Estimation of bladder wall thickness at different areas with ultrasound and its relation to cystocele

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Objective The aim was to verify our hypothesis that decreasing bladder wall thickness will facilitate ballooning of the bladder wall at this thin part that will be involved in a process of cystocele other than the last traditional reported factors.

Patients and methods This prospective study included 80 female patients between 20 and 45 years of age who were divided into two groups. Group I: 40 women were normal (control group); 20 of them were married and 20 were virgins and Group II: Comprising 40 patients have clinical manifestations of cystocele. All underwent complete history taking, physical examination, translabial, and transabdominal ultrasound examination with measurement of anterior and posterior detrusor wall thickness (DWT); also multichannel urodynamic testing was done to diagnose if there is associated obstruction or not.

Results In group I, the mean DWT in 20 virgin women was 3.28±0.79 at the anterior bladder wall and 2.72±0.77 at the posterior bladder wall by transabdominal ultrasound, whereas by translabial ultrasound it measured 3.34±0.83 at the anterior bladder wall and 2.62±0.94 at the posterior bladder wall. In 20 married women of the control group without cystocele the mean DWT was 2.85±0.72 and 2.70 ±0.75 at the anterior and the posterior bladder wall, respectively, by transabdominal ultrasound. Also, the mean DWT was 2.90±0.69 and 2.75±0.74 at the anterior and the posterior bladder wall, respectively, by translabial ultrasound. In group II the anterior and the posterior wall measured 2.95 ±0.95 and 2.25±0.73, respectively, by transabdominal ultrasound, while it measured 4.35±1.40 and 2.40±0.77, respectively, by translabial ultrasound. With obvious obstruction in group II, $P_{det}.Q_{max}$. was 29.18±7.54 whereas it was 18.10±13.40 in group I. An increased level of Q_{max} was noticed in group I with a mean value of 25.73±8.56 whereas it was of a less value in group II (15.83±6.21).

Conclusion Our findings verify our hypothesis that decreasing bladder wall thickness will facilitate ballooning of the bladder wall at this thin part. Moreover, an increase in intravesical pressure during micturition will form a pseudo-diverticulum of the bladder wall, which in turn had lost the scaffolding of the fascia and/or vaginal wall.
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Introduction

Pelvic organ prolapses (POP) including cystocele is a major health concern, especially in the elderly. The prevalence of it increases with the gradual increase in life expectancy of women; probably the first explanation of the treatment of POP dates back to 1500 BC [1].

The International Continence Society (ICS) defines anterior vaginal wall prolapse (cystocele) as the descent of anterior vagina such that the urethrovaginal junction (a point 3 cm proximal to the external meatus), or any anterior point proximal to this is less than 3 cm above the plane of the hymen [2].

Urinary symptoms associated with cystocele include either irritative and obstructive symptoms [3].

The important factors affecting POP are history of vaginal delivery, number of vaginal deliveries, elevated intra-abdominal pressure caused by obesity, constipation, chronic coughing arising from a pulmonary disease, and previous pelvic surgery, especially hysterectomy, which may lead to the disturbance of the neural circulation and network [4].

For more than 10 years, translabial ultrasound has been used to assess the lower urinary tract in urinary incontinence and prolapse. Translabial ultrasonography has been used extensively for pelvic floor assessment with recent advances in imaging technology [5].

The advantages of translabial over transvaginal ultrasound are substantial, particularly with regard to reduced invasiveness and lack of distortion, and the disadvantages are very few [6].

Urodynamic parameters such as $P_{det}.Q_{max}$ and Q_{max} were used simultaneously to predict obstruction. The best combination was obtained using a Q_{max} of 15 ml/s or less and a $P_{det}.Q_{max}$ of more than 20 cm H_2O [7].

Patient and methods

This prospective study included 80 women between 20 and 45 years of age who were divided into two groups. The first group (group I) include 40 women without manifestations of cystocele, 20 of them are virgins and the other 20 are married. Ethics committee approved this study. The second group (group II) includes 40 patients complaining of manifestations of cystocele. History taking, clinical examination including assessment of POP by inspection and/or vaginal examination (but in virgin group with inspection only), pelviabdominal, and translabial ultrasonography, urodynamic study. Informed written patient consent (was signed by all enrolled patients), all patients with pregnancy, morbid obesity, uncontrolled urinary tract infection, menstruating female, congenital anomalies in the urogenital system, and/or vertebral column were excluded. The researcher prepared a selected questionnaire after translation of it to Arabic language to evaluate lower urinary system symptoms [8–10].

Cough stress test was performed and a speculum examination was done to look for POP. Before urodynamic testing, we made sure that the urine was free of infection and there was no evidence of inflammation. Then with a comfortably full bladder, the patient was encouraged to sit to void into the voiding flow/volume transducer funnel mounted under the commode.

During all the maneuvers, the patient's dignity and privacy was maintained. The maximum void flow rate and volume was recorded, then postvoiding residual urine (PVRU) volume was recorded using a drainage catheter and measuring container. After that the patient was placed in the lithotomy position to perform urodynamic testing, the genitalia were prepared, and draped using sterile technique. A sheet was provided for covering, maintaining dignity. Then a urodynamic urethral catheter (5 Fr) was placed (dual lumen) to fill the bladder and record intravesical pressure, and a rectal catheter to record abdominal pressure under aseptic technique as possible. Transducers were equalized, and the bladder was filled by saline, at body temperature. The catheters generally are calibrated to 0 corresponding to atmospheric pressure. A complete cystometric evaluation monitors the bladder sensation and capacity was measured during filling cystometry. The bladder was filled at a medium rate of 40 ml/min [11].

Prior to ultrasound scanning, the urinary bladder was emptied completely by catheterization and then refilled with 150 ml saline (at body temperature) through a urethral catheter. Scanning was done with the patient in supine position, using an ultrasound device and a convex abdominal 3.5 MHz probe (Flex Focus 400; BK Medical, 2730 Herlev, SN 3011204, Flex Focus 400 Denmark).

The transducer (covered by a sterile rubber glove) was placed without causing significant discomfort. The resulting image includes estimation of detrusor thickness at the anterior and posterior bladder walls (supratrigonal at the posterior wall).

Detrusor wall thickness (DWT) was assessed as the thickness of the hypoechogenic layer at the bladder dome opposite the internal urethral meatus within 2 cm of the mid-sagittal plane [12].

PVRU was measured within 5 min of ordinary toilet voiding. Height, width, and depth were determined; these three diameters are multiplied by a correction coefficient of 0.5223 ml, which accounts for the nonspherical shape of the bladder when it is less than completely full [13,14].

Data were analyzed using the Statistical Program for the Social Sciences, version 20.0 (SPSS; SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean±SD. Qualitative data were expressed as frequency and percentage.

Results

The mean age of the study population of our 80 female patients was 33.53 years in group I (range: 19–45 years), and 36.35 years (range: 25–45 years) in group II.

In group I, 20 women out of 40 were virgins, another 20 married female including six nullipara, the rest of the married women (n=14) had a mean parity of 3.14 (range: 1–6) with nine women being vaginally parous and five women delivered by cesarean sections.

Urgency was the main presenting irritative symptom in both groups. The second most common presenting symptom was frequency that was recorded in 62.5% in group II and urge incontinence that was recorded in 40% in group I.

Interrupted pattern of voiding was the main presenting obstructive symptom in group II, whereas poor stream is the main presenting obstructive symptom in group I.

In group I, the mean DWT in 20 virgin women was 3.28±0.79 at the anterior bladder wall and 2.72±0.77 at the posterior bladder wall by transabdominal ultrasound, whereas by translabial ultrasound it was 3.34±0.83 at the anterior bladder wall and 2.62±0.94 at the posterior bladder wall.

In 20 married females without cystocele in group I the mean DWT was 2.85±0.72 and 2.70±0.75 at the anterior and the posterior bladder wall, respectively, by transabdominal ultrasound. Also, the mean DWT was 2.90±0.69 and 2.75±0.74 at the anterior and the posterior bladder wall, respectively, by translabial ultrasound. In group II, the anterior and posterior walls measured 2.95 ±0.95 and 2.25±0.73, respectively, by transabdominal ultrasound, while it measured 4.35 ±1.40 and 2.40±0.77, respectively, by translabial ultrasound (Table 1).

Table 1 shows statistically significant difference between group I and group II according to DWT at anterior and posterior bladder wall.

On multichannel urodynamic testing, the mean detrusor pressure at maximum flow rate ($P_{\text{det}}.Q_{\text{max}}$) was 29.18 ±7.54 in group II, whereas it was 18.10±13.40 in group I. There is significant difference according to maximum cystometric capacity between the two groups: 345.92 ±59.26 in group I and 279.56±84.99 in group II. Moreover, there was increased level of Q_{max} in group I with a mean value of 25.73±8.56, whereas less value was observed in group II 15.83±6.21, with increased PVRU in group II in relation to group I (Table 2).

Discussion

Ultrasound imaging is rapidly replacing radiological methods in the investigation of pelvic floor disorders either transrectal, transvaginal introitus, or translabial methods that are being used, with the latter probably being the most widespread due to ease of use and availability of equipment [13].

The normal bladder wall is 3–6 mm thick, although it may vary with intravesical volume. It may be thickened secondary to chronic infection, inflammation after surgery, or radiation. A decrease in bladder wall thickness may suggest clearing of an infection or inflammation [15,16]. Usually three sites are assessed: anterior wall, trigone, and dome of the bladder, and the mean of all three is calculated [17]. In our study, anterior and posterior detrusor thicknesses were assessed for all patients in separate measures. We found that in the control group (group I) the mean DWT at the posterior bladder wall was 3.05 ±0.98 mm which ranged between 2 and 4 mm whereas at the anterior bladder wall 3.16±0.75 mm ranged between 1.3 and 4.8 by transabdominal ultrasound with $P_{\text{det}}.Q_{\text{max}}$ 18.10±13.40 cm H_2O and Q_{max} 25.73 ±8.56 ml/min. In group II, the mean DWT at the posterior bladder wall was 2.25±0.73 mm ranging between 1.5 and 3 whereas at the anterior bladder wall 2.95±0.95 mm ranged between 2.2 and 3.7 with $P_{\text{det}}.Q_{\text{max}}$ being 29.18±7.54 cm H_2O and Q_{max} 15.83 ±6.21 ml/min.

DWT of 2.9 mm or greater has a high predictive value for bladder outlet obstruction (BOO) and can replace pressure flow study for the diagnosis of BOO [18].

Lekskulchai *et al.* [19] in the study of nulligravida women showed that the trigone and the dome develop from different embryologic structures. The trigone is the least distensible part of the bladder wall, as well as the thickest. They found that DWT

Table 1 Comparison between groups I and II according to detrusor thickness by transabdominal and translabial ultrasound

Detrusor wall thickness	Group I (*N*=40)	Group II (*N*=40)	*t*-Test	*P* value
Transabdominal ultrasound				
Anterior wall				
Mean±SD	3.16±0.75	2.95±0.95	6.291	0.029*
Range	1.3–4.8	2.2–3.7		
Posterior wall				
Mean±SD	3.05±0.98	2.25±0.73	5.1096	0.021*
Range	2–4	1.5–3		
Translabial ultrasound				
Anterior wall				
Mean±SD	3.25±1.05	4.35±1.40	7.482	0.031*
Range	1.8–4.7	2.2–6.5		
Posterior wall				
Mean±SD	3.35±1.08	2.40±0.77	4.530	0.028*
Range	2–4.7	1.3–3.5		

*Significant.

Table 2 Comparison between groups I and II according to urodynamic findings

Urodynamic	Group I (*N*=40)	Group II (*N*=40)	*t*-Test	*P* value
MCC				
Mean±SD	345.92±59.26	279.56±84.99	4.051	<0.001**
Range	88–448	106–494		
$P_{det}.Q_{max}$ (cm H_2O)				
Mean±SD	18.10±13.40	29.18±7.54	4.291	0.048*
Range	7–29	5–37		
PVRU (ml)				
Mean±SD	18.73±13.45	32.15±47.08	5.495	0.027*
Range	5–50	2–250		
Q_{max} (ml/min)				
Mean±SD	25.73±8.56	15.83±6.21	8.442	0.032*
Range	8.3–50	5–26.8		

MCC, maximum cystometric capacity; PVRU, postvoiding residual urine. *Significant. **Highly significant.

at the trigonal site was significantly higher than at the dome but generally still lower than 5 mm. Bladder wall thickness at the trigone and the dome correlates with each other, but it seems that changes toward detrusor hypertrophy generally are more pronounced at the dome [19]. But we notice difference in thickness between the anterior and posterior detrusor muscle of the urinary bladder wall with presence of cystocele (group II) in comparison to the control group (group I). There is noticeable thinning at the posterior wall in female patients with a cystocele average of 2.40±0.77 mm, whereas its average was 4.35±1.40 mm at the anterior wall.

Urodynamic tests can determine whether an obstruction is being experienced that is caused by POP. Flow rate and pressure/flow studies are integral in this determination. Indeed, the urodynamic level of outflow that is used for defining obstruction is more sensitive in women than in men, making this test particularly attractive for use in female patients suffering from POP [20].

In our study, our findings also agree with previous recommendations according importance of urodynamic utility in an individual basis for POP patients, with its vitality to assess urodynamic obstruction in women with obstructive urinary symptoms. We study 40 female patients with different grades of cystocele (group II), complaining of a variety of obstructive and irritative urinary symptoms, the most common presenting obstructive symptoms are straining (50%), poor stream (42.5%), interrupted pattern of voiding (52.5%), and hesitancy (45%).

In another study by Ghoniem and Strohbehn [3] showing the urinary symptoms associated with cystocele include urinary frequency and urgency (35%), urge urinary incontinence (15%), stress urinary incontinence (60%), and difficulty in voiding (23%). Urodynamically diagnosed bladder outlet obstruction was found more frequently with higher-stage cystoceles than with lower-stage cystoceles [3].

Conclusion

Our findings verify our hypothesis that decreasing bladder wall thickness will facilitate ballooning of the bladder wall at this thin part.

Moreover, an increase in intravesical pressure during micturition will form a pseudo-diverticulum of the bladder wall, which in turn had lost the scaffolding of the fascia and/or the vaginal wall. Also, translabial ultrasound is more illustrative in assessing DWT than the transabdominal ultrasound, may be due to distortion of the bladder wall by the probe.

We have approved that the translabial ultrasound could replace urodynamic study, which will enhance our therapeutic plan.

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Conflicts of interest

There are no conflicts of interest.

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