Bladder and Prostate Sonomorphology as Non Invasive Method for Assessing the Lower Urinary Tract in Patient with Symptomatic Bladder Outlet Obstruction Due to Benign Prostate Enlargement

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ABSTRACT:

BACKGROUND:

Measurement of the bladder weight, bladder wall thickness and intravesical prostatic protrusion can be done by using ultrasound which is a simple, non-invasive and less complex, which may predict bladder outlet obstruction in patient with benign prostatic hyperplasia.

PATIENTS AND METHOD:

A cross sectional comparative study conducted in Urology outpatient department at Ghazi al-Hariri hospital for surgery specialties during the period between the first of March 2017 till the end of July 2018, a sample of 47 men aged 50 years or older with LUTS/BPH grouped in 2 groups according to urodynamic results: patients with bladder outlet obstruction and patients patient without outlet obstruction.

RESULTS:

In this study, we observed that bladder wall thickness, bladder weight and intravesical prostate protrusion were higher in bladder outlet obstruction group as compared to non- bladder outlet obstruction group with significant accuracy, sensitivity and specificity.

CONCLUSION:

Ultrasonographic measurements of bladder wall thickness, ultrasound estimated bladder weight and intravesical prostate protrusion are good parameters for the diagnosis of symptomatic bladder outlet obstruction due to benign enlargement of the prostate and they are easy to measure, with no complications, less time consuming and cost effective.

KEYWORDS: bladder wall thickness, bladder weight , intravesical prostate protrusion

INTRODUCTION:

Benign prostate enlargement (BPE) is one of the most common disease in elderly men. The prevalence of histological BPE increases with age and appears in approximately 40% of men aged 50-60 years and in approximately 90% of men aged more than 80 years [1]. Bladder outlet obstruction (BOO) is the main sequel of BPE, and it results from a variety of functional and anatomical factors [2]. The diagnosis of BOO/BPH is a challenging issue that had been debated for decades [3-5] and several methods have been used but most of these tests are not exclusive to bladder outlet obstruction with BPE[5,6]. The urodynamic study was considered the most useful test available for diagnosing BOO[3,7]. Parameters predicting BOO in men with (LUTS) include detrusor pressure and maximal urine flow rate in pressure-flow studies [8]. However, this method is invasive and complex[4].

In the recent years, there has been increase of interest in noninvasive urodynamic techniques in an attempt to avoid the complications of invasive urodynamic study[9].

Measurement the bladder weight , bladder wall thickness and intravesical prostatic protrusion can be done by using ultrasound which is a simple, non-invasive and less complex and can predict bladder outlet obstruction in patient with benign prostatic hyperplasia[10].

AIM OF THE STUDY:

The present study was designed to evaluate the accuracy of ultrasonic parameters for the diagnosis of bladder outlet obstruction associated with BPE.

PATIENTS AND METHODS:

A cross sectional comparative study conducted during the period between the first of March 2017 till the end of July 2018 on men aged 50 years or older with LUTS/BPE visiting urology outpatient department at Ghazi al-Hariri hospital for surgical specialties. Only patients with

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prostate size 25 g or more were included in the study.

The exclusion criteria were :Patients with obvious neurogenic disorders, diabetes mellitus, urinary tract infection, stone disease, genitourinary malignancies ,small bladder capacity (<150) and/or a history of lower urinary tract injury or surgery.

Study procedure

Utilizing standardized questionnaire that included applied data and medical records to the patient.

All patients had undergone urodynamic (pressure flow) study and according to its result the patients was grouped into BOO and non-BOO .

Transabdominal ultrasonography (TAUS) was carried out using PHLIPS HD 11 ultrasound diagnostic scanner equipped with 3 to 12 MHz abdominal probe.

Patients were advised to drink plenty of fluids prior to the evaluation, and the TAUS was performed when the bladder volume should be between 200-400ml. The urinary bladder and prostate were scanned in the midline suprapubic area, with the patient in supine position, using the abdominal probe. During routine USG, the following parameters were estimated and recorded:

Bladder wall thickness (BWT):

The choice of the correct ultrasound probe is important for exact measurements.A 7.5 MHz ultrasound probe gives the ideal characteristics for BWT measurements at the anterior bladder wall because of better resolution [13].

There is a hyperbolic relationship between an increasing volume and decreasing BWT, with no significant changes in the BWT with increasing bladder volumes more than 250 mL[2].

Ultrasound estimated bladder weight (UEBW)[in gm]

Calculated from the bladder volume. Assuming the bladder is a sphere, the bladder wall volume calculated by subtracting the intravesical volume from the total bladder volume (which includes the bladder wall). The UEBW was obtained by multiplying this parameter with the specific gravity of the bladder tissues (which is 0.957 ± 0.026 and subsequently rounded to 1 in the calculations) [13].

Intravesical prostatic protrusion (IPP)

IPP was measured by assessing the bladder neck for protrusion of the prostate into the bladder (the distance measured in {mm} from the tip of the intravesical protrusion and the circumference of the bladder at the prostate base).

Statistical analysis

The data were analysed using Statistical Package for Social Sciences (SPSS) version 25. The data presented as mean and standard deviation. Student's t- test (two tailed) was used to compare the continuous variables between study groups.Pearson's Chi–square test was used to assess statistical association between the biological parameter levels and the study groups. A level of p – value less than 0.05 was significant.

RESULTS:

Forty seven men grouped into 2 groups according to urodynamic results: 26 patients were BOO and 21 patients were nonBOO.

Ages of the patients were 50 and above and there was no significant difference regarding the age and urodynamic study results as shown in table 1

Table 1: Age of the patients and urodynamic study result.

Age groups	Urodynamic study			P-value
	Obstructed No. (%)	Not obstructed No. (%)	Total No. (%)	
50 - 59 yrs.	8 (53.3%)	7 (46.7%)	15 (100%)	0.973 □
60 - 69 yrs.	12 (57.1%)	9 (42.9%)	21 (100%)	
70+ yrs.	6 (54.5%)	5 (45.5%)	11 (100%)	
Total	26 (55.3%)	21 (44.7%)	47 (100%)	
Age (years), Mean ± SD	64.3 ± 7.3	64.4 ± 9.2	64.4 ± 8.1	0.961 [t]

□ Pearson's Chi-square test; [t] Student's t-test

Table 2: Comparison of parameters between BOO and non-BOO groups.

Variables	Obstructe d (n=26) Mean ± SD	Not obstructed (n=21) Mean ± SD	p-value
International Prostate Symptom Score	15.7 ± 5.1	14.4 ± 4.4	0.35
Bladder wall thickness mm	4.7 ± 0.8	2.8 ± 0.5	<0.001**
Intra-vesicle prostatic protrusion mm	15 ± 3	7.1 ± 2.7	<0.001**
Ultrasound estimated bladder weight (g)	50.1 ± 14.2	27.8 ± 3.8	<0.001**
Q max ml/s	9.9 ± 1.1	16.9 ± 1.1	<0.001**
PSA ng/dl	2.2 ± 0.9	1.4 ± 0.5	0.001**

**<0.01 significant; Student's t-test

Table 3: Cut-off values and validity parameters of ultrasound findings for detection of urinary tract obstruction.

Variable	Cutoff value	AUC	Sensitivity	Specificity	PPV	NPV	Accuracy
Bladder wall thickness mm	≥4.1	0.896	0.885	0.905	0.920	0.864	0.894
Intravesicle prostatic protrusion mm	≥11.3	0.977	0.962	0.900	0.926	0.947	0.935
Ultrasound estimated bladder weight (g)	≥33.8	0.936	0.923	0.905	0.923	0.905	0.915

Table 4: Urinary tract obstruction, according to parameters' cutoff points.

Parameters	Obstructed No. (%)	Not obstructed No. (%)	Total No. (%)
Bladder wall thickness			
≥4.1 mm	23 (88.5%)	2 (9.5%)	25 (53.2%)
<4.1 mm	3 (11.5%)	19 (90.5%)	22 (46.8%)
Total	26 (100%)	21 (100%)	47 (100%)
Intra-vesicle prostatic protrusion			
≥11.3 mm	25 (96.2%)	2 (10%)	27 (58.7%)
<11.3 mm	1 (3.8%)	18 (90%)	19 (41.3%)
Total	26 (100%)	20 (100%)	46 (100%)
Ultrasound estimated bladder weight			
≥33.8 g	24 (92.3%)	2 (9.5%)	26 (55.3%)
<33.8 g	2 (7.7%)	19 (90.5%)	21 (44.7%)
Total	26 (100%)	21 (100%)	47 (100%)

DISCUSSION:

The present study was designed to estimate the diagnostic accuracies and the optimal cutoff values for prostate and bladder ultrasonographic parameters in patients with LUTS/ BPH and BOO. The purpose was to determine if these parameters measured by transabdominal ultrasonography (TAUS) could be comparable to conventional urodynamic study (PFS) for the diagnosis of BOO.

Morphologic changes in the prostate and urinary bladder can be easily evaluated by ultrasonography which is non-invasive, available, less complex and without complications. In this study, TAUS used for prostate and bladder evaluation as it is simple and easy to perform. But there is intraobserver variability of ultrasound measurements which is about ≤5% and interobserver variability between 4-12% [15,16].

The changes of the obstructed bladder are time dependent and can be divided into three distinct stages which are characterized by:

Initial phase: a progressive increase of bladder weight due to thickening of the bladder.

Compensation phase: the bladder weight remains stable, detrusor strength is unchanged or even increased, and bladder emptying is complete.

Decompensation phase: a further increase of bladder weight occurs, detrusor strength decreases,the Microscopic studies of the bladder wall in this phase show that the space between smooth muscle cells becomes wider due to additional deposition of collagen and elastic fibers.

Bladder wall hypertrophy or increased bladder mass can be assessed by measuring the bladder weight and bladder wall thickness (BWT). Measuring ultrasound estimated bladder weight (UEBW) and BWT by using ultrasound is a simple, non-invasive method that has been widely applied in the assessment of lower urinary tract conditions such as voiding dysfunction and BOO [17].

Measurement of BWT can detect (BOO) better than free uroflowmetry, post-void residual urine (PVR), or prostatic volume [2].

Furthermore, Intravesical prostatic protrusion (IPP) had been found to correlate with BOO.Furthermore, Intravesical prostatic protrusion (IPP) had been found to correlate with BOO [18].It is a morphological change due to overgrowth of prostatic middle and lateral lobes into the bladder and may lead to diskinetic movement of bladder during voiding.

The accuracy of BWT measured subjectively by TAUS for the diagnosis of BOO was remarkable in the this study, also in the most of the other previous studies [14].

There was marked variability among the previous cutoffs values reported for BOO diagnosis by Guzel et al (3.25 mm) [14], Manieri et al (5 mm) [15], Oelke et al (2 mm) [2], and Kessler et al (2.9 mm) [16]. The bladder wall is relatively thin and may be affected by the amount of bladder filling [2]. In the present study, TAUS was done when patients had a sense of bladder fullness(at least the bladder volume was between 200-400 ml), and the value of about 4.1 mm was found to be optimum cutoff to differentiate BOO from non-obstructed.

The second parameter; UEBW, the bladder is measured as one unit, and usually not affected by the amount of bladder filling [19]. UEBW represents hypertrophy of the bladder wall and this in turn will reflect BOO [20]. In this study it was founded a higher UEBW in the BOO patients, and the diagnostic accuracy at a cutoff value of 33.8 gm was high (about 91.5%). This cutoff was slightly lower than the values reported by Kojima et al [13] and Miyashita et al [20] which was about 35 gm as an optimal cutoff.

The Third parameter that has been quantified by TAUS in this study and that yielded a significant diagnostic accuracy for BOO is IPP. In this study the IPP was significantly increased in BOO group, with an optimal cutoff value of 11.3 mm and the diagnostic accuracy was about 93.5%. These results agreed with previous studies [21] (but slightly higher) evaluating IPP as a predictor for BOO/BPH as Keqin et al [14] reported a significant sensitivity and specificity of IPP in the diagnosis of BOO with a cutoff of 8.5 mm. Also Leonardo O Reis et al [20] reported a high sensitivity and specificity of IPP in the diagnosis of BOO/BPH with a cutoff value of 10 mm but in our study the cutoff value was higher.

An important point in this study is that all ultrasonographic parameters that yielded a significant accuracy for the diagnosis of BOO/BPH patients were easily measured by TAUS. The availability and non-invasive, simple and time effective nature of this method made the assessment of these anatomic parameters acceptable for routine clinical practice.

CONCLUSION:

This study showed that TAUS measurements of BWT, UEBW, and IPP are comparable to urodynamic study for the diagnosis of symptomatic BOO due to BPH. Moreover, measurement of these parameters by ultrasonography is easy, with no complications ,less time consuming and cost effective and for these reasons it is acceptable to both patients and physicians and can be used during routine clinical evaluation of patients with symptomatic BPH with or without BOO.

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