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Factors associated with anterior compartment recurrence after laparoscopic sacropexy

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Abstract

The objective of this study was to identify factors associated with anatomical anterior compartment recurrence after laparoscopic mesh sacropexy. This single-center ambispective cohort study included 143 women who underwent laparoscopic mesh sacropexy for symptomatic pelvic organ prolapse. Women operated on before initiation of the study were identified retrospectively from institutional surgical records and subsequently recalled for postoperative anatomical assessment, whereas patients treated during the later study period were followed longitudinally. Only women with an anatomical postoperative assessment performed ≥12 months after surgery were included. Anatomical anterior compartment recurrence was evaluated using Pelvic Organ Prolapse Quantification (POP-Q) measurements. Associations with recurrence were examined using univariable and multivariable logistic regression. Recurrence occurred in 18 women (12.6%). Patients with recurrence were older and had greater preoperative descent of the upper anterior vaginal wall (POP-Q point Ba). In the primary multivariable model, age [odds ratio (OR) 1.09/year, 95% confidence interval (CI) 1.02-1.17; p=0.007], Ba (OR 1.29/cm, 95% CI 1.00-1.66; p=0.048), and anterior dissection length (OR 0.81/cm, 95% CI 0.67-0.98; p=0.034) were associated with recurrence. Body mass index was not independently associated. Adjustment for the year of surgery attenuated the dissection association (p=0.127). Greater preoperative Ba and increasing age were associated with anterior recurrence. Greater anterior dissection was associated with lower recurrence odds in the primary model, but this finding was sensitive to adjustments for the surgical year.

Key words: pelvic organ prolapse, sacropexy, anterior recurrence, POP-Q, cystocele.

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Introduction

Pelvic organ prolapse (POP) is a common pelvic floor disorder, and durable anatomical support remains a central goal of reconstructive surgery. Sacrocolpopexy provides effective apical support, but recurrent or persistent prolapse may occur in individual compartments, particularly the anterior compartment.[1,2]

Anterior compartment prolapse is anatomically heterogeneous and cannot be considered solely an isolated defect of the anterior vaginal wall. Anterior and apical vaginal support are closely interrelated, and loss of apical support may contribute substantially to anterior vaginal wall descent. 3D magnetic resonance imaging studies have demonstrated strong correlations between apical and paravaginal support, particularly in the mid and upper vagina.[3] More detailed structural analyses have identified apical position, paravaginal support, and levator hiatus size as closely interrelated contributors to the presence and magnitude of cystocele.[4] These findings suggest that anterior compartment failure after prolapse surgery may, in some patients, represent a manifestation of recurrent or insufficient apical support rather than an isolated anterior defect.

Nevertheless, anterior compartment recurrence may also occur despite preserved apical suspension. The anterior vaginal wall is supported by a complex interaction among the levator ani muscles, arcus tendineus fascia pelvis, pubocervical connective tissues, paravaginal attachments, and apical suspensory structures.[5] Imaging studies of recurrent prolapse have demonstrated that failure may involve not only apical descent but also anterior vaginal wall elongation and abnormalities of middle and distal vaginal support.[6] This distinction is particularly relevant after sacrocolpopexy, in which durable apical support does not invariably prevent anterior compartment recurrence. Wong et al. reported no apical recurrence after laparoscopic sacrocolpopexy in their cohort, whereas anterior recurrence remained common; importantly, increasing distance between the distal anterior mesh and the bladder neck was associated with a progressively greater likelihood of recurrent cystocele.[7] These observations suggest that, in addition to restoration of apical support, the extent and position of anterior vaginal wall reconstruction may influence postoperative anterior compartment anatomy. However, the independent contribution of anterior dissection and distal mesh extension remains insufficiently defined.

Several additional anatomical and biological factors may influence the durability of prolapse repair. Advanced preoperative prolapse stage is among the most consistently reported predictors of postoperative recurrence. Systematic reviews and meta-analyses have demonstrated higher recurrence rates in women with stage III-IV prolapse compared with those with less advanced baseline disease.[8-10] Levator ani muscle avulsion and enlargement of the levator hiatus have also been investigated as markers of impaired

pelvic floor support. A meta-analysis reported associations between levator avulsion and recurrent prolapse, particularly anterior compartment recurrence; however, a more recent systematic review found that levator avulsion was not independently associated with overall objective recurrence after adjustment for confounders, indicating that its prognostic role remains uncertain and may vary according to the compartment and type of reconstructive procedure.[9,11]

Intrinsic connective-tissue quality may represent another component of recurrence susceptibility. Alterations in collagen composition, extracellular matrix remodeling, matrix metalloproteinase activity, and fibroblast function have been described in women with POP.[12,13] A recent systematic review and meta-analysis demonstrated lower expression of type I collagen and tissue inhibitor of metalloproteinase-1, together with increased type III collagen and several matrix metalloproteinases, in pelvic support tissues from women with POP compared with controls.[13] These findings support a biological basis for variation in pelvic support tissue strength, although direct evidence linking individual tissue biomarkers to recurrence after sacropexy remains limited. Thus, postoperative recurrence is likely multifactorial, reflecting an interaction among baseline prolapse severity, pelvic floor muscular integrity, intrinsic connective-tissue properties, and procedure-specific anatomical reconstruction.

A multicenter sacrocolpopexy cohort found increasing preoperative stage to be associated with failure, while systematic reviews have also identified advanced preoperative prolapse as an important recurrence factor.[8,14]

The POP Quantification (POP-Q) system allows objective measurement of compartment-specific anatomy, and point Ba provides a continuous measure of anterior vaginal wall prolapse.[15] Technical factors may also influence postoperative anterior support. Postoperative imaging after laparoscopic sacrocolpopexy has shown that a more distal anterior mesh position is associated with a lower likelihood of recurrent cystocele.[7] However, intraoperatively measured anterior vaginal wall dissection length has been less well characterized as a quantitative factor associated with anterior recurrence.

Patient-related characteristics may further modify the risk of recurrence. Age and body mass index (BMI) are associated with the development of POP, although their relationship with postoperative recurrence varies by population and procedure.[8,16] This study aimed to identify factors associated with anatomical anterior compartment recurrence after laparoscopic mesh sacropexy, with particular emphasis on age, preoperative Ba, BMI, and anterior vaginal wall dissection length.

Materials and Methods

Study design and population

This retrospective cohort study included women who underwent laparoscopic mesh sacropexy for symptomatic POP between 2013 and 2020. All procedures were performed by the same reconstructive surgical team.

Follow-up assessment

Postoperative follow-up duration was not uniform across the cohort. Women who had undergone surgery before initiation of the study were identified retrospectively and subsequently recalled for anatomical assessment, whereas patients treated during the later study period were followed longitudinally. For inclusion in the present analysis, a postoperative anatomical examination performed at least 12 months after surgery was required. Consequently, patients operated on earlier could have a substantially longer interval between surgery and the anatomical assessment than patients treated during the later study period.

Exact patient-level follow-up duration in months was not available in the analytical dataset used for the present study. Therefore, the mean, median, interquartile range, and range of follow-up duration could not be reliably reconstructed, and follow-up duration was not included as a covariate in the multivariable logistic regression models.

Patients were eligible if they underwent laparoscopic mesh sacropexy and had postoperative anatomical assessment after more than 12 months of follow-up. Patients treated with vaginal prolapse surgery, vaginal sacrospinous fixation, meshless sacropexy, or pectopexy were excluded. A total of 143 women fulfilled the eligibility criteria.

Preoperative assessment

POP was assessed preoperatively using the POP-Q system. Point Ba was recorded in centimeters relative to the hymen and used as a continuous measure of baseline anterior compartment prolapse severity. Age and BMI were recorded as patient-related candidate factors.

Surgical technique and concomitant procedures

All procedures were performed by the same surgical team, consisting of one attending surgeon assisted by two surgeons. A macroporous monofilament polypropylene mesh (Parietene, Covidien) was used. Where suture fixation was performed, permanent braided polyester sutures (Ticron 0) were used at the sacral promontory and cervix/apex. Vaginal wall fixation used permanent polyester sutures (Ticron 2-0) and absorbable polyglactin 910 sutures (Vicryl 2-0).

The operative technique evolved during the study period. In the earlier period, reconstruction used either a single posterior mesh strip or separate anterior and posterior strips. From 2017 onward, the strategy evolved toward an individually tailored Y-shaped mesh, and longer anterior dissections became more common after 2017. Mesh configuration and the extent of vaginal support were individualized. A posterior mesh component was placed in 133 of 143 patients (93.0%); no posterior mesh was placed in 10 (7.0%).

Following development of the vesicovaginal and, when indicated, rectovaginal planes, the dissected anterior and posterior vaginal walls were measured intraoperatively using a sterile flexible ruler introduced laparoscopically. The mesh was then individually cut and shaped according to these measurements rather than according to a predetermined template. Posterior dissection could frequently be extended to approximately 10 cm, whereas anterior dissection was often shorter because the vesicovaginal plane became progressively less distinct toward the bladder neck and proximal urethra.

Mesh was fixed at the cervix/apex and the reconstructed anterior and/or posterior vaginal wall according to the selected configuration. Promontory fixation used sutures in 133 patients (93.0%) and tackers in nine (6.3%). One patient (0.7%) had no promontory fixation recorded, confirmed as absence of fixation rather than missing coding. This represents an exception to the sacral fixation technique within the currently analyzed cohort. Following fixation, the mesh was reperitonealized.

Among the 143 patients, 6 (4.2%) had previously undergone

subtotal hysterectomy and 10 (7.0%) total hysterectomy. Concomitant procedures included laparoscopic supracervical hysterectomy in 82 (57.3%), total laparoscopic hysterectomy in four (2.8%), and vaginal hysterectomy in 2 (1.4%). Uterus-preserving surgery was performed in 39 (27.3%). These 6 hysterectomy-status categories were mutually exclusive. Other concomitant procedures were selected according to individual findings and included Burch colposuspension in 6 (4.2%), TVT in 23 (16.1%), anterior colporrhaphy in 9 (6.3%), posterior colporrhaphy in 30 (21.0%), paravaginal repair in 2 (1.4%), and perineorrhaphy in 85 (59.4%). These additional procedures were not mutually exclusive; all percentages use the 143-patient cohort as the denominator.

Measurement of anterior vaginal wall dissection length

After completion of vesicovaginal dissection, the length of the dissected anterior vaginal wall was measured intraoperatively under direct laparoscopic visualization. A sterile flexible ruler was introduced into the abdominal cavity laparoscopically and positioned along the dissected vesicovaginal plane. The measurement was taken in centimeters along the longitudinal axis of the anterior vaginal wall, from the cervical/vaginal apical reference point to the most distal extent of the vesicovaginal dissection toward the bladder neck. The ruler was placed directly along the dissected surface without estimating the distance from laparoscopic images. The measured length was recorded intraoperatively in centimeters and was subsequently used to tailor the length of the anterior mesh arm to the dissected vaginal surface. Thus, anterior dissection length represented a direct intraoperative anatomical measurement rather than a postoperative estimate or a predefined operative category.

Outcome definition

The primary outcome was anatomical anterior compartment recurrence at the postoperative clinical examination performed at least 12 months after surgery. Recurrence was defined as POP-Q point Ba>0 cm, indicating anterior vaginal wall descent beyond the hymen. Ba≤0 cm was classified as no anterior compartment recurrence. The analysis used the recorded binary recurrence variable. This compartment-specific threshold includes the portion of POP-Q stage II anterior descent beyond the hymen and more advanced anterior descent; it is not equivalent to all stage II or greater prolapse. Overall POP-Q stage depends on the most distal prolapse point across compartments. The analysis focused on anatomical recurrence rather than subjective symptoms or reoperation.

Statistical analysis

Continuous variables were summarized as mean ± standard deviation and categorical variables as number and percentage, as appropriate. Characteristics were compared between patients with and without anterior recurrence. Candidate factors were first examined using univariable logistic regression.

Logistic regression diagnostics were performed to assess model assumptions and performance. Multicollinearity among predictors was assessed using variance inflation factors (VIFs) and tolerance values. Particular attention was given to the relationship between preoperative POP-Q point Ba and anterior vaginal wall dissection length, which was additionally assessed using Pearson correlation. Model calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test with 10 groups defined by fitted-probability quantiles (8 degrees of freedom). Discrimination was assessed using the area under the receiver operating characteristic curve [area under the curve (AUC)/C-statistic), calculated from fitted probabilities. These were apparent in-sample assessments; no external validation was performed. Data were managed in Microsoft Excel, and the primary and expanded logistic models and their calibration and discrimination measures were recalculated in Python 3.12.14 using SciPy 1.17.0 and NumPy 2.3.5. Models were fitted by unpenalized maximum likelihood; 95% confidence intervals (CIs) and two-sided p-values used the Wald method. All tests were two-sided, with $p<0.05$ considered statistically significant. Because only 18 anterior recurrences occurred, the primary multivariable logistic regression model was deliberately parsimonious and included age, preoperative Ba, and anterior dissection length. BMI was subsequently added in an expanded model. Odds ratios (ORs) with 95% CIs were reported. For continuous predictors, ORs represented the change in recurrence odds associated with a 1-year increase in age, a 1-cm increase in Ba, a 1-cm increase in anterior dissection length, or a 1-kg/m^2 increase in BMI.

Because anterior dissection practices evolved during the study period, a sensitivity analysis additionally adjusted for year of surgery. An exploratory interaction between preoperative Ba and anterior dissection length was also evaluated. All tests were two-sided, and $p<0.05$ was considered statistically significant.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Azerbaijan Medical University (Protocol No. 12, 7 February 2020). Written informed consent was obtained from all participants before enrollment and surgical treatment.

Results

A total of 143 women were included. Anatomical anterior compartment recurrence occurred in 18 patients (12.6%), whereas 125 patients (87.4%) had no anterior recurrence.

Patients with recurrence were older than those without recurrence (57.78±6.95 *vs.* 50.62±11.24 years, $p<0.001$) and had greater preoperative Ba (2.56±2.23 *vs.* 1.20±2.31 cm, $p=0.025$). BMI was identical between groups (28.11±2.65 *vs.* 28.11±3.65 kg/m^2, $p=0.999$). Mean anterior dissection length was 3.67±2.74 cm in patients with recurrence and 4.32±3.09 cm in those without recurrence ($p=0.362$) (Table 1).

In univariable logistic regression, age (OR 1.08 per year, $p=0.014$) and preoperative Ba (OR 1.30 per 1-cm increase, $p=0.025$) were associated with recurrence. BMI and anterior dissection length were not significant in univariable analysis.

No evidence of problematic multicollinearity was identified. Preoperative Ba and anterior vaginal wall dissection length showed only a weak correlation ($r=0.151$, $p=0.077$). In the primary model, VIFs were 1.28 for age, 1.08 for preoperative Ba, and 1.21 for anterior dissection length, with corresponding tolerance values of 0.783, 0.927, and 0.824. The Hosmer-Lemeshow test showed no evidence of lack of fit [$\chi^2(8)=4.74$, $p=0.785$], and the model AUC was 0.765. In the expanded model including BMI, all VIFs remained low (1.08-1.37); the Hosmer-Lemeshow test was $\chi^2(8)=4.97$ ($p=0.761$), and the AUC was 0.779. These apparent performance estimates were derived from the model-development sample. With only 18 events, a nonsignificant Hosmer-Lemeshow result does not establish stable calibration or exclude overfitting.

In the primary multivariable model, age remained associated with recurrence (OR 1.09 per year, 95% CI 1.02-1.17; $p=0.007$), as did preoperative Ba (OR 1.29 per 1-cm increase, 95% CI 1.00-1.66; $p=0.048$). Greater anterior dissection length was associated with lower recurrence odds (OR 0.81 per additional centimeter,

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95% CI 0.67-0.98; p=0.034). In the expanded model including BMI, age (OR 1.10, 95% CI 1.03-1.18; p=0.005), preoperative Ba (OR 1.30, 95% CI 1.01-1.68; p=0.042), and anterior dissection length (OR 0.80, 95% CI 0.66-0.98; p=0.027) remained associated with recurrence. BMI was not independently associated (OR 0.93, 95% CI 0.79-1.09; p=0.365) (Table 2). When the year of surgery was added as a sensitivity analysis, age and preoperative Ba remained associated with recurrence, whereas the association with anterior dissection was attenuated (OR 0.83, 95% CI 0.65-1.06; p=0.127). The year of surgery was not independently associated with recurrence (OR 0.92, 95% CI 0.60-1.42; p=0.705). No significant interaction was identified between preoperative Ba and anterior dissection length (interaction OR 0.96, 95% CI 0.88-1.04; p=0.312). Because only 18 anterior compartment recurrence events occurred, the primary multivariable model was deliberately restricted to three clinically relevant predictors (age, preoperative Ba, and anterior vaginal wall dissection length), corresponding to an events-per-variable (EPV) ratio of 6.0. Addition of BMI in the expanded four-predictor model reduced the EPV to 4.5. Given the limited number of outcome events, particularly in the expanded model, the multivariable estimates were considered potentially susceptible to overfitting and coefficient instability.

Discussion

In this cohort of 143 women undergoing laparoscopic mesh sacropexy, anatomical anterior recurrence occurred in 12.6% after more than 12 months of follow-up. Increasing age and greater preoperative Ba were independently associated with higher recurrence odds. Greater anterior dissection length was associated with lower recurrence odds in the primary model, whereas BMI was not independently associated. The dissection association was attenuated after adjustment for year of surgery and therefore requires cautious interpretation.

Anterior dissection length was not significantly associated with recurrence in univariable analysis (OR 0.93 per 1-cm increase, p=0.395). Although an association emerged after adjustment for age and preoperative Ba in the primary multivariable model (OR 0.81, 95% CI 0.67-0.98; p=0.034), this association was attenuated and no longer statistically significant after additional adjustment for year of surgery (OR 0.83, 95% CI 0.65-1.06; p=0.127). This pattern is consistent with potential temporal confounding. During the study period, surgical technique and experience evolved alongside changes in the extent of anterior dissection; therefore, the observed association cannot be attributed independently to dissection length itself. Surgical year may partly capture changes in operative technique, standardization, and the surgical team's learning curve. Accordingly, these findings should be considered exploratory and do not establish a causal protective effect of greater anterior dissection.

Preoperative anterior prolapse severity

The association between greater preoperative Ba and anterior recurrence is consistent with evidence identifying advanced preoperative prolapse as a recurrence factor. In a multicenter sacrocolpopexy cohort, increasing preoperative stage was associated with failure, and systematic reviews have similarly identified advanced preoperative prolapse as one of the more reproducible recurrence factors.[8,14]

The present analysis used Ba as a continuous variable rather than relying only on POP stage. Each 1-cm increase in Ba was associated with approximately 29-30% greater recurrence odds after adjustment. This suggests that the magnitude of the anterior defect may provide useful compartment-specific information when considering postoperative anatomical risk.

Anterior dissection and distal support

Greater anterior vaginal wall dissection length was associated with lower recurrence odds in the primary multivariable model; however, the association was not significant in univariable analysis and was attenuated after adjustment for surgical year, suggesting that temporal changes in surgical technique and experience may partly explain the observed association. These data therefore do not establish an independent protective effect of greater anterior dissection. In the primary model, each additional centimeter was associated with approximately 19% lower odds of anatomical ante-

Table 1. Characteristics according to anterior compartment recurrence.

Variable	No recurrence (n=125)	Recurrence (n=18)	p
Age, years	50.62±11.24	57.78±6.95	<0.001
Body mass index, kg/m^2	28.11±3.65	28.11±2.65	0.999
Preoperative Ba, cm	1.20±2.31	2.56±2.23	0.025
Anterior dissection, cm	4.32±3.09	3.67±2.74	0.362
Year of surgery	2017.59±1.82	2017.44±1.46	0.702

Ba, most distal position of the upper anterior vaginal wall in the Pelvic Organ Prolapse Quantification system.

Table 2. Logistic regression for anterior compartment recurrence.

Predictor	Univariable OR (95% CI)	p	Primary OR (95% CI)	p	Expanded OR (95% CI)	p
Age, per year	1.08 (1.02-1.14)	0.014	1.09 (1.02-1.17)	0.007	1.10 (1.03-1.18)	0.005
Ba, per +1 cm	1.30 (1.03-1.63)	0.025	1.29 (1.00-1.66)	0.048	1.30 (1.01-1.68)	0.042
Anterior dissection, per +1 cm	0.93 (0.79-1.10)	0.395	0.81 (0.67-0.98)	0.034	0.80 (0.66-0.98)	0.027
BMI, per kg/m^2	1.00 (0.87-1.15)	0.999	Not included	Not applicable	0.93 (0.79-1.09)	0.365

OR, odds ratio; CI, confidence interval; Ba, most distal position of the upper anterior vaginal wall in the Pelvic Organ Prolapse Quantification (POP-Q) system; BMI, body mass index. Model 1 (primary): age + preoperative Ba + anterior dissection length. Model 2 (expanded): Model 1 + BMI. Both models: n=143, with 18 anterior compartment recurrences. Univariable estimates were recalculated using the coded recurrence outcome (18 events); 95% CIs and p values use the Wald method.

rior recurrence. The absence of a significant unadjusted association, followed by an association after adjustment, is compatible with the fact that the extent of dissection was individualized according to baseline anatomy.

This finding has an anatomical precedent. Wong *et al*. evaluated postoperative anterior mesh position after laparoscopic sacrocolpopexy and found that a mesh position farther from the bladder neck was associated with a progressively greater likelihood of recurrent cystocele.[7] The present study approaches the same concept using the intraoperatively recorded length of anterior vaginal wall dissection rather than postoperative imaging.

The finding should not be interpreted as evidence that increasing dissection length itself prevents recurrence. Surgical technique evolved during the study period, and adjustment for year of surgery attenuated the association. Year may represent changes in surgical experience and technique that cannot be fully separated in a retrospective cohort. Moreover, the Ba-by-dissection interaction was not significant; therefore, these data do not support a specific dissection threshold for a given Ba value.

Age and anterior recurrence

Increasing age was independently associated with anterior recurrence in this cohort. The relationship between age and recurrence is not uniform across the literature. An updated systematic review reported younger age as a recurrence factor after native-tissue surgery, illustrating that associations may differ according to operation, outcome definition, and patient population.[8] Our finding should therefore be regarded as a cohort-specific association rather than evidence of a causal age-related mechanism.

Body mass index

BMI was not associated with anterior recurrence and did not materially change the estimates for age, Ba, or dissection length. This contrasts with some native-tissue prolapse data in which BMI has been associated with failure, including anterior recurrence.[17] However, sacrocolpopexy-specific evidence is more consistent with our result: in a cohort of 556 minimally invasive sacrocolpopexies, obesity was not a significant predictor of prolapse recurrence.[16]

These findings suggest that factors contributing to development of primary POP do not necessarily have the same influence on anatomical recurrence after mesh-based apical reconstruction.

Clinical implications

The findings support attention to adequate distal anterior compartment reconstruction but do not establish that increasing dissection length independently reduces recurrence. The present data do not identify an optimal dissection length or support the routine use of deeper dissection in all patients. Rather, the extent of dissection should be individualized according to the anatomical defect and intraoperative findings. Prospective studies using standardized operative measurements are required to determine whether dissection length itself contributes independently to anterior compartment durability.

Study limitations

This study has several limitations. Its retrospective design introduces the possibility of selection bias and residual confounding. Only 18 anterior recurrences occurred, limiting the number of variables that could be incorporated reliably into multivariable models; a parsimonious primary model was therefore used. Surgical technique evolved during the study period, and anterior dissection length was related to surgical year, making it difficult to separate the effect of dissection from other temporal changes in technique and experience. Recurrence was defined anatomically using Ba>0 cm and does not necessarily correspond to symptomatic recurrence or reoperation. Finally, this was a single-center cohort treated by the same reconstructive team, which improves procedural consistency but may limit generalizability.

Comparisons with other studies should account for differences in recurrence definitions. The Ba>0 cm threshold used here requires anterior descent beyond the hymen and is more restrictive than Ba>-1 cm or a stage II or greater definition. Rates based on these thresholds, full POP-Q staging, or imaging-based criteria are therefore not directly interchangeable.

Follow-up duration was not uniform across participants because the cohort included both retrospectively identified patients who were recalled for postoperative assessment and patients followed longitudinally during the later study period. Exact patient-level follow-up duration in months was not available in the analytical dataset and therefore could not be included as a covariate in the regression models. This is particularly relevant because recurrence was analyzed as a binary outcome rather than as a time-to-event outcome; consequently, patients with longer postoperative observation may have had a greater opportunity for recurrence to be detected. This potential ascertainment bias should be considered when interpreting the recurrence estimates and associations identified in the present study.

The small number of outcome events represents an important statistical limitation. Only 18 recurrence events were observed, yielding an EPV of 6.0 in the three-predictor primary model and 4.5 in the four-predictor expanded model. The low EPV increases the potential for model overfitting, unstable regression coefficients, and imprecise effect estimates. Accordingly, the adjusted associations, particularly those from the expanded and sensitivity analyses, should be interpreted cautiously and require confirmation in larger cohorts.

Several additional limitations should be acknowledged. First, the present analysis focused primarily on anatomical recurrence and did not include validated patient-reported outcome measures, such as the Pelvic Floor Distress Inventory-20 or Patient Global Impression of Improvement. Consequently, the relationship between anatomical recurrence and patient-perceived symptoms, functional improvement, or overall satisfaction could not be evaluated. Second, postoperative imaging, such as pelvic floor ultrasound or magnetic resonance imaging, was not routinely performed to objectively assess mesh position or distal mesh extension along the anterior vaginal wall. Therefore, the intraoperatively recorded dissection length cannot be assumed to represent the exact postoperative extent or position of mesh support. These limitations restrict interpretation of the findings to the anatomical outcomes assessed clinically and preclude conclusions regarding subjective functional benefit or imaging-confirmed mesh configuration.

Conclusions

Older age and greater preoperative anterior compartment descent were associated with increased odds of anatomical anterior compartment recurrence. Greater anterior vaginal wall dissection length was associated with lower recurrence odds in the primary adjusted model, but not in univariable analysis or after additional adjustment for surgical year. This pattern suggests potential con-

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founding by changes in surgical technique and experience over time. These observational findings do not establish a causal protective effect of greater dissection or define a recommended dissection-length threshold. Prospective studies with standardized operative measurements and follow-up are needed to assess the independent contribution of anterior dissection to anatomical durability.

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