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Possible role of perineal ultrasound in the diagnosis of cystocele

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Summary

Objective: Perineal ultrasound has not yet been adequately evaluated in relation to the diagnosis of anatomical descensus of pelvic organs. Therefore, the aim of the present study was to assess whether it is possible to carry out a topographical comparison between bladders in normal seat and prolapsed ones and to quantify the extent of descensus. *Materials and Methods:* The authors selected 140 women, divided into three groups (two control groups and one case group). All patients underwent urogynaecological examination, according to the Pelvic Organ Prolapse Quantification (POP-Q), and perineal ultrasound to evaluate pubo-bladder distance. *Results:* Considering the data recorded in the two control groups, the authors established the physiological pubo-bladder distance between 27-33 mm at rest and 25-30 mm under stress. In the group with cystocele, the pubo-bladder distance was significantly lower: 20 mm at rest and three mm under stress (mean value). The authors also performed a classification of ultrasound cystocele in four stages, in accordance with clinical staging. *Conclusions:* In conclusion, the present data show the excellent potential role of perineal ultrasound in the diagnosis of cystocele, but it is necessary to perform randomized studies to standardize the method.

Key words: Perineal ultrasound; Cystocele; Pubo-bladder distance.

Introduction

Perineal ultrasound is being considered a more and more reliable diagnostic technique in the assessment of the defects of pelvic static and urinary continence. It allows to evaluate these aspects both from an anatomic and a functional point of view through the study of the movements of pelvic organs from a position at rest (static) to a developing situation induced by the increase in abdominal pressure (dynamic) [1]. For this purpose, ultrasound can be carried out with different types of ultrasonic transducers (convex, linear, endocardial, and transrectal probes), and through multiple approaches (perineal/vulval, endovaginal, transanal, and endoanal) [2].

It is well known that with passing of time pelvic organs - especially bladder and urethra in the urinary system, uterus and vagina in the genital one- undergo topographical changes as a response to previous traumatic stimuli such as pregnancies, deliveries or previous pelvic surgery, or as a response to molecular stimuli due to physiological variations such as estrogen deficiency typical of menopausal period [3]. These topographic changes would be of little significance if they did not correspond to connected pathological alterations that inevitably lead to functional and/or anatomical disorders (urinary incontinence and/or prolapse of pelvic organs) with effects on women's quality of life [4, 5]. With regards to this matter, in the last decades there have been many therapeutic advancements in urogynaecology, but still nowadays attention is mainly drawn to the improvement of diagnostic sensitivity in order to implement appropriate prevention measures or carry out early diagnoses of pelvic floor disorders. Perineal ultrasound is part of this debate as it is nowadays regarded in literature as an effective diagnostic support in the assessment of urethral mobility and of bladder neck typical of stress urinary incontinence [6-10]. On the contrary, such a method has not yet been properly judged in relation to the quantitative diagnosis of anatomic descensus of pelvic organs [11, 12]. Concerning this, the employment of magnetic resonance for imaging recently gained a more and more significant role in the assessment of pelvic organs prolapse, both due to its superior diagnostic precision and to its minor invasiveness if compared to cysto-uro proctography [13-16]. The negative factors of this technique are the economical aspect and its limited accessibility. The latter only refers to the gynaecology diagnosis as, in radiology, magnetic resonance is definitely considered the preferred exam thanks to its precision and the reduction of operator's subjectivity. Owing to these limits, to prove that perineal ultrasound is highly reliable in the diagnostic assessment of genital prolapse, a non-invasive and low cost technique should be available. Such tech-

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nique, associated with clinical examination, would considerably improve the diagnostic sensitivity of Pelvic Organ Prolapse-Quantification (POP-Q) [17].

In 2012, Chantarasorn and Dietz [18] carried out a study with the clinical and radiological comparative assessment of cystocele type II and type III based on the retrovesical angle, between urethra and trigonum, according to the classification suggested by Green [19]. This classification identifies two types of cystoceles: Green type II with retrovesical angle ≥ 140°, called "open"; and Green type III with retrovesical angle ≤ 140°, called "intact". The variation of this angle allows to establish the type of defect: central in cystoceles with intact retrovesical angle ≤ 140° and lateral in cystoceles with open retrovesical angle ≥ 140°.

In spite of the attempts to standardize precise ultrasound indexes for cystocele diagnosis, to this day we still do not have objective and certified data to be taken as a reference when employing this method.

On the strength of these premises, the aim of the present study is to consider whether it is possible to employ ultrasound to carry out a topographical comparison between bladders in normal seat (control group) and prolapsed bladders (patients with clinical diagnosis of cystocele) and whether it is possible to quantify the descensus.

Materials and Methods

This observational prospective study was approved by the ethics committee of the present department and the authors obtained the informed consent of all the patients selected. They singled out 140 women and divided them into three groups which referred to the gynaecology departments (general and menopausal medical practices) or to the *Centro del Pavimento Pelvico* (the Centre for the Pelvic Floor).

The first objective of this study was to employ ultrasound to compare the position of the bladder in a group of young, nulliparous women (average age: 30 years) with the one in a group of nulliparous women who went through menopause since at least five years (average age: 53 years). Such comparison was needed to establish whether, in the absence of risk factors, the position of the bladder remains unchanged in the two groups, and to correctly define the control group. The second objective was to employ ultrasound to diagnose cystocele in patients with such a clinical diagnose and classify the entity of the descensus.

The first group (control group A) involved 40 healthy and nulliparous women with an average age of 30 years (SD ± 0.8 - 0.5), who were selected to establish a topographic image of the bladder that would provide an ultrasound assessment of the physiological position of the bladder.

The second group (control group B) involved 40 healthy nulliparous and menopausal women with an average age of 53 years (SD ± 0.5 - 0.8), who were selected to establish a topographic image of the bladder that would provide an ultrasound assessment of the physiological position of the bladder, despite the imperceptible changes caused by the hypoestrogenism typical of menopause.

Patients in control groups (A and B) were asked to fill in validated forms to prove the absence of hidden symptoms of urinary incontinence and/or prolapse. After that, the authors selected only patients with no sign, neither objective (clinical examination) nor subjective (form), of any alteration of the pelvic static.

The third group (study group C) involved 60 peri-post-menopausal women with an average age of 54 years (SD ± 0.9 - 0.6) and a clinical diagnosis of cystocele, regardless of its stage. Cystocele clinical staging was carried out through urogynaecology assessment after voiding the bladder and in lithotomical position using the POP-Q standardization system. After the identification of pointers on the anterior and posterior walls of the vagina and of the cervix, the authors carried out the assessment of their descensus in relation to the hymen, both at rest and under stress.

All the patients were subject to an accurate anamnesis in order to exclude women with hereditary collagen diseases, obesity (BMI ≥ 30 kg/m^2) or previous pelvic surgery. In addition, every patient was submitted to transvaginal ultrasound assessment of pelvis in order to evaluate the degree of bladder fullness and the presence of possible pathologies that may have discouraged the perineal approach, which allowed differential diagnoses for possible urethral diverticular pathologies in presence of defects of the anterior wall.

After the enrolment phase, all the patients were submitted to perineal ultrasound both static (at rest) and dynamic (during the Valsalva manoeuvre).This procedure was carried out through translabial ultrasound using a convex probe 3.5 MHz positioned lengthwise the vulval opening and slightly inclined upwards, while the patient was in dorsal lithotomy position. Positioning the probe in this way allows to obtain the best assessment of all the anatomic structures of the pelvic floor and also the mid-sagittal view of the anterior perineum.

The pubic bone appears like an oval image surrounded by a regular filament (curved ligament) on the left of the screen. The anechogenic longitudinal structure in the centre of the screen is the urethra, on top of that can be seen the bladder surmounted by the uterus. Finally, the vaginal canal is displayed on the right of the screen, next to the urethra. As the pubic bone is the only fixed structure among those observed, it is the reference point for the scanning. The ultrasound reference point taken into account in the assessment of the cystocele was the distance between the bladder base and a straight line passing by the lower margin of the pubis symphysis (P-line) (Figure 1).

In the control groups (A and B), the distance from the P-line was measured at one cm from the bladder neck; while in the study group (C) it was measured from the lower part of the bladder base. Since the authors supposed that in physiological conditions the regular urethral-bladder angle is at a distance of about one cm from the posterior bladder wall, they chose to measure the P-line in the control group at one cm from the bladder neck. In addition, when assessing the P-line in both control groups, they detected that the angle between the P-line and the pubic axis was always about 30° in all the patients, with a non statistically significant standard deviation. Therefore, taking into account this random observation, they decided to measure the P-line as to make the angle always correspond to 30° also in the study group in order to create a reproducible method (Figure 2). The examination was carried out with half-full bladder (250 cc) to avoid an excessive bladder fullness that may have affected the cooperation of the patient in performing the Valsalva manoeuvre and therefore altered the values assessed. The value was correctly evaluated through bladder scan. For every patient, the measurement of these parameters was both static and dynamic. In the dynamic phase, the increase in intra-abdominal pressure was obtained asking the patient to perform a progressive top-down push without breathing. Thanks to the cine-loop method (the ability to memorize and reproduce images), the authors could observe a stop-motion of the peak of the abdominal push and detect the point of maximum descensus of the bladder base

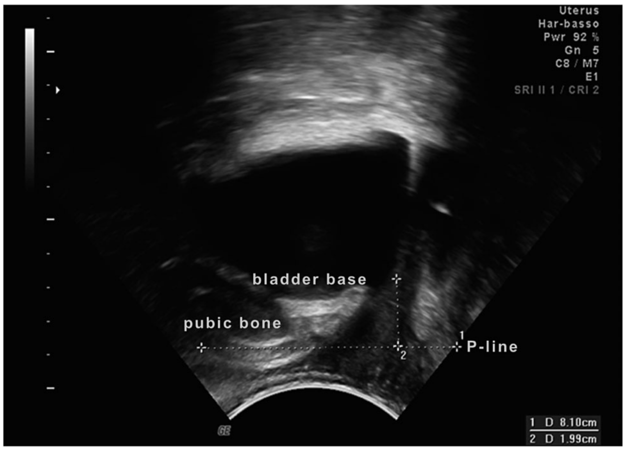

Figure 1. — Pubo-vesical distance (D2), between bladder base and P-line (D1).

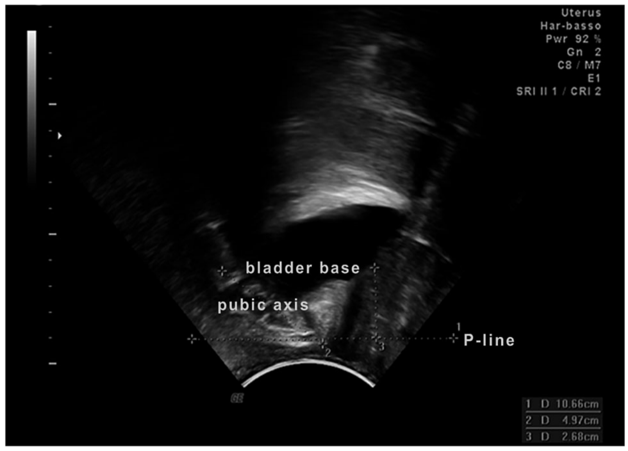

Figure 2. — Angle between P-line (D1) and pubis longitudinal axis (D2).

Table 1. — *Clinical characteristics and perineal ultrasound measurements (median values and range).*

	Control group A (healthy women) n=40	Control group B (healthy women) n=40	Study group (women with cystocele) n=60	*p*-value
Age (years)	30.0 (22 – 35)	53.0 (48 – 61)	54.0 (45 – 60)	< 0.001
Body mass index (kg/m^2)	24.0 (20 – 28)	24.0 (20 – 28)	25.0 (21 – 29)	0.061
Distance bladder base – P-line at rest (mm)	31.0 (28 – 33)	31.0 (28 – 33)	20.0 (0 – 30)	< 0.001
Distance bladder base – P-line under stress (mm)	27.0 (25 – 30)	27.0 (25 – 30)	3.0 (20 – -21)	< 0.001
Retrovesical angle	≥ 150°	≥ 150°	≥ 140° (38 patients) ≤ 140° (22 patients)	< 0.001

in respect to the P-line. When the bladder base went beyond the P-line, the values obtained were marked as negative. The ultrasound values recorded were observed by two different operators and the measurements were carried out looking at the stop-motion corresponding to the peak of the abdominal push.

Statistical analysis

The data are recorded as median, range, and standard deviation. The average of the pubo-bladder distance in the three groups was analysed through the Student t test. The concordance evaluation between the clinical and the ultrasound analysis, as well as the concordance evaluation between the operators, were evaluated according to the Cohen's kappa coefficient.

Results

The first objective was to establish some physiological ultrasound values in the two control groups. In nulliparous, healthy and young patients of control group A, the authors observed that the bladder base was at least at 28 mm from the P-line at rest (range 28/33 mm) and was at least at 25 mm during the Valsalva manoeuvre, at the peak of the abdominal push (range 25/30 mm).

In the nulliparous, healthy, and menopausal patients of control group B, we observed nearly identical values, as the difference detected was non statistically significant. More specifically, we observed that the bladder base is at least at 26.7 mm from the P-line at rest (range 26/32 mm) and at least at 24.8 mm during the Valsalva manoeuvre, at the peak of the abdominal push (range 24/30 mm).

On the basis of these data, the authors suggest that the physiological range of the pubo-bladder distance at rest is between 27 and 33, while the physiological range of the bladder descensus under stress is between 25 mm and 30 mm.

In the study group affected by cystocele, the pubo-bladder distance detected by ultrasound was markedly lower at rest -median value: 20 mm (range 0/30)- with a median value of three mm under stress (20/-21 mm). The results are shown in Table 1.

During the ultrasound assessment, the authors observed that all the patients with the same cystocele grade in the POP-Q had nearly the identical median pubo-bladder distance. Therefore, they divided the patients in four ultrasound stages. The ultrasound staging in four stages (from I to IV) was carried out consistently with the clinical staging by POP-Q system and resulted in: stage I = 16 patients; stage II = 21 patients; stage III = 17 patients; stage IV = six patients (Figures 3-6).

More specifically, patients with a median value of the pubo-bladder distance during Valsalva of 20 mm (range 10/20 mm) were appointed to the sub-group with grade I

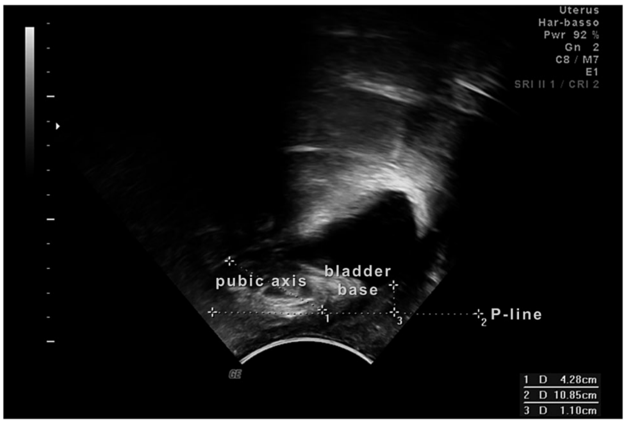

Figure 3. — Distance between bladder base and P-line under stress: ultrasound stage I (D3 = 11 mm).

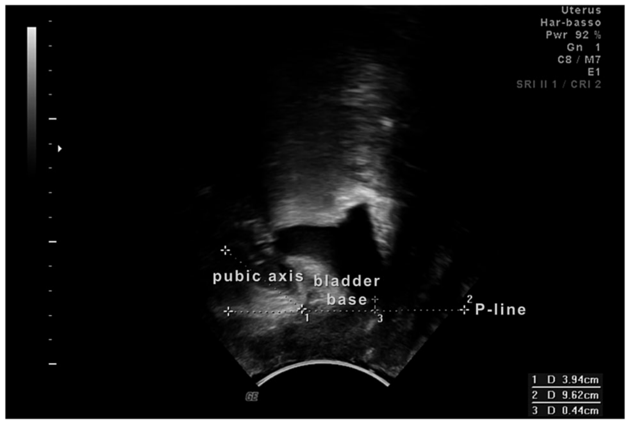

Figure 4. — Distance between bladder base and P-line under stress: ultrasound stage II (D3 = 4 mm).

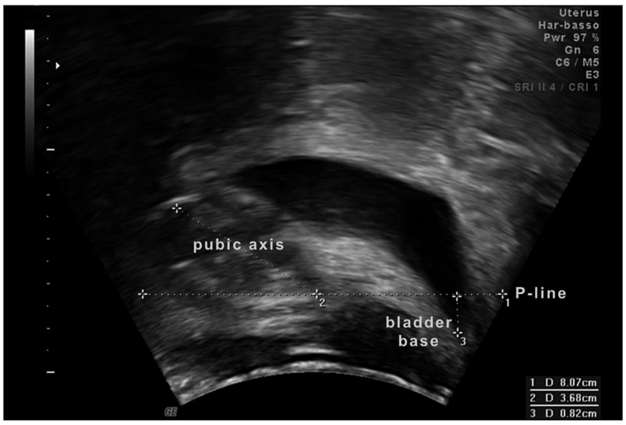

Figure 5. — Distance between bladder base and P-line under stress: ultrasound stage III (D3 = -8 mm).

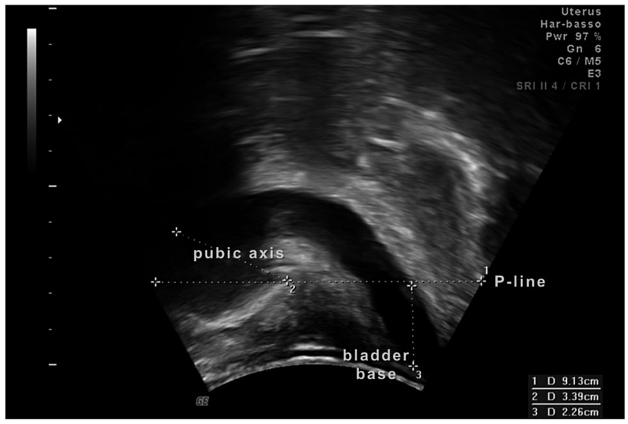

Figure 6. — Distance between bladder base and P-line under stress: ultrasound stage IV (D3 = -23 mm).

Table 2. — *Distance between bladder base and P-line and retrovesical angle in group with cystocele (median values and range) and sonographic staging (perineal ultrasound).*

N.	Distance bladder base – P-line at rest (mm)	Distance bladder base – P-line under stress (mm)	Retrovesical angle	Sonographic stage
18	27.0 (25 – 30)	16.5 (10 – 20)	≥ 140°	I
20	21.5 (15 – 24)	4.0 (0 – 9)	≥ 140°	II
15	9.0 (5 – 14)	-4.0 (-1 – -10)	≤ 140°	III
7	1.0 (0 – 4)	-14 (< -10)	≤ 140°	IV

cystocele (n = 18); patients with a median value of the pubo-bladder distance during Valsalva of 4 mm (range 0/9 mm) were appointed to the sub-group with grade II cystocele (n = 20); patients with a median value of the pubo-bladder distance during Valsalva of -4 mm (range -1/-10 mm) were appointed to the sub-group with grade III cystocele (n = 15); and patients with a median value of the pubo-bladder distance during Valsalva of -14 mm were appointed to the sub-group with grade IV cystocele (n = 7). The values of the pubo-bladder distance are reported in Table 2. The results are statistically significant for one $p < 0.01$. The concordance between the clinical and the ultrasound diagnose proved to be excellent (Cohen's kappa = 0.92, $p < 0.0001$). The concordance between the two operators proved to be good (Cohen's kappa = 0.794, $p < 0.0001$).

Discussion

The risk factors responsible for anatomical and functional disorders of the pelvic static are numerous; among them pregnancies, deliveries, bronco-pneumopathic diseases, pelvic surgery, menopause, etc. As a matter of fact, their multifactorial etiopathogenesis causes these pathologies to be remarkably frequent to such an extent that pelvic floor dysfunctions are nowadays considered a real social problem both due to their high incidence and the impact they have on the quality of life [20-22]. This justifies the considerable attention the research gave to the diagnostic-therapeutic approach to these pathologies in the last years [23-25]. Although the objective urogynaecological examination is currently considered the main diagnostic tool for pelvic floor pathologies, the evidence of the diagnostic reliability of some imaging techniques -proved by many studies reported in literature- suggests that in the future such methods could contribute to reach the gold standard in urogynaecological evaluation.

To this day, the technique that proved a reliable accuracy in the assessment of the prolapse of the pelvic organs is the dynamic magnetic resonance, but it is difficult to employ in clinical practice [26-29]. Since perineal ultrasound would be easy to employ in clinical practice, as well as non-invasive and inexpensive, many attempts have been made to standardize ultrasound models that may be used as diagnostic support in the assessment of urogynaecological dysfunctions. In the last decades, perineal ultrasound was employed to assess urethral hypermobility in relation to stress urinary incontinence [7], or to evaluate the therapeutic success of incontinence correction techniques through sling. Nonetheless, the data proving its possible role in the assessment of pelvic organs prolapse are still insufficient. Concerning this, the aim of the present study was to assess whether it is possible to establish the regular topographic position of the bladder with relation to the pubic bone, and hence to diagnose and stage a possible cystocele. Therefore, the authors established a reference line which passes by the lower margin of the pubis symphysis (P-line) using the pubis -the only fixed structure- as the main reference point to measure the distance between the mentioned line and the bladder base [30-33]. To define the physiological ranges, the authors observed two control groups of nulliparous women, one with an average age of 30, and the other with an average age of 53 in order to exclude possible biases due to menopause. They noticed that the difference between the pubo-bladder distance in the two groups was not statistically significant and therefore it is possible to use the values obtained as possible ranges for the regular physiological position of the bladder in the pelvis. On the strength of the present results, the authors considered as physiological a pubo-bladder distance under stress with values higher than 25 mm, with a range from 25 to 30 mm. Although many cut-offs were suggested [34], they must underline that no reference value is universally acknowledge in literature. In addition to this, they noticed that the angle between the P-line and the pubic axis in all these patients was always about 30°, with a non-statistically significant standard deviation. This value can be considered a random observation, but they used it as possible reproducibility index of the technique employed and therefore they established the P-line for women in the study group always at 30° on the pubic axis. Once they had established the physiological values, they assessed the patients median values according to the cystocele grade detected in the POP-Q and noticed that the pubo-bladder distance was nearly identical in patients with the same grade of cystocele.

The present results suggest that perineal ultrasound has a good diagnostic effectiveness. Nonetheless two main issues may limit its standardization in the assessment of pelvic floor dysfunctions: The absence of fixed reference points (the pubic bone is the only fixed point); and the quantification of the Valsalva stress for the dynamic measurements.

As far as the specific standardization of the Valsalva stress and the increase in intra-abdominal pressure are concerned, the attempts to standardize the manoeuvre were not widely spread. Nevertheless, this problem seems to be unimportant for the purpose of the dynamic evaluation. As a matter of fact, Dietz *et al.* [35] proved that nearly every woman can produce pressures that may generate a maximal descensus $\geq 80\%$ and therefore the standardization of the pressures provoked by the Valsalva manoeuvre is to be considered useless.

Despite the actual reliability of the perineal ultrasound, this method must be regarded only as a diagnostic support, since it cannot absolutely replace the clinical assessment of cystocele, which is nowadays the only standardized approach. Although many studies confirm a good diagnostic concordance between the clinical examination and the ultrasound evaluation, it is possible to detect some differences, most of all due to the fact that the reference point in clinical examinations is the hymen, while it is the pubic bone in the ultrasound assessment.

Conclusions

In conclusion, the present data show the excellent potential role of perineal ultrasound in the diagnosis and classification of cystocele, but it is also evident that further data are needed. Moreover, this method could be useful to carry out effective preventive interventions, for example when a pubo-bladder distance equivalent to a grade I cystocele could be considered a predictive factor of the descensus and could therefore suggest the employ of preventive protocol for pelvic-perineal rehabilitation. These data surely represent an hypothesis and further validation is needed through randomized trials on a considerably wider population to establish a possible standardization.

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