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VAGINAL AND LABIAL GRAFT URETHROPLASTY IN FEMALE URETHRAL STRICTURE: A SYSTEMATIC REVIEW

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ABSTRACT
Female urethral stricture is considered a relatively uncommon clinical condition, and urethral dilatation has traditionally been the preferred treatment. In recent years, various reconstructive surgical techniques have emerged to provide more definitive management for this challenging group of patients, including the use of grafts in urethroplasty. This study aimed to review the use of vaginal and labial grafts in urethroplasty for female urethral stricture. A systematic review was conducted using PubMed and related databases to identify studies published between 2014 and April 2025. The results were classified according to surgical technique and type of graft used in augmentation urethroplasty. A total of seven studies involving 119 patients were included. The mean follow-up period was 13.55 months for labial grafts and 17.23 months for vaginal wall grafts. Labial grafts demonstrated slightly higher success rates (84%) compared to vaginal grafts (81.73%). In the vaginal graft group, incontinence and recurrence were reported in 17.5% of cases, while failed calibration occurred in 3.8% of patients in the labial graft group. No major donor-site complications were reported. Overall, both graft types provide feasible and safe options for managing female urethral stricture, with labial grafts showing slightly better outcomes.

Keywords: female urethral stricture; labial graft urethroplasty; vaginal wall graft urethroplasty

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INTRODUCTION

Urethral stricture in women is a relatively uncommon condition. Approximately 8% of women diagnosed with lower urinary tract symptoms (LUTS) are found to have bladder outlet obstruction, with 4–13% of these cases progressing to urethral stricture (Carr & Webster, 1996; Groutz et al., 2000; Kuo, 2005; Osman et al., 2013). The prevalence of idiopathic urethral stricture in women has been reported to range between 0.08% and 5.4% (Lumen et al., 2024). Female urethral stricture caused by iatrogenic factors accounts for approximately 24.1% of cases, most commonly related to prolonged catheterisation, while trauma contributes to 16.4% of cases. The incidence of this condition increases with advancing age, particularly after 64 years (Lumen et al., 2021). The limited volume of research and the relatively small number of documented cases have made the diagnosis and management of female urethral stricture particularly challenging.

The standard treatment for this condition is urethral dilation. However, urethral dilation is associated with high recurrence rates over time and may lead to the development of more complex strictures (Waterloos et al., 2021). Surgical intervention is therefore considered a superior treatment option, supported by outcomes from male urethral stricture management that have been successfully adapted and applied in female patients (Hoag & Chee, 2017; West & Lawrence, 2019).
In recent years, a variety of surgical techniques for the management of female urethral stricture have been developed. The European Association of Urology recommends augmentation urethroplasty for patients with recurrent urethral strictures and for those who are unable to perform

intermittent self-dilatation (Lumen et al., 2024). Augmentation urethroplasty may be performed using two principal approaches: a dorsal approach, involving stricturotomy at the 12 o'clock position, and a ventral approach, involving stricturotomy at the 6 o'clock position (Tsivian & Sidi, 2006; Hoag & Chee, 2017). Vaginal and labial grafts are commonly used owing to their close anatomical proximity to the urethra, which reduces donor-site morbidity and minimises associated complications (Chua et al., 2021). The objective of this study is to report the use of labial and vaginal grafts in urethroplasty for female urethral stricture, with particular emphasis on procedural efficacy and postoperative complications.

METHOD

Sources

In order to find high-quality literature, we followed the PRISMA standards (Preferred Reporting Items for Systematic Reviews and Meta-analysis) and included both retrospective and prospective research. A thorough electronic search was performed utilizing PubMed and several databases. The search criteria utilized were 'female urethral stricture' AND 'vaginal graft' AND 'labial graft' AND 'urethroplasty' AND 'outcomes' OR 'clinical manifestations' OR 'postoperative symptoms' OR 'recurrence' as of April 2025. Based on the comprehensive results, we narrowed the selection to articles pertaining to 'people, females, aged over 19 years, written in English, and published during the last 11 years.'

Study Selection

Our inclusion and exclusion criteria determine which articles or papers are chosen. Studies involving female urethral stricture, patients who had urethroplasty with vaginal or labial grafts, with a mean age of more than 19, are all required for inclusion. The following studies were excluded from the present analysis: those pertaining to urethral fistulas, concomitant underlying medical conditions (e.g. lichen sclerosis), diverticulum repair, congenital urethral abnormalities, post-pelvic fracture urethral loss and repeated urethroplasty. The rationale underlying the exclusion of these studies is that they did not meet the inclusion criterion of "female urethral stricture". Additionally, citations from conference proceedings and full-text publications that did not individually present the result data were disregarded. Review articles and meta-analyses were also not included. All studies or articles selected were accessible and were reviewed individually by the authors. Participants in this review consisted of women diagnosed with urethral stricture. The interventions evaluated were urethroplasty procedures using either vaginal grafts or labial grafts. The comparison focused on the efficacy and success rates between the different graft types. Outcome measurements included improvement of clinical symptoms, recurrence rate, stricture-free rate, and postoperative complications.

Data Extraction and Quality Assessment

The authors independently performed the review and screening process. Data extracted included participant characteristics, details of the intervention, outcome assessment tools, and reported results. Treatment success was defined as the absence of any requirement for further intervention or surgery following the primary procedure. To minimise the risk of bias, the Joanna Briggs Institute (JBI) critical appraisal tool for case series was used for quality assessment (Mcarthur et al., 2020).

Evidence Synthesis

We performed electronic database searches (PubMed and various references) and originally identified 198 publications (Fig. 1). The quantity was reduced to 70 pieces. In total, 42 articles were excluded because they were either duplicate or non-english articles. A total of 28 articles were selected individually to assess whether they met the inclusion criteria. The final outcome comprised seven articles evaluated appropriate for inclusion in the review. These seven studies documented

119 individual patients who underwent vaginal and labial graft urethroplasty, together with the recorded outcome metrics.

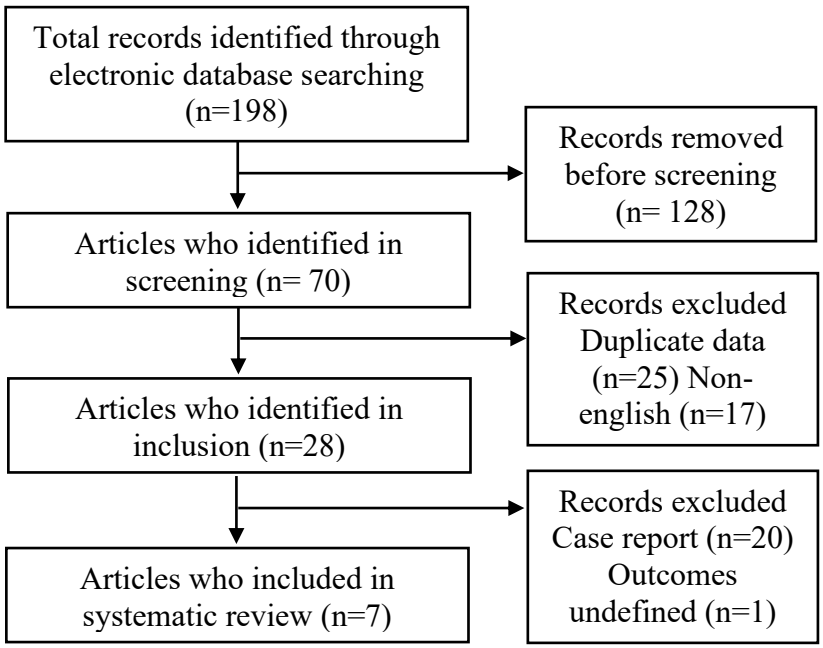

Figure 1. PRISMA flow diagram of study selection process for the systematic review of vaginal and labial graft urethroplasty in female urethral stricture.

RESULT

Quality

Two of the seven studies were prospective, while the remainder were retrospective (Table 1). The confirmation of the diagnosis was made clinically and by other methods, such as voiding cystourethrography (VCUG), cystourethroscopy, urethral calibration, and urodynamic study (UDS), or a combination of these modalities. In all the studies, the outcomes were assessed using valid instruments, both subjectively and objectively. The majority of the studies had a well-described follow-up period of more than one year, with a few having a follow-up period of less than a year.

Table 1.
Characteristics, methodological quality assessment, and clinical details of the included studies

Author(s), publication date, title, DOI, and number of participants	JBI Critical Appraisal	Etiology	Graft and Location of Stricture	Methods and Follow-up	Diagnostic	Outcomes and Complications
Manasa et al. (2019) *Dorsal onlay graft urethroplasty for female urethral stricture improves sexual function: Short-term results of a prospective study using vaginal*	Clear criteria for inclusion/exclusion: Yes Condition measured in a standard way: Yes Valid methods used for identification: Yes Consecutive inclusion: Yes Complete inclusion: Yes Clear reporting of demographic:	Undefined	Vaginal wall graft Location: Mid urethra (n = 11), distal urethra (n = 2) Average length of stricture: 1–2 cm	Prospective observational study. Inclusion criteria: LUTS with cystoscopy confirmed. Exclusion criteria: Neurogenic bladder, prior urethral surgery, pelvic/urethral fracture, and genitourinary malignancy. Surgical	Calibration: All UDS: All VCUG: All Cytoscopy: All	Outcomes were measured using IPSS score, uroflowmetry, and PVR estimation. Sexual function was assessed using the FSFI score. Success: Improvement of Qmax > 20 mL/s without instrumentation after 6

Author(s), publication date, title, DOI, and number of participants	JBI Critical Appraisal	Etiology	Graft and Location of Stricture	Methods and Follow-up	Diagnostic	Outcomes and Complications
graft	No Clear reporting of clinical information of the participants: Yes Outcomes or follow-up results reported: Yes Clear reporting of the presenting sites/clinics: Yes Appropriate statistical analysis: Yes Oxford Level: 4			intervention: Dorsal onlay vaginal graft urethroplasty. Mean follow-up: 8.5 months.		months (n = 10). Failure: No improvement after 6 months (n = 3). Sexual function improved. No postoperative incontinence was reported. Recurrence was found in three patients.
Al-Misbah et al. (2023) *Labial mucosal substitution urethroplasty for female urethral stricture: A sustainable technique* N = 60	Clear criteria for inclusion/exclusion: No Condition measured in a standard way: Yes Valid methods used for identification: Yes Consecutive inclusion: No Complete inclusion: Yes Clear reporting of demographic: Yes Clear reporting of clinical information of the participants: Yes Outcomes or follow-up results reported: Yes Clear reporting of the presenting sites/clinics: Yes Appropriate statistical analysis: Yes	Idiopathic (31; 51.67%), iatrogenic (20; 33.33%), traumatic (4; 6.67%), and recurrent (nonspecific) urethritis (5; 8.33%).	Labia minora graft Location: Proximal urethra Average length of stricture: Unclear	Retrospective study. Inclusion criteria: LUTS with clinical examination confirmed. Exclusion criteria: Unclear. Surgical intervention: Dorsal inlay labia minora graft urethroplasty. Mean follow-up: 12 months.	Symptoms assessment: All Cystoscopy: All Routine urine test: All Urine culture: All Creatinine: All Uroflowmetry: All Ultrasound (USG) of KUB region: All MCC: All PVR: All Voiding cystourethrogram (VCUG): All	Outcomes were measured using physical examination, uroflowmetry, ultrasound (USG) of the KUB region with MCC and PVR, and urine RME and culture/sensitivity tests. Success: Normalization of flow rate and PVR, resolution of symptoms, and no recurrence. Failure: No improvement and recurrent stricture. All patients showed good outcomes during the 1-year follow-up, with a success rate of 100%. After 2 years, two patients reported stricture recurrence at the proximal graft site and were managed with urethral

Author(s), publication date, title, DOI, and number of participants	JBI Critical Appraisal	Etiology	Graft and Location of Stricture	Methods and Follow-up	Diagnostic	Outcomes and Complications
						calibration. The postoperative Qmax was 24.48 mL/s, indicating improvement.
Sahin et al. (2022) *Female urethral stricture: Which one is stronger? Labial vs buccal graft* N = 14	Clear criteria for inclusion/exclusion: Yes Condition measured in a standard way: Yes Valid methods used for identification: Yes Consecutive inclusion: Yes Complete inclusion: Yes Clear reporting of demographic: Yes Clear reporting of clinical information of the participants: Yes Outcomes or follow-up results reported: Yes Clear reporting of the presenting sites/clinics: Yes Appropriate statistical analysis: Yes	Undefined.	Labia majora graft Buccal graft Location: Unclear Average length of stricture: 2.19 cm (range 1.2–2.5 cm)	Retrospective study. Inclusion criteria: Patients with long-segment stenosis who had undergone labial graft urethroplasty and agreed to participate. Exclusion criteria: Patients who did not agree to participate. Surgical intervention: Dorsal onlay labia majora graft urethroplasty. Mean follow-up: 12 months.	Symptoms assessment: All Complete Urinalysis: All Urine culture: All Uroflowmetry: All PVR: All Cytoscopy: All	Outcomes were measured using uroflowmetry, residual urine volume, and patient satisfaction rates. Success: Improvement in symptoms at the 1st, 3rd, and 12th months. Failure: Development of complications. All operations were successful. Post-treatment Qmax values at the 1st, 3rd, and 12th months were 20 mL/s, 24 mL/s, and 24 mL/s, respectively. All patients reported extreme satisfaction.
Hussain et al. (2024) *Substitution urethroplasty in female urethral stricture: Our initial experience* N = 20	Clear criteria for inclusion/exclusion Y Condition measured in a standard way Y Valid methods used for identification Y Consecutive Inclusion Y Complete inclusion Y Clear reporting of demographic	Undefined.	Vaginal Wall Graft (n=8) Labial skin graft (n=4) Buccal mucos al graft (n=8) Locatio n: Mid urethra (n=6), Distal urethra (n=14) Averag e	Prospective study. Inclusion criteria: LUTS confirmed by ultrasound (USG) of the KUB region, urethroscopy, uroflowmetry, and voiding cystourethrography. Exclusion criteria:	Symptoms assessment: All USG in KUB region: All Urethroscopy: All Uroflowmetry: All Voiding cystourethrography: All Callibration: All	Outcomes were measured using physical examination, uroflowmetry, and PVR estimation. Success: Improvement in symptoms and post-voiding flow. Failure: No improvement and failed

Author(s), publication date, title, DOI, and number of participants	JBI Critical Appraisal	Etiology	Graft and Location of Stricture	Methods and Follow-up	Diagnostic	Outcomes and Complications
	Y Clear reporting of clinical information of the participants Y Outcomes or follow-up results reported Y Clear reporting of the presenting sites/clinics Y Appropriate statistical analysis Y		length of stricture: Unclear	Complete urethral obstruction and simultaneous bladder pathology. Surgical interventions: • Ventral onlay vaginal flap urethroplasty (n = 4) • Dorsal vaginal mucosal graft urethroplasty (n = 4) • Dorsal labia minora graft urethroplasty (n = 4) • Dorsal buccal mucosal graft urethroplasty (n = 8) Mean follow-up: 12 months.		calibration. Two patients in the labia minora group experienced difficult calibration and required dilatation, which were counted as failed cases. Success rates were 75% for vaginal grafts, 75% for buccal mucosa grafts, and 50% for labia minora grafts. Buccal mucosa and vaginal grafts showed the best results.
Kaushal et al. (2018) *Dorsal onlay vaginal mucosal graft urethroplasty for refractory female urethral stricture* N = 8	Clear criteria for inclusion/exclusion N Condition measured in a standard way Y Valid methods used for identification Y Consecutive Inclusion Y Complete inclusion Y Clear reporting of demographic Y Clear reporting of clinical information of the participants Y Outcomes or follow-up results reported Y	Unclear	Vaginal wall graft Location: Unclear Average length of stricture: Unclear	Retrospective study. Inclusion criteria: LUTS, PVR, micturating cystourethrogram (MCU), history of UTIs, relevant upper urinary tract imaging, and urethral caliber < 12 Fr. Exclusion criteria: Patients who did not meet the inclusion criteria. Surgical intervention: Dorsal onlay vaginal graft	Symptoms assessment: All Uroflowmetry: All Post-void residual urine volumes: All Micturating Cystourethrogram (MCU): All Urethral Calibration: All Ultrasonography: All QOL questionnaire (‘PGI-S’ scale): All	Outcomes were measured using PVR, MVU, incidence of UTIs, and the need for repeated urethral dilatation or other therapies for urethral stricture. Success criteria: Improvement in symptoms, no recurrence, and no need for additional therapy. Failure: No sign of improvement.

Author(s), publication date, title, DOI, and number of participants	JBI Critical Appraisal	Etiology	Graft and Location of Stricture	Methods and Follow-up	Diagnostic	Outcomes and Complications
	Clear reporting of the presenting sites/clinics Y Appropriate statistical analysis Y			urethroplasty. Mean follow-up: 22.4 months.		Two patients experienced urgency incontinence, which resolved in a short period. Two patients required post-urethroplasty urethral dilatation, and one of them underwent redo urethroplasty using a buccal graft. The PGI-I score showed that four patients scored 1 (very much better), three scored 2 (much better), and one scored 3 (a little better); none scored 4 (no change) or 5 (a little worse). PVR and Qmax improved from 165.12 mL and 5.4 mL/s preoperatively to 32.12 mL and 19.03 mL/s postoperatively, respectively. The overall success rate was 75%.
Kore et al. (2022) *Dorsal onlay urethroplasty using buccal mucosal graft and vaginal wall graft*	Clear criteria for inclusion/exclusion N Condition measured in a standard way Y Valid methods used for identification Y Consecutive Inclusion Y	Post caruncle excision (1), postcatheter (2), idiopathic (3), Post-TURPT (1), Postdiverticulect omy (1), and postsling (1).	Vaginal wall graft Buccal mucosal graft Location: Buccal mucosal graft (BMG): • Mi	Retrospective study. Inclusion criteria: LUTS according to AUA, confirmed by uroflowmetry, voiding assessment, and cystoscopy.	Symptoms assessment: All Cystoscopy: All Uroflowmetry: All Post-void residual urine volumes: All VCUG: All Calibration:	Overall PVR decreased from 185 mL to 17 mL, while Qmax increased from 4 mL/s to 26 mL/s. In the BMG group, the AUA symptom

Author(s), publication date, title, DOI, and number of participants	JBI Critical Appraisal	Etiology	Graft and Location of Stricture	Methods and Follow-up	Diagnostic	Outcomes and Complications
for female urethral stricture: Outcome of a two-institution study N = 32	Complete inclusion Y Clear reporting of demographic Y Clear reporting of clinical information of the participants Y Outcomes or follow-up results reported Y Clear reporting of the presenting sites/clinics Y Appropriate statistical analysis Y		d urethra (n = 5) • Distal urethra (n = 1) • Distal to mid urethra (n = 9) • Mid to proximal urethra (n = 5) • Pan-urethra (n = 1) Vaginal wall graft (VWG): • Mid urethra (n = 1) • Distal urethra (n = 0) • Distal to mid urethra (n = 7) • Mid to proximal urethra (n = 1) • Pan-urethra (n = 2) Average length of stricture: 1.6 cm (BMG) and 1.7 cm (VWG).	Exclusion criteria: Unclear. Surgical interventions: • Dorsal onlay vaginal wall graft urethroplasty (n = 11) • Dorsal onlay buccal mucosal graft urethroplasty (n = 21) Mean follow-up: 26 months.	All	score improved from 21 to 5. In the VWG group, the AUA symptom score improved from 23 to 7. Dysuria was observed in two patients in the BMG group (6%) at the 3- and 6-month follow-up. Five patients in the VWG group reported mild complications (Clavien–Dindo Grade I or II), including transient dysuria, dyspareunia, and UTIs. The overall patency rate was 94%. No statistically significant difference was found between the two groups. Donor-site complications were reported in the BMG group (n = 3).
Önol et al. (2014) *Ventral inlay labia minora graft urethroplasty for the management of*	Clear criteria for inclusion/exclusion: Yes Condition measured in a standard way: Yes Valid methods used for identification:	Urethral caruncle excision (2), idiopathic (5).	Labia minora graft Location: Middle and proximal urethra (n = 1), middle urethra (n = 1), and middle and	Labia minora graft Location: Middle and proximal urethra (n = 1), middle urethra (n = 1), and middle and distal urethra (n = 5)	AUA symptom score: All Urine analysis: All Uroflowmetry: All PVR: All Voiding Cystourethrography: All Urethral	Outcomes were measured by assessment of voiding symptoms and uroflowmetric studies with PVR. Success criteria:

Author(s), publication date, title, DOI, and number of participants	JBI Critical Appraisal	Etiology	Graft and Location of Stricture	Methods and Follow-up	Diagnostic	Outcomes and Complications
female urethral strictures N = 7	Yes Consecutive inclusion: Yes Complete inclusion: Yes Clear reporting of demographic: Yes Clear reporting of clinical information of the participants: Yes Outcomes or follow-up results reported: Yes Clear reporting of the presenting sites/clinics: Yes Appropriate statistical analysis: Yes		distal urethra (n = 5) Average length of stricture: 1.5 cm	Average length of stricture: 1.5 cm	calibration: All	Maximum urinary flow rate > 15 mL/s with a normal-appearing flow curve and no need for additional intervention. Failure: Recurrence of stricture requiring additional intervention. One patient experienced a gradual decrease in urinary flow after 6 months and underwent internal urethrotomy. A urinary tract infection occurred in one patient and was successfully treated with antibiotics. Maximum urinary flow increased from a mean of 3.9 mL/s to 22.7 mL/s. De novo urinary incontinence was not observed. Mean AUA score decreased from 25.3 to 6.9. No fistula was reported. The overall success rate was 86%.

Etiology and Clinical Diagnostic

The etiology of urethral stricture varied across the included studies. Four studies did not clearly define the exact etiology of the stricture (Manasa et al., 2019; Hussain et al., 2024; Sahin &

Yesildal, 2022; Kaushal et al., 2018). Only three studies reported the underlying etiology, which included trauma (5.3%), iatrogenic causes (33%), idiopathic factors (56%), and urethritis (6.67%) (Al-misbah et al., 2023; Önol et al., 2014; Kore & Martins, 2022). Based on these findings, idiopathic causes accounted for the majority of female urethral stricture cases in this study.

Table 2 summarises the clinical diagnostic modalities utilised in the included studies. Urethral calibration and uroflowmetry were the most frequently performed diagnostic tests. Female urethral stricture was diagnosed using urethral calibration thresholds of less than 8 Fr or 12 Fr (Al-misbah et al., 2023; Hussain et al., 2024; Kaushal et al., 2018). One study used a urine flow rate of less than 12 mL/s as a criterion for lower urinary tract symptoms (LUTS) (Hussain et al., 2024). Cystoscopy and cystourethroscopy were the second most commonly utilised diagnostic modalities, with visual confirmation of anatomical narrowing of the urethral lumen establishing the diagnosis of female urethral stricture. Several studies employed symptom-based assessment tools, including American Urological Association (AUA) symptom scores, maximum cystometric capacity (MCC), and quality-of-life (QoL) measures. Additional diagnostic criteria included a narrowed urethra with proximal dilatation observed on a micturating cystourethrogram, elevated post-void residual volume on ultrasonography, and a urine flow rate of less than 10 mL/s (Al-misbah et al., 2023).

Table 2.
Diagnostic investigations used for identifying female urethral stricture across the included studies

Investigation	Number of Studies
Urethral Callibration	6
PVR Estimation	4
Uroflowmetry and Qmax	6
Voiding cystourethrography	4
USG-KUB	3
Urodynamics	1
Routine Urine Test/ Urinalysis	2
AUA Symptoms Score	1
Cystourethroscopy / Cystoscopy	5
Urine Culture	2
Quality of Life Score	1
MCC	1
MCU	2

Augmentation Urethroplasty

The goal of female urethral reconstruction is to preserve urethral continence and restore function. Graft augmentation urethroplasty, in particular, has become increasingly popular. Local tissue (labial, vaginal) and mouth mucosa (lingual, buccal) can be used to create free grafts. The most popular urethroplasty method was either a labial or vaginal flap. The flap or graft is placed in the urethra either ventrally (6 o'clock position) or dorsally (12 o'clock position) to complete the augmentation. The investigations evaluated the results using a variety of subjective and objective criteria. The symptoms were subjective, and the degree was assessed using a variety of quantitative techniques (e.g., sexual function questionnaires, Likert scale, AUA score, and PGI/S scale). Uroflowmetry, PVR, urethral calibre size, cystourethroscopic findings, UDS, and VCUG were the objective parameters that were measured. Table 3 displayed the results of each graft.

There were 119 individuals who had augmentation urethroplasty in total. Overall, 40 patients got vaginal graft urethroplasty, according to four studies, and 89 patients underwent labial graft urethroplasty, according to four further studies. In one study, labial and vaginal graft were used in the operation. Dorsal onlay, dorsal inlay, and ventral onlay were included in the overall surgical strategy.

Table 3.
Summary of augmentation urethroplasty techniques, number of interventions, success rates, and follow-up duration by graft type

Technique Used	No. of studies	No. of interventions	Mean Success Rate in %	Mean Follow-up in Months
Vaginal graft urethroplasty	4*	40	82%	17.23
Labial graft urethroplasty	4*	79	84 %	13.55

*There were one studies included both graft.

Outcomes of Vaginal Graft

Total of 4 studies with 40 of patients are reported in this systematic review. Previous intervention was noted in all case series, with all the patients had been through urethral dilatation and urethrotomy. Due to the failed interventions, all the patients undergone augmentation urethroplasty and used the local graft which is vaginal graft (Table 4). The technique which had been used are dorsal onlay, ventral onlay, and anterior u-shaped, Three studies had additional intervention for the patients who failed the urethroplasty.

Table 4.
Clinical outcomes, complications, and follow-up results of vaginal graft urethroplasty in the included studies

Study	No. of patien ts	Previous interventio n	Technique	Interventio n Post-operation	Stricture Free (%)	De Novo Incontinen ce	Recurren ce	Other Complicatio ns	Mean of Follow -up
Manasa *et al.*	13	Urethral dilatation (all)	Dorsal onlay vaginal graft urethroplas ty	Buccal mucosal graft urethroplas ty (n=2), urethrotom y (n=1)	76.92	No	Yes (n=3)	No	8.5 months
Hussain *et al.*	8	Repeated urethral dilatation or urethroto my	Ventral Onlay Vaginal Flap (n=4) Dorsal Vaginal Mucosa Graft (N=4	Urethral dilatation (n=1)	75	No	No	No	12 months
Kaushal *et al.*	8	Urethral dilatation (all)	Dorsal onlay vaginal graft urethroplas ty	Urethral dilatation (n=1), buccal graft urethroplas ty (n=1)	75	Urgency incontinen ce (n=2)	Yes (n=2)	No	22.4 months
Kore *et al.*	11	Urethral dilatation and urethroto my (n=1)	Dorsal onlay vaginal wall graft urethroplas ty	No	100	No	No	Mild complicatio ns (Clavien–Dindo Grade I or II), such as transient dysuria, dyspareunia , and UTIs	26 months
Total	40				82				17.23 months.

In dorsal technique, The urethra was dissected dorally and laterally from 3 to 9 o'clock through an inverted U-shaped incision, and a periurethral plane was developed with care to avoid damage to

the bulb and the clitoral body by staying close to the fibrous tissue of the urethra. This dissection was carried out to the level of the bladder neck to allow identification of the full extent of the stricture which was then sharply incised with scissors in the midline (at 12 o'clock position) dorsally. Stay sutures were placed at urethral angles to help in dissection and to facilitate placement of the graft. The urethra was again calibrated with an 18 Fr Foley catheter to ascertain that there was no residual proximal stenosis. The graft was harvested from the anterior vaginal wall. Kore and Kaushal used the same technique, but with a semilunar circum-meatal incision from 9 o'clock to 3 o'clock. The urethra was then incised in the midline dorsally starting from the meatus through the strictured segment till a dilated proximal urethra was reached. The graft was quilted to the clitoral cavernosal bed using interrupted sutures, followed by closure of the introital mucosa (Kaushal et al., 2018; Kore & Martins, 2022). The grafts used were fashioned in a scaphoid shape to prevent unnecessary urethral widening (Manasa et al., 2019). Hussain et al. employed a technique similar to that described by Kore and Martins, including the incision approach, with the graft harvested from the lateral and anterior vaginal wall (Hussain et al., 2024).

The ventral onlay approach was reported in only one study (Hussain et al., 2024). In this technique, a ventral midline urethrotomy was performed until the urethra was adequately opened to a normal calibre. A U-shaped incision was then made in the adjacent cephalad vaginal wall, and a vaginal flap was raised. After mobilisation, the flap was rotated distally and sutured to the urethral margins as an onlay over a Foley catheter. Another ventral technique described was the anterior U-shaped flap approach, in which two parallel incisions were made in the anterior vaginal wall around the urethral meatus. The vaginal walls were subsequently dissected and flipped upwards. The distal end of the vaginal flap was anastomosed to the proximal urethra, and the inner surface of the flap was tubularised over a larger Foley catheter (20 Fr).

De novo incontinence was reported in one study, while urgency incontinence occurred in two patients and resolved within a short period (Kaushal et al., 2018). Recurrence was documented in two studies, in which patients required additional interventions such as urethral dilatation, urethrotomy, and buccal mucosal graft urethroplasty (Manasa et al., 2019; Hussain et al., 2024; Kaushal et al., 2018). Kore and Martins (2022) reported other complications classified as Clavien–Dindo grade I or II, including transient dysuria, dyspareunia, and urinary tract infections (n = 5). One patient experienced a decrease in urinary flow six weeks after vaginal wall graft (VWG) urethroplasty, which subsequently stabilized with a Qmax of 12 mL/s and a postvoid residual (PVR) volume of 60 mL, with an average voided volume of 220 mL (Kore & Martins, 2022). All studies demonstrated satisfactory success rates (76.92%, 75%, 75%, and 100%, respectively) (Manasa et al., 2019; Hussain et al., 2024; Kaushal et al., 2018; Kore & Martins, 2022). Overall, the mean follow-up duration was 18.73 months, and the pooled success rate of vaginal graft urethroplasty was 81.73%. Although definitions of success varied among studies, most considered incontinence and recurrence as indicators of failure. Sexual function also improved significantly, as reflected by an increase in Female Sexual Function Index (FSFI) scores with an average gain of 6.42 points (Manasa et al., 2019).

Outcomes of Labial Graft

The table shows four studies involving a total of 79 patients in whom labial tissue was harvested. Sahin and Yesildal (2022) reported that their patients had undergone internal urethrotomy between a minimum of three and a maximum of five times prior to urethroplasty (n = 8). Meanwhile, another study documented a history of previous urethral dilatation or internal urethrotomy but did not specify the exact number of patients who had received these prior interventions (Hussain et al., 2024). Önol et al. (2014) further described that five out of seven patients in their case series had undergone previous treatments, including urethral dilatation (n = 2), urethrotomy (n = 1), or a combination of both procedures (n = 2). Four studies employed the dorsal onlay technique, one study used the dorsal inlay technique, and one study adopted the ventral inlay technique. The dorsal

inlay approach was selected because of its advantages, including a reduced risk of wound infection and urethrovaginal fistula, as well as preservation of the anterior vaginal wall to minimize the risk of postoperative incontinence. Following dorsal inlay substitution urethroplasty, a transient mild catheter was placed and fixed to the lower abdomen to prevent sub-graft hematoma formation and to improve graft survival (Al-Misbah et al., 2023).

The dorsal onlay technique typically began with a U-shaped incision below the clitoris, followed by dorsal urethral wall incision at the 12 o'clock position. In one study, a tongue-shaped pedicle flap was sutured to the margins of the urethrotomy defect, with tissue harvested from the labia minora and majora. This dorsal approach requires greater surgical expertise and experience due to its technical complexity, and special care is needed to protect the clitoral body (Sahin & Yesildal, 2022; Hussain et al., 2024). In contrast, the ventral approach is considered technically easier because of better accessibility. However, the ventral region has less supporting tissue than the dorsal region, increasing the risk of urethrovaginal fistula. Furthermore, concerns have been raised that age-related incontinence and the involvement of the ventral area in surgical reconstruction may complicate the procedure and raise the complication rate, making this approach less preferred (Sahin & Yesildal, 2022; Hussain et al., 2024).

Table 5.
Clinical outcomes, complications, and follow-up results of labial graft urethroplasty in the included studies

Study	No. of patients	Previous intervention	Technique	Post-operation Intervention	Stricture Free (%)	De Novo Incontinence	Recurrence	Other Complications	Mean of Follow-up
AL-Misbah *et al.*	60	No	Dorsal Inlay Labial Minora Graft Urethroplasty	No	100	No	No	No	12 months
Sahin *et al.*	8	Internal Urethrotomy with minimum of 3 and a maximum 5 times (all)	Dorsal Onlay Labial Major Graft Urethroplasty	No	100	No	No	No	12 months
Hussain *et al*	4	Urethral dilatation or internal urethrotomy	Dorsal Onlay Labia Minora Graft Urethroplasty	Urethral dilatation and self-calibration (n=2)	50	No	Yes (n=2)	No	12 months
Önol *et al*	7	Dilatation (n=2), urethrotomy (n=1), dilatation and urethrotomy (n=2)	Ventral Inlay Labia Minora Graft urethroplasty	Internal urethrotomy (n=1)	86	No	Yes (n=1)	No	18.2 months
Total	79				84				13.55

In another study, the ventral inlay technique was initiated by exposing the ventral urethra, with the proximal incision starting from the external meatus and extending toward the bladder neck. The fibrotic urethra was incised in the midline at the 6 o'clock position and extended several millimeters into healthy mucosa at both distal and proximal ends. The graft was then augmented to the urethra as a ventral inlay (Önol et al., 2014). Most studies reported excellent success rates, except for one study in which two patients in the labia minora graft group experienced difficulty during calibration and required subsequent urethral dilatation. Two failed cases in the labia minora graft group continued management with repeated dilatation and self-calibration (Hussain et al., 2024). Table 5 summarizes the success rates reported in each study. Urinary incontinence was not observed in any of the included studies. In the labial graft group, cases of recurrence were managed with urethral dilatation, internal urethrotomy, and self-calibration, with internal urethrotomy performed after six months of follow-up (Önol et al., 2014; Hussain et al., 2024). The mean follow-up duration in the labial graft group was 13.35 months, with an overall success rate of 84%.

DISCUSSION

Urethral stricture is defined as a narrowing of the urethral lumen caused by fibrosis and scar formation. Female urethral stricture (FUS) has become increasingly recognized due to greater clinical awareness, particularly among patients presenting with bladder outlet obstruction (BOO) (Chua et al., 2021). Nevertheless, FUS is considered uncommon for several reasons, primarily related to anatomical differences between males and females. The female urethra is approximately 4 cm in length and 6 mm in diameter and is composed of an inner longitudinal mucosal layer and an outer circular smooth muscle layer, which are continuous with the bladder mucosa and the internal urethral sphincter (Chua et al., 2021).

The female urethra has a wider diameter and less well-developed smooth muscle, resulting in a lower tendency toward fibrosis compared with the male urethra. In contrast, the male urethra is more susceptible to smooth muscle loss following injury and demonstrates qualitatively higher levels of spongiofibrosis in affected segments (Gundogdu et al., 2023; Hadidi, 2013). Female urethral stricture is frequently underdiagnosed because its symptoms may mimic other conditions such as urinary tract infections, interstitial cystitis, or vaginal atrophy. Consequently, many women do not seek medical attention until the disease has progressed to a more advanced stage.

The etiology of female urethral stricture (FUS) includes iatrogenic factors, chronic cystitis and urethritis, idiopathic causes, trauma, and inflammatory conditions. A substantial proportion of strictures are iatrogenic in nature and result from medical interventions. These include prolonged catheterization, repeated urethral instrumentation, urogynecological procedures such as urethral diverticulum repair and sling surgery, vaginal delivery, pelvic radiation, and urethral dilatation (Faiena et al., 2016; Peyronnet et al., 2024). In this review, idiopathic etiology emerged as the most common cause of FUS. Bain et al. (2025) reported that idiopathic strictures accounted for 59% of cases in their cohort. Similarly, several reviews have demonstrated that idiopathic causes ranged from 42% to 49%, while one study documented that 51.3% of FUS cases were idiopathic (Spilotros et al., 2017; Smith et al., 2006; Sarin et al., 2021).

As previously mentioned, female urethral stricture (FUS) is frequently underdiagnosed because its symptoms overlap with those of other forms of bladder outlet obstruction (BOO). Lower urinary tract symptoms (LUTS) are the most common clinical manifestations, including weak urinary stream, incomplete bladder emptying, straining, nocturia, and urinary retention (Al-Misbah et al., 2023). Physical examination therefore plays a crucial role in the diagnostic process. Most studies established the diagnosis based on urethral calibration and uroflowmetry. Additional investigations, such as endourethral ultrasonography, urinalysis, voiding cystourethrography (VCUG), cystourethroscopy, and the American Urological Association (AUA) symptom score, were used to exclude other associated urethral abnormalities.

Cystourethroscopy and VCUG are diagnostic modalities that can confirm both the presence and anatomical location of urethral strictures, allowing a definitive diagnosis to be made. Although cystourethroscopy provides limited information regarding stricture length, it remains an effective method for identifying urethral narrowing (Agochukwu-Mmonu et al., 2019). Manasa et al. (2019) diagnosed FUS based on direct visualization of anatomical narrowing of the urethral lumen during cystoscopy. When a stricture was identified, a pediatric cystoscope was used to assess its extent, measuring either 13 Fr or 9.5 Fr depending on the lumen diameter. The use of a pediatric cystoscope or ureteroscope has been recommended as a reliable approach for determining stricture length.

Flow rate and postvoid residual (PVR) volume assessment are logical initial noninvasive screening tools and allow for straightforward monitoring of treatment outcomes. However, several studies have reported variability in the maximum uroflowmetry threshold for diagnosing FUS, with cutoff values ranging from less than 10 mL/s to 20 mL/s (Al-Misbah et al., 2023; Manasa et al., 2019; Hussain et al., 2024). Urethral calibration represents a simple and early method to evaluate urethral lumen diameter. Thresholds between 12 and 20 Fr have been proposed by different authors, although most agree on a cutoff of approximately 14 Fr (Khattar et al., 2021).

Magnetic resonance imaging (MRI) was not routinely used in all studies; however, it may be valuable in identifying alternative etiologies. Conditions such as primary urethral tumors, periurethral fibrosis, and other pathologies that mimic urethral stricture can be detected using MRI (Agochukwu-Mmonu et al., 2019). Computed tomography (CT) urethrography may also assist in three-dimensional evaluation and offers the additional advantage of simulating urethroscopic assessment through a technique known as CT virtual urethroscopy (CTVU) (Agochukwu-Mmonu et al., 2019; Theisen et al., 2016).

The primary management of female urethral stricture (FUS) consists of two main approaches: endoscopic treatment and open surgical procedures (Waterloos et al., 2021; West & Lawrence, 2019). Urethral dilatation and internal urethrotomy are commonly used as initial management strategies prior to definitive urethroplasty. In one series involving seven women with urethral stricture, urethral dilatation up to 30 Fr followed by clean intermittent catheterization resulted in three out of seven patients requiring multiple repeat dilatations (Smith et al., 2006). Internal urethrotomy has also been proposed as an initial treatment option; however, no studies were identified that clearly described its standardized application or long-term outcomes. Massey and Abrams (1988) reported symptomatic improvement in 80% of patients who underwent internal urethrotomy or urethral dilatation, although it remains uncertain whether these patients had true anatomical urethral strictures.

A strong recommendation has been made for urethroplasty after a single failed conservative or endoscopic treatment for female urethral stricture (FUS) (Lumen et al., 2024). Surgical reconstruction is generally performed using two main approaches: ventral and dorsal. The ventral approach corresponds to the posterior aspect of the urethra oriented toward the vagina at the 6 o’clock position, whereas the dorsal approach is directed toward the pubic bone at the 12 o’clock position. Most authors have favored the dorsal onlay technique (Manasa et al., 2019; Hussain et al., 2024; Kaushal et al., 2018; Kore & Martins, 2022).

The dorsal approach offers several potential advantages, including avoidance of a vaginal incision and its associated postoperative complications, such as urethrovaginal fistula formation and wound-related problems (Hoag & Chee, 2017). In addition, dorsally placed grafts provide stronger mechanical support, maximize graft surface contact, and benefit from good vascularization supplied by the cavernous tissue, thereby reducing the risk of diverticulum formation (Faiena et al., 2016). Nevertheless, the dorsal technique is not without limitations. Reported complications include

intraoperative bleeding, possible injury to the clitoral structures, and damage to the urethral sphincter mechanism (Hoag & Chee, 2017).

The ventral approach was employed in two studies. This technique was selected because it is technically simpler and requires less urethral mobilization, thereby reducing the risk of urethral devascularization (Faiena et al., 2016; Hoag & Chee, 2017). By avoiding dorsal urethral dissection, the ventral route preserves the clitoral neurovascular structures and may consequently decrease the likelihood of postoperative sexual dysfunction (Faiena et al., 2016; Hoag & Chee, 2017). Furthermore, this approach provides direct access to the ventral urethra through a surgical dissection plane that is familiar to most surgeons (Peyronnet et al., 2024).

Augmentation urethroplasty has emerged as the primary treatment modality in recent years and is performed using either flap or graft techniques. Free grafts can be harvested from several donor sites, including the labia minora or majora, vaginal mucosa, and oral (buccal) mucosa (Khattar et al., 2021). Labial and vaginal grafts are considered local grafts that are relatively easy to harvest and require shorter operative time, thereby minimizing donor-site morbidity (Manasa et al., 2019). These grafts are also associated with fewer complications at the donor site compared with oral grafts. Buccal mucosa grafts are more frequently used in male urethral reconstruction but remain an important option in female urethroplasty. Buccal mucosal grafts are regarded as the optimal choice when vaginal or labial tissue cannot be utilized because of significant local tissue fibrosis or resistance (Sarin et al., 2021).

Vaginal graft urethroplasty was first introduced by Tsivian and Sidi (2006), who aimed to utilize a locally harvested graft rather than oral mucosa. They successfully performed dorsal onlay vaginal urethroplasty using this technique (Tsivian & Sidi, 2006). Vaginal grafts subsequently became recognized as an optimal reconstructive option because of their favorable characteristics, including hairlessness, ease of harvesting from the lateral or anterior vaginal wall, minimal donor-site morbidity, and technical simplicity. In addition, vaginal tissue possesses a dense epithelium with abundant elastic fibers, maintains natural moisture, and demonstrates resistance to infection (Petrou et al., 2012).

Petrou et al. (2012) further validated the dorsal onlay vaginal graft technique originally described by Tsivian and Sidi, reporting an 82% improvement rate with no cases of de novo stress urinary incontinence over a mean follow-up period of 22.7 months. Similarly, Manasa et al. (2019) applied the same technique and found no postoperative incontinence in their cohort. Several publications have also reported the use of concomitant procedures, such as Martius flap or gracilis muscle interposition, to support reconstruction and improve surgical outcomes (Campbell et al., 2022). Findings from this systematic review indicate that vaginal graft urethroplasty yields favorable clinical outcomes. These results are consistent with those reported by Singh et al. (2013), who demonstrated a success rate of 93.7%, with only one patient requiring continued self-calibration.

Labial mucosal grafts have also demonstrated promising results, as their biological characteristics closely resemble those of vaginal grafts. Tanello et al. (2002) utilized a pedicled flap from the labia minora for the treatment of distal urethral stricture in two patients and reported favorable outcomes. Rehder et al. (2010) subsequently performed labia minora graft urethroplasty in eight patients with mid- to proximal urethral strictures. In their technique, the incision was initiated at the 6 o'clock position and extended from the external meatus to the anterior vaginal wall. A similar surgical approach was adopted by Önol et al., with a slight modification involving midline splitting of the omega-shaped striated sphincter in the ventral urethra (Önol et al., 2014; Rehder et al., 2010). Rehder et al. (2010) reported successful outcomes in seven of eight patients at 12 months of follow-up, accompanied by significant improvement in voiding symptoms. These findings were consistent

with those of Önol et al. (2011), who observed successful outcomes in six of seven patients during follow-up.

Despite their advantages, the use of vaginal and labial grafts has certain limitations and concerns. Biologically, labial and vaginal tissues may undergo atrophy associated with menopause, which can contribute to the development or recurrence of urethral stricture (Hoag et al., 2016). The use of vaginal and labial grafts is also not recommended in patients with active vaginitis or lichen sclerosus. Furthermore, these grafts may be unsuitable when vaginal tissue is thin, has been exposed to radiation therapy, or has been compromised by prior surgical procedures or scarring (Khattar et al., 2021; Hoag & Chee, 2017). In this systematic review, no major complications specifically related to the use of vaginal or labial grafts were identified. However, a small number of failed cases subsequently required conversion to buccal mucosal urethroplasty, and the underlying causes of these failures remain unclear (Manasa et al., 2019; Kaushal et al., 2018).

At present, no standardized protocol has been established for postoperative follow-up after urethroplasty. Uroflowmetry and postvoid residual (PVR) volume assessment are recommended for all patients at three months postoperatively or earlier if symptoms recur (Khattar et al., 2021). In addition, voiding cystourethrography (VCUG) or urethroscopy performed after three months may assist in confirming the integrity of the surgical repair (Khattar et al., 2021). Most clinicians primarily rely on urethroscopy for follow-up evaluation. In a multi-institutional retrospective study, Hampson et al. (2019) defined stricture recurrence as the inability to pass a 17 Fr cystoscope.

Treatment outcomes are commonly assessed using uroflowmetry, PVR measurement, ultrasonography of the kidney, ureter, and bladder (USG-KUB), and the American Urological Association (AUA) symptom score. Sexual function and patient satisfaction are further evaluated using the Female Sexual Function Index (FSFI) and quality-of-life (QoL) scores. These outcome measures have demonstrated favorable results following surgery. The mean improvement in FSFI score was 6.42 points, indicating a significant enhancement in sexual function among sexually active patients. This systematic review found no significant difference in success rates between labial and vaginal graft urethroplasty, with reported success rates of 84% and 82%, respectively. Nevertheless, the included studies were heterogeneous and involved relatively small sample sizes. Most of these studies were descriptive case series with variable inclusion criteria and inconsistent definitions of success and failure.

The incidence of de novo urinary incontinence was low (2%) and was limited to urgency incontinence reported in the vaginal graft group (Kaushal et al., 2018). The majority of urethral strictures were located in the distal urethra (n = 45), with a mean stricture length of 1.79 cm. However, not all studies reported the anatomical site and length of strictures consistently, which may reduce the accuracy of these measurements. Unknown causes led to the failure of both grafts, with the vaginal graft accounting for 12.5% and the labial graft for 3.8%, respectively. Some research had shorter follow-up periods. In our view, it would be preferable for all research to utilize long-term outcomes.

CONCLUSION

Urethroplasty is an excellent and beneficial choice for female urethral stricture. In this review, both labial and vaginal grafts yielded good results (84% and 81.73%) with average follow-up periods of 13.55 and 17.23 months. Despite the lack of sufficient data and high-level evidence, the mean success rate is higher for all grafts, although there are some complications. Labial grafts are slightly more effective than vaginal grafts. Overall, both grafts can be used and should be a great initial treatment for female urethral stricture, especially for patients who already failed the first treatment. There was no morbidity in donor sites.

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