

Is the Autologous Testicular Tunica Vaginalis Graft Effective in Persistent Urethrocuteaneous Fistulas After Hypospadias Surgery? A Comparative Study

Kenan Yalçın, Engin Köllükçü, Fatih Fırat

Tokat Gaziosmanpaşa University Faculty of Medicine, Department of Urology, Tokat, Türkiye

What's known on the subject? and What does the study add?

Urethrocuteaneous fistula is one of the most common postoperative complications associated with hypospadias repair. Despite the various techniques described in the literature for urethrocuteaneous fistula repair, success rates remain relatively low, especially in recurrent cases. The fundamental principles of successful fistula repair include the use of appropriate tissue, tension-free closure, and the incorporation of a secondary protective layer. Ensuring that the suture line is covered with well-vascularized tissue is essential in preventing fistula recurrence. Autologous tunica vaginalis graft is a readily available, flexible, cost-effective material that is resistant to infection and traction, preserves erectile function, and has low morbidity. Based on our findings, the treatment has proven to be effective in the repair of persistent urethrocuteaneous fistula.

Abstract

Objective: This comparative study aims to evaluate the effectiveness of an autologous tunica vaginalis graft (TVOG) as an intermediate protective layer in the repair of persistent urethrocuteaneous fistulas (UCFs) following hypospadias surgery.

Materials and Methods: A total of 39 patients who underwent surgery for persistent UCF between 2013 and 2021 were evaluated. An intermediate protective layer was applied using a local penile dartos flap (LPDF) in 17 patients and an autologous TVOG in 22 patients. The study included cases with a history of at least one failed UCF repair and a fistula size of ≥ 4 mm. Patients with a single failed repair were treated using the LPDF method, while those with at least two previous failures underwent the TVOG technique. Surgical repair was performed at least six months after the most recent unsuccessful fistula repair. All patients were followed up intermittently for two years. During the follow-up period, medical history was taken for each patient, and the repair site and voiding function were assessed. Urine analysis, including culture and sensitivity testing when necessary, was conducted. Successful repair was defined as the absence of recurrence and the presence of a urine stream with adequate force and caliber.

Results: The mean age of patients who underwent LPDF was 6.1 years (range: 3-9), with an average operative time of 43.2 minutes (range: 35-50). For patients who received TVOG, the mean age was 6.3 years (range: 3-9), and the average operative time was 44.8 minutes (range: 34-53). The mean postoperative hospital stay was 5.9 days in the LPDF group and 5.8 days in the TVOG group. When the two techniques were compared in terms of fistula location, scrotal complications, operative time, and hospital stay duration, no statistically significant differences were observed ($p>0.05$). However, a statistically significant difference was found in the recurrence rates between the two techniques ($p<0.05$). During follow-ups, recurrent fistulas were detected in nine patients, all of whom underwent successful repair using TVOG.

Conclusion: Compared to the LPDF method, the TVOG technique represents a simple, rapid, cost-effective, and reliable approach for the repair of recurrent UCFs. By providing a highly effective secondary protective layer, TVOG has demonstrated satisfactory clinical outcomes.

Keywords: Urethrocuteaneous fistula, tunica vaginalis graft, dartos flap, autologous

Correspondence: Kenan Yalçın MD, Tokat Gaziosmanpaşa University Faculty of Medicine, Department of Urology, Tokat, Türkiye

E-mail: krsyalcin@yahoo.com **ORCID-ID:** orcid.org/0000-0003-3560-5862

Received: 25.02.2025 **Accepted:** 08.04.2025 **Epub:** 18.04.2025 **Publication Date:** 01.09.2025

Cite this article as: Yalçın K, Köllükçü E, Fırat F. Is the autologous testicular tunica vaginalis graft effective in persistent urethrocuteaneous fistulas after hypospadias surgery? A comparative study. J Urol Surg. 2025;12(3):158-164.

©Copyright 2025 The Author. Published by Galenos Publishing House on behalf of the Society of Urological Surgery.

This is an open access article under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND) International License.



Introduction

Urethrocutaneous fistula (UCF) repair is associated with one of the most common postoperative complications in hypospadias cases (1,2). Its incidence varies depending on the surgical technique and the surgeon's experience, with an average rate of approximately 7.5% (3). This rate increases with the severity of the initial anomaly and the presence of chordee, reaching up to 25% in proximal hypospadias cases (4). Several factors are known to contribute to the development of UCF, including overlapping sutures between the neourethra and skin, secondary distal obstruction due to meatal stenosis or urethral stricture, turbulent urine flow (particularly when associated with diverticula), and impaired local vascularization (5).

Fistulas are typically detected within the first few months postoperatively, although they may also develop years later. While some may close spontaneously, the majority require surgical correction. Despite the various techniques described in the literature for UCF repair, success rates remain relatively low, especially in recurrent cases (6). The fundamental principles of successful UCF repair include tension-free closure, the use of well-vascularized tissue flaps, avoidance of overlapping sutures, and correction of distal obstruction (5). Additionally, incorporating vascularized tissue between the penile skin and the fistula closure suture line is essential (7).

Studies have clearly demonstrated that a soft tissue covering over the neo-urethra yields favorable functional outcomes and contributes to a reduced incidence of UCF (8). The existing literature describes various tissues that can be used to protect the neo-urethra, including epithelialized skin flaps, dartos fascia, corpus spongiosum, and tunica vaginalis (TV) (9-13). The use of an intermediate protective layer has been shown to play a role in decreasing the incidence of UCF (14). Each of these tissues offers distinct advantages and disadvantages.

This study aims to compare and evaluate the effectiveness of an autologous tunica vaginalis graft (TVOG) in the repair of persistent UCF following hypospadias surgery.

Materials and Methods

Patients

A total of 39 patients who underwent surgery for persistent UCF between 2013 and 2021 were evaluated. The medical records of these cases were reviewed. This study was retrospective and conducted in accordance with the Declaration of Helsinki. Patients were informed that their data would be used for scientific purposes, and written consent was obtained from all participants.

Patients with an initial fistula after hypospadias surgery, a fistula diameter of ≤ 4 mm, or associated chordee were excluded from

the study. Data from 39 patients who met these criteria were evaluated. Patients who had undergone a single failed fistula repair were treated using the LPDF method, whereas those with at least two previous failed repairs received the TVOG method. Data collected included patient age, operative time, number of previous fistula repair attempts, fistula location, hospital stay duration, postoperative recurrence, and scrotal complications. All surgical procedures were performed by the same surgeon.

Surgical Technique

General anesthesia was administered in all cases. As prophylaxis, a third-generation cephalosporin antibiotic (50-100 mg/kg) was given to each patient. A preoperative examination was conducted under anesthesia. The location and number of fistulas were confirmed by injecting diluted povidone-iodine into the urethra through a Nelaton catheter inserted via the urethral meatus. Subsequently, to rule out meatal stenosis or distal urethral stricture, intraoperative urethral calibration was conducted using an 8F (or a larger size as appropriate for patient age) Nelaton catheter, and the fistula diameter was measured (Figure 1a). A circumferential incision was made around the fistula. Using meticulous dissection, the fistula edges were excised, and the fistula tract was sharply dissected down to the urethral mucosa and then completely removed. The urethra was then closed using a continuous subcuticular inverting suture with 6-0 polyglactin sutures (Figure 1b). A scrotal incision was made to harvest the TVOG (Figure 1c). The graft was placed over the suture line with its scrotal surface facing the urethra as quickly as possible (Figure 1d). The TVOG was secured in place using 6-0 polyglactin sutures (Figure 1e). Hemostasis was ensured in the scrotum, and the testis was repositioned within the scrotal sac. The remaining TV edges were sutured to the scrotal dartos layer with 4-0 polyglactin sutures, and the scrotal incision was closed in two layers. Finally, the penile skin was closed using 4-0 polyglactin sutures (Figure 1f).

In both the TVOG and LPDF groups, a compressive dressing with an elastic bandage was applied postoperatively. A transurethral catheter (8F or a larger size depending on the patient's age) was left in place for 10-12 days. Most patients were discharged between postoperative days 5 and 7. The first follow-up was conducted two weeks after catheter removal, and all patients were monitored intermittently for two years. During follow-up, patient history was reviewed, and the repair site and voiding function were assessed. Urine analysis, along with culture and sensitivity tests when necessary, was performed. Successful repair was defined as the absence of recurrence and the presence of a urine stream with adequate force and caliber.

Ethics Approval

The study was approved by the Non-Interventional Clinical Research Ethics Committee of Tokat Gaziosmanpaşa University

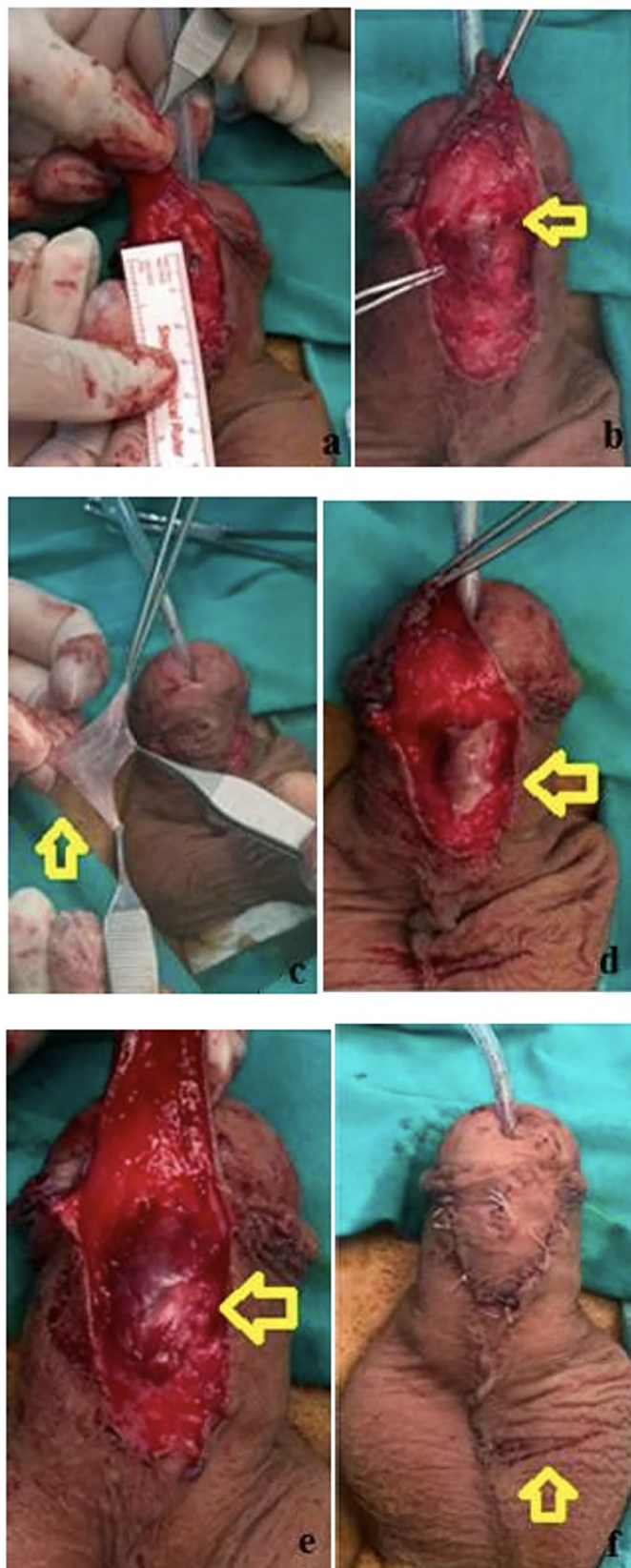


Figure 1. Intraoperative stages of autologous tunica vaginalis graft application in urethrocuteaneous fistula repair

Faculty of Medicine (approval no: 25-MOBAEK-052, date: 20.02.2025).

Statistical analysis

Statistical analyses were performed using MedCalc (version 20.009; Ostend, Belgium) statistical software. Descriptive statistics were presented as counts, percentages, means, and standard deviations. For numerical data, the Shapiro-Wilk test was used to assess whether the groups conformed to a normal distribution. Comparisons of numerical variables between groups were conducted using the independent samples t-test, while categorical variables were analyzed using the chi-square test. Groups were presented as stacked percentage bar charts. A p-value of <0.05 was considered statistically significant for result interpretation.

Results

The mean age of patients who underwent LPDF as an intermediate protective layer was 6.1 years (range: 3-9), with an average operative time of 43.2 minutes (range: 35-50). Similarly, the mean age of patients who underwent TVOG as an intermediate protective layer was 6.3 years (range: 3-9), with an average operative time of 44.8 minutes (range: 34-53). The mean postoperative hospital stay duration was 5.9 days in the LPDF group and 5.8 days in the TVOG group. The most common fistula location in both groups was the coronal level, with an incidence of 41.2% in the LPDF group and 36.4% in the TVOG group. Regarding scrotal complications, one patient (5.9%) in the LPDF group developed a hematoma, and another had a wound infection. In the TVOG group, one patient (4.5%) experienced hematoma, while two patients (9.1%) had a wound infection. No statistically significant differences were observed between the two techniques in terms of fistula location, scrotal complications, operative time, or hospital stay duration ($p>0.05$). However, recurrence rates differed significantly between the groups. Recurrence was observed in seven patients (41.2%) in the LPDF group, while only two patients (9.1%) in the TVOG group experienced recurrence. However, postoperative fistula recurrence showed a statistically significant difference between the two techniques ($p<0.05$) (Table 1).

Scrotal complications were completely resolved with cold application and antibiotic therapy. None of the 39 patients experienced testicular morbidity. Fistula recurrence was observed in seven patients (41.2%) in the LPDF group and two patients (9.1%) in the TVOG group. The recurrent fistulas were visibly smaller than the preoperative ones, which facilitated subsequent repairs. All recurrences in both groups were successfully repaired using TVOG six months after surgery. The cosmetic appearance of the penis was deemed satisfactory in all patients, with no cases of torsion or ventral chordee.

Table 1. Demographic characteristics and operation data of groups

n		LPDF			TVOG			p-value
		Mean	SD	n	Mean	SD		
Age (years)		17	6.1	1.56	22	6.3	1.67	0.62
Operative time (min)		17	43.2	4.16	22	44.8	4.97	0.28
Hospital stay duration (days)		17	5.9	0.8	22	5.8	0.7	0.64
		n	%		n	%		p-value
Site of fistula	Coronal	7	41.2		8	36.4		0.99
	Distal penile	3	17.6		4	18.2		
	Middle penile	5	29.4		7	31.8		
	Proximal penile	2	11.8		3	13.6		
Recurrence after surgery	No	10	58.8		20	90.9		0.02*
	Yes	7	41.2		2	9.1		
Scrotal complications	None	15	88.2		19	86.4		0.92
	Hematoma	1	5.9		1	4.5		
	Wound infection	1	5.9		2	9.1		

*: Significant difference at <0.05 level according to chi-square test, n (%) presented, SD: Standard deviation, TVOG: Tunica vaginalis graft, LPDF: Local penile dartos flap

Discussion

UCF is one of the most challenging complications encountered by surgeons performing hypospadias repair. Several key factors influence the outcomes of fistula repair, including the size, location, and condition of the surrounding tissue. To allow for the resolution of local inflammation, tissue healing, and revascularization, fistula repair should be performed at least six months after the previous procedure (15). The presence of distal stricture or urethral diverticulum is a significant factor contributing to fistula formation and recurrence. If distal obstruction is present, it should be corrected during fistula repair to prevent further complications (2,16). In our study, no patients had meatal stenosis or distal urethral stricture. Additionally, all patients underwent intraoperative urethral calibration prior to fistula repair to ensure optimal surgical outcomes.

The fundamental principles of successful fistula repair include the use of appropriate tissue, tension-free closure, and the incorporation of a secondary protective layer. Ensuring that the suture line is covered with well-vascularized tissue is essential in preventing fistula recurrence. Various tissue types can serve as a second protective layer, including adjacent local tissues, de-epithelialized skin, dartos flaps, and tunica vaginalis flaps and grafts (4). Despite ongoing research efforts to identify the most effective strategies and treatment algorithms, an optimal approach for UCF repair remains uncertain. Researchers face several limitations, such as variations in fistula characteristics (size, location, and local tissue condition), the small sample sizes in studies, and the diversity of surgical techniques applied in clinical practice.

In 1986, Snow (13) introduced the use of a pedicled tunica vaginalis flap (TVF) in hypospadias surgery, a technique that was

originally described by Hösli (17) in 1970. Later, in 1995, Snow et al. (18) applied TVF following hypospadias repair to prevent UCF formation. Several histological advantages make TVF a suitable protective layer in recurrent UCF repair: it is highly vascularized, thin, flexible, expandable, and easy to harvest (19). According to published data, TVF has demonstrated excellent outcomes, with a reported success rate of 85-100% in cases involving recurrent fistulas and no reported penile curvature (4,19,20). However, Pattaras and Rushton (21) reported two cases in which patients experienced exaggerated penile torque due to cremasteric reflex stimulation following hypospadias repair with TVF as a protective layer. In both cases, the fibrous band of the TV was later divided to correct the penile torque. Routh et al. (20) emphasized that strict adherence to technical principles—particularly ensuring adequate TVF dissection without including cremasteric fibers—could help prevent complications associated with TVF, such as penile curvature.

Perlmutter et al. (22) and Kajbafzadeh et al. (23) successfully corrected severe chordee associated with hypospadias using TVOG, which was sutured into a defect created in the tunica albuginea through a transverse incision at the point of maximum curvature. Additionally, TVOG has been utilized in the surgical management of Peyronie's disease following plaque excision (24-27). One of the disadvantages of TVF is the potential risk of anterior curvature and the additional surgical time required for dissection and tunneling beneath the penile skin. Moreover, in cases of recurrent UCF where local adjacent tissue is depleted, extragenital tissue, such as buccal mucosal grafts (BMG), is widely used. This has led to the adoption of TVOG as a protective layer in recurrent UCF repair (28,29). To compensate for graft contraction, the graft dimensions should be at least 20% larger than the recipient site. In the study conducted by

Hafez et al. (30), TVOG exhibited an average contraction of 22%. In our study, TVOG was used as a protective layer with a size 20% greater than the suture line, and no significant effect of anticipated contraction on urethral lumen caliber was observed. The harvesting of TVOG is technically simple, though it may prolong operative time by approximately 15-20 minutes. In our study, the average operative times were comparable between the groups. We believe that surgical experience played a key role in preventing a significant increase in operative duration.

In the literature, most small UCFs (≤ 4 mm) can be successfully corrected with simple excision and closure using a secondary protective layer. For larger fistulas that cannot be closed directly, skin flaps may be used if local skin is sufficient and flexible. When previous surgeries have resulted in scar formation and a lack of surrounding tissue, LPDF or tunneled TVF can be utilized as a protective layer (20). As a genital graft, TVOG has been effectively used for UCF repair, yielding favorable outcomes (31,32). In cases where prior surgeries have led to local tissue deficiency and inadequate blood supply, extragenital grafts may be required. BMG is commonly employed for UCF repair and has demonstrated successful results (33). In our study, LPDF and TVOG were selected based on our clinical experience in UCF repair.

According to published data, small fistulas with healthy local tissues can be successfully repaired with simple closure, achieving a success rate of 71-92%. In cases where the fistula is large or recurrent, or when local adjacent tissues are insufficient, extragenital grafts such as BMG have demonstrated success rates of 78-85% (28,29,33). Several authors have reported success rates ranging from 85% to 100% in UCF repair using TVF, including cases of recurrent fistulas (4,34). In our study, the success rate was 90.9%, which is considered high compared to previously published studies. Based on this high success rate, we suggest, that defending the use of a TV pedicle in cases with potential penile curvature risk may not be necessary. We believe that placing a protective TVOG during UCF repair is a safe and easily performed procedure.

There are a limited number of studies in the literature regarding the use of TVOG in UCF repair, with most research focusing on TVF applications. In a study conducted by Aldaqadossi et al. (32), where TVOG was used in 45 patients, a success rate of 95.6% was reported. UCF recurrence was observed in two patients (4.4%), both of whom underwent successful repair six months later. No cases of ventral chordee or testicular morbidity were reported. Similarly, Voges et al. (31) evaluated 32 patients who underwent TVOG application, reporting a success rate of 93.7%. Recurrence was observed in two patients (6.25%), both of whom were repaired successfully six months postoperatively. In our study, involving 22 patients who received TVOG, we observed a success rate of 90.9%. Among the LPDF group, recurrence occurred in

seven patients (41.2%), whereas only two patients (9.1%) in the TVOG group experienced recurrence. These recurrences were successfully repaired using the same TVOG method six months later. We consider it significant that TVOG has demonstrated effectiveness even in cases of multiple recurrent fistulas, reinforcing its reliability in UCF repair.

LPDF can be easily obtained without the need for a secondary incision, although it requires meticulous dissection. The major disadvantage of the dartos flap is that dartos dissection may lead to penile skin devascularization, which can increase the incidence of UCF formation (35). This factor may explain the 41.2% recurrence rate observed in the LPDF group in our study. Reported complications of TVF include ipsilateral testicular retraction, testicular torsion, scrotal hematoma, and even scrotal abscess (8,21). However, none of our patients experienced testicular morbidity.

Most UCFs are localized in the distal penile and coronal regions. This finding is consistent with the reports of Yassin et al. (15), Sunay et al. (36), and Santangelo et al. (37), who documented incidence rates of 59.7%, 43.2%, and 37%, respectively. In our study, UCF recurrence in the coronal region was observed in five cases in the LPDF group and two cases in the TVOG group. Additionally, two cases of recurrence occurred in the distal penile region. Recurrence was observed in two cases in the distal penile region. The high incidence of UCF localization and recurrence in the distal penile region may be attributed to the increased prevalence of distal penile hypospadias. The coronal sulcus is one of the most challenging areas for healing after reconstructive procedures, as it is poorly vascularized due to its anatomical location between the glans penis and the corpora cavernosa. Additionally, during hypospadias surgery, penile skin dissection may further disrupt coronal vascularization. In the postoperative period, erections can exacerbate coronal ischemia, increasing the risk of fistula formation and recurrence. We believe that the recurrence of UCF in seven patients within the coronal region in our study may be explained by this mechanism.

There is ongoing debate in the literature regarding the necessity of urethral or suprapubic diversion following fistula repair. Redman (38) did not recommend the use of a urethral or suprapubic catheter in the repair of small fistulas. Conversely, Eardley and Whitaker (39) suggested the use of a urethral or suprapubic catheter for 7 to 14 days in all fistula repairs. Elbakry (2) utilized suprapubic urinary diversion in cases involving large or multiple small fistulas. For a single small fistula, a urethral catheter was used for one day to prevent painful voiding. In our study, a urethral catheter was maintained for 10-12 days. We observed that the urethral catheter acted as a supporting structure, allowing for gentle compression by the external sterile dressing, stabilization of the repair, and optimization of

TVOG integration. Based on our findings, we recommend the use of a urethral catheter for 10-12 days in recurrent fistula cases treated with LPDF and TVOG.

Study Limitation

The limitations of the study include the small number of patients, the single-center and retrospective nature of the study, the need to compare more surgical techniques, and the short follow-up period. The limitations of our study are the lack of documentation of extremely important operation data such as the number of previous interventions, the time to revision from previous surgery, and the size of the fistula in patients undergoing surgery.

Conclusion

TVOG is a readily available, flexible, cost-effective material that is resistant to infection and traction, preserves erectile function, and has low morbidity. Based on our findings, the method has proven to be effective in the repair of persistent UCF. We emphasize the need for further prospective, randomized, and controlled studies to evaluate the effectiveness of this technique. Additionally, our study demonstrated that the LPDF method is not effective in the repair of persistent UCF. We further highlight the importance of conducting more prospective, randomized, and controlled studies to validate these findings.

Ethics

Ethics Committee Approval: The study was approved by the Non-Interventional Clinical Research Ethics Committee of Tokat Gaziosmanpaşa University Faculty of Medicine (approval no: 25-MOBAEK-052, date: 20.02.2025).

Informed Consent: Written consent was obtained from all participants.

Footnotes

Authorship Contributions

Surgical and Medical Practices: K.Y., E.K., F.F., Concept: K.Y., E.K., F.F., Design: K.Y., E.K., F.F., Data Collection or Processing: K.Y., E.K., F.F., Analysis or Interpretation: K.Y., E.K., F.F., Literature Search: K.Y., E.K., F.F., Writing: K.Y., E.K., F.F.

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

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Liao AY, Smith GH. Urethrocuteaneous fistulae after hypospadias repair: when do they occur? J Paediatr Child Health. 2016;52:556-560. [\[Crossref\]](#)

2. Elbakry A. Management of urethrocuteaneous fistula after hypospadias repair: 10 years' experience. BJU Int. 2001;88:590-595. [\[Crossref\]](#)
3. Hardwicke JT, Bechar JA, Hodson J, Osmani O, Park AJ. Fistula after single-stage primary hypospadias repair - a systematic review of the literature. J Plast Reconstr Aesthet Surg. 2015;68:1647-1655. [\[Crossref\]](#)
4. Pescheloché P, Parmentier B, Hor T, Chamond O, Chabaud M, Irtan S, Audry G. Tunica vaginalis flap for urethrocuteaneous fistula repair after proximal and mid-shaft hypospadias surgery: a 12-year experience. J Pediatr Urol. 2018;14:421.e1-421.e6. [\[Crossref\]](#)
5. Richter F, Pinto PA, Stock JA, Hanna MK. Management of recurrent urethral fistulas after hypospadias repair. Urology. 2003;61:448-451. [\[Crossref\]](#)
6. Routh JC, Wolpert JJ, Reinberg Y. Tunneled tunica vaginalis flap for recurrent urethrocuteaneous fistulae. Adv Urol. 2008;2008:615928. [\[Crossref\]](#)
7. Ahuja RB. A de-epithelialised 'turnover dartos flap' in the repair of urethral fistula. J Plast Reconstr Aesthet Surg. 2009;62:374-379. [\[Crossref\]](#)
8. Kadian YS, Singh M, Rattan KN. The role of tunica vaginalis flap in staged repair of hypospadias. Asian J Urol. 2017;4:107-110. [\[Crossref\]](#)
9. Smith D. A de-epithelialised overlap flap technique in the repair of hypospadias. Br J Plast Surg. 1973;26:106-114. [\[Crossref\]](#)
10. Belman AB. De-epithelialized skin flap coverage in hypospadias repair. J Urol. 1988;140:1273-1276. [\[Crossref\]](#)
11. Churchill BM, van Savage JG, Khoury AE, McLorie GA. The dartos flap as an adjunct in preventing urethrocuteaneous fistulas in repeat hypospadias surgery. J Urol. 1996;156:2047-2049. [\[Crossref\]](#)
12. Yerkes EB, Adams MC, Miller DA, Pope JC 4th, Rink RC, Brock JW 3rd. Y-to-I wrap: use of the distal spongiosum for hypospadias repair. J Urol. 2000;163:1536-1538; discussion 1538-1539. [\[Crossref\]](#)
13. Snow BW. Use of tunica vaginalis to prevent fistulas in hypospadias surgery. J Urol. 1986;136:861-863. [\[Crossref\]](#)
14. Telfer JR, Quaba AA, Kwai Ben I, Peddi NC. An investigation into the role of waterproofing in a two-stage hypospadias repair. Br J Plast Surg. 1998;51:542-546. [\[Crossref\]](#)
15. Yassin T, Bahaaeldin KH, Husein A, Minawi HE. Assessment and management of urethrocuteaneous fistula developing after hypospadias repair. Ann. Pediatr. Surg. 2011;7:88-93. [\[Crossref\]](#)
16. Barbagli G, Sansalone S, Djinovic R, Lazzeri M. Surgical repair of late complications in patients having undergone primary hypospadias repair during childhood: a new perspective. Adv Urol. 2012;2012:705212. [\[Crossref\]](#)
17. Hösli PO. Eine Technik zum verschluss von harnröhrenfisteln [method for the closure of urethral fistulas]. Urologe. 1970;9:129-130. [\[Crossref\]](#)
18. Snow BW, Cartwright PC, Unger K. Tunica vaginalis blanket wrap to prevent urethrocuteaneous fistula: an 8-year experience. J Urol. 1995;153:472-473. [\[Crossref\]](#)
19. Landau EH, Gofrit ON, Meretyk S, Katz G, Golijanin D, Shenfeld OZ, Pode D. Outcome analysis of tunica vaginalis flap for the correction of recurrent urethrocuteaneous fistula in children. J Urol. 2003;170:1596-1599; discussion 1599. [\[Crossref\]](#)
20. Routh JC, Wolpert JJ, Reinberg Y. Tunneled tunica vaginalis flap is an effective technique for recurrent urethrocuteaneous fistulas following tubularized incised plate urethroplasty. J Urol. 2006;176:1578-1580; discussion 1581. [\[Crossref\]](#)
21. Pattaras JG, Rushton HG. Penile torque after the use of tunica vaginalis blanket wrap as an aid in hypospadias repair. J Urol. 1999;161:934-935. [\[Crossref\]](#)
22. Perlmutter AD, Montgomery BT, Steinhardt GF. Tunica vaginalis free graft for the correction of chordee. J Urol. 1985;134:311-313. [\[Crossref\]](#)
23. Kajbafzadeh AM, Arshadi H, Payabvash S, Salmasi AH, Najjaran-Tousi V, Sahebpor AR. Proximal hypospadias with severe chordee: single stage repair

- using corporeal tunica vaginalis free graft. *J Urol.* 2007;178:1036-1042; discussion 1042. [\[Crossref\]](#)
24. Liu B, Li Q, Cheng G, Song N, Gu M, Wang Z. Surgical treatment of Peyronie's disease with autologous tunica vaginalis of testis. *BMC Urol.* 2016;16:1. [\[Crossref\]](#)
25. Yuanyuan M, Ning S, Yang W, Xiaoming Y, Lijie Z, Ninghan F. Testicular tunica vaginalis patch grafting for the treatment of Peyronie's disease. *Cell Biochem Biophys.* 2015;71:1117-1121. [\[Crossref\]](#)
26. Das S, Maggio AJ. Tunica vaginalis autografting for Peyronie's disease: an experimental study. *Invest Urol.* 1979;17:186-187. [\[Crossref\]](#)
27. Yalçın K, Kölükçü E, Fırat F, Erdemir F. Is testicular tunica vaginalis autologous graft successful in the surgical treatment of peyronie's disease? *Androl Bul.* 2024;26:270-276. [\[Crossref\]](#)
28. Kiss A, Pirót L, Karsza L, Merksz M. Use of buccal mucosa patch graft for recurrent large urethrocuteaneous fistula after hypospadias repair. *Urol Int.* 2004;72:329-331; discussion 331. [\[Crossref\]](#)
29. Hosseini J, Kaviani A, Mohammadhosseini M, Rezaei A, Rezaei I, Javanmard B. Fistula repair after hypospadias surgery using buccal mucosal graft. *Urol J.* 2009;6:19-22. [\[Crossref\]](#)
30. Hafez AT, Smith CR, McLorie GA, El-Ghoneimi A, Herz DB, Bağli DJ, Khoury AE. Tunica vaginalis for correcting penile chordee in a rabbit model: is there a difference in flap versus graft? *J Urol.* 2001;166:1429-1432. [\[Crossref\]](#)
31. Voges GE, Riedmiller H, Hohenfellner R. Tunica vaginalis free grafts for closure of urethrocuteaneous fistulas. *Urol Int.* 1990;45:88-91. [\[Crossref\]](#)
32. Aldaqadosi HA, Eladawy M, Shaker H, Kotb Y, Azazy S. Tunica vaginalis graft for recurrent urethrocuteaneous fistula repair after hypospadias surgery. *Int J Urol.* 2020;27:726-730. [\[Crossref\]](#)
33. Waterman BJ, Renschler T, Cartwright PC, Snow BW, DeVries CR. Variables in successful repair of urethrocuteaneous fistula after hypospadias surgery. *J Urol.* 2002;168:726-730; discussion 729-730.
34. Sharma N, Bajpai M, Panda SS, Singh A. Tunica vaginalis flap cover in repair of recurrent proximal urethrocuteaneous fistula: a final solution. *Afr J Paediatr Surg.* 2013;10:311-314. [\[Crossref\]](#)
35. Chatterjee US, Mandal MK, Basu S, Das R, Majhi T. Comparative study of dartos fascia and tunica vaginalis pedicle wrap for the tubularized incised plate in primary hypospadias repair. *BJU Int.* 2004;94:1102-1104. [\[Crossref\]](#)
36. Sunay M, Dadali M, Karabulut A, Emir L, Erol D. Our 23-year experience in urethrocuteaneous fistulas developing after hypospadias surgery. *Urology.* 2007;69:366-368. [\[Crossref\]](#)
37. Santangelo K, Rushton HG, Belman AB. Outcome analysis of simple and complex urethrocuteaneous fistula closure using a de-epithelialized or full thickness skin advancement flap for coverage. *J Urol.* 2003;170:1589-1592; discussion 1592. [\[Crossref\]](#)
38. Redman JF. Results of undiverted simple closure of 51 urethrocuteaneous fistulas in boys. *Urology.* 1993;41:369-371. [\[Crossref\]](#)
39. Eardley I, Whitaker RH. Surgery for hypospadias fistula. *Br J Urol.* 1992;69:306-310. [\[Crossref\]](#)