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ORIGINAL ARTICLE

Pessary fitting for pelvic organ prolapse: parameters associated with specific reasons for failure

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Abstract

Introduction and hypothesis The objective was to assess if specific reasons for unsuccessful pessary fitting have different predictive parameters.

Methods This is a prospective observational case–control study of women with symptomatic pelvic organ prolapse (POP) choosing pessary treatment. All women underwent an interview, clinical examination, and 3D/4D transperineal ultrasound (TPUS). Groups were defined based on fitting outcome: successful, pessary dislodgment, failure to relieve POP symptoms, pain/discomfort, increased/de novo urinary incontinence, or other reasons. Clinical, demographic, and TPUS parameters were assessed in the prediction of different reasons for unsuccessful fitting and receiver operating characteristic (ROC) curves were constructed.

Results A total of 162 women were assessed and 130 were included. Levator hiatal area (HA) on maximum Valsalva divided by ring pessary size ("Valsalva HARP ratio") was a predictor of unsuccessful fitting (OR 3.00, 95% CI 1.15–7.81, $p = 0.025$) with an area under the ROC curve (AUC) of 0.62 (95% CI 0.50–0.74, $p = 0.04$). Predictors of pessary dislodgment were: complete avulsion (OR 24.20, 95% CI 2.46–237.84, p value 0.01) and Valsalva HARP ratio (OR 2.94, 95% CI 1.32–6.55, p value 0.01) with an area under the ROC curve (AUC) of 0.92 (95% CI 0.84–0.99, $p = 0.00$). No significant parameter was identified in the prediction of pain/discomfort. Solitary predominant posterior compartment POP was a predictor of failure to relieve POP symptoms (OR 20.00, 95% CI 3.48–115.02, p value 0.00; AUC 0.75, 95% CI 0.53–0.98, $p = 0.03$).

Conclusion Complete avulsion and a small ring pessary with respect to the levator HA in Valsalva are predictors of pessary dislodgment, whereas solitary predominant posterior compartment POP is a predictor of failure to relieve POP symptoms.

Keywords Pelvic organ prolapse · Vaginal pessaries · Pessary fitting · Avulsion · Transperineal ultrasound

Introduction

Vaginal pessaries are widely used as a conservative treatment option for pelvic organ prolapse (POP) [1, 2] and have proven effective in relieving POP symptoms [3–7]. However, the success rate of pessary fitting (which is the process of finding a pessary that suits an individual woman) has been reported to be as low as 41% [8]. Numerous studies have been published on the role of demographic and clinical parameters in the prediction of (un)successful pessary fitting for pelvic organ prolapse (POP) [4, 8–18], whereas the role of transperineal ultrasound (TPUS) parameters has been investigated in only a few recent studies [19, 20]. In addition, when comparing successful and unsuccessful groups, past studies did not differentiate between specific reasons for pessary fitting failure. Therefore, the unsuccessful group was

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heterogeneous, including women with pessary dislodgment, failure to relieve POP symptoms, pain/discomfort, or urinary symptoms [11]. Only Cheung and co-workers analyzed pessary dislodgment separately from other reasons for pessary fitting failure [15, 19]. However, women requiring pessary removal for reasons of failure other than pessary dislodgment were excluded from their analysis.

Our hypothesis is that specific reasons for unsuccessful pessary fitting have different predictive parameters. Knowing which parameters are associated with a specific reason for failure could make the counseling for pessary treatment more effective: a higher risk of dislodgment, failure to relieve POP symptoms, pain/discomfort, or urinary symptoms would be known and discussed, which would in turn allow both clinicians and patients to better manage their expectations and engage in a more evidence-based decision-making process. Furthermore, the association of TPUS parameters with specific reasons for pessary fitting failure could give an indication of the added value of TPUS in pessary fitting. This is the rationale behind the current study in which the association of demographic, clinical, and TPUS parameters with specific reasons for unsuccessful pessary fitting is investigated.

Materials and methods

The data used in the current study were collected as a subset within the GYNecological Imaging using 3D UltraSound (GYNIUS) project on the assessment of pelvic floor contractility with TPUS, which was conducted at our urogynecological center, where secondary and tertiary care are provided. Women were included in the GYNIUS project between May 2018 and December 2019. The Medical Research Ethics Committee (MREC) exempted the project from ethical approval (reference 18/215), because TPUS was part of our routine diagnostic procedures and standard care. All women signed informed consent forms.

Study design and pessary fitting

This was a prospective observational case–control study on parameters associated with specific reasons for unsuccessful pessary fitting. Women with symptomatic POP choosing pessary treatment were included. Women who were already using a pessary at intake assessment, and those who started pessary fitting more than 4 weeks after intake assessment were excluded. All women underwent an interview, clinical examination, and 3D/4D TPUS. Pelvic organ prolapse was assessed using the Pelvic Organ Prolapse Quantification system (POPQ) [21]. Pessary fitting was performed according to our standard clinical practice, similar to the one described in the literature [8–11, 22, 23]. In the following, specific terminology will be used to describe different phases of pessary fitting and is presented in Table 1.

A woman could undergo one or more fitting trials until the last trial was successful. In this case, pessary fitting (our study outcome) was considered successful and pessary type and size were recorded. On the contrary, pessary fitting was considered unsuccessful if initial fitting was unsuccessful or, after one or more fitting trials, the woman was not satisfied with any pessary and a different treatment was chosen. In this case, pessary type and size of the last fitting trial were recorded, and the woman was asked which one of the following was the reason for fitting failure: dislodgment (defined as a pessary that did not stay in place because it fell down or was expelled), failure to relieve POP symptoms, pain/discomfort, increased/de novo urinary incontinence, or other reasons. With respect to the pessary type, a ring pessary (without or with support) was always tried first. If, having tried different sizes, a ring pessary was not successful, a different pessary type was tried (i.e., Gellhorn, donut, or cube pessary).

Table 1 Terminology used to describe the different phases of pessary fitting and their definitions

Terminology	Definition
Initial fitting	Pessary fitting at the first visit, which is successful if the patient leaves the clinic with a pessary that stays comfortably in place. It is unsuccessful if the woman cannot be fitted with any pessary type and size and has to undergo a different treatment
Fitting trial	The event of a woman being fitted with a specific pessary size and type, leaving the clinic with the pessary in place, and attending the 2- to 4-week follow-up in which the success of the fitting trial is assessed (i.e., the pessary is still in situ, the woman is satisfied with it and decides to continue using the pessary she was fitted with). It is unsuccessful if, for any reason, the woman does not continue using the specific pessary she was fitted with
Pessary fitting	Study outcome. Process from initial fitting to the last fitting trial. Independently of the number of fitting trials the woman undergoes, it is successful if the last fitting trial is successful (i.e., the pessary is still in situ, the woman is satisfied with it and decides to continue using the last pessary she was fitted with). It is unsuccessful if the woman has to undergo a different treatment because of unsuccessful initial fitting or last fitting trial

TPUS data acquisition

At intake, the TPUS was performed in supine position after bladder emptying. Women were instructed to perform maximal pelvic floor contraction and maximal Valsalva maneuver according to the method described by Dietz [24]. We used a Philips Epiq 7G machine with a X6-1 transducer covered with a 2-cm thick gel pad and a glove. The gel pad was used to create more distance between the transducer and the woman, so that the levator ani muscle (LAM) could be fully visible within the opening angle on the coronal plane. TPUS volumes analyzed in the current study were acquired without the pessary in situ.

TPUS data assessment

An in-house tool was developed in MeVisLab [25] for TPUS volumes assessment, which was performed by one observer (CM) blinded to all clinical data. As described in the literature, the hiatal area at rest (HArest), maximum pelvic floor contraction (HActx), and maximum Valsalva maneuver (HAval) were manually segmented at the plane of minimal hiatal dimensions [26]. From these parameters, the following were derived: displacement in contraction (DISPL-ctx), which was calculated as (HArest − HActx)/HArest, and displacement in Valsalva (DISPL-Val), which was calculated as (HAval − HArest)/HArest. In addition, we introduced the parameter HARP ratio (i.e., hiatal area to ring pessary ratio), which was calculated as the levator HA divided by the diameter of the ring pessary in centimeters. The HARP ratio enables assessment of the relative dimension of the ring pessary with respect to the levator HA dimension: if the ring pessary is small with respect to the levator HA (which we hypothesized to be associated with pessary dislodgment or failure to relieve POP symptoms), the HARP ratio is high; if the ring pessary is small with respect to the levator HA (which we hypothesized to be associated with pain/discomfort), the HARP ratio is low. Independently of the number of fitting trials a woman underwent, the ring pessary size used to measure the HARP ratio was the successful one or the last one tried in a fitting trial. The HARP ratio was calculated with the levator HA at rest (rest HARP ratio), maximal contraction (contraction HARP ratio), and maximal Valsalva maneuver (Valsalva HARP ratio). The presence of LAM avulsion was assessed on volumes obtained at maximum contraction using tomographic ultrasound imaging (TUI). Complete LAM avulsion was defined as levator–urethra gap ≥25 mm on the three central slices and could be unilateral or bilateral [26].

Predictive parameters and statistical analysis

The successful group was compared with the entire unsuccessful group and with the groups of women reporting a specific reason for unsuccessful pessary fitting. Only groups with more than five women were compared with the successful group. At first, a univariate binomial logistic regression was run. Parameters assessed on univariate analysis were demographic and clinical parameters derived from a review of the literature [4, 8–20]: age, BMI, menopause, prior pelvic surgery (i.e., prior hysterectomy and/or prior POP surgery and/or prior incontinence surgery), and solitary predominant posterior compartment POP (i.e., maximum POP stage in the posterior compartment only). In addition to demographic and clinical parameters, the following TPUS parameters were assessed on univariate analysis: HArest, HActx, HAval, DISPL-ctx, DISPL-Val, rest HARP ratio, contraction HARP ratio, Valsalva HARP ratio, and complete LAM avulsion. Subsequently, a multivariate binomial logistic regression was run. According to Vittinghoff and McCulloch [27], model performance problems are uncommon with 5–9 events per predictor variable (EPV) and still observed with 10–16 EPV. Therefore, a minimum of 5 EPV was accepted; also considering the exploratory nature of our study. Significant parameters on univariate analysis ($p < 0.05$) were selected for multivariate analysis. For both univariate and multivariate analyses, it was tested that the assumptions of the binomial logistic regression were not violated: linearity assumption (i.e., the linear relationship between the continuous independent variables and the logit transformation of the dependent variable) and absence of significant outliers. No formal sample size could be calculated because no previous study has investigated separately multiple reasons for pessary fitting failure and their predictive parameters. This should thus be considered an exploratory study. If the sample size limited the number of significant parameters that could be tested on multivariate analysis, different combinations of parameters were assessed, and the best model was selected based on Nagelkerke's R-squared [28]. For the parameters significant on multivariate analysis, receiver operating characteristic curves (ROC curves) were constructed, and the area under the ROC curve (AUC) was measured. The statistical analysis was conducted using IBM v 27 SPSS software.

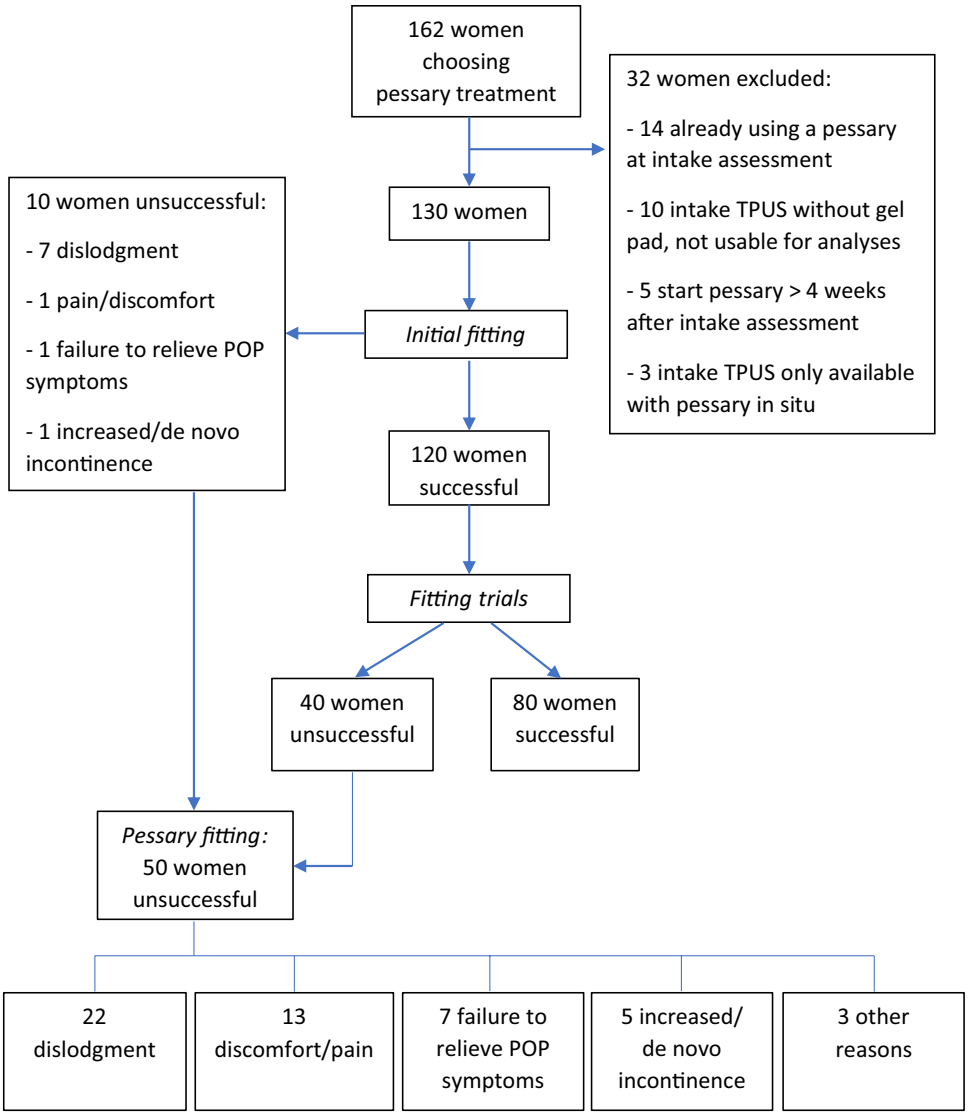

Fig. 1 Number of women at each stage and reasons for unsuccessful pessary fitting. In italics the different phases of pessary fitting. *POP* pelvic organ prolapse, *TPUS* transperineal ultrasound

Results

Figure 1 shows the number of women at each stage and the reasons for unsuccessful pessary fitting. The women underwent a maximum of three fitting trials. Therefore, pessary fitting lasted between 2 and 4 weeks, if the woman underwent only one fitting trial, and 6–12 weeks, if the woman underwent up to three fitting trials.

In Table 2 demographic, clinical, and TPUS characteristics of the women included are reported.

Table 3 shows median value and interquartile range (IQR) or number of cases and percentage of the parameters assessed per group of women. As the increased/de novo urinary incontinence group and other reasons group did not include more than five women, they were not separately analyzed. Therefore, they are not shown in Table 3.

Table 4 shows the parameters that were significant on univariate analysis in the prediction of unsuccessful pessary fitting, pessary dislodgment, and failure to relieve POP symptoms, as well as the results of the multivariate analysis. The analysis of the prediction of pain/discomfort is not shown because no significant parameter was identified. The entire univariate analysis (with significant and nonsignificant parameters) is reported in the Appendix (Tables 5, 6, 7, 8). No parameter violated the assumptions of the binomial logistic regression. On multivariate analysis, Valsalva HARP ratio was a predictor of unsuccessful pessary fitting, when no distinction was made between different reasons for failure. In the case of pessary dislodgment, the sample size limited the number of parameters that could be assessed on multivariate

Table 2 Demographic, clinical, and transperineal ultrasound (TPUS) characteristics of the women included ($N = 130$)

Parameter	Value
Age (years), median (IQR)	61.5 (14.0)
BMI, median (IQR)	24.0 (5.2)
Post-menopausal, *n* (%)	97 (74.6)
Vaginal parity, *n* (%)	128 (98.5)
Assisted vaginal delivery, *n* (%)	12 (9.2)
Prior pelvic surgery[a], *n* (%)	25 (19.2)
Predominant compartment POP, *n* (%)	
Anterior	73 (56.2)
Apical	8 (6.2)
Posterior	12 (9.2)
Anterior, apical	6 (4.6)
Anterior, posterior	23 (17.7)
Apical, posterior	3 (2.3)
Anterior, apical, posterior	5 (3.8)
POP stage, *n* (%)	
I	2 (1.5)
II	75 (57.7)
III	53 (40.8)
HArest (cm^2), median (IQR)	20.2 (6.6)
HActx (cm^2), median (IQR)	16.9 (5.1)
HAval (cm^2), median (IQR)	33.9 (12.8)
DISPL-ctx (%), median (IQR)	15.6 (13.0)
DISPL-Val (%), median (IQR)	51.0 (55.0)
Complete LAM avulsion, *n* (%)	52 (40.0)
Last pessary type, *n* (%)	
Ring	114 (87.7)
Gellhorn	4 (3.0)
Cube	1 (0.8)
Donut	1 (0.8)
Not available[b]	10 (7.7)
Last ring pessary size (cm), median (IQR)	7.0 (1.2)
Rest HARP ratio (cm), median (IQR)[c]	2.9 (1.0)
Contraction HARP ratio (cm), median (IQR)[c]	2.4 (0.7)
Valsalva HARP ratio (cm), median (IQR)[c]	4.7 (2.0)

HArest levator hiatal area at rest, *HActx* levator hiatal area on maximal contraction, *HAval* levator hiatal area on maximal Valsalva maneuver, *DISPL-ctx* (HArest − HActx)/HArest, *DISPL-Val* (HAval − HArest)/HArest, *HARP ratio* levator HA to last ring pessary size ratio

[a]Prior pelvic surgery = hysterectomy and/or POP surgery and/or incontinence surgery

[b]10 women with unsuccessful initial fitting

[c]Parameter not available for 10 women with unsuccessful initial fitting (no pessary size could be registered), 6 (tried to be) fitted with a pessary type other than a ring pessary, and in 3 the ring pessary sizes were missing

analysis. Combinations of LAM avulsion (i.e., the parameter with the highest OR) with all other parameters that were significant on univariate analysis were tested and the model with the highest Nagelkerke's R squared (46.5%) included LAM avulsion and Valsalva HARP ratio as independent variables. Solitary predominant posterior compartment POP was a predictor of failure to relieve POP symptoms (being the only parameter significant on univariate analysis; a multivariate analysis was not run).

The AUC of Valsalva HARP ratio in the prediction of unsuccessful pessary fitting was 0.62 (95% CI 0.50–0.74, $p = 0.04$). In the prediction of pessary dislodgment, the combination of LAM avulsion and Valsalva HARP ratio gave an AUC of 0.92 (0.84–0.99), $p = 0.00$. Last, the AUC of solitary predominant posterior compartment POP in the prediction of failure to relieve POP symptoms was 0.75 (0.53–0.98), $p = 0.03$.

Discussion

Specific reasons for unsuccessful pessary fitting are associated with different predictive parameters, namely pessary dislodgment is associated with LAM avulsion and Valsalva HARP ratio, and failure to relieve POP symptoms is associated with solitary predominant posterior compartment POP. Previous literature on the topic overlooked this aspect [4, 8–14, 16–18, 20], which might (partially) explain the different results between studies.

Valsalva HARP ratio was a predictor of unsuccessful pessary fitting when no distinction was made between different reasons for failure. Therefore, pessary fitting was more likely to be unsuccessful if a woman was fitted with a relatively small ring pessary with respect to the levator HA on Valsalva. This finding suggests that the support of the LAM plays an important role in holding ring pessaries comfortably in place. However, the AUC showed poor discrimination according to Hosmer et al. [29], which can be explained by the heterogeneity of the unsuccessful group.

Avulsion of LAM and Valsalva HARP ratio were predictors of pessary dislodgment, and the AUC of the combination of the two parameters showed an outstanding level of discrimination [29]. The association between LAM avulsion and pessary dislodgment confirms previous results [19], whereas Valsalva HARP ratio had never been investigated before. If our results were confirmed by more studies from different institutions, they could have the following clinical implications. When a woman chooses pessary treatment for POP, LAM avulsion should be assessed. If present, the higher risk of dislodgment should be discussed. However, pessary treatment should be encouraged, considering the higher risk of recurrence after POP surgery associated with LAM avulsion [30]. To minimize the risk of dislodgment, the maximum ring pessary size the woman can be fitted with should be selected, whilst

Table 3 Parameters presented per group of women as median value and interquartile range (IQR) or number of cases and percentage

Parameter	Successful ($n=80$)	Unsuccessful ($n=50$)	Dislodgment ($n=22$)	Pain/discomfort ($n=13$)	Failure to relieve POP symptoms ($n=7$)
Age (years), median (IQR)	63.0 (15.0)	58.5 (16.0)	57.5 (13.0)	62.0 (18.0)	61.0 (9.0)
BMI, median (IQR)	24.1 (4.5)	24.0 (6.1)	24.3 (4.8)	22.9 (9.0)	24.4 (5.7)
Menopause, *n* (%)	62 (77.5)	35 (70.0)	16 (72.7)	9 (69.2)	6 (85.7)
Prior pelvic surgery[a], *n* (%)	13 (16.3)	12 (24.0)	6 (27.3)	1 (7.7)	3 (42.9)
Solitary predominant posterior compartment POP, *n* (%)	5 (6.3)	7 (14.0)	1 (4.5)	1 (7.7)	4 (57.1)
HArest (cm^2), median (IQR)	20.1 (6.2)	21.3 (7.3)	23.9 (5.3)	19.5 (10.7)	19.0 (3.1)
HActx (cm^2), median (IQR)	16.9 (5.3)	17.2 (5.3)	20.3 (4.5)	16.1 (6.4)	14.6 (1.9)
HAval (cm^2), median (IQR)	31.9 (11.4)	37.7 (16.3)	41.3 (9.4)	28.6 (16.8)	33.6 (21.7)
DISPL-ctx (%), median (IQR)	16.2 (14.0)	14.4 (11.0)	12.9 (10.0)	15.6 (6.0)	12.4 (25.0)
DISPL-Val (%), median (IQR)	45.9 (56.0)	60.6 (56.0)	66.4 (44.0)	43.6 (61.0)	66.9 (87.0)
Rest HARP ratio (cm), median (IQR)[b]	2.9 (0.9)	3.0 (1.1)	3.4 (0.8)	3.0 (1.4)	2.8 (0.5)
Contraction HARP ratio (cm), median (IQR)[b]	2.4 (0.7)	2.5 (0.9)	3.0 (1.2)	2.4 (0.9)	2.3 (0.7)
Valsalva HARP ratio (cm), median (IQR)[b]	4.6 (1.6)	5.2 (2.7)	5.8 (2.0)	4.5 (2.8)	5.2 (2.9)
LAM avulsion, *n* (%)	25 (31.3)	27 (54.0)	18 (81.8)	6 (46.2)	2 (28.6)

HArest levator hiatal area at rest, *HActx* levator hiatal area on maximal contraction, *HAVal* levator hiatal area on maximal Valsalva maneuver, *DISPL-ctx* (HArest − HActx)/HArest, *DISPL-Val* (HAval − HArest)/HArest, *HARP ratio* levator HA to last ring pessary size ratio

[a]Prior pelvic surgery = hysterectomy and/or POP surgery and/or incontinence surgery

[b]Parameter available for 77 women of the successful group, 34 of the unsuccessful group, 11 of the dislodgment group, 12 of the pain/discomfort group, and 6 of the failure to relieve POP symptoms group

remembering that the pessary should allow a single examining finger to be passed freely all around its circumference [31]. Research should investigate the added value of TPUS in estimating the ring pessary size that is likely to stay in place. An alternative strategy to minimize the risk of dislodgment might be the use of those pessary types held in place by suction of their surface to the vaginal walls (e.g., Gellhorn, cube pessaries) because the support of the LAM might be less essential for these pessaries compared with ring pessaries. In our study, we tried to fit only one woman with a Gellhorn pessary and one woman with a cube pessary in the dislodgment group. Therefore, we can neither confirm nor exclude this hypothesis. A randomized crossover trial showed no significant difference in effectiveness between ring and Gellhorn pessaries [17]. However, the presence of LAM avulsion was not assessed in this study. It would be interesting to compare the occurrence of pessary dislodgment in women with complete LAM avulsion fitted with ring pessaries vs Gellhorn or cube pessaries. If Gellhorn or cube pessaries showed a higher success rate, these pessary types should be recommended to women with complete LAM avulsion. In addition, the results on pessary dislodgment indicate that imaging techniques have the potential to provide more insight into what a proper fit is. More research should be done in this direction with the aim of increasing the pessary fitting success rate.

Solitary predominant posterior compartment was a predictor of failure to relieve POP symptoms with an AUC of 0.75. Previous results showed the association of posterior compartment prolapse [13] or higher Colorectal-Anal Distress Inventory-8 (CRADI-8) scores [14] with unsuccessful pessary fitting. Our result confirms the hypothesis that pessary treatment is less effective in relieving symptoms of posterior compartment POP and thus less likely to be successful. We did not attempt to fit any women in the failure to relieve POP symptoms group with a pessary other than a ring pessary. It would be interesting to assess if different pessary types are more effective in this group.

Our study has several strengths. First, a prospective design was used, which reduced the risk of selection bias. Second, all scans and all TPUS

Table 4 Univariate and multivariate analysis in the prediction of unsuccessful pessary fitting ($n=50$), pessary dislodgment ($n=22$), and failure to relieve POP symptoms ($n=7$) vs successful pessary fitting ($n=80$). Only the significant parameters on univariate analysis are shown

	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Prediction of unsuccessful pessary fitting				
Significant parameters on univariate analysis				
Age	0.97 (0.94–1.00)	0.04	0.98 (0.94–1.02)	0.24
HAval	1.05 (1.01–1.09)	0.02	0.90 (0.79–1.02)	0.10
Valsalva HARP ratio[a]	1.46 (1.06–2.00)	0.02	3.00 (1.15–7.81)	0.03
LAM avulsion	2.58 (1.25–5.36)	0.01	2.41 (0.98–5.94)	0.06
Prediction of pessary dislodgment				
HArest	1.18 (1.05–1.33)	0.01		
HActx	1.23 (1.08–1.41)	0.00		
HAval	1.12 (1.05–1.20)	0.00		
Rest HARP ratio[a]	4.09 (1.24–13.49)	0.02		
Contraction HARP ratio[a]	5.77 (1.59–20.97)	0.01		
Valsalva HARP ratio[a]	2.53 (1.41–4.54)	0.00	2.94(1.32–6.55)	0.01
LAM avulsion	9.90 (3.04–32.29)	0.00	24.20 (2.46–237.84)	0.01
Prediction of failure to relieve POP symptoms				
Solitary predominant posterior compartment POP	20.00 (3.48–115.02)	0.00		

POP pelvic organ prolapse, *HArest* levator hiatal area at rest, *HActx* levator hiatal area on maximal contraction, *HAval* levator hiatal area on maximal Valsalva maneuver, *HARP ratio* levator HA to last ring pessary size ratio

[a]Parameter available for 77 women of the successful group (2 were fitted with a Gellhorn pessary, in 1 the pessary size was missing), 34 of the unsuccessful group (in 10 the initial fitting was unsuccessful, 4 tried a different pessary type, in 2 the pessary size was missing), and 11 women of the dislodgment group (in 7 the initial fitting was unsuccessful, 1 tried a Gellhorn, 1 a cube, 1 a donut, in 1 the pessary size was missing)

assessments were performed by the same clinician, thus reducing a source of variability. Third, TPUS assessment was performed with the observer blinded to all clinical data. Some limitations must also be acknowledged. The size of the outcome groups was relatively small, especially in the case of failure to relieve POP symptoms, and our results should be interpreted with caution. A larger study with a sample size based on our exploratory study is needed to confirm our findings. The parameter HARP ratio could only be assessed for a specific pessary type because measuring HARP ratio for pessaries with different shapes would have provided incomparable measures. Ring pessaries were chosen because they were the most frequently used. In addition, HARP ratio was not available in the case of unsuccessful initial fitting because no pessary could be fitted at the initial visit and the woman did not undergo a fitting trial. This limited the number of parameters that could be assessed on multivariate analysis in the prediction of pessary dislodgment. However, all combinations between LAM avulsion and the other significant parameters on univariate analysis were assessed on multivariate analysis and the best model included LAM avulsion and Valsalva HARP ratio as independent variables. An additional limitation is that parameters that might have been relevant for failure owing to pain/discomfort (i.e., vaginal atrophy and fornix posterior width) were not assessed. Future research on predictors of pain/discomfort should not overlook these parameters. Last, the generalizability of the results might be limited because the study was conducted in a urogynecological center, where primary care is not provided.

In conclusion, specific reasons for unsuccessful pessary fitting have different predictive parameters. LAM avulsion and a high Valsalva HARP ratio are predictors of pessary dislodgment, whereas solitary predominant posterior compartment POP is a predictor of failure to relieve POP symptoms. If confirmed by more studies from different institutions, our results could make the counseling for pessary fitting more effective. In addition, our study can stimulate future research on the efficacy of different pessary types in women with LAM avulsion or solitary predominant posterior compartment POP and on the added value of imaging techniques in obtaining a proper fit.

Appendix 1

Table 5 Results of univariate and multivariate binomial logistic regression in the prediction of unsuccessful ($n = 50$) vs successful pessary fitting ($n = 80$)

Prediction of unsuccessful pessary fitting				
Parameter	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Age	0.97 (0.94–1.00)	**0.04**	0.98 (0.94–1.02)	0.24
BMI	0.97 (0.88–1.07)	0.50		
Menopause	0.68 (0.30–1.51)	0.34		
Prior pelvic surgery[a]	1.63 (0.68–3.92)	0.28		
Solitary predominant posterior compartment POP	2.44 (0.73–8.17)	0.15		
HArest	1.06 (0.98–1.15)	0.14		
HActx	1.07 (0.98–1.18)	0.13		
HAval	1.05 (1.01–1.09)	**0.02**	0.90 (0.79–1.02)	0.10
DISPL-ctx	0.51 (0.01–22.69)	0.73		
DISPL-Val	1.57 (0.71–3.45)	0.26		
Rest HARP ratio[b]	1.64 (0.86–3.10)	0.13		
Contraction HARP ratio[b]	1.76 (0.85–3.63)	0.13		
Valsalva HARP ratio[b]	1.46 (1.06–2.00)	**0.02**	3.00 (1.15–7.81)	**0.03**
LAM avulsion	2.58 (1.25–5.36)	**0.01**	2.41 (0.98–5.94)	0.06

Bold indicates statistically significant parameters

HArest levator hiatal area at rest, *HActx* levator hiatal area on maximal contraction, *HAval* levator hiatal area on maximal Valsalva maneuver, *DISPL–ctx* (HArest −HActx)/HArest, *DISPL-Val* (HAval − HArest)/HArest, *HARP ratio* levator HA to last ring pessary size ratio

[a]Prior pelvic surgery = hysterectomy and/or POP surgery and/or incontinence surgery

[b]Parameter available for 77 women of the successful group (2 werefitted with a Gellhorn pessary, in 1 the pessary size was), and 34 of the unsuccessful group (in 10 the initial fitting was unsuccessful, 4 tried a different pessary type, in 2 the pessary size was)

Table 6 Results of univariate and multivariate binomial logistic regression in the prediction of pessary dislodgment ($n = 22$) vs successful pessary fitting process ($n = 80$)

Prediction of pessary dislodgment				
Parameter	Univariate analysis		Multivariate analysis	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Age	0.97 (0.93–1.01)	0.16		
BMI	0.93 (0.81–1.08)	0.34		
Menopause	0.77 (0.26–2.27)	0.64		
Prior pelvic surgery[a]	1.93 (0.64–5.87)	0.25		
Solitary predominant posterior compartment POP	0.71 (0.08–6.45)	0.76		
HArest	1.18 (1.05–1.33)	**0.01**		
HActx	1.23 (1.08–1.41)	**0.00**		
HAval	1.12 (1.05–1.20)	**0.00**		
DISPL-ctx	0.07 (0.00–14.61)	0.33		
DISPL-Val	2.17 (0.77–6.09)	0.14		
Rest HARP ratio[b]	4.09 (1.24–13.49)	**0.02**		
Contraction HARP ratio[b]	5.77 (1.59–20.97)	**0.01**		
Valsalva HARP ratio[b]	2.53 (1.41–4.54)	**0.00**	2.94 (1.32–6.55)	**0.01**
LAM avulsion	9.90 (3.04–32.29)	**0.00**	24.20 (2.46–237.84)	**0.01**

Bold indicates statistically significant parameters

HArest levator hiatal area at rest, *HActx* levator hiatal area on maximal contraction, *HAval* levator hiatal area on maximal Valsalva maneuver, *DISPL-ctx* (HArest − HActx)/HArest, *DISPL-Val* (HAval − HArest)/HArest, *HA ratio* levator HA to last ring pessary size ratio

[a]Prior pelvic surgery = hysterectomy and/or POP surgery and/or incontinence surgery

[b]Parameter available for 77 women of the successful group (2 women were fitted with a Gellhorn pessary, in 1 the pessary size was missing), and 11 of the dislodgment group (in 7 the initial fitting was unsuccessful, 1 tried a Gellhorn, 1 a cube, 1 a donut, in 1 the pessary size was missing)

Table 7 Results of univariate binomial logistic regression in the prediction of pain/discomfort ($n=13$) vs successful pessary fitting process ($n=80$)

Parameter	Univariate analysis	
	OR (95% CI)	*p* value
Age	0.97 (0.92–1.02)	0.23
BMI	0.10 (0.85–1.17)	0.98
Menopause	0.65 (0.18–2.37)	0.52
Prior pelvic surgery[a]	0.43 (0.05–3.60)	0.44
Solitary predominant posterior compartment POP	1.25 (0.13–11.65)	0.85
HArest	1.01 (0.89–1.15)	0.85
HActx	1.02 (0.88–1.18)	0.80
HAval	1.01 (0.94–1.07)	0.89
DISPL-ctx	0.35 (0.00–247.01)	0.75
DISPL-Val	1.10 (0.31–3.87)	0.88
Rest HARP ratio[b]	1.49 (0.60–3.70)	0.39
Contraction HARP ratio[b]	1.61 (0.58–4.50)	0.36
Valsalva HARP ratio[b]	1.22 (0.76–1.94)	0.41
LAM avulsion	0.53 (0.16–1.74)	0.30

HArest levator hiatal area at rest, *HActx* levator hiatal area on maximal contraction, *HAval* levator hiatal area on maximal Valsalva maneuver, *DISPL-ctx* (HArest − HActx)/HArest, *DISPL-Val* (HAval − HArest)/HArest, *HARP ratio* levator HA to last ring pessary size ratio

[a]Prior pelvic surgery = hysterectomy and/or POP surgery and/or incontinence surgery

[b]Parameter available for 77 women of the successful group (2 fitted with a Gellhorn pessary, in 1 the pessary size was missing), and 12 of the pain/discomfort group (1 initial fitting unsuccessful)

Table 8 Results of univariate binomial logistic regression in the prediction of failure to relieve POP symptoms ($n=7$) vs successful pessary fitting process ($n=80$)

Parameter	Univariate analysis	
	OR (95% CI)	*p* value
Age	0.98 (0.92–1.05)	0.56
BMI	1.05 (0.85–1.29)	0.66
Menopause	1.74 (0.20–15.43)	0.62
Prior pelvic surgery[a]	3.87(0.77–19.35)	0.10
Solitary predominant posterior compartment POP	20.00 (3.48–115.02)	**0.00**
HArest	0.91 (0.75–1.12)	0.39
HActx	0.84 (0.65–1.08)	0.16
HAval	1.02 (0.94–1.10)	0.71
DISPL-ctx	17.20 (0.01–22,082.73)	0.44
DISPL-Val	1.79 (0.45–7.22)	0.41
Rest HARP ratio[b]	0.78 (0.18–3.36)	0.74
Contraction HARP ratio[b]	0.52 (0.09–2.89)	0.45
Valsalva HARP ratio[b]	1.29 (0.67–2.47)	0.45
LAM avulsion	0.88 (0.16–4.85)	0.88

Bold indicates statistically significant parameters

HArest levator hiatal area at rest, *HActx* levator hiatal area on maximal contraction, *HAval* levator hiatal area on maximal Valsalva maneuver, *DISPL-ctx* (HArest − HActx)/HArest, *DISPL-Val* (HAval − HArest)/HArest, *HARP ratio* levator HA to last ring pessary size ratio

[a]Prior pelvic surgery = hysterectomy and/or POP surgery and/or incontinence surgery

[b]Parameter available for 77 women of the successful group (2 were fitted with a Gellhorn pessary, in 1 the pessary size was missing), and 6 of the failure to relieve POP symptoms group (1 in whom the initial fitting was unsuccessful)

Contributions C. Manzini: project development, data collection, data analysis and interpretation, manuscript writing and editing; C.H. van der Vaart: project development, data interpretation, manuscript editing; F. van den Noort: analysis tool development, manuscript editing; A.T.M. Grob: data interpretation, manuscript editing; M.I.J. Withagen: project development, data interpretation, manuscript editing.

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Declarations

Conflicts of interest Authors declare that they have no conflicts of interest.

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