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ORIGINAL ARTICLE

Differential diagnosis of middle compartment pelvic organ prolapse with transperineal ultrasound

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Abstract

Introduction and hypothesis The objective was to identify the best parameter (pubis–cervix measurement, pubis–uterine fundus measurement or pubis–pouch of Douglas measurement) on transperineal ultrasound, based on the difference between measurements taken at rest and with the Valsalva maneuver, for presurgical differential diagnosis between uterine prolapse (UP) and cervical elongation (CE) without UP.

Methods A prospective observational study of 60 consecutively recruited patients who underwent corrective surgery of the middle compartment (UP or CE without UP). A transperineal ultrasound was performed, and the descent of the pelvic organ was measured in relation to the posteroinferior margin of the pubis in the midsagittal plane, referencing the uterine fundus, pouch of Douglas and the cervix at rest and with the Valsalva test.

Results Receiver operating characteristic (ROC) curves were constructed for the three evaluated measures, based on the difference between rest and Valsalva, for the diagnosis of UP. For the pubis–cervix distance, an area under the curve (AUC) of 0.59 was obtained; for the pubis–uterine fundus distance, the AUC was 0.81; and for the pubis–pouch of Douglas distance, the AUC was 0.69. Based on the best AUC (the difference in the pubis–uterine fundus distance at rest and with the Valsalva maneuver), a cut-off point of 15 mm was established for the diagnosis of UP (sensitivity: 75%; specificity: 95%; positive predictive value: 86%; and negative predictive value: 89%).

Conclusion A difference of ≥15 mm in the pubis–uterine fundus distance at rest and with the Valsalva maneuver is useful for differentiating UP from CE without UP by ultrasound.

Keywords Pelvic floor · Prolapse organ pelvic · Ultrasound · Uterine prolapse · Uterus · Cervical elongation

Introduction

Pelvic organ prolapse (POP) is generally considered a relative indication for surgical intervention, and its diagnosis informs its management. On the other hand, ultrasound is becoming increasingly important in the diagnosis of pelvic floor pathology. In fact, it is becoming a useful tool for the preoperative assessment of POP pelvic floor pathology. The ultrasound diagnosis of POPs has been defined according to the affected compartment, defining the different cut-off points as the distance below the posteroinferior margin of the pubic symphysis at which POP is considered significant [1, 2].

However, in addition to defining the compartment to which the POP belongs, to make an assessment it is necessary to perform a differential diagnosis to determine the correct therapeutic approach. Within the previous compartment, different types of cystoceles have been described according to the positioning of the urethra [3–5]. In the posterior compartment, differential ultrasound diagnosis has also been established between different pathologies, namely, rectocele, enterocele, and perineal hypermotility [6].

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However, although the differential ultrasound diagnosis of POP of the anterior and posterior compartment has been defined, currently, no ultrasound parameter has been described for the differential diagnosis of POP of the middle compartment. Clinically, POP of the middle compartment encompasses two different pathologies, namely, uterine prolapse (UP) or cervical elongation (CE) without UP. In addition, these two pathologies can coexist; in fact, lower parity and advanced stage UP are predictors of CE in women with UP [7]. In contrast to UP, in cases of CE without UP, DeLancey level I (the cardinal–uterosacral ligament complex) remains relatively intact. In fact, the difference between UP and CE without UP is clinically observable and can be used to make a differential diagnosis between the two using the POP quantification system (POP-Q) [8]. At present, 2D ultrasound diagnosis of symptomatic UP is based on descent of the cervix in relation to the posteroinferior margin of the pubic symphysis with maximal Valsalva [2]. However, this concept does not allow a presurgical differential diagnosis between UP and CE without UP as it does not assess the support mechanisms of the pelvic organs, as the POP-Q system does [8]. Therefore, the objective of our study is to identify the best parameter (pubis–cervix measurement, pubis–uterine fundus measurement or pubis–pouch of Douglas measurement) on transperineal ultrasound, based on the difference between rest and Valsalva, for the presurgical differential diagnosis of UP and CE without UP.

Materials and methods

A prospective observational study was conducted between 1 June 2018, and 31 January 2020. A total of 60 patients who underwent middle compartment pelvic floor corrective surgery (correction of UP or CE without UP) and who had no history of previous pelvic floor corrective surgery were consecutively recruited. All patients were assessed for POP during a consultation with a standardized interview and a clinical examination using the International Continence Society Pelvic Organ Prolapse Quantification (ICS-POP-Q) system [9]. Significant prolapse of each compartment was defined as Ba = −0.5, C = −5, and Bp = −0.5 [10]. UP was defined as stage 2 or greater apical compartment prolapse and CE without UP was defined as C point ≥ 0, D point ≤ −4, and estimated cervical length ≥5 cm on pelvic examination.

The examiner (JAGM) were blinded to obstetric data related to delivery. The ultrasound machines used were a Toshiba 500 Aplio (Toshiba Medical Systems, Tokyo, Japan) with a PVT-675MV 3D abdominal probe. Images were acquired with patients in dorsal lithotomy position on the gynecological examination table and under empty bladder conditions [11, 12]. The transducer was carefully placed on each patient's perineum, applying the minimal possible pressure. Three volume measurements were taken for each patient: at rest, with the Valsalva maneuver (minimum of 6 s [13]) and with maximum contraction. To ensure a stable reference line, previously established criteria were followed [2]. Pelvic organ descent was measured in relation to the posteroinferior margin of the pubis [2] in the midsagittal plane [14], referencing the uterine fundus (defined as the hyperechoic line most distal to the pubis from the uterine fundus), the pouch of Douglas (defined by the hyperechoic line of the peritoneal fold at the uterine insertion), and the cervix (defined by the most descended hyperechoic point in the cervix) at rest and with the Valsalva maneuver (Videos 1, 2; Figs. 1, 2). Measurements inside the posteroinferior pubic margin were defined as negative values, and measurements outside were defined as positive values [15].

Statistical analysis

The numerical variables were summarized using the mean and standard deviations, and frequencies and percentages were calculated for the qualitative variables. The numerical variables of the groups defined according to the UP/CE dichotomous variable were compared using Student's *t* test for independent samples or the Mann–Whitney test if the data did not meet the normality assumption (Shapiro–Wilk test). The association between qualitative variables was determined using Fisher's exact test.

Receiver operating characteristic (ROC) curves were constructed to classify patients into one of two groups (prolapse yes/no) based on the value of the difference between the cervix–fundus measurements at rest and with the Valsalva maneuver. The area under the ROC curve (AUC) and a table with the coordinate points of the ROC curve were obtained to identify the cut-off point for patient classification.

According to the sample size calculation and to estimate the sensitivity to UP based on a 95% confidence interval with an expected sensitivity of 90% and an accuracy of 10%, 53 patients were needed.

Ethical approval

The study (1259-N−20) was approved by the local Ethics and Research Committees.

Results

A total of 60 patients were included, of whom 40 had UP and 20 had CE without UP. Their clinical and general characteristics are shown in Table 1.

Table 2 shows the measurements obtained in the midsagittal plane at rest and with the Valsalva maneuver. The pubis–

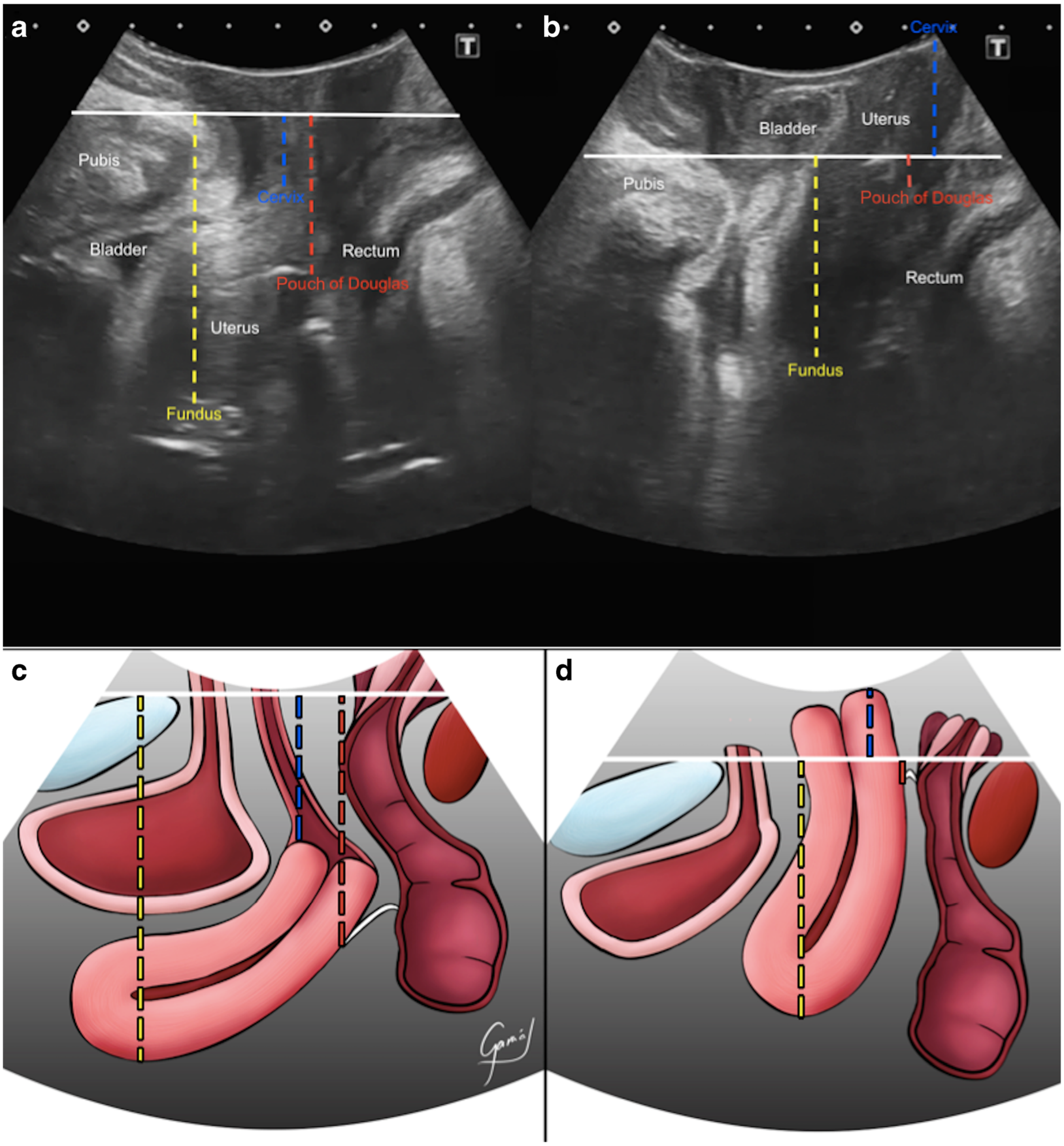

Fig. 1 Uterine prolapse in the mid-sagittal plane. **a**, **c** at rest. **b**, **d** Valsalva maxima. *White line*: posteroinferior margin of the pubis; *blue line*: pubis–cervix distance; *yellow line*: pubis–uterine fundus distance; *red line*: pubis–pouch of Douglas distance

cervix distance with the Valsalva maneuver was 19.2 ± 8.6 mm in the patients with UP and 16.6 ± 5.7 mm in the patients with CE without UP (p=0.196). When we compared the differences between measurements taken at rest and with the Valsalva maneuver, we observed that the pubis–cervix measurements were 13.3 ± 13.1 mm in the UP group and 9.1 ± 9.6 mm in the CE without UP group (p=0.249), the pubis–uterine fundus measurements were 20.2 ± 28.9 mm in the UP group and 8.7 ± 22.8 mm in the CE without UP group (p<0.0005), and the pubis–pouch of Douglas measurements were 16.8 ± 16.2 mm in the UP group and 12.7 ± 28.2 mm in the CE without UP group (p=0.020.).

Receiver operating characteristic curves were constructed for the three evaluated measurements, based on the difference between the rest and Valsalva conditions, for the diagnosis of UP (Fig. 3). For the pubis–cervix distance, an AUC of 0.59 was obtained; for the pubis–uterine fundus distance, the AUC was 0.81; and for the pubis–pouch of Douglas distance, the AUC was 0.69. The best AUC was determined by the difference in the pubis–uterine fundus distance between rest and Valsalva conditions. Based on this finding, we established a cut-off point for the diagnosis of UP of a difference of 15 mm in the pubis–uterine fundus distance between rest and Valsalva conditions; this cut-off had a sensitivity of 75% (95% CI = 64–86%), a specificity of 95% (95% CI = 89–

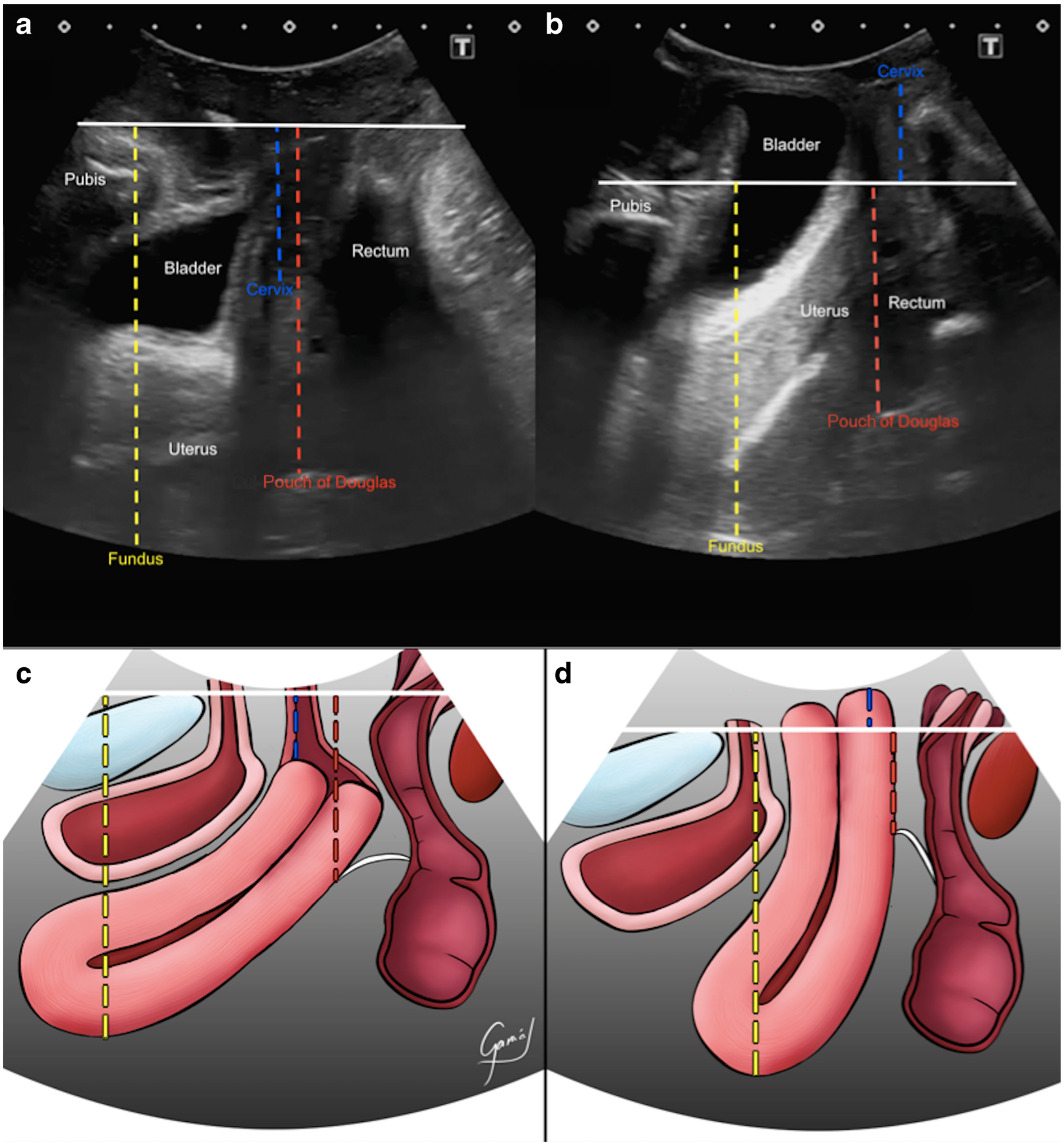

Fig. 2 Cervical elongation without uterine prolapse in the mid-sagittal plane. **a**, **c** at rest. **b**, **d** Valsalva maxima. *White line*: posteroinferior margin of the pubis; *blue line*: pubis–cervix distance; *yellow line*: pubis–uterine fundus distance; *red line*: pubis–pouch of Douglas

Table 1 General and clinical characteristics of the patients included

	UP (n = 40)	CE without UP (n = 20)	p	95% CI
Age	64.8 ± 9.3	50.8 ± 9.7	<0.0005	8.8; 19.2
BMI	27.8 ± 3.4	28.8 ± 5.4	0.925	−2.3; 2.2
Stress incontinence	3/40 (7.5%)	2/20 (10.0%)	1	−17.9%; 12.9%
Urge incontinence	7/40 (17.5%)	2/20 (10.0%)	0.704	−10.2%; 25.1%
Mixed incontinence	1/40 (2.5%)	1/20 (5.0%)	1	−13.2%; 8.2%
Cystocele	30/40 (75.0%)	3/20 (15.0%)	<0.0005	39.4%; 80.6%
Rectocele	10/40 (25.0%)	1/20 (5.0%)	0.081	−3.5%; 36.5%
Enterocele	4/40 (10.0%)	0/20 (0%)	0.291	−0.7%; 19.3%

Table 2 Measurements obtained in the mid-sagittal plane at rest and in Valsalva

	UP (*n* = 40)	CE without UP (*n* = 20)	*p*	95% CI
Pubis–cervix measurement				
Rest	5.9 ± 10.3	7.6 ± 10.1	0.230	−5.4; 1.6
Valsalva	19.2 ± 8.6	16.6 ± 5.7	0.196	−0.9; 4.9
Pubis–uterine fundus measurement				
Rest	−59.4 ± 28.9	−70.9 ± 17.1	0.06	−0.2; 18.0
Valsalva	−39.3 ± 18.5	−62.2 ± 30.8	<0.0005	17.8; 36.7
Pubis–pouch of Douglas measurement				
Rest	−32.4 ± 14.7	−39.7 ± 12.0	0.054	−0.2; 13.0
Valsalva	−15.6 ± 11.5	−26.9 ± 24.2	0.001	10.1; 24.7
Pubis–cervix measurement. Difference between rest and Valsalva	−13.3 ± 13.1	−9.1 ± 9.6	0.249	−8.1; 2.2
Pubis–uterine fundus measurement. Difference between rest and Valsalva	−20.2 ± 28.9	−8.7 ± 22.8	<0.0005	−23.0; −10.9
Pubis–pouch of Douglas measurement. Difference between rest and Valsalva	−16.8 ± 16.2	−12.7 ± 28.2	0.020	−19.3; −1.7

100%), a positive predicted value (PPV) of 86% (95% CI = 78–95%), and a negative predicted value (NPV) of 89% (95% CI = 82–97%).

Discussion

The parameter that best differentiated UP from CE without UP was the difference in the pubis–uterine fundus distance between rest and Valsalva conditions, which had an AUC of 0.81. Thus, a cut-off point of 15 mm was established for the diagnosis of UP; this cut-off point had a sensitivity of 75%, a specificity of 95%, a PPV of 86%, and an NPV of 89%.

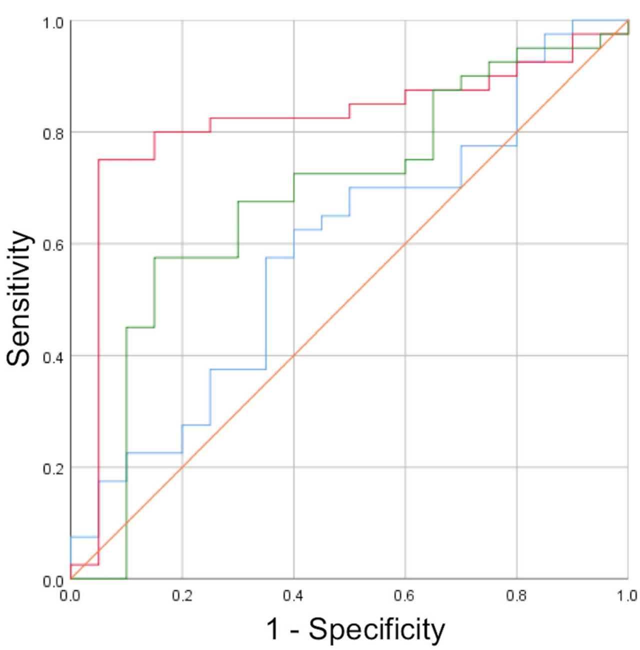

Fig. 3 Receiver operating characteristic curves for the diagnosis of uterine prolapse (UP) according to the difference between rest and Valsalva in the pubis–cervix distance (*blue line*), in the pubis–pouch of Douglas distance (*green line*), and in the pubis–uterine fundus distance (*red line*)

Previously, the optimal limit for predicting significant prolapse in the middle compartment was defined as a distance of 15 mm on Valsalva between the posteroinferior margin of the pubis and the cervix [2]. Although the study that yielded this limit was the only one to have established an optimal cut-off point for defining significant uterine prolapse [2], it did not define the relationship of the pelvic structures at rest and with the Valsalva maneuver, nor did it assess the apical fixation points of the POP using ultrasound. It also did not perform a differential diagnosis between UP and CE without UP as it did not evaluate patients with CE without UP. Therefore, when a cut-off of 15 mm between the posteroinferior margin of the pubis and the cervix with the Valsalva maneuver is used to define middle-compartment POP, UP and CE without UP cannot be differentiated, making preoperative ultrasound evaluation difficult in these cases.

There is a discrepancy between ultrasound and clinical evaluations of middle-compartment POP. A previous study established a good correlation (r = 0.77) [16] between middle-compartment POP and ultrasound symptoms. The study by Broekhuis et al. [17] reported a lower correlation. Kluivers et al. [18] defined 2D translabial ultrasound as not superior to clinical assessment by POP-Q in the evaluation of symptomatic prolapse. However, clinical assessment using the ICS-POP-Q system has limitations in that it only provides information about the anatomical surface and uses a mobile soft-tissue point (the hymen) as a reference point. The hymen was previously used as a reference on transperineal ultrasound for comparison with clinical assessment, concluding the superiority of clinical assessment over ultrasound determination [19]. However, the study by Lone et al. did not include patients with prolapse greater than POP-Q stage 2 [19], unlike the patients included in our study.

We consider that ultrasound study of POP before corrective surgery is interesting to determine the anatomical state of the different pelvic structures. The use of transperineal ultrasound for POP prior to surgery provides additional important information for the surgical procedure. In turn, the assessment of apical support in the study of middle-compartment POP is important, as previously reported [20]. In our study, we applied the concept of indirectly evaluating the integrity of this apical support by ultrasound. For this purpose, we defined the differences in the measurements of the pubis–uterine fundus and pubis–pouch of Douglas distances between rest and Valsalva to determine the mobility of the uterus with respect to its initial position. Although the pouch of Douglas is altered in cases of enterocele [16], we measured it in the peritoneal fold in the uterus (Figs. 1, 2), thus providing a measure that remains stable even if there is an enterocele. Therefore, our studied parameters assess the support of the uterus by the corresponding ligaments. We were thus able to identify women whose apical support is outside the "normal range" to detect those who require a hysterectomy and/or an apical support procedure and to avoid such procedures in patients who do not need them [20]. Biomechanical studies show that the ligamentous support associated with the closure of the levator hiatus by the levator ani muscle determines the support of the pelvic organs [21]. In cases of apical support failure, an increase of 20% in the length of the cardinal ligaments is observed [22]. In addition, the change in length that occurs in these ligaments during the Valsalva maneuver is double in patients with POP compared with patients with normal support [22]. For this reason, we believe that the determination of apical failure in the UP should be evaluated by comparing the uterine situation at rest with the situation in Valsalva.

We present to our knowledge the first study on the differential diagnosis between UP and CE without UP by transperineal ultrasound. In addition, we are the first to use the difference in pubis–uterine fundus distance measurements taken at rest and with the Valsalva maneuver to establish the differential diagnosis of middle-compartment POP; this can allow us to assess apical support failure in patients with UP. Unlike the 15-mm cut-off point previously established for the diagnosis of symptomatic UP (single measurement of the pubis–cervix distance under Valsalva conditions) [2], our parameter is not influenced by the length of the cervix. Because our cut-off point differed between rest and Valsalva, it is also not influenced by uterine size. In addition, we consider that our ultrasound evaluation would a priori cause less discomfort to the patients than the usual clinical evaluation using the ICS-POP-Q system.

Our study does have some limitations as our patients were not assessed in standing position. However, it was previously described that the assessment of POP during the Valsalva maneuver in the supine position showed no differences in POP descent compared with the standing position [23]. Another aspect that requires improvement is the small number of patients included; however, it was sufficient to obtain the expected results. It would be interesting to test and validate our results in future studies with more patients. Our ultrasound studies were performed by a single expert pelvic floor ultrasound examiner (JAGM); therefore, it would also be interesting to assess the interobserver reliability of these measurements in future studies.

A ≥ 15-mm difference in the pubis–uterine fundus distance between rest and Valsalva conditions is useful for differentiating UP from UP without CE by ultrasound.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00192-020-04646-1

Compliance with ethical standards

Conflicts of interest None.

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