Original Research Article

To Evaluate Usefulness of Ultrasound Cystodynamogram in Evaluation of Bladder Outlet Obstruction: An Institutional Based Study

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Received: 18-05-2021 / Revised: 10-07-2021 / Accepted: 18-08-2021

Abstract

Background: Bladder outlet obstruction (BOO) is a urological condition where the urine flow from the urinary bladder through the urethra is impeded. The present study was conducted to assess usefulness of ultrasound cystdynamogram in evaluation of bladder outlet obstruction. **Materials and Methods:** The 51 patients for this prospective observational study of bladder outlet obstruction were selected from the cases admitted to surgical wards of Saraswathi Institute of Medical Sciences, Hapur, Anwarpur, Uttar Pradesh (India) during Feb 2019 to Feb 2020. All the patients included in this study were subjected to standard diagnostic criteria including detailed history, International prostatic symptom score (IPSS), physical examination, digital rectal examination (DRE), Complete blood counts (CBC), renal biochemistry, complete urine analysis, culture and sensitivity (C/S), uroflowmetry and ultrasonography. The results were correlated with each other and subjected to statistical analysis. Chi square test was applied to calculate the p values for the associations between the variables studied. **Results:** The present study showed that the age distribution in our study ranged from 40 to 92yrs with peak prevalence in 7th and 8th decade of life. Maximum no. of patients in our study were farmers. The most commonly reported symptom was frequency of micturition, found in 47 patients. Nocturia was the second most common LUTS subtype. 94.2% of the patients had an International prostate symptom score of more than 7. Physical examination in all the cases of our study group did not reveal any significant finding. Except for the digital rectal examination which gave useful information about the approximate prostate size. DRE showed significant correlation (p= 0.008), when was compared with the different IPSS scores. Digitally evaluated size of the prostate also did correlate well with the size of prostate assessed on USG. 17.6% of the patients of our study turned out to be diabetic. USG gave a fair evidence about: Prostate size – 40 cases (78.4%) had the prostate of more than 30gms, Intravesical protrusion of prostate – 31.4% had median lobe protrusion into the bladder Presence of bladder calculus - 2 patients had bladder calculus, Presence of diverticula –only 1 out of 51 had bladder diverticulum while 2 had trabeculations visible on USG, Bladder wall thickness - most of the patients had the thickness of 6mm or 5.5mm, 39.2% and 35.3% respectively, Post void residual – 54.9% of cases had significant amount of post void residual**. Conclusion:** The present study concluded that however, ultrasound cystodynamogram cannot replace pressure flow studies in the diagnosis of Bladder Outlet Obstruction, but it can provide a valuable improvement over symptom score and simple uroflowmetry in the diagnosing the cause of lower urinary tract dysfunction.

Keywords: Bladder Outlet Obstruction, Ultrasound Cystodynamogram, Lower Urinary Tract Symptoms.

Introduction

Bladder outlet obstruction (BOO) is a urological condition where the urine flow from the urinary bladder through the urethra is impeded. The hallmark of bladder outlet obstruction is urinary retention which may be acute or chronic. Urinary retention is a common urological problem seen worldwide, predominantly in the elderly. The incidence increases with age so that a man in his 70s has 10% chances and a man in his 80s has more than 30% chances of having episode of acute urinary retention[1,2].

According to Drach et al. Uroflowmetry is the measurement of urine flow over time. It is an objective and noninvasive urodynamic study that may reveal an abnormal voiding phase of the micturition cycle. The single most important parameter of the uroflowmetry is the maximum urinary flow (Qmax), which is volume dependent[3].Salam M. Momtaz B. et al. concluded that, Ultrasound cystodynamics is a noninvasive test for assessing the bladder function correlated to voiding cystometry to 70% of cases in normal bladder function and 85% of overactive bladder and 9O% in adynamic or hyporeflexic bladder. Moreover, this test can recognize the structural defect like bladder neoplasm, hydronephrosis that cannot be detected by urodynamic study. This test is cost effective as this can be done almost anywhere with a 1/4thcost of invasive urodynamic study[4]. The present study was conducted to assess usefulness of ultrasound cystdynamogram in evaluation of bladder outlet obstruction.

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Materials and methods

The 51 patients for this prospective observational study of bladder outlet obstruction were selected from the cases admitted to surgical wards of Saraswathi Institute of Medical Sciences, Hapur, Anwarpur, Uttar Pradesh (India) during Feb 2019 to Feb 2020. Patients of all age groups and male gender, well informed patients, willing to comply with the study protocol were included in this study. Patients who had undergone previous surgery, patients who could not void due to

urinary retention. patients whose voided volume repeatedly did not exceed 125mL were excluded from the study. All the patients included in this study were subjected to standard diagnostic criteria including detailed history, International prostatic symptom score (IPSS), physical examination, digital rectal examination (DRE), Complete blood counts (CBC), renal biochemistry, complete urine analysis,culture and sensitivity(C/S),uroflowmetry and ultrason-ography. In digital rectal examination 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**.** A case history was recorded in detail as per the proforma and IPSS scoring system and any salient feature of the cases were recorded. A note was recorded regarding the previous history of similar illness, previous operations or any instrumentation, urinary infection, and treatment. The following necessary investigations were done after a thorough clinical examination of the patient.

Urine

Midstream urine was collected in a sterilized wide mouthed container after necessary precautions. After physical examination for colour, a commercially available reagent strip (Multistix SG, Siemens Ltd) was used for the detection of pH, proteins and sugar in urine. Then microscopy was done for the detection of pus cells, red blood cells, epithelial cells and crystals.

Blood

A routine blood examination was done, such as Hb%, W.B.C. count (Total and Differential).

Also, blood urea, serum creatinine and random blood sugar levels were done using VITROS 250 dry chemistry auto analyser and noted.

Ultrasound Cystodynamogram Findings

Patients were advised to take fluids per orally and hold on the act of micturition to the appropriate limit of urge to pass the urine. Who were then ultrasonographically evaluated, which was performed using a 5-MHz curved-array transducer positioned suprapubically, and the following parameters were noted in a state of full bladder.

- Bladder wall thickness
- Bladder volume
- Presence of diverticula
- Distal ureteric anatomy
- Prostatic volume
- Intravesical prostatic protrusion (median lobe enlargement)
- Presence of intra-vesical pathology (carcinoma or calculi)

This was followed by uroflowmetric measurement, which was performed using gravimetric/weight transducer type uroflow meter.

The following parameters were observed in the uroflowmetry examination.

- Total volume voided.
- Flow time
- Voiding time
- Rate of flow of urine
  - Maximum Flow
  - Average Flow

And a review ultrasound examination was done to assess the amount of postvoid residual urine, using the same ultrasound machine. The results of IPSS score, clinical findings, and ultrasound cystodynamogram were reported independently and in combination. The results were correlated with each other and subjected to statistical analysis. Chi square test was applied to calculate the p values for the associations between the variables studied.

Results

The present study showed that the age the mean age of the patients was 60yrs.Maximum no. of cases (27.5%) were found in 70-79yrs of age group and 25.5% of patient found in 60-69yrs of age group. So overall 7^{th} and 8^{th} decade was the most common age group in which LUTS were found.Amongst the studied patients (n= 51), most commonly reported symptom was frequency of micturition, found in 47 patients. While nocturia was the second most common LUTS subtype.In this study group most (56.8%) of the patients were farmers i.e; 29 out of 51. While rest of the patients were either businessman (23.5%), labourer (11.8%), or unemployed (7.8%).

Table 4 shows the distribution of patients according to the total IPSS score, where 47.1% of the patients had a total score of 8–19 and 20-35 each, while only 5.8% of patients were mildly symptomatic with a score less then 7.On comparing the IPSS score with the prostate size, which was evaluated on ultrasonography, did not show significant results with a p value of 0.379. As 81.9% of patients with IPSS score more than 7 had a prostate size of less than 30gms.Digital rectal examination of these cases also showed significant correlation (p= 0.008) amongst the study group, when were compared with the different IPSS scores.The frequency of patients according to the thickness of bladder wall is given in table 7, most of the patients had the thickness of 6mm or 5.5mm, 39.2% and 35.3% respectively.

During the uroflowmetry study, 72.5% of cases showed the maximum urine flow rate of lower then 15ml/s. The mean of maximum flow of all patients was 12.76ml/s. While this peak flow rate ranged from the maximum of 33ml/s to the minimum of 3ml/s.On comparing the max flow with the IPSS score of study population, it showed significant correlation between the two (p value 0.000). As the patients with higher symptom score had lower maximum flow rates.

Table 9, 10 and 11 shows the percentage distribution of the maximum flow rate of the ultrasonographic findings of prostate size, protrusion of median lobe and bladder wall thickness, depicting insignificant correlation between all with p values of 0.016, 0.066 and 0.491 respectively. While max flow did show significant correlation with the time taken for the act of voiding (voiding time) p value 0.002.

On comparing the final diagnosis 'made using ultrasound cystodynamogram' with the different ultrasonographic and uroflowmetry parameters used in the study, many significant correlations were reported. Table 12 shows that out of the 28 patients who were finally diagnosed of having BPH, 16 had prostate size between 40-60gms and 5 had the size of >60gms (p value 0.000) i.e; 75% of BPH patients had prostate size >40gms.

Table 13 shows that in BPH diagnosed patients 50% of cases had median lobe protrusion while in non BPH patients only 8.7% of cases had protruding median lobe, of about 1cm.

Table 14 also shows significant correlation between BPH group and bladder wall thickness (p value 0.004). As 96.4% of the patients with BPH had either normal thickness or thicker bladder wall, while amongst non BPH patients 65.2% of patients had either normal or thinner bladder wall.

Similarly, even post void residual urine was found significantly raised among the BPH group (p value 0.001).

Table 1: Age distribution of the patients

Age group (Yrs.)	No. of patients (n=51)	Percentage (%)
40-49	12	23.5
50-59	10	19.6
60-69	13	25.5
70-79	14	27.5
90-99	2	3.9
Total	51	100

Table 2: Age wise distribution of symptoms

Age	Incomplete Emptying	Frequency	Intermittency	Urgency	Weak Stream	Straining	Nocturia
40-49	4	11	3	4	7	7	7
50-59	4	10	4	8	8	6	10
60-69	11	10	9	6	11	13	13
70-79	8	14	7	11	9	6	12
90-99	0	2	2	2	2	2	2
Total	27	47	25	31	37	34	44

Table 3: Distribution of Occupation

Occupation	Percentage (%)	No. of patients (n=51)
Businessman	23.5	12
Farmer	56.9	29
Labourer	11.8	6
Unemployed	7.8	4
Total	100	51

Table 4: Distribution of Total IPSS Score

IPSS	No. of patients (n=51)	Percentage (%)
Mildly Symptomatic	3	5.8
Moderately Symptomatic	24	47.1
Severely Symptomatic	24	47.1
Total	51	100

Table 5: Values of prostate size in different symptom scores

IPSS Score	Prostate Size on USG			
	< 30gms	**30-60 gms**	**> 60gms**	
Mildly Symptomatic	18.1%	2.9%	0.00%	P value 0.379
Moderately Symptomatic	45.5%	48.6%	40%	
Severely Symptomatic	36.4%	48.6%	60%	

Table 6: Distribution of DRE amongst symptom groups

IPSS	DRE					P value 0.008
	flat	**+**	**++**	**+++**	**Total**	
Mildly Symptomatic	2	1	0	0	3	
Moderately Symptomatic	6	10	6	2	24	
Severely Symptomatic	4	1	17	2	24	
Total	12	12	23	4	51	

Table 7: Distribution of bladder wall thickness

Bladder wall thickness	No. of patients (n=51)	Percent
5mm	11	21.6
5.5mm	18	35.3
6mm	20	39.2
6.5mm	2	3.9
Total	51	100

Table 8: Distribution of maximum urinary flow

Max flow	No. of patients (n=51)	Percentage (%)
<15ml/s	37	72.5
15-25ml/s	9	17.6
>25ml/s	5	9.8
Total	51	100

Table 9: Distribution of Max flow according to IPSS score

Max flow	IPSS score				p value 0.000
	Mildly symptomatic	**Moderately symptomatic**	**Severely symptomatic**	**Total**	
<15ml/s	0	13	24	37	
15-25ml/s	0	9	0	9	
>25ml/s	3	2	0	5	
Total	3	24	24	51	

Table 10: Distribution of Max flow according to Prostate size

Max flow	Prostate size on USG			
	< 40gms	**40-60 gms**	**> 60gms**	
<15ml/s	60%	85.70%	72.50%	**p value 0.164**
15-25ml/s	20%	14.30%	17.60%	
>25ml/s	20%	0%	9.80%	

Table 11: Distribution of Max flow according to the median lobe protrusion

Max flow	Median Lobe			
	1cm	2cm	No	
<15ml/s	100%	100%	60%	p value 0.066
15-25ml/s	0%	0%	25.7%	
>25ml/s	0%	0%	14.3%	

Table 12: Distribution of Max flow for different thickness of bladder wall

Max flow	Bladder wall thickness				
	5mm	5.5mm	6mm	6.5mm	
<15ml/s	81.8%	55.6%	80%	100%	p value 0.491
15-25ml/s	9.1%	33.3%	10%	0%	
>25ml/s	9.1%	11.1%	10%	0%	

Table 13: Distribution of prostate size in BPH group

BPH	USG estimated size of prostate				
	< 40gms	40-60 gms	> 60gms	Total	
No	18	5	0	23	p value 0.000
Yes	7	16	5	28	

Table 14: Presence of Median lobe in BPH group

BPH	Median Lobe				
	1cm	2cm	No	Total	
No	2	0	21	23	p value 0.005
Yes	8	6	14	28	

Table 15: Distribution of thickness of bladder wall in BPH group

BPH	Bladder wall thickness					
	5mm	5.5mm	6mm	6.5mm	Total	
No	10	5	8	0	23	p value 0.004
Yes	1	13	12	2	28	

Table 16: Distribution of PVRU in BPH group

BPH	PVRU			
	<50	>50	Total	
No	16	7	23	p value 0.001
Yes	7	21	28	

Discussion

A total of 51 patients with lower urinary tract symptoms were studied in the present study, which showed a peak incidence of cases (53%) in 7th and 8thdecade of life with a mean age of 60yrs (range 40-92yrs). This was in keeping with the age distribution of patients suffering LUTS reported in previous studies.

IPSS score

In the present study, the most common symptoms were of frequency of micturition and noturia, with which 47 and 44 cases suffered respectively out of 51.The mean of the total IPSS score in our study was 17.9 ± 6.1 (Mean ± SD), which was comparable with results of the other studies.

Uroflowmetry

In our study out of the 51 patients presenting with LUTS, 72.5% of patients had a low Qmax when the limit of normal of Qmax was kept between 15-25ml/sec.

The mean Qmax in our study group was 12.76 ± 8.1ml/sec which is comparable with the values of other studies.

The Relationship Between Symptoms and Uroflowmetry Variables

The Qmax of our study correlated well with the symptom score, higher was the symptom score, lower was the Qmax. All 37 patients with Qmax<15ml/sec had IPSS scores of >7, of which 35.1% were moderately symptomatic and 64.9% were severely symptomatic, while all those who had normal Qmax (>15ml/sec) scored <19 on there IPSS, which is similar to the obsevations quoted in other literatures.

M.-Y. Kang et al. concluded, even though several non-invasive methods used for the evaluation of BOO, only maximal flow rate plays a significant role in predicting of BOO in Korean men with LUTS. Thus, abnormal finding of uroflowmetry indicates the need for performing PFS.

Table 17: Age distribution

Authors	(Year)	N	Mean Age ± SD
Damir Aganovic et al[5]	2012	110	65.3 ±7.4yrs
Hyoung Keun Park et al[6]	2012	90	68.8 ± 9.4yrs
Chi-Kwok Chan et al[7]	2011	186	65.5 ± 7.6yrs
Lee LS et al[8]	2010	259	63yrs
M.-Y. Kang et al[9]	2009	137	69.90±7.67yrs
Mauro Dicuio, MD et al[10]	2003	67	67.5 ± 8.0yrs
Present study	2013	51	60 ± 13.8yrs

Table 18: IPSS Score distribution

Authors	(Year)	N	Mean IPSS (SD)
Hyoung Keun Park et al[6]	2012	90	19.2 (9.5)
Damir Aganovic et al[5]	2012	110	18.2 (5.8)
Chi-Kwok Chan et al[7]	2011	186	13.5 (6.8)
M.-Y. Kang et al[9]	2009	137	19.32 (8.8)

Mauro Dicuio, MD et al[10]	2003	67	16.3 (9.4)
Present study	2013	51	17.9 (6.1)

Table 19: Distribution of Max flow rate

Authors	(Year)	N	Mean Qmax ± SD
Damir Aganovic et al[5]	2012	110	10.3 ± 3.9 ml/sec
Hyoung Keun Park et al[6]	2012	90	13.4 ± 6.2 ml/sec
M.-Y. Kang et al.[7]	2009	137	7.34±3.12 ml/sec
Present study	2013	51	12.76 ± 8.1ml/sec

Ultrasonography

Prostate size

According to Walsh PC et al. hyperplasia of the prostate gland is a progressive condition with an onset in the early thirties and worsening with age. There are no good epidemiological studies of the incidence of clinical prostatism at different ages. However, it has been shown that 50% of men aged 51-60 years and 90% of men over age of 80 years have histological evidence of benign prostatic hyperplasia.11

In the present study 33.3% of symptomatic patients in the age group of 40-49 had enlarged prostate (>30gms), while the size was seen to increase progressively with age. In 7thand 8th decade of life 15.4% and 21.4% of the studied cases had prostate size more than 60gms respectively.Although a poor correlation has been observed between symptoms and prostate size. About 19% of moderate and severely symptomatic patients had a prostate size of less than 30gms.

Bladder Wall Thickness

Oelke et al[12]conducted a prospective study to find non-invasive tests for the evaluation of BOO; they suggested ultrasound measurements of detrusor wall thickness was better than the Qmax, postvoid residual volume or prostate volume for the diagnosis of BOO. Jequier and Rousseau demonstrated that normal values of bladder wall thickness in children were not dependent on age or gender, but were significantly dependent upon the level of the bladder filling[13].In our study bladder wall thickness of the studied group ranged from 5mm to 6.5mm, with most patients having a thickness of 5.5 and 6mm, n= 18 and 20 respectively.

Also, it was seen that most patients of the BPH group had a wall thickness of greater than 5.5mm, while those diagnosed of having detrusor weakness had a thin bladder wall. Although bladder wall thickness did not show much correlation with the presence of residual urine or max flow.

Intravesical Prostatic Protrusion (IPP)

KeongTatt Foo MD et al[14] noted that, a low-grade IPP is generally associated with good Qmax (>12 mL/s), however if the Qmax is low, then further investigations such as flexible cystoscopy or pressure flow study would need to be done in order to rule out other differential diagnoses such as urethral stricture or detrusor dysfunctions. If there is a high-grade IPP (>10 mm), even if there is a good Qmax of >12 mL/s, there is still a 65% chance that the patient is obstructed on pressure flow studies.[122] In other words IPP is a better predictor of urodynamics obstruction than Qmax.

In the present study31.4% of cases had median lobe enlargement. IPP also showed positive correlation with age, as the age increased percentage of presence of median lobe also increased.

When compared with the symptom score (IPSS), IPP showed positive correlation, as 16.7% of moderately symptomatic patients and 50% of severely symptomatic patients did show median lobe enlagement, while none of the mildly symptomatic patient had IPP.

Ultrasound Cystodynamogram / Ultrasound Cystodynamics (USCD)

Schafer W, in 1995 said, the gold standard to evaluate grade of lower urinary tract symptoms is urodynamic study with pressure flow analysis[15]Sonkeet al[16]demonstrated that frequently used diagnostic parameters such as prostate volume, postvoid residual volume and I-PSS were not useful for the prediction of BOO, and the correlation between these parameters and the PFS findings was poor. The only study found on USCD done by Boothroyd AE et al[17] showed the diagnostic capability of USCD was studied in 116 consecutive cases 46 of whom had also had VCMG. Comparison of the data obtained using both techniques revealed no significant difference. USCD has proved to be accurate, safe and reproducible and is of particular value in patient follow-up.

Conclusion

The present study concluded that however, ultrasound cystodynamogram cannot replace pressure flow studies in the diagnosis of BOO, but it can provide a valuable improvement over symptom score and simple uroflowmetry in the diagnosing the cause of lower urinary tract dysfunction. Moreover, this test could also recognize the structural defect like bladder calculus, neoplasm, diverticulum that cannot be detected by urodynamics. After the completion of this study, we believe that ultrasound cystodynamogram is an excellent, non-invasive, easy and cheap investigation for evaluation of lower urinary tract symptoms.

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Conflict of Interest: Nil
Source of support: Nil