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Perineal Ultrasound for Evaluating Bladder Neck and Urethra in Stress Urinary Incontinence

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Abstract

Background Urinary incontinence is a silent epidemic severely affecting the quality of life of women. Urodynamic study is the gold standard investigation for assessing women with urinary incontinence. However it is invasive and unavailable in some hospitals. Ultrasound is safe, noninvasive and available in most units.

Objective To determine the role of perineal ultrasound for assessing the bladder neck mobility, pubo urethral angle and retrovesical angle during rest and straining in normal women and in those with stress urinary incontinence.

Methods Twenty patients with urodynamic stress urinary incontinence and twenty age-matched control patients were included in the study. Perineal sonography was carried out in both groups to evaluate the role of this technique in the diagnosis of stress urinary incontinence. By using the posterior edge of the symphysis pubis as a reference point, posterior urethra-vesical angle (PUVA) and the angle between the vertical axis and urethral axis (alpha angle) were measured at rest and on straining. Bladder neck mobility was evaluated only at the cephalocaudal plane by measuring the desensus diameter.

Results Posterior urethro-vesical angle (PUVA) was found to be significantly different between the study and control groups both at rest and on straining ($P < 0.05$). The pubo urethral angle (alpha angle) was found to be significantly different between study and control groups only on straining ($P < 0.05$).Cephalocaudal distance (desensus diameter) of urethra was longer in patients with stress urinary incontinence ($P < 0.05$).

Conclusion Perineal sonography has an important role in diagnosing patients with stress urinary incontinence.

Key words Perineal ultrasound, stress urinary incontinence, bladder neck

Introduction

Urinary Incontinence defined as a complaint of involuntary loss of urine. It is distressing condition, although rarely life threatening, severely affecting all aspects of women's life and psychologically (1).

Ultrasonography is a safe, non-invasive, acceptable and available tool in most units as well as the expertise to use it (2). The results of ultrasound examination of a female's lower urinary tract comprise quantitative and qualitative findings. Quantitative parameters are measurement of the retrovesical angle, alpha angle (angle between vertical axis of symphysis and urethral axis), bladder neck descends and the position of internal urethral orifice, while the qualitative parameters to determine and describe the funneling of bladder neck and the position and mobility (fixed or hypermobile) of urethra and bladder base (vertical, rotational, or no descent) (3). It's use in urogynecology for the assessment of bladder neck mobility and funneling of the internal urethral meatus both of which are important in women with urinary incontinence. The position of the bladder neck is determined relative to inferio-posterior margin of the symphysis pubis or relative to a system of coordinates based on the central axis of the symphysis pubis. Measurements are taken at rest and on maximal Valsalva, and the yields difference is the numerical value for bladder neck descent. Comparative studies have shown good correlations with radiological methods [4]. The reproducibility of measurements of bladder neck mobility is high [5]. On Valsalva, the proximal urethra will be seen to rotate in a posteroinferior direction to a greater or lesser degree, due to the fact that the urethra and anterior vaginal wall are tethered to the symphysis pubis and the pelvic sidewall.

Aims of this study is to determine the role of perineal ultrasound in the diagnosis of genuine stress incontinence by assessing the reproducibility of an electronic sonographic technique for measurement of (bladder neck mobility, posterior urethrovesical angle and urethral angle) and comparing these ultrasound variables in women with stress urinary incontinence and in controls.

Methods

This is observational cross sectional study included 40 women were selected from patients attending outpatient clinic of Obstetrics and Gynecology at Al-Kadhimiya Teaching Hospital during the period from the first of May 2010 till the end of June 2011.

Participants: 20 women with urodynamically proven genuine stress urinary incontinence constituted the study group and 20 women without stress urinary incontinence. The control group where selected from outpatient clinic and medical staff volunteers.

Inclusion criteria: Women with stress urinary incontinence proved by urodynamic study.

Exclusion criteria: Women with history of urge incontinence plus sign of Detrusor over activity on urodynamic study or other type of urinary incontence e.g. mixed incontinence, those with neurological disease (e.g. diabetic neuropathy, multiple sclerosis, spinal cord injury. etc), Pregnant patients or within 6 weeks postpartum, those With previous surgical treatment for urinary incontinence and uterovaginal prolapse, pelvic cancer and Patients with recurrent urinary tract infection.

The participants in the study were informed about the nature of study and its benefits, and an informed consent was obtained from each participant.

Detailed history and physical examination were performed including age, parity, past medical, obstetrical, gynecological, drug and surgical history, urogynecological symptoms (e.g. dysuria, frequency, nocturia, feeling of lump, condition which precipitating stress urinary incontinence like coughing, sneezing, lifting heavy weight, study of symptom, it's duration, severity, number of incontinence episodes, did she need pads).

For all women urine was sent for microscopic examination, culture and sensitivity and UTI were treated if present.

Incontinent patient underwent standard urodynamic investigation to establish the diagnosis of genuine stress urinary incontinence and absence of Detrusor overactivity.

Perineal Utrasongraphy: Perineal sonography was done to evaluate the urethrovesical junction to all participants. patient was asked to come in comfortably filled bladder, in dorso-lithotomy position, Perineal ultrasound was performed using Siemens Versa ultrasound machine, the 3.5 MHz probe, covered with sterile glove, was placed on sagittal axis of perineum after gel application. The image was frozen and placed on one side of screen when inferior edge of symphysis pubis, the bladder, urethro-vesical junction, and the urethra were visualized. The patient was asked to strain and again the image was frozen and placed on the other half of screen.

The intersection point of coronal plane passing through the urethro-vesical junction and the horizontal plane passing below the symphysis pubis was marked during both rest and stress position to measure the desensus diameter.

All the sonographic parameters were measured by the same senior sonographist.

Perineal ultrasonography was carried out in both groups (study and control) to evaluate the role of this technique in the diagnosis of stress urinary incontinence. By using the posterior edge of the symphysis pubis as reference point***, the following parameters were measured at rest and during straining:***

1-The posterior urethro-vesical angle (PUVA) described as the angle between the urethral axis and the floor of the bladder axis one-third closer to the urethra.

2- *The alpha angle* described as the angle between the vertical axis and urethral axis.

3- *Desensus diameter* to evaluate bladder neck mobility at cephalocaudal plane.

For each parameter two measurements were taken and the average was calculated.

The correlation of bladder neck and symphysis pubis during the resting phase and stress in patient with stress urinary incontinence is shown in figure 1.

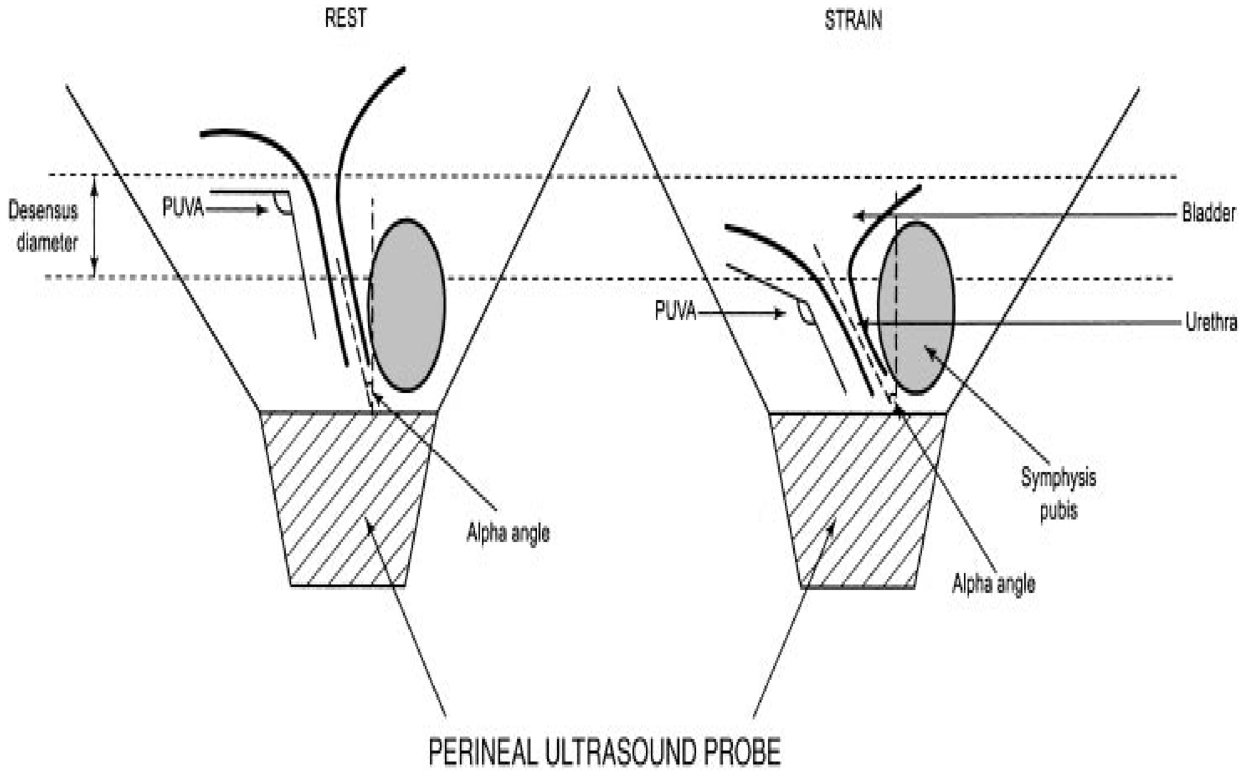

Figure 1. Diagram showing measurement taken by perineal ultrasound

- The posterior urethro-vesical angle (PUVA) is the angle between the urethral axis and the floor of the bladder axis one –third closer to the urethra.

- The alpha angle described as the angle between the vertical axis and urethral axis.

- Desensus diameter: the intersection point of coronal plane passing through the urethro-vesical junction and the horizontal plane passing below the symphysis pubis measured at rest and during Valsalva maneuver and the difference represent the desensus diameter.

Statistical analysis

Data were analyzed using SPSS version 16 and Microsoft office Excel 2007. Numeric data were expressed as mean +SD. Student t-test was used to compare between numeric data. P-value less than 0.05 were considered significant.

Results

The study group included 20 women with urodynamically proven stress urinary incontinence and a control group included 20 age matched healthy women without stress urinary incontinence.

There was statistically significant difference regarding the parity and weight between the two groups with P value (0.001, < 0.001) respectively, with parity range was 2-7 in the study group and 1-4 in the control group. The age range in the study group was 38-54 year and 40-51 year in the control group. There was no significant difference regarding the age. As shown in table 1 and figure 1.

Table1. Age, parity, and weight in the study (with stress urinary incontinence) and control groups

Characteristics	Study group (n =20)	Control group (n=20)	*P-value*
Age	46.90±7.66	45.42±5.66	0.08
Parity	5.15±2.412	2.90±1.30	0.001
Weight	78.45±8.83	67.90±4.80	<0.001

Statistically significant difference is found in all three sonographic parameters as shown in table 2.

Table 2. Comparison of Perineal sonographic parameters between the study group and control group

US findings	Study group (n =20)	Control group (n=20)	*P-value*
Desensus diameter(mm)	26.32±1.70	10.90±4.69	<0.001
PUVA (at rest)	127.82°±8.10°	108.28°±4.35°	<0.001
PUVA (at Valsalva maneuver)	170.67°±15.08°	113.97°±32.18°	<0.001
Alpha angle (at rest)	20.16°±3.50°	18.55°±3.50°	0.222
Alpha angle (at Valsalva maneuver)	52.87°±5.27°	28.46°±6.28°	<0.001

PUVA =posterior urethro-vesical angle

Table 3 represents comparison of perineal sonographic parameters between Patients with or without cystocele in the study group. There was no significant difference in desensus diameter, PUVA and alpha angle at straining between two groups. There was statistically significant difference in PUVA at rest between those with and without cystocele.

Table 3. Perineal sonographic parameters in patients with or without cystocele in the study group

US findings	Cystocele absent (n =8)	Cystocele present (n=12)	*P-value*
Desensus diameter(mm)	21.51±2.75	23.38±8.97	0.510
PUVA (at rest)	124.59°±9.66°	129.98°±6.42°	0.009
PUVA (at Valsalva maneuver)	164.20°±14.60°	174.15°±11.42°	0.128
Alpha angle (at rest)	18.26°±2.61°	21.43°±3.52°	0.051
Alpha angle (at Valsalva maneuver)	50.08°±5.64°	52.07°±6.50°	0.491

Table 4 represents Comparison of Perineal sonographic parameters in pre- and postmenopausal patients in the study group where all sonographic parameter (PUVA, alpha angles both at rest and Valsalva maneuver) were not significantly different except the desensus diameter which was significantly higher in postmenopausal than premenopausal women.

Table 4. Perineal sonographic parameters in pre- and postmenopausal patients in the study group

US findings	Premenopausal (n =9)	Postmenopausal (n=11)	*P-value*
Desensus diameter(mm)	24.08±4.90	29.15±3.80	0.048
PUVA (at rest)	124.74°±10.29°	126.34°±4.94°	0.119
PUVA (at Valsalva maneuver)	162.26°±15.74°	1.77.55°±10.85°	0.520
Alpha angle (at rest)	19.58°±4.08°	20.63°±3.06°	0.445
Alpha angle (at Valsalva maneuver)	51.84°±6.96°	53.71°±3.52°	0.051

Table 5. Sensitivity, specificity, positive and negative predictive values for stress incontinence, when the desensus diameter was >15 mm and the posterior urethra-vesical angle (PUVA) was >120°.

Parameter	Desensus diameter >15 mm	PUVA (rest) >120°	Mean PUVA >130°	Beta angle (valsalva) >140°
Sensitivity%	95	95	95	95
Specificity %	98.5	97.4	97.45	97.5
Positive predictive value %	98.3	98.2	97.95	97.7
Negative predictive value%	95.45	95.45	95.45	95.45

Discussion

Perineal sonography is a simple, non-invasive technique for the objective assessment of the lower urinary tract in patients with urinary incontinence. In contrast to the radiological techniques, perineal sonography produces direct dynamic images of the continence mechanism without exposure to X-ray. Evaluation of the urethro-vesical junction in stress urinary incontinence is essential. For this reason the Q-tip test, a clinical test with debatable specificity; lateral cystourethrography, a conventional method; and videourethrocystography, a sophisticated method, have been used. As sonography is inexpensive, reliable, easy to apply and free of any contrast material and X-ray exposure, it has practically replaced all the former methods in the evaluation of the urethro-vesical junction in stress urinary incontinence patients within the last decade [6].

Several studies have been published regarding the reliability of perineal ultrasound for diagnosis of genuine stress urinary incontinence all over the world [3,7-9].

On one line with our study, Kolbi et al (Vienna) 1988 compare Perineal ultrasound with urethrocystography in 30 patients with genuine stress incontinence they found that the Perineal sonography had similar result of urethrocystography where the B angle was (129.1±23), alpha angle was (20.8±13.2) both at rest, B angle was (151.3±21.9) and alpha angle was (38±19.1) both at straining where P value was significant (p <0.001) which is agree with our result where alpha angle, B angle at rest, alpha angle and B angle at valsalva maneuver (20.16±3.50), (127.82±8.1), (52.87±5.27), (170.6 ±15.08) respectively where P value<0.001 (10) .

Shah et al 2007 again reanalyzed sonographic variable (retrovesical angle or PUVA) in comparism to lateral cystourethrography who concluded that perineal ultrasound was superior than lateral cystouethrography and within the routine evaluation of women suffering from incontinence, the lateral cysturethrogram can be replaced by Perineal ultrasound without any limitations of the diagnostic value [11].

Alper et al (Turkey) 2001 investigated the role of sonographic imaging in the evaluation of stress incontinence by measuring PUVA angle at both rest and straining by Perineal and Transvaginal route, he concludes that the Perineal sonography is superior to Transvaginal route in the evaluation of stress urinary incontinence [8].

In a study by Gungor *et al*.1997, suggested that posterior urethro-vesical angle (PUVA) of more 120 on straining assessed by Transvaginal Ultrasound, correlated with poor support of the bladder neck, stress urinary incontinence, and posterior urethro-vesical angle of less than 120° on straining, correlated well with good support to the urethro-vesical junction [12]. While in comparison to our result PUVA was >140° associated poor urethro-vesical junction support. this minor difference may be the difference of ultrasound route where the present study the route of ultrasound was transperineal which was superior than Transvaginal as mentioned by Alper's study 2001[8], where there are two problem in transvaginal approach first it prevent free movement of bladder, specially in patient with marked descent of bladder neck. Second problem is that probe themselves move during stress, giving false impression of motion, thus distortions occurring during stress may be partially art factual.

Other finding of our study, Cephalocaudal distance (desensus diameter) was longer in patients with stress urinary incontinence ($P < 0.001$).

Weil et al (Netherlands) 1993 measured the cephalocaudal and ventro-dorsal components of urethro-vesical junction mobility by transrectal sonography in 33 incontinent and 22 continent patients. The cephalocaudal mobility was statistically significant in contrast to the ventrodorsal mobility [13].

Demirci *et al*. carried out perineal sonographic measurements of the cephalocaudal and the ventro-dorsal components of urethro-vesical junction movement at rest and at stress in 35 patients with stress urinary incontinence and 20 continent controls. The cephalocaudal distance of the urethro-vesical junction, from the pubis at rest position, was similar in both Continent and incontinent groups, but there was a significant difference during stress. The cephalocaudal mobility and the ventro-dorsal distance from the pubis were markedly different between the two groups both at rest and during stress. However, the ventro-dorsal mobility was similar in both groups. It was concluded that the urethro-vesical junction mobility of stress incontinence cases was higher on the cephalocaudal axis than the ventro-dorsal axis. The distance between urethro-vesical junction and the pubis was greater on the ventro-dorsal axis as compared to the control group and urethro-vesical junction passed down the pubic symphysis in 63% of stress incontinence cases during stress [14].

Pregazzi *et al* (Italy) 2002 concluded that Bladder neck mobility can be demonstrated by Perineal or vaginal ultrasound and measured using the symphysis pubis as the immobile reference; Perineal utrasonography show a significant difference in ultrasound variable (bladder neck-symphysis pubis distance) both at rest and valsalva maneuver between stress incontinent and continent control group, where p value was <0.001[7], which consistent with our study where p value also was <0.001.

Brandt *et al* (Brazil) 2006 found that hypermobility of urethro-vesical junction with significant elongation of proximal urethral length over 14 mm by perineal ultrasound in 36 women complaining stress urinary incontinence [15]. This study is consistent with study done by Delancey *et al* (USA) 2007evaluated 240 women but in primiparous who found that the vesical neck movement measured during cough with translabial ultrasound with stress incontinence was 15 ± 6.2 versus 10.9 ± 6.2 in primiparous continent women $P< 0.001$[16], which agree with result of our study where cut off point of bladder neck mobility was 15mm.

The result of our observation was in agreement with result of Minardi *et al* (Italy) 2007 they assess the patients with stress incontinence by Perineal ultrasound with 3 point scale(the posterior urethro-vesical angle, the angle of urethral inclination, and the proximal pubourethral distance) were significantly different under stress compared to the resting phase where p value=0.028 [(17)].

Di pietto *et al* (Italy) 2008 study used Perineal ultrasound to assess urethral mobility they proposed a physiological range of pubic–urethral distance under stress in young women between 10 and15 mm, and in post-menopause women who establish a non-rigid range of mobility in relation to age and parity: between 15 and 18 mm [(9)] .

In a study by Gungor *et al*. 1997, suggested that urethro-vesical junction descent of more than 1 cm on straining assessed by Transvaginal ultrasound, correlated with poor support to bladder neck, stress urinary incontinence and urethro-vesical junction drop of less than 1 cm correlated well with good support to the urethro-vesical junction [(12)]. While in comparison to our result desensus diameter > 15 mm associated poor urethro-vesical junction support this difference may be due to using of Transvaginal approach in Gungor's study which prevents free movement of bladder, especially in patient with marked descent of bladder neck as mentioned above.

On the contrary to our study, Farah study (Baghdad) 2006 show perineal ultrasound had low sensitivity and specificity in assessing bladder neck mobility in 18 women with genuine stress incontinence where the sensitivity, the specificity and the positive predictive value was 36.4%, 50%, 66.7% respectively [(18)], which agree with Gaupp et al (USA) 2009 who was evaluating bladder neck mobility in 73 women, 31 were with stress incontinence and 42 continent as control group of similar age and parity by Perineal ultrasound by 5 experts blinded to continence status, the sensitivity, the specificity, ppv and npv (negative predictive value) was 53.0±8.8 %, 61.2±12.4 %, 48.8±8.2%, 65±7.3% respectively[(19).]

In conclusion, perineal sonography has an important role in diagnosing patients with stress urinary incontinence. In particular, a posterior urethro-vesical angle >140° and a desensus diameter >15 mm correlates with poor support of bladder neck in patients with stress incontinence.

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