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ORIGINAL ARTICLE

Ultrasound assessment of bladder descent and its correlation with prolapse severity in Chinese women: a prospective multicenter study

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Abstract

Introduction and hypothesis Translabial ultrasound is currently regarded as one of the most promising modalities in the evaluation of female pelvic organ prolapse. However, abnormal bladder descent on pelvic floor ultrasound has not been established among Chinese women. This study aimed to establish optimal cutoffs for defining bladder prolapse among Chinese women using translabial ultrasound.

Methods In this prospective multicenter study, 674 women with symptoms of lower urinary tract dysfunction and/or pelvic floor dysfunction were finally included and underwent interview, Pelvic Organ Prolapse Quantification (POP-Q) examinations and 4D translabial ultrasound. The receiver-operating characteristic (ROC) statistic was used to assess accuracy and define the optimal cutoffs.

Results The mean patient age was 42.6 (range, 19–82) years. Multivariable analysis showed that both POP-Q assessment and translabial ultrasound findings for anterior compartment were significantly associated with prolapse symptoms. The ROC statistics suggested an optimal cutoff value of 10 mm below the symphysis pubis of bladder position on Valsalva for predicting prolapse symptoms, with an area under the curve (AUC) of 0.73. Compared to translabial ultrasound, POP-Q stage showed similar accuracy for predicting prolapse symptoms (AUC: 0.74; $P = 0.79$), with an optimal cutoff of POP-Q stage ≥ 2.

Conclusions This study proposed that the descent of the bladder to ≥ 10 mm below the symphysis pubis on Valsalva should be proposed as an optimal cutoff value for defining abnormal bladder prolapse on translabial ultrasound among the Chinese population. These cutoff values are nearly identical to those previously established in mainly Caucasian women.

Keywords Bladder prolapse · Pelvic organ prolapse quantification · Translabial ultrasound

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Abbreviations

FPOP	Female pelvic organ prolapse
ICS POP-Q	International Continence Society Pelvic Organ Prolapse Quantification
ROC	Receiver-operating characteristic
AUC	Area under the curve
CI	Confidence interval

Introduction

Female pelvic organ prolapse (FPOP), defined as the descent of one or more of the female pelvic organs, is a common gynecological condition [1]. Symptomatic FPOP significantly impacts quality of life among women, with an estimated risk as high as 20% for the need of gynecological surgical intervention [2]. FPOP has been shown to be significantly associated with symptoms of issues such as stress incontinence, voiding dysfunction, fecal incontinence and others [3–5].

Imaging techniques have played an important role in the investigation of FPOP [6]. Of the available techniques, translabial ultrasound is currently regarded as one of the most promising modalities in the evaluation of prolapse [7, 8]. The development of translabial ultrasound has contributed greatly to the understanding of FPOP, and it has also helped settle some arguments in the field [6, 9]. Our recent findings suggested that the sonographic cutoffs for abnormal uterine descent in the Chinese population are different from those described previously in mainly Caucasian populations [10]. This is of great significance given the fact that ethnic differences should be considered in the assessment of pelvic organ prolapse when using translabial ultrasound.

From the available data, research appears to be limited on the subject of the sonographic cutoffs for abnormal bladder descent in women of different races. In previous findings, Dietz HP et al. suggested that descent of the bladder to 10 mm should be proposed as cutoff for the diagnosis of abnormal bladder descent in mainly Caucasian women [11]. Nevertheless, to date the best cutoffs for defining abnormal bladder prolapse among Asian population have not been well established on translabial ultrasound.

Therefore, this study sought to establish the best cutoff values for abnormal bladder prolapse among Chinese women using translabial ultrasound.

Patients and Methods

Study population

This prospective, multicenter study involved ten clinical centers located in Mainland China (Chinese Clinical Trial Registration No. ChiCTR ROC 16,009,855). The study protocol was approved by the local Institutional Human Research Ethics Committee. Informed consent was obtained from each study participant. For quality control, the data from the entire study were controlled and analyzed by the principal investigator.

The study was conducted between February 2017 and September 2018. Women who were seen at tertiary gynecological centers for lower urinary tract symptoms and/or symptoms of pelvic organ prolapse were recruited. All participants went through a local standardized interview, a clinical examination using the International Continence Society (ICS) Pelvic Organ Prolapse Quantification (POP-Q) assessment, and a 4D translabial ultrasound examination. For the purposes of the research, prolapse symptoms were defined as 'the sensation of a lump in the vagina and/or a dragging sensation in the vagina' [12]. Women with a history of either hysterectomy or pelvic floor surgery for prolapse or incontinence were excluded from the data. Women < 1 year postpartum were also excluded from the study.

ICS POP-Q assessment

The clinical examinations at each center were assessed by experienced gynecologists (each with ≥ 2 years of experience with ICS POP-Q examinations) using the ICS POP-Q method [13, 14]. The gynecologists who performed the assessments were blinded to the patients' clinical data as well as the results of the 4D translabial ultrasound examinations.

The ICS POP-Q examination assessed anterior, central and posterior compartment descent by measuring the maximum downward displacement of the anterior vaginal wall, cervix and posterior vaginal wall relative to the hymen with the patient in a maximal Valsalva maneuver. The quantitative descriptions of the ICS POP-Q assessments from this study were recorded using the five stages of pelvic organ support according to the ICS POP-Q system (Table S1). Dominant prolapse in the apical and/or posterior compartment was defined as follows: (1) apical compartment prolapse had the same or higher POP-Q stage than the anterior compartment prolapse and/or (2) posterior compartment prolapse had a higher POP-Q stage than the anterior compartment. This is because, based on previous findings [10, 15], stage 1 uterine prolapse is just as significant in predicting prolapse symptoms as stage 2 anterior or posterior compartment prolapse on ICS POP-Q assessments.

Four-dimensional translabial ultrasound examination

The 4D translabial pelvic floor ultrasound examinations were performed using a GE Voluson S6 or S8 ultrasound device with a 4-8 MHz curved array volume transducer and acquisition angle of 85° (GE, Kretztechnik, GmbH, Zipf, Austria). All ultrasounds were conducted by senior sonographers (each trained for at least 50 consecutive examinations). The sonographers had no access to the patients' other clinical data. The patients were examined in the supine position after bladder emptying and defecation, as previously described. Volume acquisitions were obtained at rest, on contraction, and on Valsalva, and at least three volumes were acquired on Valsalva. Great care had to be taken to have the Valsalva maneuver performed for a minimum duration of 6 s without levator coactivation [16, 17].

Archived 4D translabial ultrasound data sets were analyzed offline at a later date by two investigators using 4D View software (version 10.0, GE Medical Systems). These two investigators both had at least 2 years of experience with 4D translabial pelvic floor ultrasound examination and were both blinded to all other data. Using the offline system, they evaluated anterior, central and posterior compartment descent by measuring the leading edge of the bladder relative to the inferior margin of the symphysis pubis (Fig. 1). Positions above the symphysis pubis were given as positive values, while positions below were given as negative values.

Statistical methods

Statistical analysis was performed using IBM SPSS Statistics 22 software for Windows (SPSS Inc., Chicago, IL, USA) and Medcalc (version 11.2; 2011 MedCalc Software Bvba, Mariakerke, Belgium).

The quantitative variables (age and body mass index) were found to be normally distributed using a one-sample Kolmogorov-Smirnov test and therefore were expressed as mean values and standard deviations. The qualitative variables were expressed as counts and percentages. Comparisons of the quantitative variables between the cohorts were assessed using an unpaired *t*-test. A chi-squared test was performed for comparisons of the qualitative variables between the cohorts. The performance of measuring bladder descent on translabial ultrasound to predict prolapse symptoms was evaluated using receiver-operating characteristic (ROC) statistic, expressed as area under the curve (AUC), and its 95% confidence interval (CI). Differences between the AUCs were compared by the DeLong test. The sensitivity, specificity and 95% CIs were also presented and compared using a chi-squared test. The highest Youden index was used to generate the optimal cutoffs of bladder descent on Valsalva for the prediction of prolapse symptoms: Youden's index = sensitivity + specificity – 1 [18]. $P < 0.05$ was considered statistically significant.

Results

Participant Characteristics

Between February 2017 and September 2018, 967 women were initially recruited for the study. Women < 1 year postpartum were excluded ($n = 159$). There were 89 women with dominant prolapse in the apical and/or posterior compartment(s) who were not included for analysis. Twelve women were excluded for either a previous history of hysterectomy or pelvic floor surgery for prolapse or incontinence. Two were excluded for being under the age of 18, and five others declined to participate in the study. Twenty-six data sets were further excluded because of missing POP-Q information, missing US data or technically suboptimal ultrasound volume data. In total, 674 women were included in the final analysis (69.7%, 674/967).

Table 1 presents the demographic data and symptom assessments of the total cohort. The mean age of the 674 study participants was 42.6 (range, 19– 82) years, and the mean body mass index was 23.2 (range, 15.4–35.5) kg/m^2. One hundred eighty-seven post-menopausal women (27.7%, 187/674) participated in the study. Two hundred sixty-two women, or 38.9% of the cohort, reported prolapse symptoms (a lump or drag felt in the vagina). Of the 262 women with prolapse symptoms, 38 were found to have no prolapse on POP-Q examinations, and 224 were classified as POP-Q stage ≥ 1. One hundred eighty-three women presented symptomatic multicompartment prolapse, while 41 showed symptomatic isolated cystoceles. Symptomatic cystoceles descended on average to 6.6 mm below the symphysis pubis (range, 26.5 mm above to 31.9 mm below).

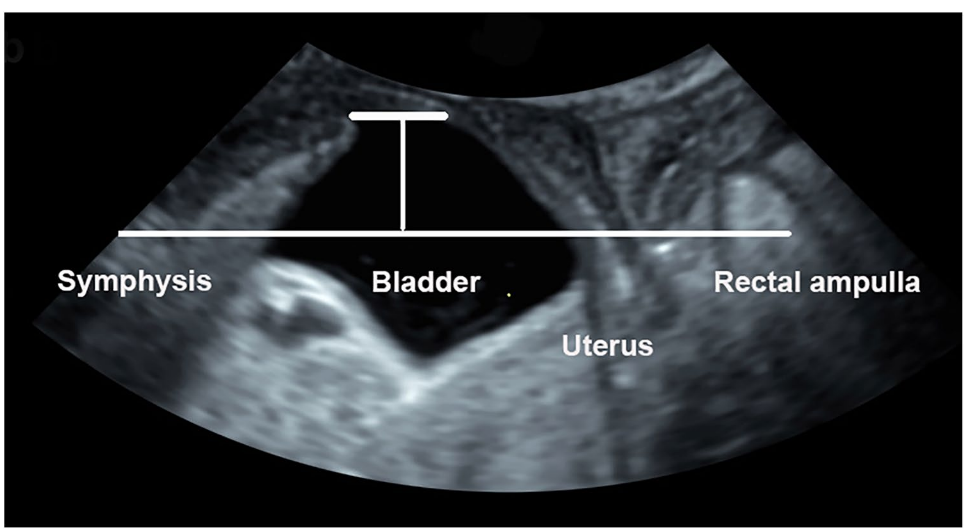

Fig. 1 Typical translabial ultrasound image (midsagittal plane) in a woman with symptomatic isolated cystocele on translabial ultrasound, showing the measurement of the position of bladder during maximum Valsalva relative to the line of the posteroinferior margin of the symphysis pubis

Table 1 Baseline characteristic of the enrolled participants ($n = 674$)

Variable	Value
Age at recruitment (years old)	42.6 ± 13.8
Age at first delivery (years old)	25.3 ± 4.1
Body mass index (kg/m^2)	23.2 ± 3.0
Postmenopausal	187 (27.7%)
Vaginal parity	559 (82.9%)
Parity ≥ 2	487 (72.3%)
Birth weight of heaviest baby (kg)	3.2 ± 0.6
Presenting symptoms	
Stress/urge urinary incontinence	343 (50.9%)
Urinary frequency	146 (21.7%)
Symptoms of voiding dysfunction	63 (9.3%)
Symptoms of prolapse	262 (38.9%)
Pelvic Organ Prolapse Quantification (POP-Q) examination	
Anterior compartment	
Stage = 0	234 (34.7%)
Stage = 1	194 (28.8%)
Stage = 2	153 (22.7%)
Stage ≥ 3	93 (13.7%)
Apical compartment	
Stage = 0	344 (51.0%)
Stage = 1	168 (24.9%)
Stage = 2	128 (19.0%)
Stage ≥ 3	34 (5.0%)
Posterior compartment	
Stage = 0	460 (68.2%)
Stage = 1	134 (19.9%)
Stage = 2	68 (10.1%)
Stage ≥ 3	12 (1.7%)

Data are expressed as mean ± standard deviation or number (percentage)

Univariable and multivariable analysis for the associated factors of prolapse symptoms

Univariable and multivariable logistic regression analyses were performed for the associated factors of prolapse symptoms in the population after excluding patients with dominant prolapse in apical/posterior compartments (Table 2). Univariable analysis revealed that age at recruitment ($P < 0.001$), body mass index ($P = 0.002$), postmenopausal status ($P < 0.001$), vaginal parity ($P < 0.001$), POP-Q assessment for anterior compartment ($P < 0.001$), and bladder position on Valsalva ($P < 0.001$) and at rest ($P < 0.001$) were significantly associated with prolapse symptoms. Multivariable analysis showed that only age at recruitment ($P < 0.001$), POP-Q assessment for anterior compartment ($P < 0.001$), and bladder position on Valsalva ($P < 0.001$) and at rest ($P = 0.04$) were significantly associated with prolapse symptoms.

Cutoffs of translabial ultrasound parameter for defining abnormal bladder descent

As presented in Table 3, translabial ultrasound parameters for evaluating bladder descent, including bladder position at rest, bladder position on Valsalva and descent distance of bladder on Valsalva, were all significantly correlated with ICS POP-Q stages for anterior compartment (all P values < 0.001). Higher POP-Q stage was correlated with lower bladder position at rest and on Valsalva and longer bladder descent distance on Valsalva.

Table 4 and Fig. 2 show the comparisons of the optimal cutoff values and AUCs of bladder descent of ultrasound parameters and POP-Q stages for predicting prolapse symptoms in the population after excluding patients with dominant prolapse in apical/posterior compartments. The ROC statistics suggested an optimal cutoff value of 10 mm below the symphysis pubis of bladder position on Valsalva for predicting prolapse symptoms, with an AUC of 0.73 (95% CI: 0.70–0.77). Comparable accuracy of ICS POP-Q stage (AUC: 0.74; 95% CI: 0.70–0.77) for predicting prolapse symptoms was obtained through ROC analysis, with an optimal cutoff of POP-Q stage ≥ 2 ($P = 0.79$). The AUCs revealed that other two translabial ultrasound parameters, bladder position at rest and descent distance of bladder on Valsalva, showed lower performances for predicting prolapse symptoms in comparison with bladder position on Valsalva, with AUCs of 0.61 (95% CI: 0.57–0.65) and 0.67 (95% CI: 0.63–0.70), respectively ($P < 0.001$; $P < 0.001$).

Discussion

This prospective multicenter study aimed to determine the optimal cutoffs of bladder descent using translabial ultrasound to assess prolapse symptoms among Chinese women for the first time to our knowledge. The data suggested that bladder position of 10 mm below the symphysis pubis on Valsalva should be proposed as the optimal cutoff value for predicting prolapse symptoms among the Chinese population, with comparable accuracy of ICS POP-Q stage ≥ 2 for assessing prolapse symptoms.

The prevalence of pelvic organ prolapse is relatively high among parous populations [1]. Translabial ultrasound examination has been proven to be a useful procedure for evaluating the pelvic floor [6], but assessment criteria of different pelvic floor structures have not been well defined among women of different races. Our recent finding claimed that 4.79 mm above the symphysis pubis of uterine position on Valsalva should be established as the optimal cutoff value for abnormal uterine descent on translabial ultrasound among the Chinese population [10]. These are different from values described previously in

Table 2 Univariable and multivariable logistic regression analysis for the associated factors of prolapse symptoms after exclusion of patients with dominant prolapse in apical/posterior compartments ($n = 674$)

Parameter	Univariable analysis		Multivariable analysis	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Clinical variables				
Age at recruitment (years old)	1.07 (1.05–1.08)	< 0.001	1.04 (1.03–1.06)	< 0.001
Age at first delivery (years old)	0.97 (0.93–1.01)	0.12		
Body mass index (kg/m^2)	1.09 (1.03–1.15)	0.002		
Postmenopausal	4.51 (3.15–6.45)	< 0.001		
Vaginal parity	3.11 (1.83–5.28)	< 0.001		
Parity ≥ 2	1.14 (0.80–1.62)	0.47		
Birth weight of heaviest baby (kg)	1.18 (0.88–1.57)	0.27		
POP-Q assessment for anterior compartment		< 0.001		< 0.001
Stage = 0	1 (reference)		1 (reference)	
Stage = 1	3.40 (2.16–5.33)		1.99 (1.15–3.44)	
Stage = 2	4.13 (2.58–6.61)		1.76 (0.91–3.41)	
Stage ≥ 3	29.11 (14.95–56.66)		18.51 (3.89–88.05)	
Ultrasound parameters				
Bladder position on Valsalva (mm)	0.93 (0.91–0.94)	< 0.001	0.96 (0.94–0.98)	< 0.001
Bladder position at rest (mm)	0.92 (0.88–0.96)	< 0.001	0.96 (0.91–1.00)	0.04

POP-Q Pelvic Organ Prolapse Quantification; *OR* odds ratio; *CI* confidence interval

Table 3 Bladder descent on translabial 4D ultrasound in women with different POP-Q stages for anterior compartment

Ultrasound parameters	POP-Q stages for anterior compartment				*P* value
	Stage = 0	Stage = 1	Stage = 2	Stage ≥ 3	
Bladder position at rest (mm)	28.1 ± 3.6	26.6 ± 4.6	26.4 ± 4.7	25.3 ± 10.4	< 0.001
Bladder position on Valsalva (mm)	3.7 ± 9.5	-4.9 ± 9.3	-12.2 ± 10.3	-20.6 ± 11.3	< 0.001
Descent distance of bladder on Valsalva (mm)	23.2 ± 10.1	30.9 ± 9.6	36.4 ± 8.5	40.8 ± 9.5	< 0.001

Data are expressed as mean ± standard deviation

Table 4 Accuracy of bladder descent on ultrasound and clinical examinations in the prediction of prolapse symptoms

Parameter	Cutoff value	AUC (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	LR + (95% CI)	LR – (95% CI)
Ultrasound parameter						
Bladder position at rest	26 mm	0.61 (0.57–0.65)	0.44 (0.38–0.50)	0.78 (0.73–0.82)	1.97 (1.7–2.3)	0.72 (0.6–0.9)
Bladder position on Valsalva	-10 mm	0.73 (0.70–0.77)	0.56 (0.50–0.62)	0.78 (0.74–0.82)	2.60 (2.3–2.9)	0.56 (0.4–0.7)
Descent distance of bladder on Valsalva	40 mm	0.67 (0.63–0.70)	0.35 (0.29–0.41)	0.88 (0.84–0.91)	2.89 (2.4–3.4)	0.74 (0.6–1.0)
Clinical parameter						
POP-Q stage for anterior compartment	Stage 2	0.74 (0.70–0.77)	0.56 (0.50–0.62)	0.76 (0.72–0.80)	2.33 (2.1–2.6)	0.58 (0.5–0.7)

POP-Q Pelvic Organ Prolapse Quantification; *AUC* area under the receiver-operating characteristic curve; *CI* confidence interval; *LR*, likelihood ratio

mainly Caucasian populations [19]. Nevertheless, the current data confirmed that the definition of significant bladder descent on pelvic floor ultrasound is similar to the values established in a previous study in mainly Caucasian populations (descent of the bladder to ≥ 10 mm below the symphysis pubis on maximal Valsalva) [11]. These cutoffs might be useful in assessing prolapse on pelvic floor ultrasound among women of different races and might further imply that abnormal uterine descent in Asian women is different from that in women of other different ethnic

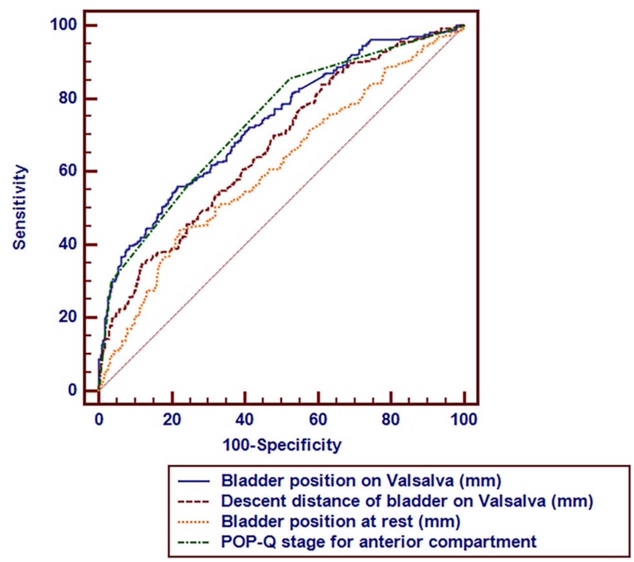

Fig. 2 Comparisons of AUCs of translabial ultrasound parameters and POP-Q assessment for predicting prolapse symptoms. *AUC* area under the curve; *POP-Q* Pelvic Organ Prolapse Quantification

groups. Future studies are needed to better explore the reason for this discrepancy.

From our data, clinical findings (ICS POP-Q stages) only showed moderate accuracy in predicting prolapse symptoms, which is consistent with previous results [11, 20]. Different from translabial ultrasound, ICS POP-Q system provides information only on the surface anatomy rather than on the underlying organs and functional anatomy of the pelvic floor. Consequently, it may lead to lacking awareness of levator co-activation on Valsalva maneuver on POP-Q examination [6]. However, it should be noted that there was no significant difference between the predictive value of clinical findings (ICS POP-Q stages) and translabial ultrasound examinations in the evaluation of prolapse symptoms. The current findings help provide more evidence for clinicians in the assessment of pelvic floor dysfunction with translabial ultrasound examinations.

To the best of our knowledge, this prospective, multicenter study was performed with the largest sample size conducted among Chinese women. In addition, the current study ought to establish the optimal cutoff value of abnormal bladder descent on translabial ultrasound among Chinese population for the first time. Nevertheless, this study had several limitations. First, there exists a possibility of selection bias in the study population as it was conducted in women presenting for lower urinary tract symptoms and/or symptoms of pelvic organ prolapse. Second, this study was limited in scope to examining those of Chinese nationality. However, the optimal cutoffs determined in this study for defining bladder prolapse on translabial ultrasound among Chinese women are similar to the definitions established among mainly Caucasian populations by a previous study [11], which might suggest that anterior prolapse assessment does not vary much among different ethnic groups. Finally, that our documented POP-Q stages are not actual coordinates since it has been claimed that Ba = -1 may be regarded as normal is also a weakness of this study.

In summary, this study proposed that the descent of the bladder to ≥ 10 mm below the symphysis pubis on Valsalva should be proposed as an optimal cutoff value for the ultrasonic prediction of significant anterior compartment prolapse among the Chinese population. These cutoff values are nearly identical to those previously established in mainly Caucasian women. The current findings suggested pelvic ultrasound findings of prolapse are significantly associated with POP-Q findings for the anterior compartment, and both pelvic floor ultrasound and POP-Q examinations are useful tools in the evaluation of pelvic prolapse.

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Ying Chen: Data analysis.
Jiawei Tian: Protocol development, Manuscript editing.
Xinling Zhang: Protocol development, Manuscript editing.

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Declarations

Conflicts of interest None.

References

1. Brincat CA. Pelvic organ prolapse: reconsidering treatment, innovation, and failure. JAMA. 2019;322:1047–8.
2. Smith FJ, Holman CD, Moorin RE, Tsokos N. Lifetime risk of undergoing surgery for pelvic organ prolapse. Obstet Gynecol. 2010;116:1096–100.
3. Lukacz ES, Santiago-Lastra Y, Albo ME, Brubaker L. Urinary incontinence in women: a review. JAMA. 2017;318:1592–604.

4. Slieker-ten Hove MC, Pool-Goudzwaard AL, Eijkemans MJ, Steegers-Theunissen RP, Burger CW, Vierhout ME. The prevalence of pelvic organ prolapse symptoms and signs and their relation with bladder and bowel disorders in a general female population. Int Urogynecol J Pelvic Floor Dysfunct. 2009;20:1037–45.
5. Verbeek M, Hayward L. Pelvic floor dysfunction and its effect on quality of sexual life. Sex Med Rev. 2019;7:559–64.
6. Dietz HP. Pelvic floor ultrasound: a review. Am J Obstet Gynecol. 2010;202:321–34.
7. Shek KL, Dietz HP. Assessment of pelvic organ prolapse: a review. Ultrasound Obstet Gynecol. 2016;48:681–92.
8. AIUM/IUGA practice parameter for the performance of Urogynecological ultrasound examinations: Developed in collaboration with the ACR, the AUGS, the AUA, and the SRU. Int Urogynecol J. 2019;30:1389–400.
9. Zhang M, Lin X, Zheng Z, Chen Y, Ren Y, Zhang X. Artificial intelligence models derived from 2D transperineal ultrasound images in the clinical diagnosis of stress urinary incontinence. Int Urogynecol J. https://doi.org/10.1007/s00192-021-04859-y.
10. Wu M, Wang X, Lin X, et al. Cut-offs for defining uterine prolapse using transperineal ultrasound in Chinese women: prospective multicenter study. Ultrasound Obstet Gynecol. 2021;58:127–32.
11. Dietz HP, Lekskulchai O. Ultrasound assessment of pelvic organ prolapse: the relationship between prolapse severity and symptoms. Ultrasound Obstet Gynecol. 2007;29:688–91.
12. Dietz HP, KamisanAtan I, Salita A. Association between ICS POP-Q coordinates and translabial ultrasound findings: implications for definition of "normal pelvic organ support". Ultrasound Obstet Gynecol. 2016;47:363–8.
13. Madhu C, Swift S, Moloney-Geany S, Drake MJ. How to use the Pelvic Organ Prolapse Quantification (POP-Q) system? Neurourol Urodyn. 2018;37:S39-s43.
14. Wang YT, Jiang JY, Han JS. A review of the pelvic organ prolapse quantification system in China. Int Urogynecol J. 2016;27:287–90.
15. Dietz HP, Mann KP. What is clinically relevant prolapse? An attempt at defining cutoffs for the clinical assessment of pelvic organ descent. Int Urogynecol J. 2014;25:451–5.
16. Dietz HP. Ultrasound imaging of the pelvic floor. Part I: two-dimensional aspects. Ultrasound Obstet Gynecol. 2004;23:80–92.
17. Dietz HP. Ultrasound imaging of the pelvic floor. Part II: three-dimensional or volume imaging. Ultrasound Obstet Gynecol. 2004;23:615–25.
18. Fluss R, Faraggi D, Reiser B. Estimation of the Youden Index and its associated cutoff point. Biom J. 2005;47:458–72.
19. Cheung RYK, Chan SSC, Shek KL, Chung TKH, Dietz HP. Pelvic organ prolapse in Caucasian and East Asian women: a comparative study. Ultrasound Obstet Gynecol. 2019;53:541–5.
20. Barber MD. Symptoms and outcome measures of pelvic organ prolapse. Clin Obstet Gynecol. 2005;48:648–61.

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