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Urethral ligament plication with a midline approach for stress urinary incontinence: Preliminary experience and outcomes

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ABSTRACT

Objective: To evaluate the short-term outcomes of urethral ligament plication (ULP) with a midline approach as a minimally invasive surgical option for the treatment of stress urinary incontinence (SUI).

Materials and Methods: This retrospective study included 23 women diagnosed with SUI who underwent ULP using a midline vaginal approach. A single non-absorbable polyester suture was placed through the lateral arms of the pubourethral ligament and tied beneath the urethra. The primary outcome measure was the cough stress test performed postoperatively on day 7 and day 30. Operative time, hospital stay, and development of complications were also recorded.

Results: At postoperative day 7, 16 patients (69.6%) had a negative cough stress test, while 7 (30.4%) remained positive. At day 30, continence was achieved in 17 patients (73.9%), with 6 patients (26.1%) testing positive. The mean operative time was 37.4±5.7 minutes, and the mean length of hospital stay was 1.26±0.45 days. No major intraoperative complications occurred.

Conclusion: The midline approach to ULP demonstrated promising short-term outcomes in the treatment of SUI, with continence rates comparable to previously reported paraurethral techniques. The procedure is simple, mesh-free, and appears safe; however, these findings are based on a pilot series and further studies with larger cohorts and long-term follow-up are required to confirm its efficacy and durability.

Keywords: Urethral ligament plication; stress urinary incontinence; polyester repair of pubourethral ligament; midline approach for SUI

INTRODUCTION

Stress urinary incontinence (SUI) is defined as the involuntary leakage of urine that occurs when intravesical pressure exceeds urethral closure pressure during activities such as coughing, sneezing, physical exertion, or exercise.[1] According to the Integral Theory, functional defects of the pubococcygeus muscle (PCM) and the pubourethral ligament (PUL), which are responsible for urethral closure at rest, may disrupt the continence mechanism and lead to urine leakage.[2]

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To date, more than 200 surgical techniques have been described for the treatment of urinary incontinence. Nevertheless, the primary therapeutic goal in SUI remains to prevent the elongation of a lax PUL and to ensure adequate periurethral collagen support.[3,4] In this context, mid-urethral sling (MUS) procedures have been widely adopted as the standard treatment for many years.[5] However, mesh-related complications have led to extensive debate, litigation, and even regulatory restrictions in several countries, thereby increasing interest in non-mesh alternatives. Moreover, in the evolving landscape of global healthcare, there has been a growing demand for shorter, minimally invasive procedures associated with faster recovery.[4]

Among these alternatives, the urethral ligament plication (ULP) technique described by Petros and Palma[4], which utilizes non-absorbable polyester sutures, has emerged as a promising approach. In the original ULP technique, bilateral dissection into both paraurethral spaces is performed, and four critical attachment points of the PUL that contribute to urethral closure—the mid-urethra, the retropubic portion, the external urethral ligament (EUL), and the PCM—are engaged bilaterally, mechanisms that were previously defined within the framework of the Integral Theory.[2] In contrast, in our study presenting the midline approach to ULP, the procedure is performed through a single midline incision, with a single knot placed only through the retropubic branches of the PUL.

The concept of PUL repair has been pioneered and elegantly described by Petros and Ulmsten[2] within the framework of the Integral Theory. Their work has established a new perspective on the pathophysiology and surgical treatment of SUI. Inspired by this foundation, we aimed to present our initial clinical experience with a midline approach to ULP. This modification does not intend to replace or challenge the original description, but rather to explore whether a simplified, less invasive route could provide practical advantages while maintaining clinical effectiveness in selected patients.

MATERIALS AND METHODS

This retrospective observational study was conducted at the Department of Obstetrics and Gynecology, Kırşehir Ahi Evran University Training and Research Hospital, between 2023 and 2025, by reviewing the medical records of patients who underwent surgery for SUI. Ethical approval was obtained from the Kırşehir Ahi Evran University Faculty of Medicine Health Sciences Scientific Research Ethics Committee (decision no: 2025-08/92, date: 29 April 2025).

The diagnosis of SUI was established in patients with a history of SUI symptoms and a positive cough stress test performed when the bladder was filled with approximately 300 mL of urine. Patients with urethral hypermobility demonstrated by the Q-tip test and those who achieved continence with retropubic support during the Marshall-Bonney test were selected for surgery. Preoperatively, all patients underwent assessment of pelvic organ prolapse according to the POP-Q system. Age, menopausal status, body mass index (BMI), parity, and operative time were recorded. Patients who underwent midline PUL plication performed exclusively by the principal surgeon and who had at least one month of follow-up were included. Exclusion criteria were surgery for indications other than SUI, concomitant procedures such as transobturator tape (TOT) or pelvic organ prolapse repair, operations performed by different surgeons, and incomplete follow-up data.

All patients were scheduled for postoperative follow-up at the 7th and 30th days. During these visits, patients were questioned about stress incontinence symptoms, and a cough stress test was performed with a bladder volume of at least 300 mL in the lithotomy position while separating the labia and asking the patient to cough 2-3 times. The presence of SUI symptoms on day 7 and at day 30, preoperative and postoperative hemoglobin (Hb) levels, cough stress test results, development of complications, and length of hospital stay were considered outcome variables.

Surgical Technique

All procedures were performed under spinal anesthesia in the low lithotomy position. For prophylaxis, 1 g of intravenous cefazolin was administered approximately 30 minutes before surgery. A Foley catheter was placed under sterile conditions. A vertical midline incision was made approximately 2 cm below the urethra. Through this single incision, paraurethral dissection was performed bilaterally until the retropubic portions of the PUL,[6] located laterally, were palpated. Non-absorbable polyester sutures (No. 2) were passed through each branch of the retropubic PUL, providing adequate tension, and tied at the midline at the level of the urethra (Figures 1, 2). The vaginal mucosa was then closed using 2-0 polyglactin sutures. The simplified technique had previously been introduced in a letter to the editor.[7] The Foley catheter was removed at 24 hours postoperatively. Hb levels were obtained 24 hours before and after surgery. All surgeries and subsequent follow-ups were performed by the same senior obstetrician-gynecologist.

Data were obtained from the hospital information management system, operative notes, laboratory results, and outpatient clinic follow-up forms.

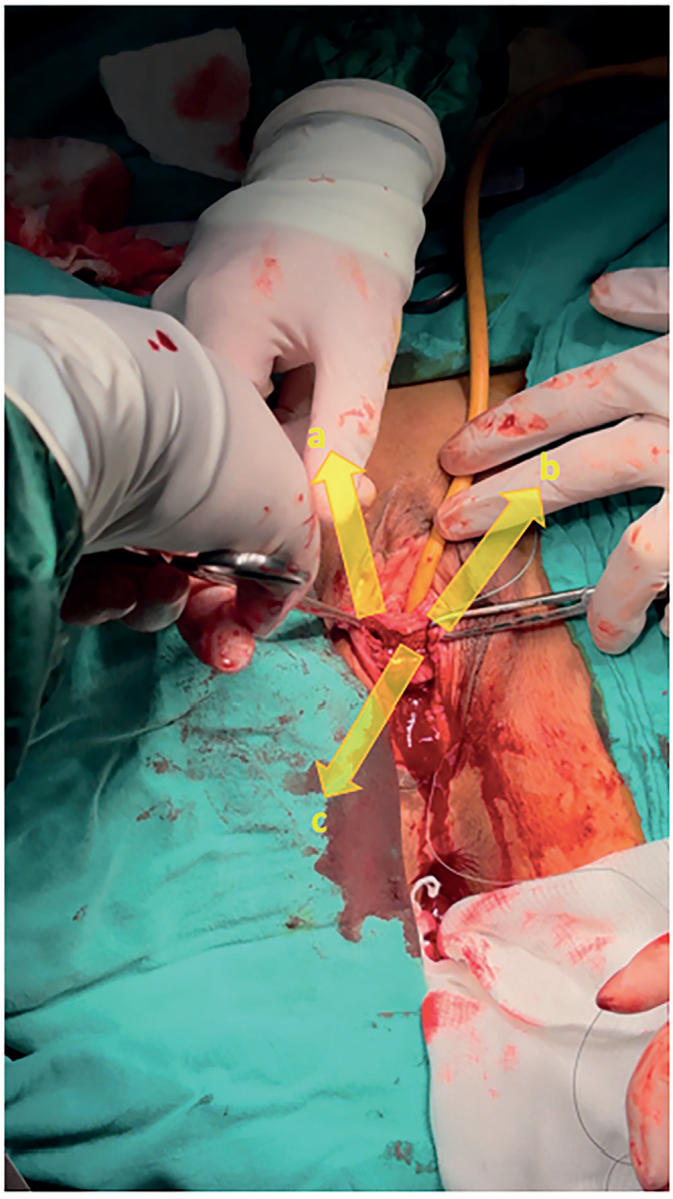

Figure 1. a: The sulcus created in the paraurethral area for the plication of the right PUL; b: The suture passed through the left lateralbranch of the PUL; c: A midline vertical incision made approximately 2 cm below the urethra
PUL: pubourethral ligament

Statistical Analysis

Statistical analyses were performed using SPSS version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation and minimum-maximum values, whereas categorical variables were reported as numbers (n) and percentages (%). The distribution of continuous variables was assessed using the Shapiro-Wilk test. Differences between preoperative and postoperative Hb levels were analyzed with the Wilcoxon signed-rank test. Cough stress test results at days 7 and 30 were evaluated together with patients' subjective symptoms;

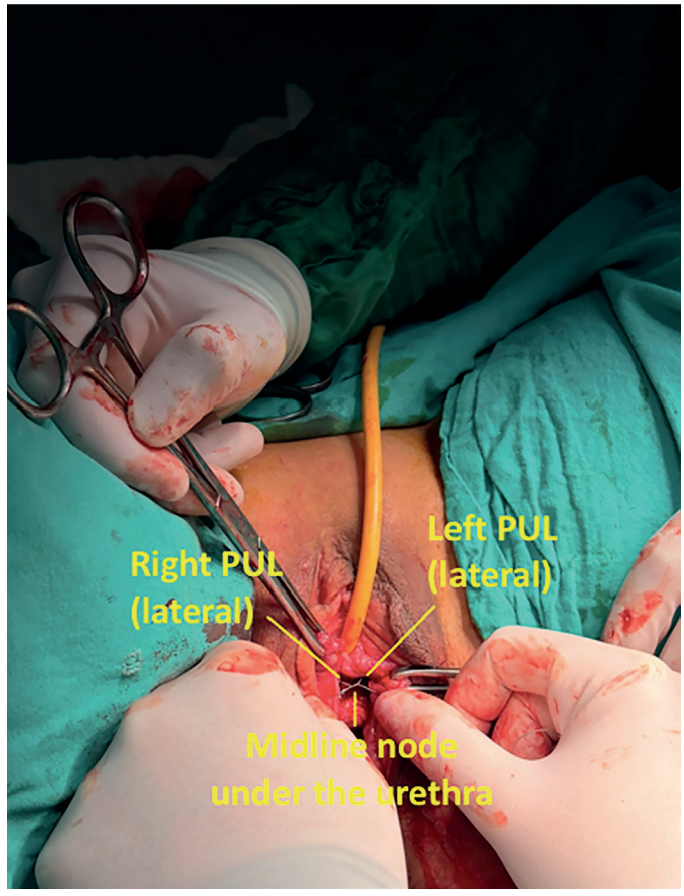

Figure 2. The suture passed through the right and left lateral branches of the PUL and was tied at the midline beneath the urethra
PUL: pubourethral ligament

the cough test was used only as a supportive observational tool. Associations between surgical success and categorical factors were analyzed using the chi-square test or Fisher's exact test where appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

The mean age of the 23 patients included in the study was 57.4±5.8 years (range: 47-68), and the mean BMI was 29.5±3.1 kg/m² (range: 25-36). Sixteen patients (69.6%) were postmenopausal, while seven (30.4%) were premenopausal. Since patients with primary surgical indication of genital prolapse were excluded from the study, only stage 0 or stage I prolapse was observed in the POP-Q evaluation. Six patients (26.1%) were classified as stage 0, and 17 patients (73.9%) as stage I prolapse. The mean POP-Q values were as follows: Aa: -1.5±0.3, Ba: -2.0±0.4, C: -6.0±1.0, Ap: -1.3±0.3, Bp: -1.8±0.4, TVL: 9.0±0.5.

The mean preoperative Hb level was 12.8±0.35 g/dL, whereas the postoperative Hb level was 12.1±0.38 g/dL. The mean operative time was 37.4±5.7 minutes (range: 30-48), and the mean length

of hospital stay was 1.26±0.45 days. Table 1 demonstrates the demographic and perioperative characteristics of the patients.

At postoperative day 7 follow-up, SUI symptoms assessed by anamnesis had resolved in 16 patients (69.6%), while persisting in 7 patients (30.4%). At postoperative day 30, symptoms had regressed in 18 patients (78.3%), whereas 5 patients (21.7%) continued to report incontinence. According to the postoperative cough stress test, 16 patients (69.6%) were negative and 7 (30.4%) were positive on day 7, while at day 30, 17 patients (73.9%) were negative and 6 (26.1%) were positive. Detailed results are shown in Table 2.

At postoperative day 30, patients with a positive cough stress test had a significantly higher mean age (63.5±3.8 years vs. 55.3±4.8 years, p=0.001), BMI (33.0±2.4 vs. 28.2±2.3 kg/m², p=0.002), and operative time (45.7±1.8 min vs. 34.5±3.1 min, p<0.001) compared with those who tested negative. Detailed comparative results are shown in Table 3. Although all cases with treatment failure at day 30 were in the postmenopausal period, the association between menopausal status and surgical outcomes was not statistically significant (p=0.124).

All patients were advised to avoid sexual intercourse for 6 weeks postoperatively; therefore, early dyspareunia was not assessed. During the study period, no major complications such as acute urinary retention, hematoma, or intraoperative organ injury were observed. However, according to the Clavien-Dindo classification,[7] two complications (8.7%, n=2) occurred: One patient developed infected granulation tissue on postoperative day 27 requiring surgical excision under local anesthesia (Grade IIIa), and another patient reported severe vulvar pain at the one-month follow-up visit. Laboratory investigations including urinalysis, complete blood count, and C-reactive protein were within normal limits, and the pain resolved spontaneously without further intervention (Grade I).

Table 1. Demographic and perioperative characteristics of the patients

Variable	Mean ± SD	Minimum-maximum	Median
Age (years)	57.4±5.8	47-68	
BMI (kg/m²)	29.5±3.1	25-36	
Operation time (minute)	37.4±5.7	30-48	
Hb preop (g/dL)	12.8±0.35	11.9-13.3	
Hb postop (g/dL)	12.1±0.38	11.0-12.6	
Parity		1-5	3
Hospital stay (stay)		1-2	1

SD: standard deviation; BMI: body mass index; Hb: hemoglobin

Table 2. Postoperative outcomes of SUI symptoms and cough stress test

	Postoperative 7th day n (%)	Postoperative 30th day n (%)
SUI symptom present	7 (30.4%)	5 (21.7%)
SUI symptom absent	16 (69.6%)	18 (78.3%)
Cough test positive	7 (30.4%)	6 (26.1%)
Cough test negative	16 (69.6%)	17 (73.9%)

SUI: stress urinary incontinence

Table 3. Comparison of demographic and operative variables according to 30th-day cough stress test results

Variable	Negative (n=17)	Positive (n=6)	p-value
Age (years)	55.3±4.8	63.5±3.8	0.001
BMI (kg/m²)	28.2±2.3	33.0±2.4	0.002
Operation time (minute)	34.5±3.1	45.7±1.8	<0.001

Values are presented as mean ± standard deviation. Statistical analysis was performed using the Independent Samples t-test; BMI: body mass index

DISCUSSION

In the present study, the midline approach for PUL plication was assessed. This technique, characterized by being less invasive and technically simpler, achieved a 73.9% success rate at 30 days based on the cough stress test. These findings provide preliminary evidence that the midline approach may be a promising short-term alternative and could be considered among mesh-free surgical options for the management of SUI. Short-term outcomes demonstrated that ULP with the midline approach increased continence rates from 69.6% on postoperative day 7 to 73.9% on day 30. This improvement may be explained, as described in the Autogenic Ligament Procedure, by the progressive collagen deposition in response to the foreign material that typically intensifies during the postoperative weeks.[9] In contrast, Petros and Palma[4] reported that 30 of 31 patients undergoing the original bilateral paraurethral approach achieved a negative cough stress test before hospital discharge, indicating a higher early success rate even prior to the onset of collagen formation. Although our final success rate appears lower, the improvement observed between the two postoperative assessments suggests that approximation of the lateral arms of the PUL with non-absorbable polyester sutures may stimulate collagen deposition around the ligamentous structures and immediately beneath the urethra, thereby progressively reducing urethral hypermobility. However, it is

important to emphasize that in Petros's original ULP technique, all four critical sites contributing to urethral function (the mid-urethra, the retropubic portion, the EUL, and the PCM) are repaired, whereas in our study only a single site—the retropubic portion—was addressed, which may have limited the overall effectiveness of the procedure.

Sivaslıoğlu et al.[10] reported a 12-month cure rate of 83% in their ULP series, whereas Brasoveanu et al.,[11] in their evaluation of long-term outcomes of TOT and ULP, reported a 70% improvement rate in 40 patients undergoing ULP. In our series, a continence rate of 73.9% was achieved in the early follow-up period. The higher long-term success rates reported by Sivaslıoğlu et al.[10] may be attributable to the experience level of the urogynecology teams involved or directly to the surgical technique, namely bilateral repair of the lateral, medial, and external arms of the PUL. In addition, the lower surgical response rates reported by Brasoveanu et al.[11] may be explained by the limited sample size and the short, one-month follow-up period in our study.

Brasoveanu et al.[11] performed the ULP procedure on an outpatient basis and reported a mean hospital stay of 1.02±0.15 days even in the TOT group. These findings suggest that ULP could potentially be performed rapidly and simply under local anesthesia, even in office-based settings, in the future. Although we propose that the midline approach to ULP is a simpler and less invasive technique, it should be noted that all operations in our series were performed by a single surgeon. This surgeon had commenced residency training in obstetrics and gynecology nine years earlier and had been practicing as a specialist for the past five years, yet had only recently begun performing this specific technique. Therefore, it is likely that the surgical learning curve influenced our results. Indeed, while Brasoveanu et al.[11] reported a mean operative time of 9.9 minutes in the ULP group, the mean operative time in our series was 37.4±5.7 minutes, and the mean hospital stay was 1.26±0.45 days, findings that can most probably be attributed to the same reason.

As is well known, the MUS provides a scaffold along its entire length, thereby creating a well-defined U-shaped neocollagenous PUL,[10] the midline ULP transmits tensile forces through a single suture knot passed from the lateral arms and tied beneath the urethra (Figure 2). In this setting, the central transmission of tension may initiate a localized, albeit limited, collagen response around the knot. Although this reaction would not reproduce the broad U-shaped structure obtained with a mesh tape, it may still result in a U-like collagen accumulation radiating from the knot and thereby prevent further elongation of the lax PUL. Nevertheless, this explanation has not been demonstrated histologically or radiologically in our study; however, the mechanism underlying SUI cure in the patients may plausibly have developed through this process. In our study, patients with treatment failure at day 30 had significantly higher age, BMI, and operative times, suggesting that elderly, obese patients and those with longer procedures may be at greater risk of short-term surgical failure. However, although all patients with failure were postmenopausal, menopausal status was not statistically associated with surgical outcomes (p=0.124), most likely due to the limited sample size. In our study, the choice of a midline approach may evoke the impression of a modification of the Kelly plication. In Kelly and Dumm's[12] procedure, sutures are placed in the periurethral tissues at the bladder neck, whereas in our technique the sutures are passed through the retropubic arms of the PUL and tied at the midline. This strategy aims not merely to narrow the bladder neck, but to restore the ligamentous support of the urethra.[12] Nevertheless, it is true that the concept of approaching ULP through the midline has its roots in the historical familiarity of the Kelly plication.

Study Limitations

This study has several limitations. First, the relatively small sample size and the evaluation of outcomes limited to a one-month follow-up restrict the generalizability of our findings. Moreover, all operations were performed by a single surgeon who had only recently begun performing this technique, and therefore the potential influence of the learning curve should be considered. Complication assessment was confined to the early postoperative period; thus, long-term complications such as dyspareunia or chronic pelvic pain could not be evaluated. Finally, no direct control group with MUS or other surgical techniques was included, and our results can therefore only be compared indirectly with those reported in the literature. Despite these limitations, the present study provides encouraging short-term results in a limited series; however, it should be regarded as a pilot investigation that requires confirmation with 12-month outcomes.

CONCLUSION

Although the initial results from this pilot series are encouraging, the small sample size and short follow-up remain important limitations. If long-term durability is confirmed in larger cohorts, ULP with the midline approach may represent a safe and simple alternative for the treatment of SUI.

ETHICS

Ethics Committee Approval: Ethical approval was obtained from the Kırşehir Ahi Evran University Faculty of Medicine

Health Sciences Scientific Research Ethics Committee (decision no: 2025-08/92, date: 29 April 2025).

Informed Consent: Written consent was obtained from the patient for the sharing of the photographs included in the original document.

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FOOTNOTES

Contributions

Surgical and Medical Practices: A.T., Concept: A.T., F.D., Design: A.T., Data Collection or Processing: A.T., Analysis or Interpretation: A.T., Literature Search: A.T., F.D., Writing: A.T., F.D.

DISCLOSURES

Conflict of Interest: No conflict of interest was declared by the authors.

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