Original article

Comparison of accuracy of functional measurements of the urethra in transperineal vs. endovaginal ultrasound in incontinent women

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Abstract: Transperineal dynamic ultrasound (TPUS) and endovaginal dynamic ultrasound enable evaluation of the anatomical relationships and mobility of the urethral complex. However, endovaginal access may influence the resting position and anatomy of the pelvic floor structures. The objective of the study was to compare the accuracy of functional measurements of the female urethral complex in incontinent women performed by TPUS and novel 3-D endovaginal ultrasound (3D-EVUS). Twenty-five incontinent female patients underwent TPUS and 3D-EVUS examinations (median age: 56.28 years, range: 28.93 - 76.47). The bladder-symphysis distance (BSD) and the length of urethra were measured at rest, during Valsalva manoeuvre and squeeze to assess the mobility of the urethra. In the group of 10 (40%) incontinent patients with no coexisting anatomical disturbances there were no statistical differences between the two ultrasonographic techniques. In the group of 15 (60%) incontinent patients with associated pelvic organ prolapse (POP) the measurements of the length of urethral complex and BSD differed significantly. Assessment of length and mobility of urethral complex in incontinent patients with POP using EVUS is inaccurate due to alterations of anatomical relations caused by the introduction of the transducer into the vagina, which makes the squeeze test impossible to perform properly. However in incontinent patients with no coexisting anatomical disturbances both TPUS and EVUS methods have the same accuracy.

Key words: Dynamic transperineal ultrasound; Endovaginal ultrasound; Stress urinary incontinence; Pelvic Organ Prolapse.

INTRODUCTION

Female urinary incontinence (UI) and pelvic organ prolapse (POP) are conditions with severe economic and psychosocial impact affecting millions of women. It is estimated that almost 30% of women older than 35 years suffer from POP and/or UI.[1] The etiology of PFD is multifactorial and includes surgical interventions, number and type of deliveries, hormones' profile, aging, obesity.[1-3] The diagnosis of these conditions is based on physical examination and imaging, mostly on ultrasound examination. Transperineal ultrasound (TPUS) and endovaginal ultrasound (EVUS), which are widely used, give only general information on anatomy, anatomical relationships and mobility of pelvic floor structures, but are insufficient to give a highly detailed assessment. Recently introduced high resolution three-dimensional (3D) EVUS seems to be a very promising modality to improve the imaging of female pelvic floor dysfunctions.

Aim of this study was to compare the diagnostics methods TPUS and EVUS in the assessment of urethral mobility in female patients suffering from stress urinary incontinence.

MATERIALS AND METHODS

Twenty-five females suffering from stress urinary incontinence (SUI) were enrolled in this study (median age: 56 years, range: 28-76 years) and underwent TPUS and 3D-EVUS examinations. Transperineal US was performed with a 6 MHz convex transducer (tape 8802, B-K Medical, Herlev, Denmark), while EVUS was performed with a 6.5-9 MHz multiplanar transducer (tape 8848, B-K Medical, Herlev, Denmark) with perpendicular and transverse beam formation to the urethra and 3-D acquisition system. All the examinations were performed using the same ultrasound scanner (ProFocus 2202, B-K Medical, Herlev, Denmark). Three-D application was used for the assessment of the morphology of the urethra and surrounding structures. Transperineal US was performed by positioning the transducer tenderly onto the perineum, in midsagittal line, to visualize pubic symphysis, urethra and bladder, vagina and anal canal (Fig. 1). Endovaginal US was performed by inserting the transducer into vagina in a neutral position with no compression on the urethral complex and surrounding structures. It was mandatory to visualize the pubic symphysis and entire urethra from bladder neck to external meatus (Fig. 2).

We divided females in two groups: patients suffering only from SUI (first group: 10 patients - 40%) and patients with SUI and coexisting POP (second group: 15 patients - 60%; 7 cystocele, 8 recto/enterocele). Mobility of the urethra was evaluated by measuring the bladder-symphysis distance (BSD - distance from bladder neck to the lowest margin of the pubic symphysis) and the length of urethral complex. These measurements were taken at rest, during Valsalva manoeuvre and squeeze. For each patient 12 measurements were taken: urethral length and BSD at rest, during Valsalva and squeeze manoeuvre by using both TPUS and EVUS. For the statistical analysis the mean values, standard deviation (SD) and

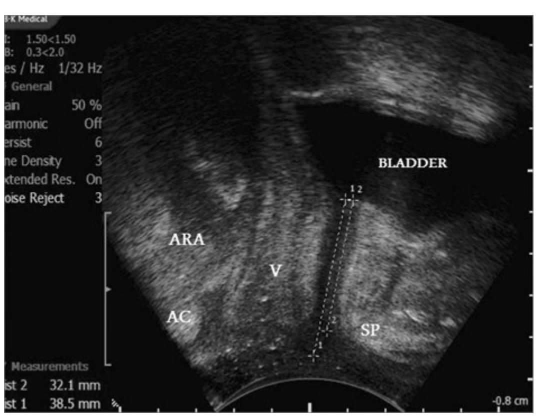

Fig. 1. – Transperineal ultrasound of pelvic floor. AC- anal canal, SP- pubic symphysis, V - vagina, ARA - anorectal angle. The measurements of urethral length is 38.5 mm and BSD is 32.1 mm in this 30 Y incontinent patient.

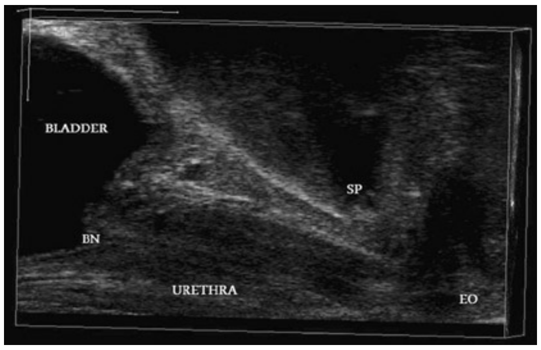

Fig. 2. – Longitudinal view of the urethral complex obtained by a 180° rotational transducer with perpendicular beam formation, 9-12 MHz frequency and with "free-hand" 3-D acquisition. BN - bladder neck, SP - pubic symphysis, EO - external orifice of the urethra.

Fig. 3. – TPUS. BSD 22 mm, urethral length 39,5 mm; 48 Y incontinent patient with coexisting cystocele.

t-Student test were used. Five percent inference error was assumed as statistically significant ($p < 0.05$).

RESULTS

Mean values of the measurements taken in the first group of patients are presented in table 1, whilst the measurements obtained in the second group of patients are presented in table 2. In the first group of 10 (40%) incontinent patients with no coexisting anatomical disturbances there were no statistical differences in the length of urethral complex at rest and during Valsalva manoeuvre and squeeze between TPUS and EVUS. The values of BSD taken at rest and during Valsalva manoeuvre were also similar. In the second group of 15 (60%) incontinent patients suffering from POP the measurements of the length of urethral complex taken by TPUS and EVUS differed significantly in all three tests ($p < 0.001$). Measurements of BSD at rest and during squeezing were also significantly different ($p < 0.01$ at rest and $p < 0.05$ during squeezing). The values of BSD during Valsalva manoeuvre varied between TPUS and EVUS although the difference was not statistical.

DISCUSSION

Transperineal ultrasound is a cheap, available and relatively easy to perform technique for the assessment of urethral morphology and relationship of the urethra with bladder and pubic symphysis. The lowest margin of pubic symphysis represented the point of reference for measurements. A huge disadvantage of TPUS is the inaccurate urethral assessment due to an extensive compression of the transducer onto the perineum. Moreover, this examination is not adequately precise in the evaluation of the urethra because it is not possible to distinguish the layers of the urethral wall or to visualize the urethral support. This could be due to the use of the low frequency convex transducer routinely used for abdominal ultrasound which is not dedicated for the assessment of pelvic floor. However, TPUS allows an easily assessment of urethral mobility during dynamic tests.[3] Transperineal ultrasound is reliable in the diagnostics of POP,[5] being accordant with ICS-POPQ scale, as confirmed by the study of 140 patients with POP performed by Dietz and al.[4]

Endovaginal ultrasound with novel high frequency transducer (9-16 MHz) as well as 3-dimensional data acquisition represents a more precise method in the assessment of urethra as well as other pelvic floor structures. This transducer was initially used in proctology for the evaluation of the anal canal, morphology of the anal sphincters, fistulas and staging of the rectal cancer,[9, 10] as well as in urology for prostate brachytherapy. The biplane transducer with perpendicular and transverse beam formation allows visualization of the structures on the axial plane, as well as on the sagittal plane, and 3D data acquisition allows their reconstruction on the coronal plane. Untill now it was achievable only by CT or MRI not by ultrasound. To perform EVUS correctly, it is extremely important to insert the transducer into the vagina in a neutral position and not to compress

TABLE 1. – *Mean values (M) and standard deviation (SD) of the urethral length and BSD obtained by TPUS and EVUS in the group of 10 patients with only stress urinary incontinence.*

	Urethral length at rest	*Urethral length at Valsalva*	*Urethral length at squeezing*	*BSD at rest*	*BSD at Valsalva*	*BSD at squeezing*
TPUS	M: 32,5 mm	30,1 mm	33,3 mm	18,9 mm	6,2 mm	19,9 mm
	SD: 2,87 mm	2,5 mm	3,7 mm	5,1 mm	11,4 mm	6,78 mm
EVUS	M: 32,6 mm	29,7 mm	33,1 mm	18,9 mm	6,3 mm	21,1 mm
	SD: 3,49 mm	3,5 mm	3,3 mm	2,8 mm	8,1 mm	5,7 mm

TABLE 2. – *Mean values (M) and standard deviation (SD) of the urethral length and BSD obtained by TPUS and EVUS in the group of 15 patients with stress urinary incontinence and pelvic organ prolapse.*

	Urethral length at rest	*Urethral length at Valsalva*	*Urethral length at squeezing*	*BSD at rest*	*BSD at Valsalva*	*BSD at squeezing*
TPUS	M: 34,7 mm	31,3 mm	33,6 mm	21,2 mm	13,9 mm	20,9 mm
	SD: 3,76 mm	2,84 mm	3,68 mm	7,5 mm	11,4 mm	9,3 mm
EVUS	M: 36,8 mm	28,7 mm	31,8 mm	23,1 mm	13,5 mm	22,1 mm
	SD: 3,64 mm	2,02 mm	3,5 mm	6,4 mm	7,7 mm	7,4 mm

Fig. 4. – TPUS. BSD during Valsalva manouvre 5.6 mm in 48 Y incontinent patient with coexisting cystocele.

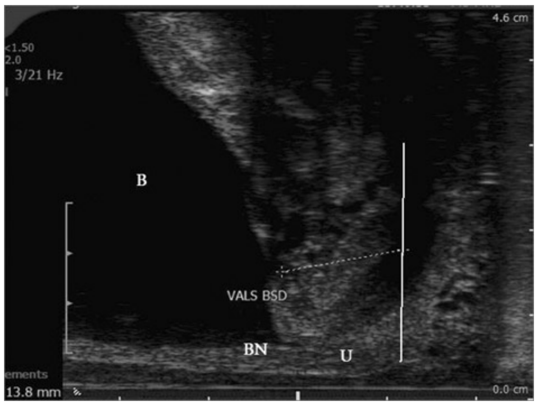

Fig. 6. – EVUS. Measurements of BSD (13 mm) during Valsalva manoeuvre in 61 Y incontinent patient. B - bladder, BN - bladder neck, U - urethra.

extensively on the urethra, the anal canal or the surrounding structures. Only the neutral position allows the most reliable evaluation of the morphology and anatomical relations and offers the possibility to detect potential disturbances.

In the diagnosis of urinary incontinence it is very important to assess precisely the location of the urethra and its morphology, to distinguish the layers of the urethral wall, to depict the striated sphincter and to assess the bladder neck at rest and during dynamic tests. The location of the urethra was until now described by the values of different angles observed on the sagittal plane during TPUS.[8] However, the measurements obtained only in one plane could not give the whole information about the diagnosed disturbances and should not be considered as prognostic factors. Thus, 3D-EVUS, giving an opportunity of the assessment of the urethral angulations on three different planes, seems to be a very promising alternative method to TPUS. Moreover 3D-EVUS provides very precise assessment of anatomy and morphology of female pelvic floor structures and can improve our knowledge on etiology of their disorders.

This study shows that in females suffering from SUI and coexisting pelvic organ prolapse the endovaginal examination is not reliable in the assessment of the urethral mobility due to alterations of anatomical relations resulted from introduction of the transducer into the vagina. Additionally, in all patients the transducer inserted into vagina makes squeeze test impossible to perform appropriately. However, in the measurements of the length of urethral complex and BSD at rest and during Valsalva manoeuvre in incontinent patients with no coexisting anatomical disturbances both TPUS and EVUS methods have the same accuracy.

Fig. 5. – EVUS. Measurements of BSD (21 mm) and urethral length (32.4 mm) at rest in 61 Y incontinent patient.

CONCLUSION

In incontinent women with no coexisting anatomical disturbances both ultrasound methods (TPUS and EVUS) have the same accuracy in the measurements of urethra complex and BSD at rest and during Valsalva manoeuvre. Measurements taken by EVUS during squeezing and measurements in incontinent women additionally suffering from pelvic organ prolapse appears to be inaccurate due to the introduction of the transducer into the vagina, which alters the anatomical relationships of the pelvic structures.

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