Perineal ultrasound evaluation of urethral mobility after the TVT-O procedure

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Summary

Aims: The aim of study was to assess, by means of perineal ultrasound (US), women treated with the trans-obturator suburethral sling procedure for urinary stress incontinence (USI). *Methods:* Twelve women with USI and urethral hypermobility were enrolled. Static and dynamic perineal US of urethral mobility was performed before and after tension-free vaginal tape opturator (TVT-O) procedure: US parameters evaluated were pubis-urethra distance and inclination angle of the urethral axis. *Results:* The Valsalva stress US evaluation showed a return to normal range of the pubic urethral distance in all cases ($p = 0.0001$); also a correction of the angle of inclination of the urethral axis occurred in all patients ($p < 0.0001$). *Conclusions:* Our results propose the use of perineal US for patients with USI as an additional diagnostic tool and a means for postsurgical follow-up.

Key words: Perineal ultrasound; Urinary stress incontinence; TVT-O.

Introduction

Urinary stress incontinence (USI), defined by the International Continence Society (ICS) as the complaint of involuntary urinary leakage on effort or exertion, or on sneezing or coughing, is an involuntary leakage of urine during periods of raised intraabdominal pressure, in the absence of a detrusor contraction [1].

In fact, during a woman's life, the uterus, vagina, bladder neck and urethra undergo various "topographic" modifications caused by pregnancy, childbirth, postmenopausal estrogen deficiency and pelvic surgery, and within these settings particular importance has to be given to urethral mobility, which can be involved in the pathogenesis of USI when the proximal urethra is no longer within the intraabdominal closure pressure zone [2, 3].

The degree of urethral mobility is evaluated essentially by clinical examination, but it is not well defined or standardized: on vaginal examination urethral length, position and mobility are assessed, and hypermobility of the bladder neck may be visualised during a cough or Valsalva as the backward and downward movement of the urethra by the Q-tip cotton bud test.

Ultrasound (US) of the pelvic floor (perineal/vulvar, introital, endovaginal, transanal, endoanal [4, 5]) is currently gaining importance as a diagnostic tool for the evaluation of defects of the pelvis surrounding tissues and continence disorders. It allows the healthcare provider to obtain both anatomical or "static" images and functional or "dynamic" characteristics, during the increase of intraabdominal pressure [6], with important information concerning cervical-urethral mobility [7, 8] and USI [9, 10].

The mainstay of treatment for USI is conservative management with containment devices and physiotherapy, with recourse to surgery where indicated and desired. Advances in surgical techniques have led to the availability of various minimally invasive interventions such as suburethral sling procedures, e.g. tension-free vaginal tape obturator (TVT-O) procedure [11].

We attempted to evaluate and quantify the degree of urethral mobility using perineal US in women with USI treated with the TVT-O procedure [12]. The two US parameters used were pubic-urethral distance, which is the distance between the pubis and midurethra, and inclination angle of the urethral axis, which is the angle between the pubic bone and the internal urethral orifice [13, 14].

Materials and Method

Subjects and surgical procedures

Twelve postmenopausal women with USI and urethral hypermobility referred to our Pelvic Floor Centre were enlisted in the study. The trial obtained approval from an independent Ethics Committee and formal, informed consent from the patients was obtained.

These subjects underwent acquisition of urogynecologic history, urogynecologic clinical examination (urogynecologic objective examination, voiding diary, Q-tip test, stress test, pubococcygeal test), urodynamic assessment (cystomanometry, urofluxmetry, pressure-flux study, and urethral pressure profile), transabdominal and transvaginal pelvic US. Moreover, the patients underwent static and dynamic perineal US to evaluate the degree of urethral mobility.

Inclusion criteria for the study were: postmenopausal age, body mass index (BMI) ≥ 18.5 kg/m^2, history of at least one vaginal childbirth, and moderate/severe USI. Exclusion criteria were: age > 65 years, BMI ≥ 30 kg/m^2, urge incontinence with overactive bladder or detrusor instability, pelvic organ prolapse, previous urogenital surgery, or current or previous use of estrogen therapy.

The patients filled out an anonymous questionnaire to ascer-

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Fig. 1

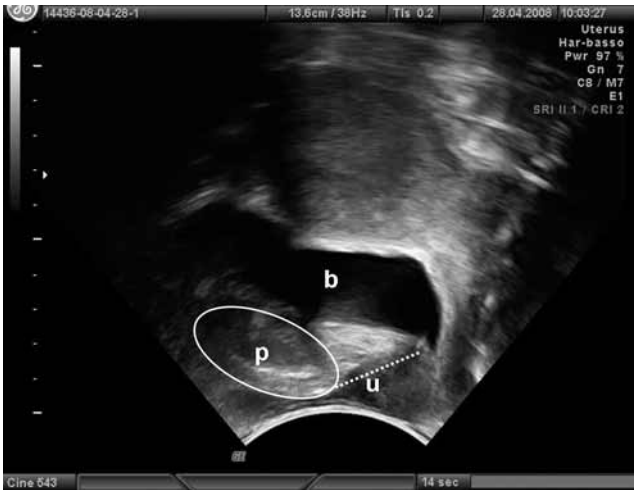

Fig. 2

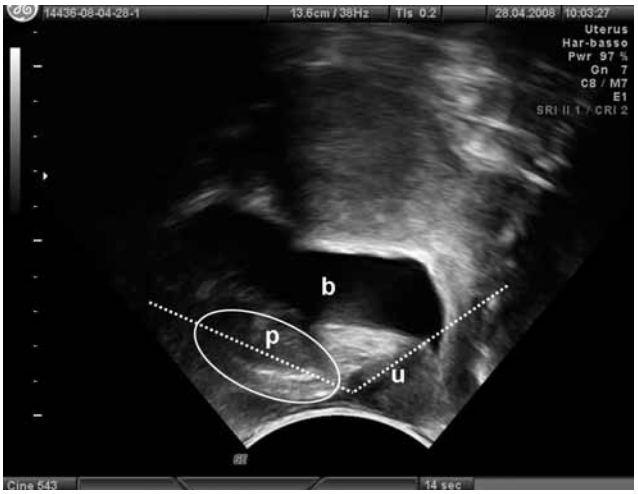

Fig. 3

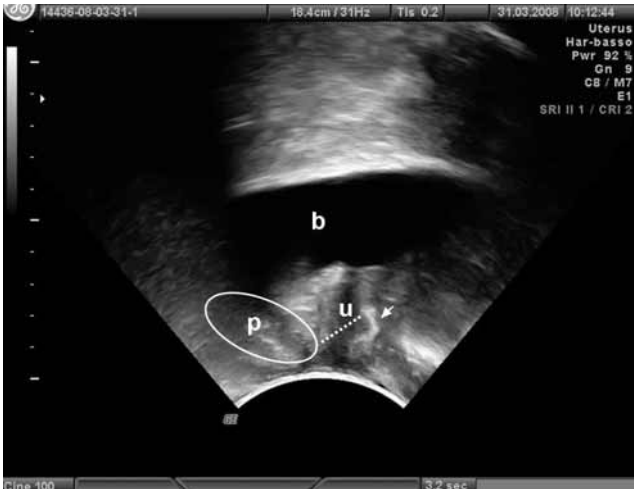

Fig. 4

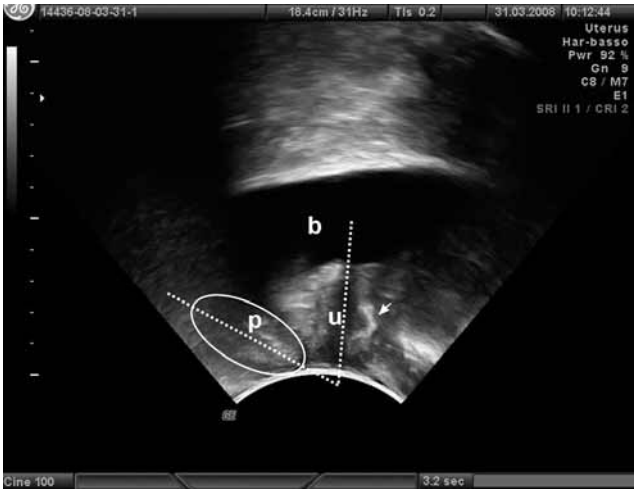

Figure 1. — Presurgical pubic-urethral distance under stress (p: pubic bone; b: bladder; u: urethra).
Figure 2. — Presurgical inclination angle of urethral axis under stress (p: pubic bone; b: bladder; u: urethra).
Figure 3. — Postsurgical pubic-urethra distance under stress (p: pubic bone; b: bladder; u: urethra; arrow: sling).
Figure 4. — Postsurgical inclination angle of urethral axis under stress (p: pubic bone; b: bladder; u: urethra; arrow: sling).

tain the absence of symptoms of prolapse. In addition only those women who showed absence of objective clinical signs of an altered suspension state of the pelvic organs or who, at the most, showed mild cystocele were enrolled.

Subsequently the patients underwent the TVT-O procedure (TVT-O™, Ethicon) to correct the urethral hypermobility and restore urinary continence. TVT-O was carried out according to the technique described by de Leval [11]: a paraurethral dissection plane is made from a minimal suburethral incision to the obturator foramen; the obturator membrane is punctured, an introducer is passed along the passage made, and a spiral trocar of the TVT-O device is guided along the introducer through the obturator membrane before being rotated out through the groin incision (made at a plane 2 cm above the urethral meatus at a point 2 cm lateral to the labial crural folds); once the trocar is pulled through and the correct tension has been achieved, the plastic cover over the tape is removed and the tape is thus positioned without tension under the junction between the mid and distal urethra (an instrument between the tape and urethra ensures that the mesh remains tension free); lateral vaginal fornices are checked for breaches in the vaginal epithelium at the conclusion of the procedure to avoid paraurethral vaginal mesh erosion.

The patients, after a clinical check within a month from the surgery, completed a post-surgery follow-up at six months, and on this occasion they were tested again clinically and by perineal US. A more precocious US assessment was intentionally left out because we do not consider it very reliable in the imminence of surgery.

The cure was defined as no urine loss during stress. Improvement was defined as significantly fewer leakage episodes during stress than before surgery, with a satisfied patient.

Ultrasound procedure and measurement parameters

The US procedure was carried out on patients with a half-full bladder (approx. 250 cc) as it is advisable to avoid excessive bladder filling which could jeopardize later patient collaboration in performing the Valsalva maneuver and alter the measurement of the US parameters [13, 15].

All subjects underwent a perineal US test by the translabial technique using a convex probe of 3.5 MHz longitudinally placed on the vulvar rim and inclined slightly superior with the patient in dorsal lithotomy, with the hips flexed and slightly abducted, after covering the transducer with a glove for hygienic reasons (Voluson® 730 Expert, General Electric). This produced

a large panoramic view of the anatomical structures in the front section of the pelvic floor. This probe placement also allowed median sagittal scanning of the front perineum [4, 6].

As to the optimal orientation of images in the mid-sagittal plane, some authors [4] prefer an orientation as on conventional transvaginal US (cranioventral aspects to the left, dorsocaudal to the right), while others [6], including the authors, prefer image inversion on the US system [14]. We use an up-down inversion to simplify image interpretation. Therefore, the US beam originates from the bottom of the monitor and the patient's caudal part is displayed in the lower portion. It could also be useful to hold the probe so that the patient's front remains on the left and the back on the right of the monitor. This has the practical advantage of allowing full correspondence between the movements of the right hand (doing the scanning) and the movements displayed on the monitor as is seen in all other US examinations. Since any image reproduced in one of the above orientations can be converted to the other by simple rotation through 180°, formal standardization may not be necessary [6].

The pubic bone appears as an oval image surrounded by regular wrapping (curved ligament), on the left of the screen. The transonic longitudinal structure in the middle of the screen is the urethra and above this is the bladder. On the upper part of the bladder the uterus is evident and finally, on the right of the screen and adjacent to the urethra, is the vaginal canal [14].

As the pubic bone is the only fixed structure inside the observation field it was used as a landmark for taking the measurements: the pubic-urethral distance, which is the distance between the rear margin of the pubic bone and the rear wall of the midurethra and the inclination angle of the urethral axis, which is obtained by drawing a line through the major axis of the pubic bone and a line through the longitudinal axis of the urethra [6, 13, 14]. The mid urethral reference point was determined by subjective assessment. Bladder neck position and mobility can also be assessed by perineal US [9, 10]: points of reference are the central axis of the pubic symphysis [2] or its inferoposterior margin [16].

All subjects received both a "static" and "dynamic" evaluation. In the "dynamic" phase the same structures are observed except the abdominal pressure is increased through the Valsalva maneuver. This was achieved by having the subject 'cough'. Specifically, the use of cine loop (the ability to store and reproduce the last images) allowed the evaluation of urethral mobility, using the above measurement parameters, at the time of the major abdominal push.

US measurements were all obtained by one investigator and a single measurement, however patients had to carry out the Valsalva maneuver several times and the maximum excursion was selected by cine loop for the measurement.

There was no specific standardization of the Valsalva effort and increases in intraabdominal pressure. In fact, attempts at standardising the Valsalva maneuver have not found widespread application since intraabdominal pressure measurement is required, i.e. a rectal balloon catheter.

We estimated as indicative values of normal urethral range on Valsalva in postmenopausal women with at least one vaginal childbirth, between 15 and 18 mm for the pubic-urethral distance and 80-120° for the inclination angle of the urethral axis [14].

Statistical analysis

Data were analysed using the paired Student t-test and results were expressed by mean ± standard deviation (SD) and range. The level of statistical significance was set at $p < 0.05$.

Results

The subjects who enlisted in the study (n = 12) were 56.83 ± 6.10 years old (range 47-65), with a BMI of 25.08 ± 3.12 kg/m² (20-30).

In patients affected by USI, the presurgical perineal US values of the pubic-urethral distance on Valsalva were always ≥ 18 mm, except one case with a mean value of 21.52 ± 3.74 mm (range 12-26) (Figure 1); this distance at rest was 18.73 ± 3.64 mm (range 11-24).

Values of the angle of inclination of the urethral axis on Valsalva before the TVT-O procedure were always ≥ 120° with a mean of 123.58 ± 3.94° (range 120-131) (Figure 2); this angle at rest was 103.08 ± 2.57° (range 100-109) (Table 1).

Table 1. — *Baseline characteristics and perineal ultrasound measurements – mean ± S.D (range).*

	(n = 12)
Age *(years)*	56.83 ± 6.10 *(47-65)*
BMI *(kg/m²)*	25.08 ± 3.12 *(20-30)*
Pubic-urethral distance - Rest *(mm)*	18.73 ± 3.64 *(11-24)*
Pubic-urethral distance - Valsalva *(mm)*	21.52 ± 3.74 *(12-26)*
Angle of inclination of urethral axis - Rest *(°)*	103.08 ± 2.57 *(100-109)*
Angle of inclination of urethral axis - Valsalva *(°)*	123.58 ± 3.94 *(120-131)*

Table 2. — *Pre- and postsurgical (TVT-O) values of distance of the pubic-urethral and inclination angle of the urethral axis at rest and on Valsalva – mean ± S.D.*

	Presurgery values		*Postsurgery values*	
	Rest	Valsalva	Rest	Valsalva
Pubic-urethral distance *(mm)*	18.73 ± 3.64	21.52 ± 3.74	13.17 ± 2.79 [a]	15.33 ± 2.27 [b]
Angle of inclination of urethral axis *(°)*	103.08 ± 2.57	123.58 ± 3.94	99.58 ± 3.60 [c]	106.42 ± 5.16 [d]

[a] $p = 0.0003$ vs presurgery values at rest; [b] $p = 0.0001$ vs Presurgery values on Valsalva; [c] $p = 0.0183$ vs presurgery values at rest; [d] $p < 0.0001$ vs presurgery values on Valsalva.

In all cases of patients treated for USI return in the range of normality of the pubic-urethral distance was calculated and registered. For postmenopausal women on Valsalva effort the pubic-urethral distance at rest was 13.17 ± 2.79 mm (range 8-16) at six months from the TVT-O procedure ($p = 0.0003$); the same parameter on Valsalva was 15.33 ± 2.27 mm (range 11-18) after surgery ($p = 0.0001$) (Figure 3).

Moreover the angle of inclination of the urethral axis was corrected in all patients to the normal range for Valsalva values: the angle of inclination of the urethral axis at rest was 99.58 ± 3.60° (range 92-105) at six months from surgical intervention ($p = 0.0183$); the same parameter on Valsalva was 106.42 ± 5.16° (range 102-118) after surgery ($p < 0.0001$) (Figure 4) (Table 2).

Postsurgical follow-up at six months showed significant improvement in the values of US parameters corresponding to a correction of USI, except in one case when there was a recourse to self-catheterism for partial retention; it resolved after five days.

Discussion

Mobility of the female urethra undergoes various modifications due to pregnancy, postmenopausal estrogen deficiency, and pelvic surgery: this urethral hypermobility can be involved in the pathogenesis of USI [2, 3].

The degree of urethral mobility is evaluated essentially by clinical examination, but it is not yet well defined and standardised; perineal US of the pelvic floor is currently gaining importance as a diagnostic tool for the evaluation of pelvic anatomical and functional defects [6] with key information on cervical-urethral mobility [7, 8] and USI [9, 10].

In the present study we evaluated the pubic-urethral distance and the inclination angle of the urethral axis by perineal US to quantify the degree of urethral mobility in women with USI treated with the TVT-O procedure [11, 12]. These two simple and reproducible US measurements, which have been used previously for similar purposes [6, 13, 14], were taken through the perineal technique at rest (static) and under Valsalva stress (dynamic) conditions. We have defined values beyond which urethral mobility under stress can be considered as pathological such as a normal range for postmenopausal women: a pubic-urethral distance between 15 and 18 mm and inclination angle of the urethral axis in the range of 80-120° [14].

In our experience, women affected by USI and treated with the TVT-O procedure had surgical correction in the normal range of the pubic-urethral distance and the angle of inclination of the urethral axis for Valsalva values. In fact, a significant improvement in the values of US parameters of urethral mobility at six-month postsurgical follow-up was recorded: $p = 0.0003$ for pubic-urethral distance adjustment at rest, and $p = 0.0001$ under Valsalva stress; $p = 0.0183$ for modification of the angle of inclination of the urethral axis at rest, and $p < 0.0001$ on Valsalva maneuver (Table 2).

The correction of USI in all study group cases implies that urethral modifications produced by the TVT-O sling on pubic-urethral distance and inclination angle of the urethral axis can explain the improvement in urinary continence.

However, the present findings require further validation and clarification, particularly through increased testing with a larger sample cohort. Nonetheless our results, even if in a small study group, suggest a role for perineal functional US in the estimated parameter as an additional diagnostic research fool in postsurgical follow-up of patients with USI.

Urinary incontinence due to stress is frequently associated with urethral hypermobility in women. Establishing a range of normality for urethral mobility through US is extremely useful when examining women suffering from USI. Our experience proposes a simple and reproducible US technique and measurement for diagnosis and postsurgical follow-up in women with USI with urethral hypermobility treated with the TVT-O procedure. The perineal evaluation of this same mobility brings about various possible therapeutic choices. Furthermore, these US recordings can be of great help both in identifying a surgical correction operation and in postoperation follow-up [12].

Perineal US in USI and surgical options can surely have a supplementary function at the objective examination and at the classical urogynecologic diagnostics in evaluating urethral mobility and its possible regression after surgery. Moreover, perineal US is economical and has easy technical availability as well as exam repeatability.

Acknowledgements

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