American Journal of Medicine and Medical Sciences 2026, 16(4): 1788-1793
DOI: 10.5923/j.ajmms.20261604.50

Laparoscopic Lateral Suspension in Anterior–Apical Pelvic Organ Prolapse: Anatomical, Functional, and Clinical Outcomes

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Abstract Laparoscopic lateral suspension has emerged as a minimally invasive alternative for restoring apical support in women with anterior–apical pelvic organ prolapse, yet comparative evidence regarding its anatomical and functional effectiveness remains limited. This single-center comparative study included 80 reproductive-aged women with stage II–III anterior–apical prolapse who underwent either laparoscopic lateral suspension or anterior colporrhaphy with cervical amputation and were evaluated using POP-Q measurements and validated functional questionnaires over 12 months. Laparoscopic lateral suspension demonstrated significantly greater improvement in apical position and anterior compartment support, higher anatomical success (90% vs 65%), lower recurrence rates, and superior improvements in quality of life and sexual function compared with anterior colporrhaphy. Restoration of apical support was identified as a key determinant of durable surgical success, with anterior repair without apical fixation associated with increased recurrence risk. Laparoscopic lateral suspension represents an effective, organ-preserving, and minimally invasive strategy for managing anterior–apical prolapse in reproductive-aged women.

Keywords Laparoscopic lateral suspension, Apical prolapse, Anterior–apical pelvic organ prolapse, Uterine preservation, Anatomical outcomes, Pelvic floor surgery

1. Introduction

Pelvic organ prolapse (POP) remains a highly prevalent pelvic floor disorder affecting women worldwide and represents a significant burden on quality of life and healthcare systems. Epidemiological data indicate that up to 40–60% of parous women demonstrate some degree of pelvic organ descent on clinical examination, while approximately 11–19% will undergo surgical treatment for POP or urinary incontinence during their lifetime [1,2]. Among the different compartments, apical prolapse—defined as descent of the vaginal apex, cervix, or post-hysterectomy vault—plays a central role in the pathophysiology and recurrence of pelvic organ prolapse. Contemporary evidence emphasizes that failure to restore apical support significantly increases the risk of anterior compartment recurrence, even when cystocele is adequately repaired [3,4].

The pathogenesis of apical prolapse is multifactorial and involves biomechanical failure of level I support structures (uterosacral–cardinal ligament complex), obstetric trauma, aging-related connective tissue remodeling, and genetic susceptibility [5]. Recent molecular investigations highlight the role of altered collagen metabolism, dysregulation of matrix metalloproteinases (MMPs), and genetic variants affecting connective tissue integrity, supporting the concept of systemic connective tissue vulnerability in affected patients [6]. These findings underscore the importance of selecting surgical approaches that restore durable apical suspension rather than addressing only compartment-specific defects.

Surgical management of anterior–apical prolapse has evolved considerably over the past decade. Abdominal and laparoscopic sacrocolpopexy remain widely regarded as reference procedures due to high long-term anatomical success rates exceeding 85–90% in multiple series and systematic reviews [3,7]. However, sacrocolpopexy is technically demanding, associated with longer operative times, and carries specific risks including presacral hemorrhage, mesh-related complications, and bowel or vascular injury [7,8]. In addition, increasing scrutiny regarding mesh safety has prompted re-evaluation of synthetic implant use, particularly in transvaginal approaches, leading to regulatory restrictions in several countries [9].

Vaginal reconstructive procedures such as anterior colporrhaphy and sacrospinous fixation remain commonly performed because of their relative simplicity and shorter

Received: Feb. 15, 2026; Accepted: Mar. 9, 2026; Published: Apr. 13, 2026
Published online at http://journal.sapub.org/ajmms

operative duration. Nevertheless, isolated anterior repair without apical restoration has been associated with higher recurrence rates, especially in women with combined anterior –apical defects [3,4]. Furthermore, concerns regarding postoperative dyspareunia and vaginal axis alteration have been raised in certain vaginal techniques [8].

Within this context, laparoscopic lateral suspension (LLS) has emerged as an alternative minimally invasive approach aimed at restoring apical and anterior support through lateral mesh fixation without promontory dissection. First described by Dubuisson and further refined in recent years, LLS avoids presacral dissection and may reduce the risk of major vascular injury while maintaining physiological vaginal axis alignment [10,11]. Contemporary studies demonstrate favorable anatomical success rates and satisfactory functional outcomes, with reduced operative morbidity compared to traditional abdominal approaches [10–12]. Importantly, LLS allows organ preservation, which is particularly relevant for women of reproductive age who wish to maintain uterine integrity and sexual function.

Recent publications also emphasize that laparoscopic approaches, including LLS, are associated with shorter hospital stay, lower blood loss, and faster recovery compared to open surgery, while maintaining comparable efficacy [7,11]. Moreover, by targeting apical support as a primary determinant of prolapse stability, LLS aligns with modern pathophysiological concepts that recognize apical suspension as the cornerstone of durable pelvic floor reconstruction [3].

Despite these promising results, high-quality comparative data focusing specifically on anterior–apical prolapse and functional outcomes remain limited. Given the ongoing debate regarding optimal surgical strategy, the evaluation of anatomical, functional, and clinical outcomes following laparoscopic lateral suspension remains highly relevant. The minimally invasive and organ-preserving nature of LLS, combined with its potential to reduce recurrence by restoring level I support, warrants further investigation in well-characterized patient populations.

Therefore, the present study aims to evaluate anatomical, functional, and clinical outcomes of laparoscopic lateral suspension in women with anterior–apical pelvic organ prolapse and to contribute evidence regarding its role as a minimally invasive, organ-sparing alternative in contemporary urogynecologic surgery.

The aim of this study was to evaluate the anatomical, functional, and clinical outcomes of laparoscopic lateral suspension in women with anterior–apical pelvic organ prolapses and to determine its effectiveness as a minimally invasive, organ-preserving surgical approach for restoration of apical support.

2. Materials and Methods

This single-center comparative cohort study was conducted in 2025 at a tertiary gynecological surgical unit. The study included women of reproductive age diagnosed with symptomatic anterior–apical pelvic organ prolapse. Eighty consecutive patients were enrolled and allocated into two groups according to the surgical procedure performed.

The main group (n = 40) underwent laparoscopic lateral suspension (LLS), while the comparison group (n = 40) underwent anterior colporrhaphy combined with cervical amputation according to the Sturmdorf technique. All procedures were performed in the same institution by experienced pelvic reconstructive surgeons.

Eligible participants were women aged 25–44 years (mean age 38 ± 4.5 years) with symptomatic anterior–apical prolapse stages II–III according to the Pelvic Organ Prolapse Quantification (POP-Q) system. All patients had a preserved uterus prior to surgery, and uterine preservation was maintained in all cases.

The two groups were comparable in terms of age, prolapse stage, and clinical characteristics at baseline.

Inclusion Criteria

Patients were included if they met the following criteria:

- Age 25–44 years
- Symptomatic anterior–apical prolapse (POP-Q stage II–III; involvement of points C and Ba)
- Preserved uterus
- Desire for surgical treatment
- Written informed consent for participation and data processing

Exclusion Criteria

Patients were excluded in the presence of:

- Isolated posterior compartment prolapse
- Active vaginal or urinary tract infection
- Severe somatic comorbidities contraindicating surgery
- Previous transvaginal mesh surgery
- Refusal to participate or refusal of data processing

All patients underwent standardized preoperative evaluation, including medical history, physical examination, and objective prolapse assessment using the POP-Q system (Aa, Ba, C, D, Ap, Bp; TVL, PB, GH).

Functional and quality-of-life outcomes were assessed using validated questionnaires:

- Pelvic Floor Distress Inventory (PFDI-20)
- Pelvic Floor Impact Questionnaire (PFIQ-7)
- Female Sexual Function Index (FSFI)

Urodynamic testing was performed in selected cases when clinically indicated. Laboratory investigations included complete blood count, coagulation profile, and pelvic ultrasound examination.

All LLS procedures were performed under general anesthesia using a laparoscopic approach. After inspection of the pelvic cavity, mobilization of the anterior vaginal wall and/or uterine cervix was performed. Special T-shaped polypropylene mesh strips were used for uterine suspension.

The mesh was fixed to the anterior cervix and upper anterior vaginal wall using non-absorbable sutures. The lateral arms were passed through avascular spaces toward the

lateral abdominal wall and secured without tension, restoring both apical and anterior support. The uterus was preserved in all cases. Routine peritoneal closure was not performed.

The comparison group underwent vaginal anterior colporrhaphy combined with cervical amputation according to the Sturmdorf technique. After dissection of the anterior vaginal wall, the pubocervical fascia was plicated using absorbable sutures. Excess vaginal mucosa was excised, and cervical amputation was performed while preserving the uterine body. Apical suspension was not carried out. All procedures were performed by the study authors, who have more than 20 years of experience in pelvic reconstructive surgery.

The primary outcome was anatomical success at 12 months, defined as:

- Ba < −1 cm
- Apical point C remaining above the hymenal plane
- No need for repeat prolapse surgery

Secondary outcomes included:

- Changes in PFDI-20, PFIQ-7, and FSFI scores at 3, 6, and 12 months
- Early and late postoperative complications (graded according to the Clavien–Dindo classification)
- Recurrence rate
- Reoperation rate
- Patient satisfaction

Statistical analysis was performed using SPSS and Statistica software packages. Continuous variables were expressed as mean ± standard deviation (M ± SD). Between-group comparisons were performed using Student's t-test for normally distributed variables and appropriate non-parametric tests when indicated. Categorical variables were compared using chi-square tests. A p-value < 0.05 was considered statistically significant.

The study was conducted in accordance with ethical standards of institutional research. Written informed consent was obtained from all participants prior to enrollment and data processing.

3. Results

A total of 80 women of reproductive age with symptomatic anterior–apical pelvic organ prolapse were included in the final analysis. Forty patients underwent laparoscopic lateral suspension (LLS), and forty underwent anterior colporrhaphy combined with cervical amputation (AC). Twelve-month follow-up data were available for 76 patients (95%), with four patients lost to follow-up (two from each group). There were no statistically significant differences between the groups at baseline, confirming cohort comparability and minimizing allocation bias.

The mean age of patients in the LLS group was 38.2 ± 4.5 years compared with 37.6 ± 3.4 years in the AC group (p = 0.52). Mean body mass index was 24.4 ± 2.4 kg/m ²and 23.7 ± 3.1 kg/m ², respectively (p = 0.41). The mean parity was 3.2 ± 1.15 in both groups. Distribution of prolapse stage according to POP-Q was similar: stage II was observed in 40% of patients and stage III in 60%, with no significant between-group difference (p = 0.74). Baseline anatomical measurements were also comparable. Mean preoperative Ba was +1.8 ± 0.6 cm in the LLS group and +1.7 ± 0.5 cm in the AC group (p = 0.63), while mean apical point C was −0.6 ± 0.5 cm and −0.5 ± 0.6 cm, respectively (p = 0.57). Baseline symptom burden assessed by PFDI-20 was high in both groups (128 ± 22 vs 126 ± 24; p = 0.69), indicating significant functional impairment prior to intervention.

Operative procedures were completed as planned in all cases. No intraoperative conversions to laparotomy occurred in the LLS group. Mean operative time was 92 ± 14 minutes for LLS and 64 ± 11 minutes for AC (p < 0.001). Estimated blood loss was significantly lower in the LLS group (85 ± 30 mL) compared with the AC group (110 ± 35 mL; p = 0.01). Mean hospital stay was 2.1 ± 0.6 days following LLS and 2.4 ± 0.7 days following AC (p = 0.08). No intraoperative visceral or vascular injuries were recorded in either group. Early postoperative complications (Clavien–Dindo grade I–II) occurred in 10% of LLS cases and 12.5% of AC cases (p = 0.72), primarily consisting of transient urinary retention and minor febrile episodes. No grade III–IV complications were observed. Importantly, no mesh exposure or erosion was detected during the follow-up period.

Significant anatomical improvement was observed in both groups at 12 months; however, restoration of apical support was markedly superior in the LLS group. Mean Ba improved to −2.1 ± 0.4 cm in the LLS group compared with −0.9 ± 0.6 cm in the AC group (p < 0.001). The magnitude of Ba correction from baseline was −3.9 cm in the LLS group versus −2.6 cm in the AC group. Mean apical point C improved to −6.2 ± 0.7 cm following LLS, whereas AC resulted in a mean C value of −3.4 ± 0.8 cm (p < 0.001). The difference in apical descent correction between groups was clinically and statistically significant, confirming the effectiveness of apical restoration achieved through lateral suspension.

Using predefined criteria (Ba < −1 cm, apical point C above hymenal plane, and absence of reoperation), anatomical success at 12 months was achieved in 90% (36/40) of patients in the LLS group compared with 65% (26/40) in the AC group (absolute risk difference 25%; p = 0.01). The number needed to treat (NNT) to prevent one recurrence when using LLS instead of AC was 4. Recurrence occurred in 10% of patients after LLS and 35% after AC. Reoperation was required in one patient (2.5%) in the LLS group and five patients (12.5%) in the AC group.

Functional outcomes paralleled anatomical findings. At 3 months, significant improvement was observed in both groups, but greater reductions in symptom severity were already evident following LLS. This difference persisted and stabilized at 6 and 12 months. At 12 months, mean PFDI-20 score decreased from 128 ± 22 to 42 ± 14 in the LLS group (mean reduction 86 points), compared with a decrease to 61 ± 18 in the AC group (mean reduction 65 points; p < 0.01). Similarly, mean PFIQ-7 scores improved to 28 ± 12 after LLS and to 44 ± 15 after AC (p < 0.01). Effect size analysis

demonstrated a large clinical effect in the LLS group (Cohen's d > 1.2).

Sexual function significantly improved in both groups. Mean FSFI increased from 19.4 ± 3.1 preoperatively to 27.8 ± 2.9 after LLS, compared with an increase to 24.1 ± 3.0 after AC ($p < 0.01$ between groups). The proportion of women reporting resumption of regular sexual activity was 85% in the LLS group and 70% in the AC group. Dyspareunia was reported in 7.5% of patients following AC and 2.5% following LLS ($p = 0.28$). Overall patient satisfaction ("very satisfied") was reported in 88% of women in the LLS group compared with 62% in the AC group ($p = 0.02$).

Multivariate logistic regression analysis was performed to identify predictors of recurrence. Independent predictors included anterior colporrhaphy (OR 3.4; 95% CI 1.4–8.1; $p = 0.004$), POP-Q stage III (OR 2.6; 95% CI 1.1–6.2; $p = 0.03$), and presence of connective tissue dysplasia (OR 2.9; 95% CI 1.2–7.0; $p = 0.01$). BMI and parity were not significant predictors. These findings confirm that absence of apical restoration significantly increases recurrence risk.

No pregnancies occurred during the follow-up period. Uterine preservation was successfully maintained in all cases in both groups, and no subsequent uterine pathology requiring intervention was identified.

Overall, the results demonstrate that laparoscopic lateral suspension provides superior anatomical correction, improved functional recovery, and lower recurrence rates compared with isolated anterior colporrhaphy in women with anterior –apical pelvic organ prolapse, while maintaining a favorable safety profile.

4. Discussion

The present comparative study demonstrates that restoration of apical support through laparoscopic lateral suspension (LLS) results in superior anatomical and functional outcomes compared with anterior colporrhaphy combined with cervical amputation in women of reproductive age with anterior–apical pelvic organ prolapse. The magnitude of anatomical correction at the apical level and the significantly lower recurrence rate observed after LLS underscore the central role of level I support in the long-term stability of pelvic floor reconstruction.

The importance of apical restoration has been repeatedly emphasized in contemporary evidence. The most recent Cochrane review addressing surgical management of apical prolapse concluded that abdominal or laparoscopic procedures providing durable apical fixation are associated with lower subjective prolapse symptoms and lower reoperation rates compared with vaginal repairs lacking robust apical support [7,14]. Our findings are consistent with these conclusions, demonstrating a 25% absolute difference in anatomical success between LLS and isolated anterior repair, with a number needed to treat of four to prevent one recurrence. This magnitude of benefit is clinically meaningful and aligns with high-quality comparative data published over the past decade.

The recurrence rate observed in the anterior colporrhaphy group (35%) falls within the range reported in multiple observational studies and registry analyses. Publications in *International Urogynecology Journal* have documented recurrence rates of 30–40% following isolated anterior repair when apical descent is not concurrently addressed [15,16]. Rooney et al. previously demonstrated that advanced anterior prolapse is highly correlated with apical descent, suggesting that failure to correct apical support predisposes to anterior compartment relapse [4]. Our data reinforce this mechanistic relationship, as patients undergoing LLS—where apical fixation is central—experienced significantly fewer recurrences.

Sacral colpopexy remains widely regarded as a reference standard for apical prolapse repair; however, it requires presacral dissection and carries potential risks of major vascular injury and longer operative times [7,8,14]. In contrast, LLS avoids promontory dissection and lateralizes the suspension vector, potentially reducing presacral complications while preserving physiological vaginal axis alignment. Recent reports in *JMIG* and *International Urogynecology Journal* indicate that LLS achieves anatomical success rates between 85% and 93%, comparable to sacrocolpopexy but with shorter hospital stays and reduced blood loss [11,12,17]. The 90% success rate observed in our study is consistent with these contemporary findings.

Functional outcomes further strengthen the clinical relevance of apical restoration. Improvements in PFDI-20 and PFIQ-7 scores were significantly greater in the LLS group, with large effect sizes. Similar findings have been reported in prospective laparoscopic prolapse studies demonstrating that comprehensive apical reconstruction yields greater improvement in symptom burden and daily activity limitations [17,18]. Importantly, sexual function recovery—as measured by FSFI—was superior following LLS. Dyspareunia rates were lower compared with anterior repair, possibly reflecting preservation of vaginal length and axis. Prior studies have suggested that vaginal procedures may alter vaginal geometry, potentially affecting postoperative sexual function [8,19]. Our results support the hypothesis that minimally invasive apical suspension better preserves anatomical relationships relevant to sexual health.

Mesh safety remains a central issue in prolapse surgery. Regulatory scrutiny of transvaginal mesh has reshaped surgical practice worldwide [9]. However, abdominal or laparoscopic mesh placement under direct visualization continues to be considered acceptable when appropriately indicated [7,14]. Notably, no mesh exposure was observed in the present series, likely reflecting careful patient selection, use of lightweight polypropylene T-shaped mesh, and experienced surgical technique. Comparable low mesh complication rates have been reported in modern laparoscopic series [11,17].

Predictor analysis further supports a pathophysiological framework. Stage III prolapse and connective tissue dysplasia were independent risk factors for recurrence, consistent with molecular evidence highlighting altered collagen metabolism and extracellular matrix remodeling in prolapse pathogenesis

[6]. These findings align with recent literature emphasizing that structural connective tissue vulnerability may compromise fascial repair durability, thereby favoring suspension-based strategies [15,20].

The strengths of this study include a homogeneous reproductive-aged cohort, standardized POP-Q assessment, validated functional instruments, and a high follow-up rate (95%). Nevertheless, limitations must be acknowledged. The study was conducted at a single center and was not randomized, which may introduce selection bias. Although groups were comparable at baseline, unmeasured confounders cannot be excluded. Additionally, follow-up was limited to 12 months; longer-term durability beyond two to five years remains to be established, as highlighted in recent systematic reviews [14,18].

Despite these limitations, the data provide clinically meaningful evidence supporting laparoscopic lateral suspension as a minimally invasive, organ-preserving approach capable of achieving durable anatomical correction and improved functional outcomes in anterior–apical prolapse. Given the central importance of apical support in prolapse stability, LLS represents a rational evolution in pelvic reconstructive surgery, particularly in women of reproductive age where uterine preservation and sexual function are critical considerations.

Future research should focus on multicenter randomized trials comparing LLS with sacrocolpopexy and vaginal apical fixation techniques, as well as long-term follow-up assessing durability, sexual function, and pregnancy outcomes.

5. Conclusions

Laparoscopic lateral suspension provides significantly superior anatomical restoration of apical support compared with anterior colporrhaphy in women of reproductive age with anterior–apical pelvic organ prolapse. The marked improvement in apical position translated into a substantially lower recurrence rate and reduced need for reoperation at 12 months.

Beyond anatomical correction, laparoscopic lateral suspension resulted in greater improvement in pelvic floor symptom burden, quality of life, and sexual function, highlighting the clinical importance of durable apical fixation in functional recovery.

Anterior colporrhaphy without apical reinforcement demonstrated acceptable short-term symptom relief in selected cases; however, it was associated with a significantly higher risk of recurrence in patients with combined anterior–apical defects, particularly in those with stage III prolapse or underlying connective tissue vulnerability.

These findings support the concept that restoration of apical support is a key determinant of surgical success in anterior–apical prolapse. Laparoscopic lateral suspension represents a minimally invasive, organ-preserving, and clinically effective alternative for appropriately selected patients, particularly women of reproductive age in whom uterine preservation and sexual function are essential considerations.

Longer-term multicenter studies are warranted to confirm durability beyond one year and to further refine patient selection criteria.

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