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The Role of Ultrasound-Estimated Bladder-Wall Thickness In the Prediction of Detrusor Overactivity in Patients with Irritative Lower Urinary Tract Symptoms

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ABSTRACT

Objective: To explore the specificity and sensitivity of increased bladder wall thickness as measured by transabdominal ultrasonography (TAU) for diagnosing detrusor overactivity (DO) in patients with lower urinary tract symptoms (LUTS) compared to the results of filling cystometry as a gold-standard diagnostic procedure.

Methods: This prospective study included 60 patients who were neurologically free with irritative LUTS. The study included 40 females and 20 males. Patients were divided into 2 groups. Group 1 included 40 patients with urodynamic evidence of DO and Group 2 (control) included 20 patients with normal urodynamic studies. All patients were submitted to a history, clinical examination, urine analysis and culture, blood chemistry, and pelviabdominal ultrasound.

Results: The mean age of Group 1 and Group 2 was 22.4 ± 2.4 and 27.6 ± 2.1 years, respectively. All patients had urgency. While 25% of patients in Group 1 had urge incontinence, no patients in Group 2 had urge incontinence. Those in Group 1 (65%) had nocturnal enuresis compared to 10% in Group 2; more than 1 patient had more than 1 complaint. The mean bladder-wall thickness as measured by TAU was significantly higher in Group 1 (5.2 ± 0.27 mm) than in Group 2 (2.8 ± 0.47 mm) ($p < 0.001$).

Conclusion: Transabdominal ultrasound is a sensitive diagnostic technique when predicting DO in patients with LUTS. This technique is noninvasive and easily performed in an office setting with negligible risks. Further studies are required to validate the findings of this study before this technique can be recommended as a primary diagnostic tool for DO.

INTRODUCTION

Overactive bladder (OAB) syndrome is a common cause of urgency with or without urge incontinence, usually associated with frequency and nocturia. According to the recommendations of the International Continence Society (2002), the diagnosis of overactive bladder is only objectively made as an involuntary detrusor contraction that may be spontaneous or provoked during filling cystometry (CMG) while the patient is attempting to inhibit voiding [1]. Although CMG is accurate in diagnosing detrusor overactivity (DO), it carries the disadvantage of being invasive when repeated for the evaluation of treatment outcomes, especially in children. Hashim and Abrams found that 69% of men and 44% of women with urgency (OAB dry) had detrusor overactivity, while 90% of men and 58% of women with urgency and urge incontinence (OAB wet) had DO [2].

Bladder wall thickness (BWT), as measured by ultrasound, has been used in the diagnosis of voiding dysfunction. Children with recurrent urinary tract infections and nocturnal enuresis have significantly thick bladder walls [3,4]. Oelke et al. claimed

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that the measurement of BWT could detect bladder outlet obstruction (BOO) better than free uroflowmetry, post-void residual urine (PVR), or prostatic volume [5]. It was postulated that patients with DO had a thicker bladder wall than normal [6-8]. This could be attributed to detrusor hypertrophy secondary to repeated isometric bladder contractions against a competent, closed bladder neck [7]. A thicker BWT at the maximum bladder capacity measured by transabdominal ultrasonography (TAU) can be useful as a biomarker for DO in patients with OAB syndrome [8]. On the other hand, Kuo et al. observed that BWT increased in men but not in women with DO [9].

The mean normal BWT in women is 3.04 mm and 3.33 mm in men, with a slight increase with age for both genders. An increase of more than 5 mm in BWT may indicate detrusor hypertrophy [10]. In another view, a bladder wall cross-section of more than 3 to 4 mm measured at 50% of expected bladder capacity suggests underlying detrusor overactivity [11].

From these observations, there is some agreement that the ultrasonographically measured BWT has a role in the diagnosis of DO; however, there is no standardized method for measuring BWT, or if it should be measured while the bladder is empty, half full, or at maximum capacity. Moreover, the resolution of the ultrasound and accurate identification of the bladder wall also varied greatly in previous ultrasound studies of BWT.

The purpose of this study is to explore the specificity and sensitivity of increased bladder wall thickness, as measured by suprapubic ultrasonography, for diagnosing detrusor overactivity (DO) in patients with lower urinary tract symptoms (LUTS) compared to the results of filling cystometry as a gold-standard diagnostic procedure.

PATIENTS AND METHODS

This prospective study included 60 patients with LUTS who attended the urodynamic laboratory, Urology Department, Al-Azhar University. All patients were under 45 years old, neurologically free, and did not have bladder outlet obstruction. All patients underwent a full evaluation that included medical history, clinical examination, urine analysis, and urine culture. Patients were divided into 2 groups: Group 1 comprised 40 patients with DO as diagnosed by filling cystometry, while Group 2 included 20 patients with a normal, stable bladder and were considered a control group. The bladder was filled with 50 ml saline, and the bladder wall thickness was measured via transabdominal ultrasound at 3 sites: the right lateral wall, the left lateral wall, and the dome using a BK Medical ultrasound scanner machine (Herlev, Denmark). The average thickness was calculated for each bladder wall in every patient. A free urinary flow rate was initially performed. The postvoid residual urine volume was measured using the urodynamic catheter. Uroflowmetry results correlated with the voided volume using the Liverpool nomogram to exclude bladder outlet obstruction. Cystometry was done in the sitting position using an Ellipse 4 AUDACT machine (Andromeda; Munich, Germany). Detrusor overactivity was considered present when involuntary contractions of any magnitude were observed during bladder filling, whether spontaneous or provoked. Definitions and methods conformed to the recommendations of the International Continence Society (ICS) [1].

Table 1. Clinical characteristics of DO and control patients.

	DO Patients	Control Patients	p Value
total no.	40	20	
mean age $\pm$ SD	22.4 $\pm$ 2.4	27.6 $\pm$ 2.1	0.2
gender			
M (%)	10 (25%)	10 (50%)	
F (%)	30 (75%)	10 (50%)	
clinical presentation			0.04*
urgency	40 (100%)	20 (100%)	
frequency	36 (90%)	16 (80%)	
NE	26 (65%)	0 (0%)	
urge incontinence	10 (25%)	0 (0%)	
nocturia	4 (10%)	0 (0%)	
mean BWT + SD	5.2 $\pm$ 0.27	2.8 $\pm$ 0.47	0.0001*

The urodynamic results statistically correlated with the measured bladder-wall thickness. The results were expressed as mean ± SD. The student's single-factor t test was used to compare the different variables and the probability $p < 0.05$ was considered significant. Receiver-operator characteristic (ROC) curve was used to determine the specificity and sensitivity of BWT in the diagnosis of DO. Statistical analysis was performed with the use of SPSS 13.0 for Windows (SPSS Inc.; Chicago, IL).

RESULTS

Group 1 included 40 patients, 10 males and 30 females, between the ages of 10 to 44 years old (mean age: 22.4 ± 2.4), while group 2 included 20 patients, 10 males and 10 females, between the ages of 15 to 41 (mean age: 27.6 ± 2.1). There was no significant difference between Group 1 and Group 2 regarding age distribution ($p < 0.2$) (Table 1).

The most frequent symptom in both groups was urgency. All patients in both groups had urgency. Frequent micturition was present in 90% of the patients in Group 1 and in 80% in Group

2. No patients in Group 2 had urge incontinence or nocturia. In Group 1, 26 patients (65%) had nocturnal enuresis compared to 10% in Group 2. Twenty-five percent of patients in Group 1 had urge incontinence (Table 1). The mean Qmax in Group 1 was 22.03 ± 7.36 compared to 24.24 ± 4.34 ml/sec.

The mean bladder-wall thickness as measured by transabdominal ultrasonography was significantly higher in Group 1 than in Group 2 ($p < 0.001$). Mean thickness was 3 mm or less in 13 patients in Group 2 (65%) and more than 3 mm but less than 5 mm in 5 patients in Group 2 (25%). Bladder thickness was more than 5 mm in 2 patients (10%) in comparison to Group 1, was 5 mm or less in 11 patients (27.5%), more than 5 mm in 27 patients (67.5%), and more than 10 mm in 2 patients (5%) (Table 2). Women with DO have a thick bladder wall (5.29 ± 1.4 mm) compared to control group women (3.6 ± 2.08 mm); however, this difference was not statistically significant ($p < 0.06$).

Table 2. Differences in BWT with both groups.

BWT	DO Patients (n = 40)	Control Patients (n = 20)
≤ 3	0	13 (20%
> 3 - < 5	11 (27.5%)	6 (25%)
5 - < 10	27 (67.5%)	2 (10%)
≥ 10	2 (5%)	0

DISCUSSION

The non-neurogenic DO is a phenomenon that affects as much as 10% of the population. The bladder-wall thickness increases in patients with OAB due to detrusor hypertrophy secondary to isometric detrusor contractions. The increase in the intravesical pressure during these contractions gives the patient an urge to void. The patient attempts to remain continent depending on the contractions of the urethral sphincter and pelvic floor muscles. This leads to detrusor hypertrophy [8].

The ultrasonographic demonstration of the bladder wall hypertrophy could be detected experimentally [12] and clinically [13]. Because bladder outlet obstruction (BOO) in females remains rare except after surgeries for stress incontinence [14,15], we used bladder-wall thickening as an indicator for DO. It was easy to rule out BOO as a cause of bladder wall thickening by doing free uroflowmetry and measuring post-void residual urine. This offered the opportunity to find out if and how ultrasonographic measurements of the bladder-wall thickness in patients with OAB differ from healthy women. If TAU-assessed BWT proved to be a sensitive test for the diagnosis of DO, women suffering from OAB can be saved from invasive urodynamics during follow-up of their treatment. We found that an increase in the bladder wall thickness > 3.75 mm was positively detected detrusor overactivity during CMG, with a sensitivity of 91.67% and a specificity of 90%. These findings agree with that of Khullar and his associates [7] who suggested using this technique as a noninvasive screening method for the diagnosis of DO in women with urinary incontinence without outflow obstruction. It could replace the use of ambulatory urodynamics in patients without sphincter incompetence [16]. Despite the fact that most of our patients had mixed stress and urge incontinence, their bladder walls were thicker than normal. This result is not consistent with the findings of Robinson and his associates [16] who found that patients with incompetent urethral sphincters had normal bladder wall thicknesses. This could be attributed to the assumptions that detrusor contractions against the partially competent sphincter and pelvic floor contraction can still lead to detrusor hypertrophy.

A mean BWT > 5 mm was found to be a sensitive screening method for diagnosing detrusor instability in symptomatic women without outflow obstruction; however, the measurement was performed by transvaginal ultrasound with an empty bladder [11]. In our study, we found that the average BWT of 3.75 mm measured by transabdominal ultrasound at a bladder capacity of 50 ml was sensitive in predicting DO (sensitivity: 91.67%).

In this study, BWT in women with DO was greater but not significantly different than in the control group. This result is similar to the findings of Khullar et al. who found that BWT in women with DO was significantly greater than in controls [7], but it was different from the findings of Blatt et al. [17] who found a BWT difference between women with DO and control women. However, there was no significant difference in BWT between men and women in the control group. This result is similar to the findings of Blatt et al. [17] and different from the findings of Oelke et al. in healthy adults where men had a greater BWT than women [5]. This gender difference of BWT in DO patients may have been caused by occult BOO in the men with DO.

CONCLUSION

Transabdominal ultrasound is a sensitive diagnostic technique in the prediction of DO in patients with LUTS. Compared to invasive urodynamic studies, TWA is a noninvasive technique that can be easily performed in the office setting with negligible risks. Further studies are required to validate the findings of this study before this technique can be recommended as a primary diagnostic tool for DO.

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