Original Article

Transperineal ultrasound imaging of the pelvic floor muscles in women with pelvic floor dysfunction symptoms: A cross-sectional study

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ABSTRACT

Objective: Transperineal ultrasound (TPUS) assessment of the pelvic floor muscle (morphological and dynamic function) in women with pelvic floor dysfunction symptoms.

Study design: A cross-section study, 73 women complaining of any of the pelvic floor disorder symptoms. Digital palpation of the puborectalis muscle using modified Oxford score grading system (MOS), 2 D and 3 D TPUS were done at rest, maximum contraction, and at valsalva. Levator ani defects, and/or avulsion were identified. Levator urethral gap (LUG) was measured. Ultrasound measurements were correlated to MOS, and presence of symptoms

Results: The mean percentage decrease in the antro posterior hiatal diameter (LHap) during contraction was significantly lower in women with UpfmC than those with NpfmC as assessed by MOS. A cut-off percentage decrease in LHap at contraction <6.5% predicted UpfmC; area under the curve 0.64, sensitivity 46.24%, specificity 100% and accuracy 61.6%. A cut-off percentage increase in LHap > 2% predicted UpfmC; area under the curve 0.81, sensitivity 38.5%, specificity 81% and accuracy 50.6%. LUG was significantly longer in UpfmC. All cases of ultrasound diagnosed avulsion had an UpfmC by MOS. MOS had a strong positive correlation with percentage decrease LHap (contraction), and a strong negative correlation with the percentage increase in LHap (Valsalva), and LUG.

Conclusion: Ultrasound is clinically valuable, reasonable, allows morphological and dynamic evaluation of the function of PFM in women with pelvic floor dysfunction symptoms, and correlated well with MOS. LUG increased its validity for diagnosis of levator avulsion.

1. Introduction

Although; the prevalence of Pelvic floor dysfunction is high, affecting millions of women worldwide in different conditions (social, sexual, physical, psychological, domestic relationships, financial, etc.), many people still have no, limited knowledge, or awareness of pelvic floor health and so do not have, or seek how to prevent or correct these disorders [1]. This dysfunction may be presented as pelvic organ prolapse, stress urinary incontinence, (SUI), fecal incontinence (FI), chronic pelvic pain, sexual problems, and/or chronic constipation [2]. Assessment of pelvic floor muscle activity plays a major role in Urogynecology and physiotherapy as a part of the conservative treatment of pelvic floor disorders (PFD) [3]. Physiotherapy and pelvic floor muscle training have a positive effect on pelvic organ prolapse symptoms, sexual function, and urinary incontinence [4]. Presence of Levator avulsion is a major risk factor for female pelvic organ prolapse (POP) and recurrence after surgical correction [5]. This dysfunction can be diagnosed clinically using vaginal palpation [6]. Palpation is subjective, less reproducible, and difficult to teach than imaging methods [7]. Studies that used ultrasound for assessment of pelvic floor muscle activity and strength are still few [8].

The present study aimed to evaluate the levator ani muscle in both morphology (rest), and function (contraction and valsalva) in symptomatic women using 2D, 3D trans-perineum ultrasound (TPUS), to compare these features to clinical digital palpation and symptoms, and helping in diagnosis of muscle dysfunction.

2. Methods

A cross-section study, at 80% power of the study and confidence interval 95% the estimated sample size is 73 cases of those were referred to Uro-gynecology out-patient clinic, and complaining of any of the pelvic floor disorder symptoms such as: Pelvic organ prolapse (POP), Stress urinary incontinence (SUI), urgency,

symptoms of obstructed defecation, fecal incontinence (FI), pelvic pain, and/or sexual problems. Women with a history of previous genitourinary surgery, under current pharmacotherapy for overactive bladder, or not understanding the techniques were excluded from the study. After receiving approval from Zagazig University Institutional Review Board, informed written consent had been taken from every case. All cases were subjected to a full history taking, clinical examination and vaginal digital palpation of the puborectalis muscle which was performed by a single trained examiner. Women were asked to contract their pelvic floor muscles maximally by asking them to pull in and lift up the urethra, vagina and rectum as if trying to control passing of gas. The strength of muscle contraction was assessed subjectively by digital palpation according to the modified Oxford Score (MOS) grading system by introducing the index finger deep in the vagina up to 4 cm (as the insertion of the puborectalis muscle on the inferior ramus of the pubic bone is only 2–4 cm proximal to the perineum) and palpating the puborectalis muscle at each side of the vagina during contraction The MOS was used to grade pelvic floor muscle strength on a scale of 0–5 (0: no contraction; 1: minor muscle contraction'flicker'; 2: weak muscle contraction; 3: moderate muscle contraction; 4: good muscle contraction; 5: strong muscle contraction against resistance). .A normal function of the pelvic floor was defined as if there was a good or strong contraction (NpfmC). A poor pelvic floor muscle function as an under active (UpfmC) if there was an absent or weak pelvic floor muscle contraction. An avulsion injury of the puborectalis muscle was diagnosed if the inferior aspects of the muscle were detached from the pelvic side-wall, with no muscle remaining on the inferior pubic ramus.

2.1. Ultrasound imaging

2D and 3D trans-perineum ultrasound examinations were performed by single examiner who was blind to clinical data, using a GE Voluson 730 machine (GE Medical System Kretz Technik, Zipf, Austria) with a RAB 4–8 MHz curved array volume transducer. In the supine position, with flexed and slightly abducted hips after urine voiding. The transducer was placed on the perineum, in the mid sagittal plane with minimal pressure being applied after covering it with an un-powdered glove or thin plastic wrap for hygienic reasons. The quality of pelvic floor muscle contractions was subjectively evaluated on the 2D cine loop obtained at rest, on maximum muscle contraction and at valsalva. The acquisition was performed with the main axis of the transducer in the mid-sagittal plane, showing the inferior margin of the pubis, urethra and bladder neck as well as the levator ani muscle posterior to the anorectal junction. The preferred image orientation was with the symphysis pubis (cranioventral) to the left, and the anorectal canal (dorsocaudal) to the right. 3D ultrasound volumes were acquired with the acquisition angle to be set at 85° or higher, allowing visualization of the entire levator hiatus as the area of interest. The hiatal antro-posterior distance (LHap) between the inferior margin of the pubic symphysis and the pubo-rectalis sling was measured at rest, on maximum contraction, and at valsalva. The percentage difference decrease [value$_{rest}$ − value$_{contraction}$/value$_{rest}$] for contraction was calculated as a measurement of pelvic floor muscle function. The percentage difference increase [value$_{vulsalva}$ − value$_{rest}$/value$_{rest}$] for valsalva was calculated as a measurement of pelvic floor muscle function. The technique used for acquiring 3D imaging was the same as prescribed for obtaining 2D imaging in maximum contraction. The inferior margin of the symphysis pubis was used as a reference point in 2D and 3D datasets for identification of Levator ani abnormality (LAA), and "avulsion". Tomographic ultrasound imaging (TUI) was used for quantification of these levator defects. A set of 8 slices with an interslice interval of 2.5 mm was obtained, from 5.0 mm below

to 12.5 mm above the hiatal plane, in a volume obtained on maximal levator contraction. Levator "avulsion" was defined as a clear detachment of the muscle anteromedial from the pubic bone during contraction in any of the three central slices, either unilateral or bilateral The levator urethral gap (LUG) was measured from the center of the hypoechogenic structure indicating the urethral mucosa and smooth muscle, to the most medial aspect of the muscle insertion on the inferior pubic ramus. Levator ani avulsion was defined as LUG > 25 mm either unilateral or bilateral according to [9]. 2D and 3D measurements were performed offline on a PC using image processing software 4D View (4D View version 10.7; GE Kretz Medizintechnik, Zipf, Austria). Post-processing and offline analysis of stored ultrasound was performed by an operator, who is blinded to clinical and demographic data at the time of the analysis.

3. Statistical analysis

Statistical analysis was performed using SPSS version 15 (SPSS, Chicago, IL, USA). To calculate the agreement between measurements, the interclass correlation coefficient (ICC) was calculated using a general linear univariate model to evaluate the different variance components. The scale developed by Altman was utilized in the classification of the reliability values [10].

4. Results

A total of 73 patients were included, with mean age 41.5 (range, 23–67) years, and mean BMI 33.2 (range, 23.7–44.3) kg/m². Four patients were primipara (5.5%) who had delivered by cesarean section and 69 were multiparas (69%), 65 of them had a vaginal delivery (89.0%). Concerning clinical data, 71% of cases complained of POP, 49.3% of SUI or urgency, 5.5% of FI, 38.4% pelvic pain, and 5.5% of sexual problems. However, 60.3% of women had more than one complain. According to the MOS, 28.8% of studied women (21/73) had NpfmC (good, strong) and 71.2% (52/72) had UpfmC (minor, weak and moderate contraction) (Table 1). The age and body mass index were statistically significantly higher in women with UpfmC (p < 0.05). The majority of cases with UpfmC were of high parity (98.1%)) and most of them delivered by vaginal route (96.2%) (Table 2). The proportion of women complaining of POP (84.6%); pelvic heaviness (53.8%) and more than one complain (76.9%) who had UpfmCwas significantly higher than those with NpfmC (p < 0.001). While: the difference was not signifiant regarding the other complaint (SUI, urgency, FI, and Sexual problems) (Table 3). The mean value ± SD of hiatal antro-posterior diameter was measured by 2D ultrasound at rest, at pelvic floor contraction and at vulsalva. The percentage decrease in LHap diameter from rest to contraction and its percentage increase from rest to vulalava were also calculated and presented. Mean value ± SD of LUG was measured by 3D ultrasound. In women with pelvic floor muscle dysfunction, the LHap diameters at all phases as well as the LUG

Table 1
Grading of the pelvic floor muscle contraction using the Modified Oxford Scale (MOS).

Contraction	Qualification	Grading	N	%
Underactive (UpfmC)	No contraction	0	0	0.0%
	Minor	1	4	5.5%
	Weak	2	16	21.9%
	Moderate	3	32	43.8%
Normal (NpfmC)	Good	4	21	28.8%
	Strong	5	0	0.0%

C: under active pelvic floor muscle contraction. NpfmC: normal pelvic floor muscle contraction.