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ORIGINAL RESEARCH

Long-Term Effectiveness and Safety of Laparoscopic Uterosacral Ligament Suspension with Hysterectomy for Pelvic Organ Prolapse: A Prospective Cohort Study with Over 7 Years of Follow-Up

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Purpose: Pelvic organ prolapse (POP) is a common gynecologic disorder. Laparoscopic uterosacral ligament suspension (L-USLS) is a minimally invasive native-tissue repair for apical POP, but long-term data beyond 5 years remain limited. This study aimed to evaluate the long-term outcomes of L-USLS combined with hysterectomy for symptomatic POP.

Patients and Methods: A single-center prospective cohort study was conducted at Peking Union Medical College Hospital from June 2015 to March 2019. Consecutive women with symptomatic apical POP who underwent L-USLS with hysterectomy were enrolled. Standardized assessments including pelvic organ prolapse quantification (POP-Q) examination and validated questionnaires (PFDI-20, PFIQ-7, PISQ-12, PGI-I) were performed preoperatively, at 3 months and annually postoperatively.

Results: Of the 34 enrolled patients, 31 (91.2%) completed a minimum of 7 years of follow-up, with a mean follow-up duration of 102.7 ± 13.8 months (median 8.5 years). At the last follow-up, the composite, anatomical, and subjective success rates were 41.9%, 77.4%, and 48.4%, respectively. The lower composite success rate is attributable to its strict definition requiring satisfactory anatomy, absence of bothersome bulge symptoms and no retreatment for POP simultaneously. No apical compartment recurrence was observed. The overall recurrent prolapse rate was 22.6%, with recurrence limited to the anterior and posterior compartments. A total of 93.5% of patients remained free from retreatment for POP. Among the 29 patients without preoperative urinary incontinence symptoms, de novo postoperative urinary incontinence occurred in 10.3%.

Conclusion: L-USLS with hysterectomy may provide durable apical support and low retreatment rates for symptomatic apical POP over long-term follow-up. This native-tissue procedure may be a feasible option for carefully selected patients, though longer surveillance is needed to monitor late anterior or posterior compartment recurrence. Larger comparative studies are required to confirm its effectiveness.

Keywords: laparoscopic uterosacral ligament suspension, pelvic organ prolapse, long-term, effectiveness

Introduction

Pelvic organ prolapse (POP) is a common pelvic floor disorder in women. Its incidence increases with age and imposes a substantial burden on quality of life and clinical practice.[1] Surgical repair remains the definitive treatment for symptomatic moderate-to-severe POP, and restoration of apical vaginal support is central to successful repair because apical support deficiency is closely associated with recurrence in other vaginal compartments.[2]

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Uterosacral ligament suspension (USLS) is a classic native-tissue repair for apical POP that avoids mesh-related complications, such as vaginal mesh exposure and mesh-related pain, and is therefore widely used in clinical practice.[3] Transvaginal USLS (V-USLS) is the traditional approach for mid-pelvic defect repair; however, its clinical standardization is limited by a steep learning curve and a relatively high risk of ureteral injury related to the narrow operative field.[4] With the evolution of minimally invasive surgery, laparoscopic uterosacral ligament suspension (L-USLS) has emerged as an attractive alternative for apical POP repair. This technique provides a magnified and clear operative field, allows precise suture placement, and minimizes surgical trauma, which is conducive to accurate apical reconstruction.[5] Beyond conventional transvaginal and laparoscopic approaches, robotic-assisted USLS offers enhanced dexterity but remains limited by cost and accessibility,[6] while newer transvaginal natural-orifice endoscopic surgery (vNOTES) approaches have shown promising short-term outcomes but lack long-term validation.[7]

Multiple meta-analyses and short- to medium-term follow-up studies have confirmed the favorable efficacy and safety of L-USLS, demonstrating satisfactory anatomical correction, symptom improvement, and a low rate of perioperative complications.[8–10] Recent studies on native-tissue apical suspension, including systematic reviews of vNOTES-USLS and reports on combined Manchester procedure with USLS for uterine prolapse,[7,11] have further expanded the scope of minimally invasive strategies, but remain limited to short-term or mid-term follow-up. However, long-term durability is the key indicator of the clinical value of any POP repair technique, because prolapse recurrence and de novo lower urinary tract symptoms may emerge beyond the initial 2–3 years after surgery.[12] To date, high-quality evidence on the long-term outcomes of L-USLS remains limited, and few prospective cohort studies with follow-up beyond 7 years have systematically evaluated cumulative success, anatomical durability, symptom improvement, and long-term complications. This evidence gap limits a comprehensive understanding of the long-term value of L-USLS and its role in individualized clinical decision-making.

Against this background, we conducted a single-center prospective cohort study to report the long-term outcomes of L-USLS for symptomatic POP after more than 7 years of follow-up. Using standardized longitudinal follow-up, anatomical assessment, and patient-reported outcome measures, we aimed to clarify the cumulative composite success rate, anatomical and subjective outcomes, and complication profile of L-USLS over extended follow-up. As one of the long-term prospective cohort studies with over 7 years of follow-up on L-USLS to date, the findings are expected to provide clinically relevant support for the optimization of native-tissue surgical strategies for POP.

Materials and Methods

Study Design and Participants

This single-center prospectively maintained cohort study was conducted at the Department of Obstetrics and Gynecology, Peking Union Medical College Hospital. The study was approved by the Institutional Review Board of Peking Union Medical College Hospital (No. JS-1744), and all participants provided written informed consent before enrollment. Consecutive women with symptomatic pelvic organ prolapse (POP) who underwent laparoscopic uterosacral ligament suspension (L-USLS) with hysterectomy between June 2015 and March 2019 were prospectively enrolled and followed according to a predefined longitudinal protocol.

Inclusion and Exclusion Criteria

Inclusion criteria were as follows: (1) symptomatic POP with predominant apical compartment prolapse confirmed by pelvic organ prolapse quantification (POP-Q) staging; (2) an indication for surgical repair of POP and willingness to undergo L-USLS; (3) complete baseline POP-Q examination findings and valid questionnaire data; and (4) the ability to complete regular postoperative follow-up and cooperate with clinical assessments. Exclusion criteria were as follows: (1) pregnancy or planned pregnancy; (2) suspected or confirmed gynecologic malignancy requiring radical surgery; (3) a history of mesh-based apical suspension surgery for POP; (4) prior pelvic radiotherapy; (5) chronic pelvic pain of unknown origin; (6) active pelvic infection at the time of surgery; (7) neurological disease or severe medical comorbidities affecting bladder or bowel function; and (8) insufficient clinical records for ascertainment of the primary endpoint.

Surgical Technique

All procedures were performed by senior gynecologists with extensive experience in minimally invasive pelvic reconstructive surgery. The L-USLS technique has been described previously in detail.[13] Briefly, laparoscopic hysterectomy was performed followed by laparoscopic exposure of the bilateral uterosacral ligaments. Consecutive size 2 Ethibond (X519, Ethicon, LLC, Somerville, NJ, USA) sutures were placed on both sides of the uterosacral ligaments in all cases, then continuously plicated toward the root of the ipsilateral uterosacral ligament, and finally secured to the corresponding suture on the contralateral side. The bilateral sutures were then anchored to the ipsilateral vaginal cuff apex to achieve bilateral elevation of the apical compartment.

Laparoscopic hysterectomy was performed in all patients. Adnexal management was individualized based on menopausal status and shared decision-making with the patients. Premenopausal patients with regular menses underwent bilateral salpingectomy with ovarian preservation and menopausal or perimenopausal patients underwent either bilateral salpingectomy or bilateral salpingo-oophorectomy, based on patient preference and preoperative counseling. Concomitant procedures were performed only when clinically indicated. No routine anti-incontinence procedure was performed in this cohort; only patients with severe symptomatic stress urinary incontinence (SUI) confirmed by urodynamic testing underwent concomitant anti-incontinence surgery. Native-tissue repair was used for concomitant anterior or posterior vaginal wall prolapse according to surgeons.

Follow-Up Schedule and Data Collection

Standardized postoperative evaluations were scheduled at 3 months after surgery and annually thereafter, with a predefined minimum follow-up duration of 7 years. Outpatient clinical assessment was the primary follow-up modality. For 7 patients who were unable to attend outpatient visits because of advanced age or geographic limitations, alternative follow-up methods were used. One patient provided external medical records confirming reoperation for recurrent prolapse. The remaining 6 patients completed structured WeChat-based video follow-up with family assistance. During these remote assessments, physicians guided family members to assist with Valsalva maneuver and visual inspection, and symptom questionnaires were completed by telephone or video call. All 7 patients completed the questionnaires required for subjective outcome assessment. Anatomical status at the last follow-up was determined using either external medical records or remote clinical assessment; however, these evaluations were not obtained through standardized in-person POP-Q examination and may therefore have introduced information bias.

Each follow-up assessment comprised two core components: objective anatomical evaluation and subjective patient-reported outcome assessment. When in-person assessment was feasible, objective anatomical status was evaluated using POP-Q examination. For patients followed remotely, anatomical status at the last follow-up was determined using external medical records or remote clinical assessment. Subjective outcomes were assessed using validated Chinese versions of the Pelvic Floor Distress Inventory-20 (PFDI-20), the Pelvic Floor Impact Questionnaire-7 (PFIQ-7),[14] the Pelvic Organ Prolapse/Urinary Incontinence Sexual Function Questionnaire Short Form (PISQ-12),[15] and the Patient Global Impression of Improvement (PGI-I) scale.

All postoperative complications, including de novo urinary incontinence, de novo constipation, pelvic pain, ureteral injury, and retreatment for POP (including pessary use or reoperation), were recorded throughout follow-up through medical chart review and structured patient interviews.

Outcome Definitions

The primary outcome was composite success at the last follow-up, defined as the simultaneous fulfillment of the following three criteria: (1) anatomical success, with POP-Q points Aa, Ba, Ap, Bp, and C remaining above the hymen during Valsalva; (2) subjective success, defined as the absence of bothersome vaginal bulge symptoms, indicated by a response of "none" to question 3 of the PFDI-20; and (3) no retreatment for POP, including pessary treatment or surgery.[16] Secondary outcomes included anatomical success, subjective success, patient-reported global improvement, perioperative and postoperative complications, retreatment, compartment-specific recurrence, and changes in patient-reported questionnaire scores. In this study, recurrent prolapse was defined as anatomical failure failing to meet the above anatomical success criterion. Estimated

blood loss was recorded for the entire surgical procedure, including laparoscopic hysterectomy, adnexal surgery when performed, concomitant native-tissue repair, and L-USLS, rather than for the suspension step alone.

Statistical Analysis

All statistical analyses were performed using R version 4.2.0 (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables are presented as mean ± standard deviation (SD) for normally distributed data or median (interquartile range, IQR) for non-normally distributed data. Categorical variables are presented as counts and percentages (n, %). Preoperative and last follow-up POP-Q measurements and questionnaire scores were compared using Wilcoxon signed-rank tests. Key outcome proportions were reported with 95% confidence intervals. All tests were two-sided, and $P<0.05$ was considered statistically significant. As this was a single-center prospectively maintained cohort study, the sample size was determined by the number of consecutive eligible patients treated during the predefined study period, and no formal a priori sample size calculation was performed. The primary outcome was prespecified, whereas analyses of secondary outcomes were considered exploratory; therefore, no formal adjustment for multiple comparisons was applied, and these findings should be interpreted cautiously.

Results

Between June 2015 and March 2019, 34 consecutive patients met the inclusion criteria and were enrolled in the study (Figure 1). Three patients were lost to follow-up, resulting in a final evaluable cohort of 31 patients (91.2% follow-up rate). Baseline and perioperative characteristics of the study population are presented in Table 1. All patients had symptomatic POP with predominant apical compartment involvement, and 24 of 31 evaluable patients (77.4%) had POP-Q stage III prolapse. Regarding adnexal surgery, 15 patients (48.4%) underwent salpingectomy with ovarian preservation,

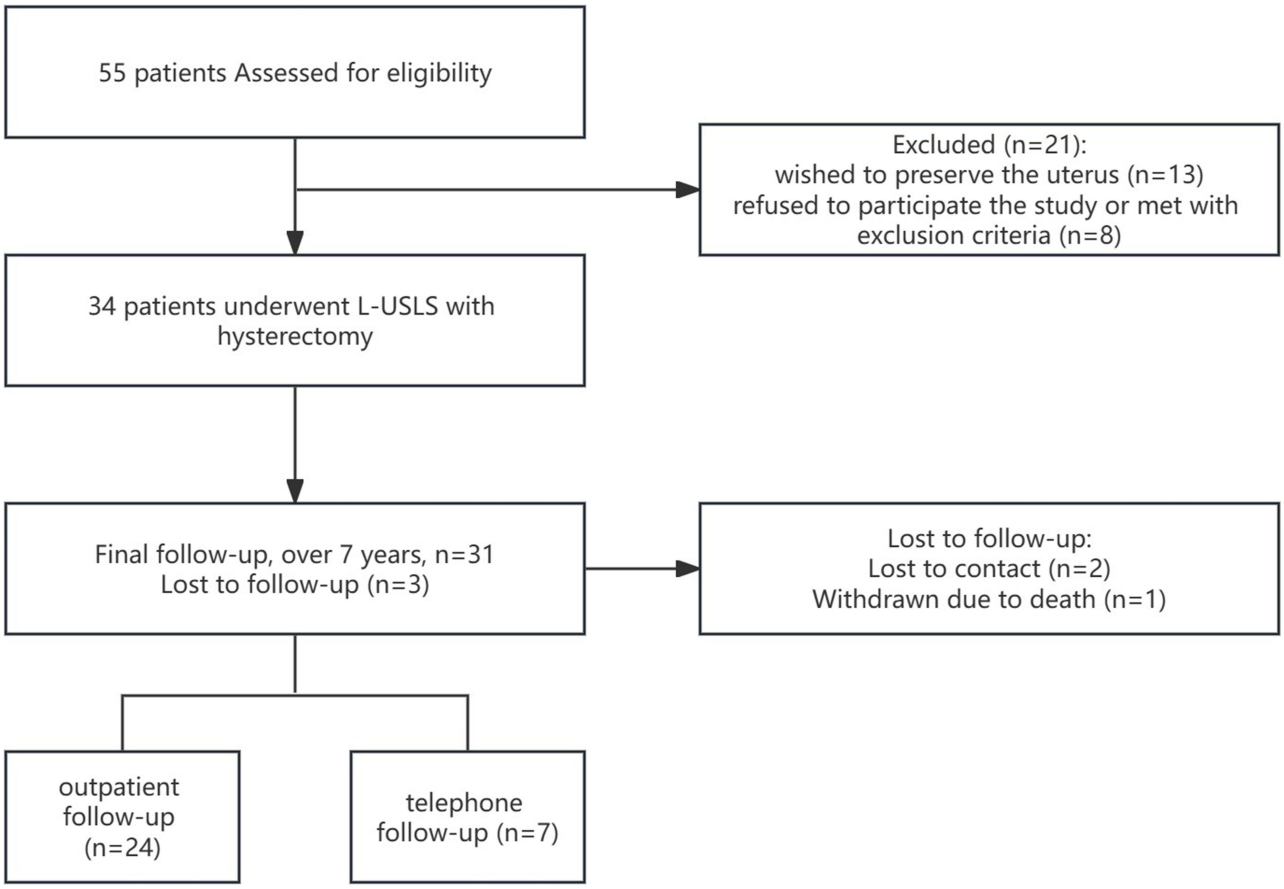

Figure 1 Follow-up of patients who underwent laparoscopic uterosacral ligament suspension in this study.

Table 1 Baseline Characteristics and Perioperative Details of Patients Completing Follow-Up

Characteristic	Patients Completing Follow-Up (N = 31)
Age, mean ± SD (year)	52.6 ± 8.2
BMI, mean ± SD (kg/m^2)	24.1 ± 2.6
Gestation, median (IQR)	2.0 (2.0–4.0)
Parity, median (IQR)	1.0 (1.0–1.0)
Delivery, n (%) ‡	
CS	2 (6.5)
VD	28 (90.3)
Nulliparous, n (%)	1 (3.2%)
Menopausal status, n (%)	
Regular	12 (38.7)
Postmenopausal	14 (45.2)
Perimenopausal	5 (16.1)
Diabetes mellitus, n (%)	0 (0.0)
Hypertension, n (%)	5 (16.1)
Urinary incontinence type, n (%)	
No	27 (87.1)
UUI	0 (0.0)
MUI	2 (6.5)
SUI	0 (0.0)
OSUI	2 (6.5)
POP stage, n (%)	
II	7 (22.6)
III	24 (77.4)
IV	0 (0.0)
Previous POP surgery, n (%)	0 (0.0)
Previous hysterectomy, n (%)	0 (0.0)
Previous anti-incontinence surgery, n (%)	0 (0.0)
Previous pelvic surgery, n (%)	3 (9.7)
Concomitant surgical operations, n (%)	
TVT	0 (0.0)
Anterior vaginal repair	2 (6.5)
Posterior vaginal repair	3 (9.7)
Adnexal surgery	31 (100.0)
Salpingectomy	15 (48.4)
Salpingo-oophorectomy	16 (51.6)
Surgical duration, mean ± SD (min)	67.9 ± 25.7
Estimated blood loss, mean ± SD (mL)	369.7 ± 256.8
Perioperative complications, n (%)	
Ureteral injury	0 (0.0)
Pulmonary embolism	0 (0.0)
Urinary retention	2 (6.5)
Postoperative infection	3 (9.7)
Catheterization, mean ± SD (day)	1.1 ± 0.3
Postoperative hospital stay, mean ± SD (day)	3.9 ± 1.3

Note: ‡Delivery mode is reported for parous patients (n=30); 1 patient was nulliparous.
Abbreviations: BMI, body mass index; SD, standard deviation; IQR, interquartile range; CS, cesarean section; VD, vaginal delivery; UUI, urgency urinary incontinence; MUI, mixed urinary incontinence; SUI, stress urinary incontinence; OSUI, occult stress urinary incontinence; POP, pelvic organ prolapse; TVT, tension-free vaginal tape.

while 16 patients (51.6%) underwent salpingo-oophorectomy. No patient underwent concomitant anti-incontinence surgery during the index procedure, and no intraoperative ureteral injury was recorded.

The median follow-up duration was 8.5 (7.4–9.7) years, and the mean follow-up time was 102.7 ± 13.8 months. At the last follow-up, the composite success rate was 41.9% (13/31, 95% CI 24.5–60.9%), the anatomical success rate was 77.4% (24/31, 95% CI 58.9–90.4%), and the subjective success rate was 48.4% (15/31, 95% CI 30.2–66.9%). No apical compartment recurrence was observed. The overall recurrent prolapse rate was 22.6% (7/31, 95% CI 9.6–41.1%), with recurrence confined to the anterior and posterior compartments. Specifically, anterior compartment recurrence occurred in 5 patients (16.1%, 95% CI 5.5–33.7%) and posterior compartment recurrence in 2 patients (6.5%, 95% CI 0.8–21.4%). A total of 29 patients (93.5%, 95% CI 78.6–99.2%) remained free from retreatment for POP (Table 2). Two patients required retreatment: one received pessary management for recurrent anterior compartment prolapse associated with voiding and defecatory difficulties, and the other underwent repeat prolapse surgery with concomitant anti-incontinence surgery at an outside hospital during follow-up. Among the 29 patients without preoperative urinary incontinence symptoms, de novo postoperative urinary incontinence developed in 3 patients (10.3%, 95% CI 2.2–27.4%). De novo postoperative constipation or chronic pelvic pain was no reported (0/31 each, 95% CI 0.0–11.2%) (Table 2).

Preoperative and last follow-up POP-Q measurements and patient-reported outcome scores were summarized in Table 3, and changes in POP-Q points were illustrated in Figure 2. Compared with baseline, all major POP-Q points improved significantly at the last follow-up (all P<0.001). The greatest improvement was observed at point C, from a preoperative median of 2.0 (1.0, 3.0) to −7.0 (−7.0, −6.0). Postoperatively, patients exhibited significant improvements in prolapse-specific symptom scores, including total PFDI-20 (44.8 [38.8, 72.0] vs 11.8 [0.0, 52.2], P=0.021) and POPDI-6 subscale scores (25.0 [16.8, 33.2] vs 8.2 [0.0, 16.8], P<0.001). In contrast, no significant changes were detected in CRADI-8 (6.2 [6.2, 18.8] vs 3.2 [0.0, 6.2], P=0.062) and UDI-6 scores (16.8 [8.2, 25.0] vs 4.2 [0.0, 29.2], P=0.645), indicating limited postoperative improvement in bowel and urinary symptoms. By contrast, no significant change was observed in PFIQ-7 and its subscales (all P>0.05). Because paired PISQ-12 data were available for only 2 patients, sexual function outcomes were summarized descriptively without formal statistical comparison. On the PGI-I scale, 17 of 31 patients (54.8%) reported being "much better" or "very much better" at the last follow-up.

Table 2 Long-Term Follow-Up Outcomes

Outcome	Patients Completing Follow-Up (N=31)
Follow-up time, mean ± SD (month)	102.7 ± 13.8
Composite success, n (%, 95% CI)	13 (41.9, 24.5–60.9)
Anatomical success	24 (77.4, 58.9–90.4)
Subjective success	15 (48.4, 30.2–66.9)
No retreatment for POP	29 (93.5, 78.6–99.2)
De novo postoperative urinary incontinence*, n (%, 95% CI)	3/29 (10.3, 2.2–27.4)
De novo postoperative constipation£, n (%, 95% CI)	0 (0.0, 0.0–11.2)
Chronic pain, n (%, 95% CI)	0 (0.0, 0.0–11.2)
Recurrent prolapse, n (%, 95% CI)	7 (22.6, 9.6–41.1)
Anterior compartment	5 (16.1, 5.5–33.7)
Posterior compartment	2 (6.5, 0.8–21.4)
Retreatment for POP, n (%, 95% CI)	2 (6.5, 0.8–21.4)

Notes: Values are presented as n (%) with exact 95% confidence intervals (CI) unless otherwise indicated. Composite success was defined as the simultaneous presence of anatomical success, subjective success, and no retreatment for POP. Anatomical success was defined as POP-Q points Aa, Ba, Ap, Bp, and C remaining below the hymen at the last follow-up. Recurrent prolapse was defined as anatomical failure and categorized according to the recurrent compartment. Exact 95% CI were calculated using the Clopper–Pearson method. *De novo postoperative urinary incontinence was defined as a score of 1–4 on the second or third item of the UDI-6 at the final follow-up, among patients with no such symptom preoperatively (score = 0). £De novo postoperative constipation was defined as a score of 1–4 on the first item of the CRADI-8 at the final follow-up, among patients with no such symptom preoperatively (score = 0).

Table 3 Preoperative and Last-Follow-Up POP-Q and Questionnaire Scores

Outcome	Before Surgery	Last Follow-Up	P value
Aa	−1.0 (−1.0, 0.0)	−2.0 (−2.5, −1.5)	<0.001*
Ba	−1.0 (−1.0, 0.0)	−2.0 (−2.5, −1.5)	<0.001*
C	2.0 (1.0, 3.0)	−7.0 (−7.0, −6.0)	<0.001*
Ap	−2.0 (−2.0, −1.0)	−2.5 (−3.0, −2.0)	<0.001*
Bp	−2.0 (−2.0, −1.0)	−2.5 (−3.0, −2.0)	<0.001*
PFDI-20	44.8 (38.8, 72.0)	11.8 (0.0, 52.2)	0.021*
POPDI-6	25.0 (16.8, 33.2)	8.2 (0.0, 16.8)	<0.001*
CRADI-8	6.2 (6.2, 18.8)	3.2 (0.0, 6.2)	0.062
UDI-6	16.8 (8.2, 25.0)	4.2 (0.0, 29.2)	0.645
PFIQ-7	17.0 (6.2, 37.0)	0.0 (0.0, 17.8)	0.311
POPIQ-7	2.5 (0.0, 16.8)	0.0 (0.0, 0.0)	0.326
UIQ-7	7.5 (1.2, 14.0)	0.0 (0.0, 13.0)	0.454
CRAIQ-7	0.0 (0.0, 5.0)	0.0 (0.0, 0.0)	1.000
PISQ-12[#]	37.5 (35.8, 39.2)	41.0 (41.0, 41.0)	–
PGI-I response of much better or very much better, n (%)	–	17 (54.8)	–

Notes: Values are presented as median (interquartile range) unless otherwise indicated. Preoperative and last follow-up comparisons were performed using Wilcoxon signed-rank tests. Each comparison was based on patients with paired baseline and last follow-up data available for the corresponding variable. *P < 0.05. [#]PISQ-12 data were available in only 2 patients with paired baseline and last follow-up assessments; therefore, only descriptive statistics are presented and no formal statistical comparison was performed.
Abbreviations: PFDI-20, Pelvic Floor Distress Inventory-20; POPDI-6, Pelvic Organ Prolapse Distress Inventory-6; CRADI-8, Colorectal-Anal Distress Inventory-8; UDI-6, Urinary Distress Inventory-6; PFIQ-7, Pelvic Floor Impact Questionnaire-7; POPIQ-7, Pelvic Organ Prolapse Impact Questionnaire-7; UIQ-7, Urinary Impact Questionnaire-7; CRAIQ-7, Colorectal-Anal Impact Questionnaire-7; PISQ-12, Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire-12; PGI-I, Patient Global Impression of Improvement.

Discussion

This study provides long-term follow-up data on L-USLS combined with hysterectomy for symptomatic apical POP, with a median follow-up of 8.5 years. No apical recurrence was observed, while overall prolapse recurrence (22.6%) and retreatment (6.5%) rates remained low. As one of the few prospective studies reporting outcomes beyond 7 years, these findings contribute important evidence regarding the durability of this native-tissue apical repair.

Our findings should be interpreted within the context of an evolving evidence base for USLS. A recent systematic review and meta-analysis confirmed the favorable safety profile and short-term effectiveness of L-USLS but highlighted the lack of long-term prospective data.[17] Consistent with the 5-year outcomes from the OPTIMAL trial, our cohort achieved a 7-year composite success rate of 41.9%, comparable to the 38.5% success rate reported for transvaginal USLS.[18] Direct comparison remains challenging because of differences in surgical approach, baseline patient characteristics, follow-up duration, and outcome definitions. Similarly, the lower failure rate 22.2% reported by Sears et al,[19] may be partly explained by milder baseline prolapse severity Despite these differences, the collective evidence suggests that USLS, particularly when performed laparoscopically, can provide durable long-term apical support.

The anatomical success rate of 77.4% supports L-USLS as an effective native-tissue repair for symptomatic apical POP. Notably, all recurrences were confined to the anterior or posterior compartments, whereas apical support remained intact throughout follow-up. This pattern suggests that long-term failure is more likely related to defects in non-apical compartments rather than loss of apical suspension itself. Because concomitant anterior or posterior repair was performed selectively and severe multicompartment prolapse was uncommon in this cohort, recurrence in these compartments may reflect underlying fascial weakness, lateral support defects, or baseline disease severity. Prior data also suggest that posterior repair does not necessarily improve overall surgical success and does not address the pathophysiology of an enlarged genital hiatus.[20] These findings indicate that patients with advanced multicompartment prolapse may benefit from more comprehensive reconstructive strategies to reduce long-term recurrence risk.

Notably, despite satisfactory anatomical restoration and a low retreatment rate, a substantial proportion of patients reported persistent subjective bulging sensation, resulting in a marked discrepancy between anatomical success (77.4%)

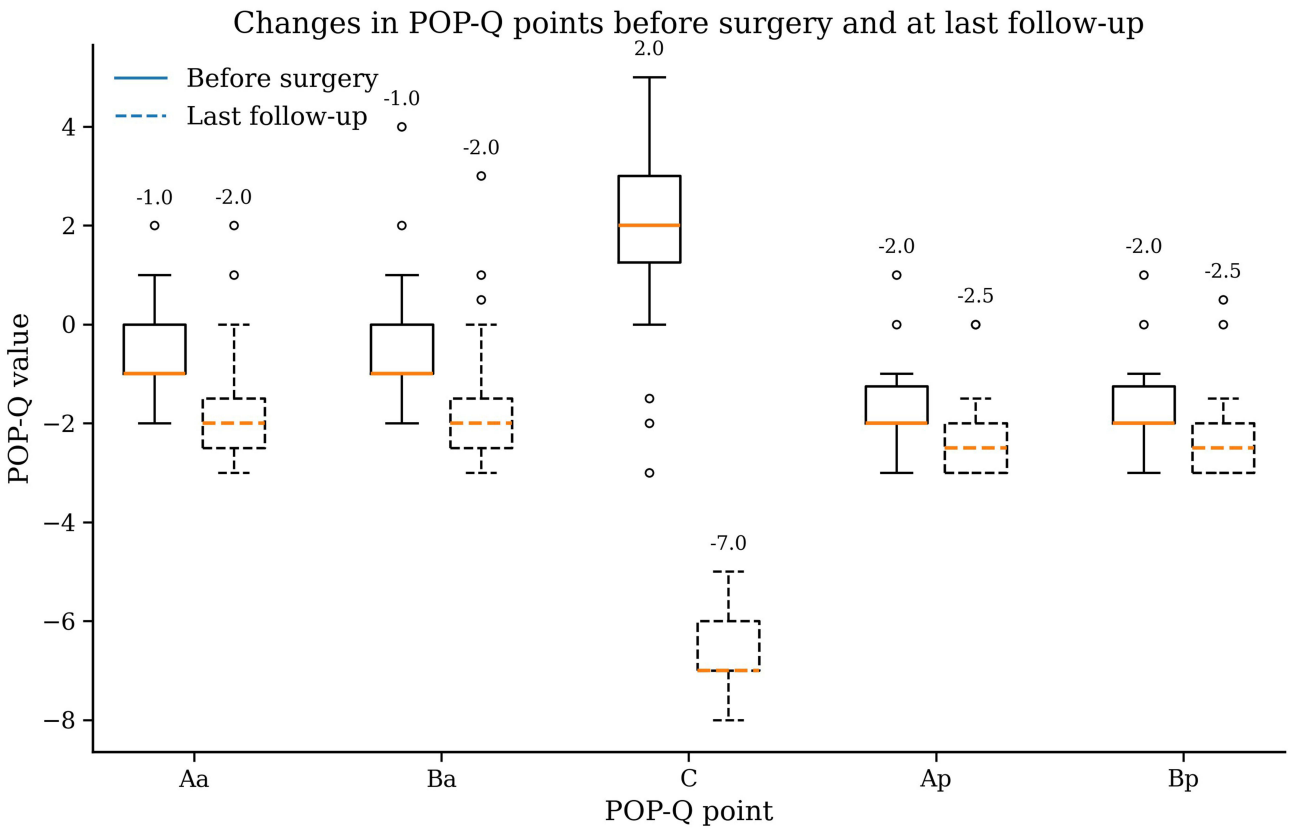

Figure 2 Boxplots showing changes in POP-Q points (Aa, Ba, C, Ap, and Bp) before surgery and at the last follow-up. Boxes indicate the median and interquartile range, and whiskers indicate the data range.

and composite success (41.9%). This finding suggests that strict composite endpoints incorporating patient-reported bulge symptoms may identify suboptimal outcomes that cannot be captured by anatomical assessment alone. One possible explanation is pelvic organ cross-sensitization and dysfunction of the brain–pelvic floor–visceral axis, whereby persistent neural hypersensitivity, altered central perception, and abnormal pelvic floor muscle tone may maintain a subjective sensation of vaginal bulging despite adequate anatomical support.[21] Although this mechanism remains speculative, it highlights the complex relationship between anatomical correction and symptom perception after POP surgery. Consistent with this interpretation, significant improvement was observed in prolapse-specific symptom scores, and more than half of patients reported being "much better" or "very much better" on the PGI-I scale, suggesting that prolapse-related symptom relief remained the primary determinant of patient-perceived benefit.

From a broader clinical perspective, L-USLS should be considered alongside other contemporary approaches for apical POP repair. Abdominal sacrocolpopexy is widely regarded as the reference standard because of its anatomical durability, but its use must be balanced against mesh-related complications, greater surgical invasiveness, and higher perioperative morbidity.[22] For patients who prefer a mesh-free native-tissue repair or are less suitable candidates for abdominal surgery, L-USLS offers a minimally invasive native-tissue alternative with favorable long-term outcomes and a low rate of serious complications.[23] Emerging approaches such as vNOTES-USLS and the Manchester procedure combined with USLS have further expanded treatment options,[7,11] but robust long-term data for these techniques remain limited. Recent comparisons between laparoscopic uterosacral hysteropexy and hysterectomy-based approaches further highlight the evolving role of uterus-preserving native-tissue strategies and the importance of patient selection.[24]

This study has several strengths. It is among the few prospective studies reporting outcomes of L-USLS with follow-up exceeding 7 years, and the high follow-up rate reduces the risk of attrition bias. In addition, standardized POP-Q assessments and validated patient-reported outcome measures were used throughout follow-up, enhancing the reliability of outcome evaluation. Several limitations should also be acknowledged. First, the single-center design and

relatively small sample size limit generalizability and may reduce the precision of recurrence. Second, we used a combination of in-person visits and WeChat remote follow-up. Remote assessments cannot replace standardized in-person POP-Q evaluation and may introduce bias to anatomical outcome analysis. Besides, no multiple comparison adjustment was performed for exploratory secondary analyses, so these findings need cautious interpretation. Third, the small cohort also restricted the detection of rare perioperative and postoperative adverse events, leading to limited conclusions on the overall safety profile. Fourth, urinary and bowel function were evaluated via patient questionnaires alone, without objective tests like urodynamic testing or defecography, which affects the comprehensiveness of functional assessment. Finally, the small number of sexually active participants limits the interpretation of post-operative sexual function. All above limitations should be considered when evaluating the long-term efficacy and safety of this procedure.

Conclusions

In conclusion, L-USLS combined with hysterectomy may provide durable apical support for symptomatic apical POP, with a low retreatment rate and sustained improvement in prolapse-specific symptoms over long-term follow-up. This procedure may represent a feasible native-tissue surgical option for carefully selected patients with apical POP. Continued long-term follow-up remains important for detecting late recurrence of anterior or posterior compartment prolapse, as this apical repair cannot address non-apical defects, and such recurrence often leads to reoperation. Given the limitations of our single-center cohort without a comparator group, larger comparative studies are still required to further verify its clinical value and relative advantages over other surgical approaches.

Abbreviations

CRADI-8, Colorectal-Anal Distress Inventory-8; CRAIQ-7, Colorectal-Anal Impact Questionnaire-7; L-USLS, Laparoscopic uterosacral ligament suspension; PFDI-20, Pelvic Floor Distress Inventory-20; PFIQ-7, Pelvic Floor Impact Questionnaire-7; PGI-I, Patient Global Impression of Improvement; PISQ-12, Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire-12; POP, Pelvic organ prolapse; POPDI-6, Pelvic Organ Prolapse Distress Inventory-6; POPIQ-7, Pelvic Organ Prolapse Impact Questionnaire-7; POP-Q, Pelvic organ prolapse quantification; SUI, Stress urinary incontinence; UDI-6, Urinary Distress Inventory-6; UIQ-7, Urinary Impact Questionnaire-7.

Ethics Approval and Informed Consent

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the Peking Union Medical College Hospital (PUMCH) (No. JS-1744). Written informed consent was obtained from the patients.

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Author Contributions

Y.W.Z, L.Z and J.C contributed to the conception and study design, Y.W.Z and J.B.W.Y contributed to data collection and data management. Y.W.Z and J.B.W.Y contributed to data analysis and manuscript writing. R.S.Y, L.Z and J.C contributed to manuscript review. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article. All authors gave final approval of the version to be published, have agreed on the journal to which the article has been submitted and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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