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Transvaginal and Perineal Ultrasonography in Measurement of Resting Urethral Angles in A Cohort of Continent Iraqi Women

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Abstract

Background Ultrasonography of the pelvic floor, either by the trans-perineal or the endo-vaginal/introital approach, has been effectively utilized in the diagnostic workup of urinary incontinence. Anterior and posterior urethral angles, funneling of bladder neck, urethral hypermobility and bladder base position can be evaluated using pelvic floor ultrasonograph.

Objective To assess the impact of variability of ultrasound technique (transvaginal ultrasound; TVS, and transperineal; TPUS) on the measurement of the resting urethral angles in a sample of continent Iraqi women.

Methods This study included 100 healthy continent adult females, The numerical values of the urethral angles were obtained by both TVS and TPUS techniques in a sample of women attending Ultrasound Unit in Al-Imamein Al-kadhimein Medical City during 2017.

Results The α angle mean of studied women measured by TVS was 91.92 while that measured by TPUS was 78.67 with highly significant difference between both techniques ($p<0.001$). Conversely, the ß angle mean of studied women measured by TVS was 102.25 while that measured by TPUS was 112.08 with highly significant difference between both techniques ($p<0.001$). As a result, the α angle was higher among continent women by TVS and ß angle was higher among continent women by TPUS. Although no significant difference, the average α angle increased with increased age of continent women while average ß angel was decreased with increased age of continent women. The average α angle of continent women was significantly increased among obese multiparous women at age group <40 years age ($p=0.007$). The average B angle of continent women was significantly increased among obese multiparous women at age group <40 years age ($p<0.001$).

Conclusion The ultrasound approach whether TVS or TPUS have an essential impact on the measured numerical value of different urethral angles, and the women age, parity and body habitus individually and in combination affect the measurement of the urethral angles.

Keywords Transvaginal ultrasound, transperineal ultrasound, resting urethral angle, continent women

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List of abbreviations: BND = Bladder neck descent, MRI = Magnetic resonance imaging, TPUS = Transperineal ultrasound, TVS = Transvaginal sonography, VCUG = Voiding cystourethrography

Introduction

Radiological tests are of prime importance in the assessment of women with urethral symptoms because the clinical assessment of urethral complaints is often challenging. A patient with

urethral pathology will likely present with one of the following complaints: dysuria, dyspareunia, dribbling, increased frequency of urinary tract infections, incontinence, a mass in the region of the urethra, or obstruction symptoms. There are several diagnostic tests utilized in the evaluation of the female urethra, some are radiological, others are urodynamic tests [1,2].

Voiding cystourethrography (VCUG) and other conventional radiological tests, has assumed a fairly little part in the determination of urethral and periurethral pathologies. The improvement of transvaginal ultrasound (TVS) and transperineal ultrasound (TPUS) has enabled superior evaluation of the urethra both statically and dynamically (i.e., during rest and stress). It is recommended that TPUS can provide functional assessment of pelvic floor [3]. Recently, magnetic resonance imaging (MRI) has in the come to play an important role imaging of the female urethra, perineum, vagina, and pelvic floor, due to its well-known high contrast capabilities including multiplanar imaging of the whole pelvis in both static and dynamic modes [4].

A dramatic improvement in female urethral evaluation was possible in the advent of the recent advances in ultrasound (US) and MRI. Regarding US, high-resolution TVS and TPUS are the mainstay in the assessment of urethral diseases and variations from the norm [5].

US of the pelvic floor, has been effectively utilized in various gynecological and nongynecological conditions due to its well-known advantages being safe, free of radiation hazard, cheap, and rapid assessment tool [6].

The most common measurable parameters to be assessed in the US workup of incontinence are: the bladder neck descent, the (α) angle and the (β) angle, these are usually assessed at rest and stress [7]. Lately, US investigations of the urethra have prevailed over other imaging modalities yet there is little data on normal values and perplexity on measurement methods. There is a need to discover more objective parameters for the investigation of urinary incontinence. TPUS enabled good visualization of the bladder base, urethra and the perineum and it also measures and quantifies reduction of muscular thickness of the urethral sphincter in subjects with incontinence [8].

This study aimed to assess the impact of variability of US techniques on the measurement of the resting urethral angles at TVS and TPUS in continent Iraqi women and correlate them with certain variable as age, parity and body mass index in a cohort of continent women.

Methods

A cross sectional analytic study was performed in the US Unit, Radiology Department, Al-Imamein Al-kadhimiin Medical City from 1st of January till 30th of December 2017. It included 100 continent women. The subjects were selected from the US unit to which they were referred for transvaginal sonography for various gynecological reasons.

Inclusion criteria

Only those volunteers among outpatient gynecology clinic patients who did not have urinary incontinence complaints, with normal US study regarding the genital organs, the urinary bladder and pelvic cavity were enrolled.

Exclusion criteria

Pregnant women, puerperants, patients with overactive bladder, pelvic organ prolapse, urinary tract infection, nocturia, post-coital incontinence, diabetes mellitus, and known neurological disease were excluded.

The demographic information for each woman was recorded including age, reason beyond referral, the parity, as well as the participant height and weight to calculate the body mass index (BMI).

Ethical approval

The study was approved by the Institutional Review Board (IRB), College of Medicine, Al-Nahrain University. Verbal consent was obtained to participate in the study.

US techniques

TVS was performed while the urinary bladder was only partially filled to less than 150 ml as assessed by trans abdominal US. TVS was done using multi-frequency micro convex transducer of US systems (GE VolusonE6). The participant was put in lithotomy position and covered with a draw sheet for the sake of comfort and privacy. The TVS transducer was covered with sterile condom after filling the latter with acoustic coupling gel. The transducer was then introduced through the vagina for assessment of the pelvic organ. After excluding any abnormality and if the woman fits into the inclusion criteria, the subject`s approval to participate in the study was obtained, the probe was then withdrawn to the mid vagina without exerting any pressure to avoid distortion of the lower urinary tract. A mid sagittal plane with the bladder neck and symphysis pubis in the field was obtained for assessment of bladder neck and urethra and the urethral angles were measured.

After completion of TVS, the TVS probe was withdrawn, the 3.5 MHz convex transducer is prepared for TPUS. The probe, covered with sterile glove, was placed on the interlabial region of the vulva in a sagittal orientation after gel application using the lower edge of the symphysis pubis as a reference point in order to obtain views of the symphysis pubis, bladder and urethra and the same measurements were obtained.

Urethral angles measurements

The urethral angles in both sonographic approaches were assessed in the same way. When the lower point of symphysis pubis, the urinary bladder, the vesico-urethral junction, and the urethra were set into view during rest, the α and β angles were measured; α angle is the angle between the axis of proximal urethra and the central axis of the symphysis pubis, β angle is the angle between the proximal urethral axis and the posterior wall of the urinary bladder. Three consecutive measurements were taken and the average value recorded. The numerical values of the urethral angles obtained by both US techniques was assessed to find out if the technique variability have an impact on the normal range obtained. In addition, the numerical values of each angle in both techniques were correlated statistically with the variables as age, parity & body mass (Figure 1).

Definition of variables

Bladder neck position and descent: it is the distance from the bladder neck to the symphysis pubis is measured on rest then at maximal Valsalva maneuver. Difference in measurement is equal to the numerical value for bladder neck descent (BND) [(7)].

Anterior urethral angle (α) angle: it is the angle between the axis of the proximal half of the urethra with respect to the X axis of the pubic bone [(8)].

Posterior urethro-vesical point (β) edge: it is characterized as the angle shaped between a line drawn along the proximal half of the urethra and a line drawn along the lowest part of the base of bladder [(8)].

Bladder wall thickness: it is measured at the thickest segment of its four walls. A mean wall thickness of <5 mm is said to be observed 85% of normal subjects [(9)].

Statistical analysis

All patients' data entered using computerized statistical software; statistical package for social sciences (SPSS) version 22 was used. Descriptive statistics presented as (mean ± standard deviation) and frequencies as percentages. Independent sample t-test was used to compare between two means. In all statistical analysis, level of significance (p value) set at ≤0.05.

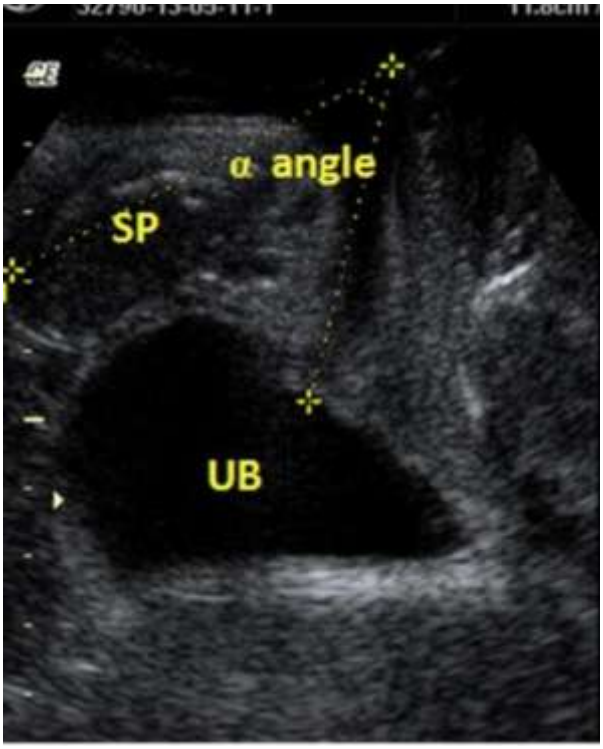

Figure 1. TPUS for the assessment of α angle at rest. SP, symphysis pubis; UB, urinary bladder

Results

Demographic criteria

This study included 100 healthy continent women with mean age of 34.2±9.4 years with range of (20-52 years); mean BMI of the subjects was 29.4±5.6 Kg/m^2; 40% of them were obese. On other hand, the continent women were distributed according to parity as followings; 24% nulliparous, and 40% have 3 children and over was shown in table 1.

Table 1. Characteristics of the study sample

Variable		No.	%
Age (years)	mean±SD	34.2±9.4	
	Range	20-52	
	<40	65	65.0
	≥40	35	35.0
BMI (Kg/m^2)	mean±SD	29.4±5.6	
	Normal	23	23.0
	Overweight	37	37.0
	Obese	40	40.0
Parity	Nulliparous	24	24.0
	<3 children	36	36.0
	≥3 children	40	40.0

N=100

Urethral angles measurements

Mean α angle of continent women was significantly higher as detected by TVS (P<0.001), while mean ß angle of continent women was significantly higher as detected by TPUS (P<0.001) (Table 2).

Table 2. Mean measurements of α and ß measurements of continent women according to TVS and TPUS

Variable	Transvaginal Mean±SD	Transperineal Mean±SD	P value*
α angle	91.92±20.16	78.67±26.72	<0.001
ß angle	102.25±15.3	112.08±13.66	<0.001

*Independent sample t-test

α angle

The average α angle was not significantly different according to women BMI groups for nulliparous women at age group <40 years (P=0.1) while average α angle of obese multipara women was significantly higher than normal BMI multipara women at age group <40 years (P=0.007). The average of α angle for obese nulliparous women 40 years old age and over was 89.0±14.2 while there was no nulliparous women with normal BMI aged 40 years old age and over in present study. The average α angle of normal BMI multipara women at age group 40 years and over was not significantly different from average α angle of obese multipara women at age group 40 years (P=0.3). No significant differences were observed in average α angle between nulliparous obese women at age group <40 years and nulliparous obese women at age group ≥40 years. Similarly, there were no significant differences in average α angles between multi-parity women with normal BMI or obese regarding age groups. The average α angle was higher in older nulliparous obese women as compared with younger nulliparous obese subjects, furthermore both these groups exhibited higher values than normal weight nulliparous subjects. The same applies to the young and old multiparous subgroups . The highest average angle value was reported at young obese multiparous group (Table 3).

Table 3. Comparison of alpha angle average measurements of both US techniques according to different characteristics of continent women according to body mass index

Age groups	Nulliparous Normal BMI Mean±SD	Nulliparous Obese Mean±SD	P value*	Multiparous Normal BMI Mean±SD	Multiparous Obese Mean±SD	P value*
<40 years	77.1±8.5	86±15.4	0.1	83±12.5	98.5±18.9	0.007
≥40 years	-	89±14.2	-	79.8±3.4	89.4±13.8	0.3
P value*		0.7		0.2	0.07	

*Independent sample t-test

Regarding parity, the average α angle was not significantly different according to women parity groups for normal BMI women at age group <40 years (p=0.06) and average α angle of obese women was not significantly different according to parity of women at age group <40 years (P=0.3). The average of α angle measured by both US technique for normal BMI multiparous women 40 years old age and over was 79.0±2.7 with no nulliparous women with normal BMI aging 40 years old age and above in present study. The average α angle of obese nulliparous women at age group 40 years and over was not significantly different from average α angle of obese multi-parity women at age group 40 years (p=0.9) (Table 4).

Table 4. Comparison of alpha angle average measurements of both US techniques according to different characteristics of continent women according to parity

Age groups	Normal BMI Nulliparous Mean±SD	Normal BMI Multiparous Mean±SD	P value*	Obese Nulliparous Mean±SD	Obese Multiparous Mean±SD	P value*
<40 years	77.1±8.5	92.8±19.7	0.06	86.0±15.4	98.5±18.9	0.3
≥40 years	-	79.0±2.7	-	89.0±14.2	89.4±13.8	0.9
P value*		0.2		0.4	0.4	

*Independent sample t-test

ß angle

The average ß angle measured by both US techniques was not significantly different according to women BMI groups for nulliparous women at age group <40 years (P=0.6) while average ß angle of obese multipara women was significantly higher than normal BMI multi-parity women at age group <40years (p<0.001). The average of ß for obese nulliparous women 40 years old age and over was 107.4±12.9, while no nulliparous women with normal BMI aging 40 years old age and over in present study. The average ß angle measured by both US techniques of normal BMI multipara women at age group 40 years and over was not significantly different from average beta angle of obese multipara women at age group 40 years (p=0.08). No significant differences were observed in average ß mean between nulliparous obese women at age group <40 years and nulliparous obese women at age group ≥40 years. Similarly, there were no significant differences in average beta means between multi-parity women with normal BMI or obese regarding age groups (Table 5).

Table 5. Comparison of beta angle average measurements of both US techniques according to different characteristics of continent women according to body mass index

Age groups	Nulliparous Normal BMI Mean±SD	Nulliparous Obese Mean±SD	P value*	Multiparous Normal BMI Mean±SD	Multiparous Obese Mean±SD	P value*
<40 years	105.6±9	106.1±9	0.6	94.9±11.1	110.1±8.5	<0.001
≥40 years	-	107.4±12.9	-	92.6±5.4	107.5±12.4	0.08
P value*		0.9		0.8	0.1	

*Independent sample t-test

Regarding parity, the average ß angle was significantly lower among normal BMI nulliparous multiparous women than normal BMI nulliparous women at age group <40 years (p=0.04), while average ß angle of obese nulliparous women was not significantly different from obese multi-parity women at age group <40 years (p=0.3). The average of ß angle measured by both US technique for obese multiparous women 40 years old age and above was 92.6±5.4, while no nulliparous women with normal BMI aging 40 years old age and above in present study. The average ß angle measured of obese nulliparous women at age group 40 years and over was not significantly different from average ß angle of obese multi-parity women at age group 40 years (p=0.9) (Table 6).

Table 6. Comparison of beta angle average measurements of both US techniques according to different characteristics of continent women according to parity

Age groups	Normal BMI Nulliparous Mean±SD	Normal BMI Multiparous Mean±SD	P value*	Obese Nulliparous Mean±SD	Obese Multiparous Mean±SD	P value*
<40 years	105.6±9	94.9±11.1	0.04	106.1±9.0	110.1±8.5	0.3
≥40 years	-	92.6±5.4	-	107.4±12.9	107.5±12.4	0.9
P value*		0.7		0.8	0.3	

*Independent sample t-test

Discussion

The present study clearly shows that the two commonly used approaches for assessment of bladder neck mobility, namely the TVS and TPUS, exhibit significant variations in the frequently measured urethral angles with lower values for alpha angle at TPS and higher value for β angle at TPUS.

A significance difference was found in current study between TVS and TPUS techniques regarding the mean α angel value in continent women. This finding is similar to report study in Czech found that the use of TVS approach in US for assessment of urethral dynamic function might be accompanied by increase in compression effect, which in turn leads to variation in urethral angles in Czech [10]. The mean α angle in present study as measured by TPUS was 78.67, while the mean ß angle was 112.08, a finding that is higher than that documented by same approach in a local study at 2016 by Al-Saadi (α angle = 43.9 and ß angle = 107.53) [6]. Although the same examination approach was used, the wide range of difference might be attributed to variation of degree of bladder filling or the criteria of the studied sample regarding the age, parity or BMI.

The mean ß angle measured by TVS in the present study was significantly lower than the mean ß angle measured by TPUS, this finding is inconsistent with results of Alper et al., [11] study in Turkey who reported that a β angle mean was greater than β angle measured by TPUS in both continent and incontinent women. This inconsistency may be due to differences in age, parity and body weight of selected healthy women between two studies. This variation in the measured values had led Alper et al., to conclude that TVS is not reliable for diagnosis of genuine stress incontinence as it may cause distortion of the lower urinary tract and thus may result in wrong measurement.

The mean ß angle of continent women by TVS approach is lower than ß angle of what reported by previous Chinese study [12]. This may be due to differences in age, parity and body weight of selected healthy women between two studies.

The current study showed a significantly increase of average α and ß angles among obese women with history of multiparty at middle age group but no significant difference in other groups. Moreover, we have found that significantly lower average β angle is present among normal BMI nulliparous women than normal BMI multiparous women at age group <40 years (p=0.04), but no significant difference in other groups. These findings are supported by other studies; Richter et al., [13] considered that overweight and obesity is a potential risk factor for the change in urethral angles and thus the development as well as the severity of urinary incontinence among women, similarly, Tunn et al., [14] reported an increase in weakness of pelvic floor muscles and subsequently change in urethral angles among healthy continent women in relation to increased parity. Several other risk factors for women incontinence at middle age group were suggested as race, smoking, diabetes, and hysterectomy [15].

Upon reviewing the worldwide literatures concerned with the subject of normal vales and range of urethral angles and comparing these with the current study findings, it can be easily judged that it is not possible to adopt a specific range. This is due to the fact that several variables play an essential role concerning the numerical value for each specific angle, in addition, there is significant overlap in the range between different groups as well as the presence of different combinations of these variables in each individual. The above-mentioned obstacles can be considered as reasonable explanation for the lack of standard range to be used in the practice of assessing the integrity of the pelvic floor in women with incontinence. That why it is recommended that when dealing with urethral angle measurement, the type of US approach used, should be taken into consideration before interpreting the results as normal or abnormal , also a special attention should be paid to the different variables when conducting researches on female urethra particularly when selecting the control group to be matched not only for age but for parity , mode of delivery, body mass index and other risk factors known to affect the pelvic floor function.

In conclusion, the US approach whether TVS or TPUS have an essential impact on the measured numerical value of different urethral angles, moreover, the women age, parity and BMI, individually and in combination can affect the measurement of these angles.

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Author contribution

Dr. Farhan: study design. Dr. Fakher: data collection and statistical analysis. Dr. Hummadi: literature review. Dr. Al-Saadi: Final revision of the article.

Conflict of interest

None.

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