Published in final edited form as:

Female Pelvic Med Reconstr Surg. 2012 ; 18(4): 227–232. doi:10.1097/SPV.0b013e3182626294.

Longitudinal Changes in Pelvic Organ Support Among Parous Women

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Abstract

Objective—The objective of this study was to characterize changes in pelvic organ support and symptoms of prolapse over time and identify characteristics associated with worsening of support.

Methods—Participants were recruited based on the mode of delivery (cesarean vs vaginal delivery) of their first child. The Pelvic Organ Prolapse Quantification system was used to describe support at baseline and 12 to 18 months later. Symptoms were assessed using a validated questionnaire. Outcomes of interest included the proportion of women with a change in support greater than 1 cm at the anterior vaginal wall (Ba) or posterior vaginal wall (Bp) and a change in support greater than 2 cm at the apex (C). Characteristics associated with worsening of support were identified using 2-sided Fisher's exact test and multivariable logistic regression.

Results—Among 749 participants, 60% had delivered by cesarean delivery only. Worsening support at Ba, Bp, and C was observed in 8%, 2%, and 6%, respectively. Worsening at any point was observed in 110 women (15%). Women with prolapse symptoms at baseline were not more likely to experience worsening of support. In a multivariable model, age older than 40 years (odds ratio [OR], 1.64; 95% confidence interval [CI], 1.09–2.49), vaginal delivery (OR, 3.12; 95% CI, 1.38–7.07), and genital hiatus greater than or equal to 2 (OR, 2.36; 95% CI, 1.03–5.43) were all associated with worsening support in at least 1 compartment.

Conclusions—Over 12 to 18 months, characteristics most strongly associated with worsening of pelvic support include genital hiatus size, vaginal birth, and age.

Keywords

pelvic organ prolapse; child birth; vaginal delivery; natural history; longitudinal study

Pelvic organ prolapse is commonly believed to be chronic and progressive. Nevertheless, very little is known about the natural history of this condition. The handful of studies that have considered changes in support over time suggest that pelvic organ support may improve as well as worsen.^{1,2} For example, Bradley² assessed prolapse annually using the Pelvic Organ Prolapse Quantification (POPQ) system for participants in the Women's Health Initiative. Among 259 women followed up for 3 years, the average 1-year incidence

of prolapse was 26%, and the 1-year resolution rate was 21%. To our knowledge, the Women's Health Initiative study is the only longitudinal study of prolapse severity using a validated measure.

There is virtually no information about how prolapse symptoms change over time. Most published studies considering the relationship between prolapse severity and symptoms have been cross-sectional and suggest a weak correlation.^{3,4} Women seeking treatment for prolapse often report an acute onset of symptoms, rather than gradual progression.⁵ We are not aware of longitudinal studies of prolapse symptoms using a validated measure. Thus, the natural history of prolapse symptoms is unknown.

This study was undertaken to investigate changes in pelvic organ support over time. Using data from 2 annual assessments, we describe changes in pelvic organ support and prolapse symptoms among 749 parous women participating in the Mothers' Outcomes after Delivery study. We also identify obstetric exposures and other characteristics associated with worsening of pelvic organ support over 1 year.

MATERIALS AND METHODS

The Mothers Outcomes After Delivery (MOAD) study is a longitudinal, prospective cohort study established to investigate pelvic floor disorders and other health outcomes after child birth, with a focus on comparing cesarean delivery versus vaginal birth.⁶ It is coordinated by investigators from the Johns Hopkins University and Greater Baltimore Medical Center. Participants were recruited from the obstetric population at Greater Baltimore Medical Center, a large, private hospital in suburban Maryland. Institutional review board permission was obtained at both sites. All participants provided written, informed consent. Recruitment methods have been reported previously.⁶ To be eligible for MOAD, a woman must have given birth to her first child (index birth) 5 to 10 years before enrollment. Participants were recruited based on the mode of delivery (cesarean vs vaginal delivery) of their first child. In the enrolled population, 60% had delivered exclusively by cesarean delivery, and 40% had experienced at least 1 vaginal birth. The cesarean delivery and vaginal birth groups were matched for age at the time of first delivery and years since that delivery.

Enrolled participants are assessed for pelvic floor disorders annually. Pelvic organ support is assessed at each study visit with the POPQ system.⁷ The examination is performed by study physicians or a research nurse, each of whom has demonstrated competency in performing the research examination before the study; competency is reconfirmed throughout the study. Each POPQ point is measured to the nearest 0.5 cm. At the time of each examination, the clinician is blinded to the woman's delivery history, her symptoms, and the results of previous study examinations.

The primary outcome of interest in the current analysis was change in pelvic organ support from enrollment (baseline) to first follow-up visit (12–18 months later). As such, analysis was restricted to study participants who, at the time of analysis, had completed 2 annual assessments. In addition, because our goal was to examine the natural history of pelvic organ support and prolapse-related symptoms, we excluded women who reported surgery for prolapse. We compared changes in 3 POPQ points: the anterior wall (point Ba), the posterior wall (Bp), and the apex (C). For each point, the median value and interquartile range (IQR) were calculated.

To fully characterize the observed changes over time, pelvic organ support at these 3 POPQ points was examined from 3 perspectives. First, we created a graphical pairwise comparison (baseline and follow-up) for each measure using diamond plots.⁸ The diamond plot is a 2-dimensional grid that displays bivariate counts of the data for each coordinate. Counts are

displayed as shaded polygons whose areas are proportional to the counts of the respective cell. As such, larger polygons represent larger counts.

We also identified the number of women with worsening (and improvement) at each POPQ point. We defined a threshold for “meaningful” change.² For Ba and Bp, the threshold was a change in support of greater than 1 cm. At the apex, a change in support of greater than 2 cm was considered meaningful. Using these definitions, the proportion of women with “meaningful” change of support was calculated for points Ba, Bp, and C. We also calculated the prevalence of “meaningful worsening in a least 1 compartment” (eg, meaningful worsening at 1 of the 3 POPQ points).

To provide context for both improvement and worsening in support, we calculated “net worsening” (or “net improvement”) for each POPQ point. The rationale for this measure is that prior research on the natural history of pelvic organ prolapse has suggested that support may improve as well as worsen over time.^{1,2} Net worsening was defined as the difference between the percentage of women with meaningful worsening and the percentage of women with meaningful improvement (using the thresholds previously defined). Ninety-five percent confidence intervals (95% CIs) for net worsening were calculated by treating change as a multinomial variable (3 categories: worsening, no change, improvement). Finally, to consider “worsening” in a different context, we also calculated the incidence of prolapse, defined as the development of prolapse to or beyond the hymen during the 12- to 18-month follow-up period.

Symptoms of prolapse were assessed using the Epidemiology of Prolapse and Incontinence Questionnaire (EPIQ), a validated self-administered questionnaire.⁹ This questionnaire includes a single item related to symptoms of pelvic organ prolapse: “Do you have a sensation that there is a bulge in your vagina or that something is falling out from your vagina?” Women with that symptom are asked to grade the bother related to that symptom on a continuous scale from 0 to 100. A score of 0 signifies either the absence of this symptom or no bother related to the symptom. At the other extreme, a score of 100 represents maximum bother. Thus, an increase in score signifies increasing bother.

A goal of the study was to identify characteristics associated with longitudinal worsening in pelvic organ support or prolapse symptoms. Worsening was considered separately for the anterior wall, posterior wall, and the apex as well as a composite of the three (ie, “meaningful worsening in at least 1 compartment”). Risk factors hypothesized to be associated with worsening included maternal age, race, parity, body mass index (BMI), and obstetric history. Age, race, and parity were self-reported at enrollment. Body mass index was based on height and weight measured at study enrollment. Obstetric characteristics considered in this analysis were defined across a woman’s obstetric history, taking into account exposures at more than 1 delivery for multiparous women. Specific obstetric exposures considered in this analysis included vaginal versus cesarean delivery, the extent of labor before cesarean delivery, birth weights of infants delivered vaginally, history of episiotomy or laceration, and history of forceps delivery. Obstetric exposures were derived from abstraction of delivery records. If relevant data were missing from the medical record, the participant’s recall was used to classify obstetric exposures. As a possible risk factor for worsening of support, we also considered the POPQ measure of the genital hiatus (GH) during Valsalva at baseline¹⁰ and the presence of prolapse symptoms at baseline (EPIQ prolapse score >0).

Characteristics of women with and without worsening of support were compared using 2-sided Fisher’s exact tests. Risk factors relevant only in the context of a vaginal birth (birth weight, operative delivery, episiotomy, and laceration) were compared in the subset of

women with 1 or more vaginal births. Characteristics associated with worsening support were considered in a multivariable logistic regression, where the presence or absence of “meaningful worsening in at least 1 compartment” was the outcome of interest. All analysis was performed using SAS statistical software version 9.2 (SAS Institute Inc, Cary, NC). Statistical significance was determined at the $\alpha = 0.05$ level.

RESULTS

At the time of this analysis, of 955 women eligible for the second annual visit, 755 had completed 2 annual assessments. We included women who had completed a second assessment within 12 to 18 months of the enrollment assessment. Risk factors for loss to follow-up included age younger than 40 years, BMI greater than 30 kg/m², and African American race. Obstetric exposures did not differ between women who completed 2 assessments and those who failed to follow up. Six of these women reported surgery for prolapse and were excluded from this analysis. Demographic and obstetric characteristics for the 749 women included in this analysis are summarized in Table 1.

At baseline, the median measures (in centimeters) for Ba, Bp, and C were -2 (IQR, -2.5 to -1.5), -2.5 (IQR, -3 to -2), and -6.5 (IQR, -7 to -5.5), respectively. At follow-up, these measurements were -1.5 (IQR, -2 to -1), -2.5 (IQR, -2.5 to -2), and -6.5 (IQR, -7 to -5.5), respectively. Diamond plots depicting the number of women with specific values at baseline and at first annual follow-up visit for each of the 3 pelvic organ support measurements are shown in Figure 1. The plots illustrate that the majority of women had no meaningful change in support over time, although both substantial improvement (Fig. 1, shaded in green) and worsening (Fig. 1, shaded in red) of support was observed at each POPQ site. Greater than 1-cm worsening of support at Ba and Bp was observed in 8% and 2% of women, respectively. Greater than 2-cm worsening of support at C was observed in 6%. One hundred ten participants demonstrated meaningful worsening in at least 1 compartment (15%). Conversely, improved support was observed at Ba in 3% of women, at Bp in 3%, and at C in 5%.

Considering both improvement and worsening of support at the population level, we observed significant net worsening at Ba in 5.1% (95% CI, 2.8–7.4). Net changes in support at Bp and C were not significantly different from 0 (net improvement at Bp, 0.5% [95% CI, -1.1 to 2.2], and net worsening at C, 0.7% [95% CI, -1.7–3.0]).

We also considered the incidence of new prolapse. Of 749 participants, 692 had no prolapse to or beyond the hymen at baseline. Of these, 47 (7%) developed prolapse over the period of observation.

Prolapse symptoms (EPIQ prolapse score >0) were reported by 30 women (4%) at baseline and by 22 women (3%) at follow-up. Fourteen of the 30 women with symptoms at baseline reported no prolapse symptoms at follow-up, and 6 women who did not report prolapse symptoms at baseline reported new symptoms at follow-up. Of the 6 women with new prolapse symptoms at follow-up, none met our objective criteria for worsening of support at Ba, Bp, or C. Of the 110 women who met our criteria for worsening of support at any POPQ site, 106 were asymptomatic at both time points. Given the low incidence of prolapse symptoms ($n = 6$), we could not investigate the factors associated with worsening symptoms.

Characteristics associated with worsening pelvic organ support for each of the 3 POPQ measures are described in Table 2. Vaginal child birth was associated with worsening of support at the anterior (Ba) and posterior (Bp) vagina ($P = 0.03$ and $P < 0.01$, respectively). Worsening of posterior support was also associated with forceps delivery, maternal age older than 35 years at first delivery, and older age at enrollment. Worsening of apical

support was more common in women with a longer interval between delivery and study enrollment. Women with a smaller GH (<2 cm with Valsalva) at baseline were less likely to have worsening of anterior support ($P < 0.01$). We did not observe an association between pelvic organ support worsening and race, obesity, or parity. Among women who had at least 1 vaginal birth, we did not observe an association between worsening of support and history of episiotomy, perineal laceration, or macrosomia. The presence of prolapse symptoms at baseline was not associated with subsequent worsening of support. Even among a subset of 14 women who reported prolapse symptoms in the “bothersome” range (score >33),⁹ the presence of symptoms at baseline did not predict worsening (data not shown).

In a multivariable analysis, we evaluated the association between any meaningful worsening in at least 1 compartment and the independent risk factors in Table 2. Because women are recruited to join this study 5 to 10 years from first delivery, age at delivery, age at enrollment, and years since delivery are inherently interrelated. For this analysis, we focused on age at enrollment. Another relationship considered in the multivariable model was the strong association between vaginal birth and GH greater than or equal to 2 cm at enrollment: 95% (n = 318) of women with a history of a vaginal birth had GH of 2 cm or greater. Because we suspected that vaginal birth may cause a larger GH, we developed a model in which we adjusted for GH only among women who delivered by cesarean delivery.

In the multivariable model, age at enrollment, history of at least 1 vaginal delivery, and a GH at least 2 cm at enrollment among women who delivered by cesarean delivery were significantly associated with worsening support. Specifically, the odds of worsening support increased more than 60% for women older than 40 years at enrollment (odds ratio [OR], 1.64; 95% CI, 1.09–2.49). Among women who delivered by cesarean delivery only, those with GH of 2 cm or greater at enrollment were more than twice as likely to experience worsening of support (OR, 2.36; 95% CI, 1.03–5.43). Finally, compared with women who delivered by cesarean delivery only and who had GH less than 2 cm at enrollment, the odds of worsening support was more than tripled for women with a history of at least 1 vaginal birth (OR, 3.12; 95% CI, 1.38–7.07).

DISCUSSION

Over 1 year, we observed both improvement and worsening of pelvic organ support. However, with respect to the natural history of pelvic organ support among parous women, the most notable finding from this research is the trend toward deterioration in support, especially at the anterior vaginal wall. Specifically, 8% of the population experienced deterioration of greater than 1 cm in anterior vaginal support, whereas 3% experienced improvement of greater than 1 cm, leading to a 5% net worsening at a population level. Over the interval of 12 to 18 months, the deterioration in support was less evident at the posterior wall and apex.

Meaningful worsening of vaginal support was observed in 15% of our participants and was significantly associated with a history of at least 1 vaginal birth. However, the results of this study suggest that size of the GH plays an important role. Among women who had never delivered vaginally, those with a narrow GH (<2 cm with straining) were much less likely to have worsening of support over 1 year than were women with a larger hiatus. Thus, the impact of vaginal birth on prolapse progression may be linked to the size of the GH. We speculate that a larger GH may be a marker for either disruption of the levator ani muscle or levator muscle atrophy.¹¹ A computer simulation model developed by Chen and colleagues¹² predicts that levator weakness should result in a larger GH and progressive prolapse. Our results are consistent with this hypothesis.

It is unlikely that levator injury is the only explanation for the size of the GH. For example, this research focused on obstetric exposures and did not consider the potential impact of behavioral and lifestyle exposures, such as exercise, occupation, and chronic straining for constipation. Also, levator disruption is rare after cesarean birth.^{13,14} Our findings argue for further research to identify the anatomic determinants of the size of the GH and the biological mechanisms responsible for the association between hiatus size and pelvic organ support.

Regarding the longitudinal changes in uterovaginal support observed in this study, our results are similar to a prospective study by Bradley et al.,² in which 259 postmenopausal women were followed for 2 to 4 years. In the study of Bradley et al.,² both worsening and improvement of vaginal support were observed. Similarly, in a study of 412 postmenopausal women followed over 2 to 8 years, Handa et al.¹ reported both progression and regression of pelvic organ prolapse. In both of these studies, parity was associated with new or progressive prolapse, although neither considered the impact of delivery type. Our results, in a much younger cohort, suggest that vaginal delivery may be more associated than cesarean delivery with deterioration of utero-vaginal support.

We did not observe a high incidence of prolapse symptoms over 1 year. Indeed, only 6 women reported new prolapse symptoms over the period of observation, and none of these women had deterioration in support. Also, almost all of the women in this study with objective worsening of pelvic organ support over 1 year remained asymptomatic. We anticipate that a longer duration of follow-up will be necessary to capture measurable changes in symptoms over time. Alternatively, our findings may reflect a limited correlation between prolapse symptoms and objective measures of prolapse, which would be consistent with results of prior cross-sectional studies.^{3,4} An important implication of our findings is that research relying on prolapse symptoms will not accurately reflect objective changes in support. An additional important finding with clinical implications is that the women presenting with prolapse symptoms at baseline were not more likely to experience worsening support over 1 year than were women who were asymptomatic at baseline. This suggests that symptoms may not be a harbinger of worsening support.

A strength of this study is the use of a validated examination technique to serially assess support. Another strength is the long-term perspective provided by an assessment of parous women 5 to 10 years after delivery. Prior studies comparing pelvic organ support to child birth events have typically been limited to the first 6 to 12 months after delivery,¹⁵⁻¹⁷ and in that setting, the long-term significance of observed associations is unclear. Finally, the size of this study was sufficient to provide relatively precise estimates of changes in support and to identify characteristics associated with worsening support.

The chief limitation of this research is that the period of observation was only 12 to 18 months. We cannot say with certainty that the changes observed in this study are representative of annual changes over a longer period. For example, we do not know if the rate of change would be constant over a longer period of observation or whether some women experience acute deterioration in support. Women seeking care for prolapse often report a sudden onset of symptoms.⁵ Thus, further longitudinal studies will be needed to model changes in support over time, to describe the typical trajectory for the development of symptomatic prolapse, and to investigate characteristics associated with rapid deterioration. Also, further follow-up of our cohort will also allow us to address the question of the impact of time since delivery on the development of prolapse.

This research does not address the important question of whether surgery for prolapse influences subsequent changes in support over time. Our study population included only a

small number of women ($n = 6$) with prior prolapse surgery. This subset was too small for an investigation of the impact of prior surgery on longitudinal changes in support, and therefore these women were excluded from the present study. In addition, longitudinal follow-up of this cohort is planned and will provide additional data to address this question.

An important consideration in the interpretation of our findings is that the MOAD study population was selected such that 60% of participants delivered their first baby by cesarean birth. Thus, this population is not representative of the general population of parous women because of the relatively high proportion of women who have experienced only cesarean deliveries and because of the older maternal age at the time of first delivery. The changes observed in this population, such as the observed 5% net worsening in anterior vaginal support, may not be generalizable to other populations of parous women.

This research adds to a small body of knowledge regarding the natural history of pelvic organ prolapse across a woman's life span. Progression is an important concept because mild prolapse has no impact on health or quality of life, whereas more severe cases lead to symptoms and disability. Thus, the study of factors that influence progression may lead to prevention opportunities. A greater understanding of the underlying biology of pelvic organ prolapse will come from the identification of factors that influence disease severity and promote progression over time.

Acknowledgments

Support was provided by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (R01HD056275).

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FIGURE 1.

Diamond plots: 2-dimensional grids displaying bivariate counts of the data for each coordinate. Counts are displayed as shaded polygons whose areas are proportional to the counts of the respective cell relative to the cell with the largest count (fully shaded). As such, larger polygons represent larger counts. A, Anterior vaginal wall (Ba), with a fully-shaded cell representing $n = 69$; (B) posterior vaginal wall (Bp), with a fully shaded cell representing $n = 112$; vaginal apex or cervix (C), with a fully-shaded cell representing $n = 44$. For each diamond plot, red shading indicates worsening from enrollment to follow-up, green represents improvement, and blue indicates no change.

TABLE 1

Descriptive Statistics for 749 Parous Women

Characteristic *	Median (IQR) or % (n)
Age at first delivery, y	32 (29–36)
Age, y	40 (36–43)
Years between first delivery and enrollment	7.4 (6.3–9.0)
African-American race, % (n)	12 (89)
Parity, % (n)	
1	26 (197)
2	56 (418)
3	18 (134)
Vaginal delivery, ever, % (n)	45 (335)
Vaginal delivery with macrosomia (birth weight ≥ 4 kg), $\dagger$ % (n)	14 (48)
Vaginal delivery with forceps, ever, $\dagger$ % (n)	16 (54)
BMI, kg/m ²	25.3 (22.5–29.8)
BMI ≥ 30 kg/m ² , % (n)	24 (177)

Missing data: BMI, n = 1; vaginal delivery with macrosomia ever, n = 3; vaginal delivery with forceps ever, n = 2.

* Measured at baseline, unless otherwise indicated.

$\dagger$ Reported among the n = 335 women with a history of at least 1 vaginal birth.

Frequency of Clinically Meaningful Worsening Pelvic Organ Support Over 1 Year: Overall and by Risk Factors of Interest in 749 Parous Women

TABLE 2

	n	Anterior Support (Ba): >1-cm Worsening		Posterior Support (Bp): >1-cm Worsening		Apical Support (C): >2-cm Worsening		Worsening in at Least 1 Compartment *	
		% (n)	P †	% (n)	P †	% (n)	P †	% (n)	P †
Overall	749	8 (58)		2 (18)		6 (42)		15 (110)	
Race									
Non-African-American	660	8 (51)	0.99	3 (17)	0.71	5 (33)	0.08	14 (95)	0.53
African-American	89	8 (7)		1 (1)		10 (9)		17 (15)	
Maternal age at 1st delivery									
35 years	531	8 (40)	0.76	2 (9)	0.06	5 (27)	0.38	13 (70)	0.09
>35 years	218	8 (18)		4 (9)		7 (15)		18 (40)	
Years between 1st delivery to enrollment									
7.5 years	382	7 (27)	0.50	3 (10)	0.81	3 (11)	<0.01	12 (45)	0.02
>7.5 years	367	8 (31)		2 (8)		8 (31)		18 (65)	
Maternal age at enrollment									
40 years	376	7 (26)	0.41	<1 (3)	<0.01	5 (18)	0.34	12 (44)	0.02
>40 years	373	9 (32)		4 (15)		6 (24)		18 (66)	
BMI at baseline > 30 kg/m ²									
<30 kg/m ²	571	8 (45)	0.87	2 (14)	0.99	5 (28)	0.14	15 (83)	0.81
30 kg/m ²	177	7 (13)		2 (4)		8 (14)		15 (27)	
Parity									
1 delivery	197	8 (16)	0.88	3 (6)	0.59	8 (16)	0.10	18 (36)	0.10
> 1 deliveries	552	8 (42)		2 (12)		5 (26)		13 (74)	
Delivery status									
Cesarean only	414	6 (24)	0.03	<1 (3)	<0.01	6 (24)	0.87	12 (50)	0.03
1 vaginal delivery	335	10 (34)		4 (15)		5 (18)		18 (60)	
Birth weight ‡									
All vaginal deliveries 4 kg	284	10 (29)	0.99	5 (13)	0.99	6 (16)	0.99	18 (51)	0.84
1 vaginal delivery >4 kg	48	10 (5)		4 (2)		4 (2)		19 (9)	

	n	Anterior Support (Ba): >1-cm Worsening		Posterior Support (Bp): >1-cm Worsening		Apical Support (C): >2-cm Worsening		Worsening in at Least 1 Compartment*	
		% (n)	P †	% (n)	P †	% (n)	P †	% (n)	P †
Forceps delivery ‡									
No forceps deliveries	279	11 (30)	0.62	3 (8)	<0.01	5 (15)	0.99	17 (47)	0.24
1 forceps delivery	54	7 (4)		13 (7)		6 (3)		24 (13)	
Episiotomy ‡									
No episiotomies	144	10 (14)	0.86	5 (7)	0.79	3 (5)	0.22	16 (23)	0.47
1 episiotomy	191	10 (20)		4 (8)		7 (13)		19 (37)	
1- or 2-degree perineal laceration ‡									
No lacerations	136	10 (13)	0.85	5 (7)	0.79	6 (9)	0.46	18 (25)	0.89
1 Laceration	199	11 (21)		4 (8)		5 (9)		18 (35)	
Baseline GH straining									
<2 cm	122	<1 (1)	<0.01	<1 (1)	0.33	6 (7)	0.99	7% (8)	<0.01
2 cm	627	9 (57)		3 (17)		6 (35)		16 (102)	
Baseline POP symptoms									
No	719	8 (57)	0.72	2 (17)	0.53	6 (40)	0.68	15 (106)	0.99
Yes	30	3 (1)		3 (1)		7 (2)		13 (4)	

Missing data: BMI, n = 1; vaginal birth with macrosomia, n = 3; operative vaginal birth, n = 2.

POP indicates pelvic organ prolapse.

* Defined as meaningful worsening at 1 or more of the 3 support measurements (Ba, Bp, or C).

‡ Based on Fisher's exact test.

‡ Among n = 335 women with a history of 1 or more vaginal deliveries.