s as the mean of maximum flow rate in the study by Malik *et al*.[6]. Range was 6.1–18.8 ml/s. In this study, maximum flow rate was correlated with prostate volume. *P* value was found out to be < 0.01, thereby showing a positive correlation between both parameters.

Correlation between prostate volume and maximum flow rate was studied taking into consideration all the three grades of BPH. *P* value came out to be < 0.001 which is suggestive of a significant correlation between maximum flow rate and prostate volume. Mohammed *et al*.[7] in their study also showed significance seen in the correlation between peak flow rate and prostate volume. Distribution of mean prostate volume according to maximum flow rate was studied statistically. Mean values of prostate volume were found to be higher in patients having maximum flow rate of <10 ml/s. *P* < 0.001 was suggestive of a significant correlation between mean prostate volume and maximum flow rate. This signifies that the higher the prostate volume, the lower the maximum flow rates. Relationship between maximum flow rate and IPSS was considered statistically. *P*<0.001 was significantly suggesting a positive correlation between maximum flow rate and IPSS. Singla *et al*.[8] and El Din *et al*.[9] in their studies had suggested a significant correlation between the above-mentioned parameters. However, Heynes *et al*.[10] in their study had stated a significant negative correlation between maximum flow rate and IPSS.

While studying the mean maximum flow rate according to IPSS, it was found that mean maximum flow rate was found to be highest in patients with IPSS ≤ 7 with *P* < 0.001, thereby indicating a positive correlation between the parameters. This suggests that higher the IPSS, lesser is the flow rate. El Din *et al*.[9] had, in their study, shown that there was no correlation between prostate volume and IPSS. Basawaraj *et al*.[4] in their study suggested a weakly significant correlation between the two parameters. However, the statistical analysis of prostate volume versus IPSS showed strongly significant correlation between the two parameters as *P* value was < 0.001. Mean prostate volume was higher in patients with IPSS 18–35. It denotes that higher the prostate volume higher is severity index in patient's BPH.

CONCLUSION

On the basis of data which were obtained after evaluation of 60 patients with benign prostatic hyperplasia, it can be concluded that prostate volume and its relationship with peak flow of output can help to predict the degree and cause of obstruction. Larger the size of gland lower the peak flow rate. It will help clinicians to determine the severity of the symptoms and line of management to be undertaken. The higher the prostate volume, the higher the possibility of the cause to be obstructive due to benign prostatic hyperplasia. Of all the parameters of uroflowmetry, maximum flow rate was the most representative of the symptoms severity of the patient. Uroflowmetry, IPSS, and ultrasound are non-invasive, easy, and cheap investigation in evaluation of LUTSs, mainly due to BPH.

Our study states that maximum flow rate and prostate volume show a positive significant correlation having *P* < 0.01. Considering all the three grades of BPH, a positive correlation was found between prostate volume and maximum flow rate. *P* < 0.001 is suggestive of a significant correlation between maximum flow rate and prostate volume. It indicates that maximum flow rate decreases with increase in the prostate volume.

Distribution of mean prostate volume according to maximum flow rate was studied statistically. *P* <0.001 was suggestive of a significant correlation between mean prostate volume and maximum flow rate signifying that the higher the prostate volume, the lower the maximum flow rates.

Statistically, *P* <0.001 represents a positive correlation between maximum flow rate and IPSS, thereby stating the higher the IPSS lesser is the mean flow rate. While studying the mean maximum flow rate according to IPSS, it was found that mean maximum flow rate was found to be highest in patients with IPSS ≤7 with *P* <0.001, thereby indicating a positive correlation between the parameters. This suggests that higher the IPSS lesser is the flow rate. The statistical analysis of prostate volume versus IPSS showed strongly significant correlation between the two parameters as *P* value was <0.001. Mean prostate volume was higher in patients with IPSS of 18–35. It denotes

that higher the prostate volume higher is severity index in patients with BPH.

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How to cite this article: Goyal M, Dobhal D, Tyagi P, Goyal SK. To Know the Correlation of Prostate Size on Ultrasound with International Prostate Symptom Score and Uroflowmetry in Benign Prostatic Hyperplasia. Int J Sci Stud 2020;8(3):52-58.

Source of Support: Nil, **Conflicts of Interest:** None declared.