Original Article

Glans cap-preserving dorsal inlay-free graft augmentation technique for reconstruction of meatal stenosis and fossa navicularis strictures: Analysis of short-term functional outcomes

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ABSTRACT

Introduction: Meatal stenosis and fossa navicularis strictures (FNSs) are commonly caused by lichen sclerosus and instrumentation. We present the technique and short-term functional outcomes of glans cap-preserving dorsal inlay-free graft augmentation for the reconstruction of meatal stenosis and FNS.

Methods: This retrospective study analyzed patients with meatal stenosis and FNS who underwent glans cap-preserving dorsal inlay-free graft augmentation at our institute since 2019. The surgical technique included a ventral subcoronal approach, preservation and mobilization of the glans cap, a ventral midline urethrotomy incision over the stricture, and a dorsal midline meatotomy incision extending to the proximal normal urethral mucosa at the fossa navicularis, followed by dorsal inlay graft augmentation. During the follow-up, patients were periodically assessed for symptom scores, urinary flow rates (UFRs), and patient-reported outcomes.

Results: A total of 26 patients with a mean age of 45 ± 15 years were assessed. The predominant cause of stricture was lichen sclerosus (n = 15; 58%). The mean stricture length was 3.8 ± 0.5 cm, 73% had a circumcised phallus, and an oral mucosa graft augmentation was performed in 22 (85%) patients. Notable postoperative complications included intractable meatal hemorrhage (n = 1) and glans suture granuloma (n = 1), which required intervention. At a mean follow-up of 40 months, there were four failures, of which one patient required redo-urethroplasty. The remaining patients (n = 22; 85%) showed improved symptom scores ($P < 0.05$), UFRs ($P < 0.05$), and satisfactory patient-reported outcomes.

Conclusion: Glans cap-preserving dorsal inlay-free graft augmentation is a safe and feasible technique with satisfactory short-term functional outcomes for the management of meatal stenosis and FNS in carefully selected patients.

INTRODUCTION

Meatal stenosis and fossa navicularis stricture (FNS) are infrequent conditions that are most commonly associated with lichen sclerosus and urethral instrumentation.[1] FNS is often missed on radiological imaging, primarily owing to its anatomical location. It is often diagnosed based on bothersome symptoms, dysuria, poor flow rates, and inability to calibrate the urethral lumen. The initial management of meatal stenosis and FNS often involves urethral dilatation.[2] However, definitive surgical intervention is required in recurrent strictures that are refractory to urethral dilatation.[1,2] Various surgical techniques have been described for the

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management of meatal stenosis and FNS, wherein the reconstruction of the urethral lumen is performed with a free graft or local vascularized flap using either inlay or onlay techniques.[2-6] The most commonly utilized tissues for augmenting the urethral plate include the oral mucosa graft (OMG) and inner preputial free graft (IPG).[3,4,6] The primary goals of treatment of FNS include alleviating the bothersome symptoms, ensuring unobstructed urine flow, and achieving cosmetically pleasing glans. However, the technical challenge lies in enhancing the caliber of the urethral lumen without altering the contour of the glans. Therefore, we deemed glans cap preservation as the optimal approach, contingent upon its application in specific clinical scenarios. In this study, we have shared our experience with this technique, as well as analyzed the short-term functional outcomes of glans cap-preserving dorsal inlay-free graft augmentation for the reconstruction of meatal stenosis and FNS.

METHODS

We performed a retrospective analysis of a prospectively maintained database of patients with meatal stenosis and FNS who underwent glans cap-preserving dorsal inlay-free graft augmentation at our institute between 2019 and 2021. Patients with a minimum follow-up period of 2 years were included in this study. This study was approved by the institutional ethics committee. Informed consent was obtained from all the patients before the surgical intervention. Patients' clinical data, lower urinary tract symptoms and dysuria scores, blood investigations, radiological imaging such as antegrade and retrograde urethrograms, and maximum urinary flow rate (UFR-Qmax) were retrieved from the hospital's online database system.

Surgical technique

The operative procedure was performed with the patient in the supine position under general anesthesia. Broad-spectrum intravenous antibiotics were administered before the start of the surgery. Urethroscopy was performed with a 6 French (Fr) ureteroscope to assess the caliber of the urethral stricture, the stricture length, and the configuration and delineation of the normal proximal urethral mucosa. A 5 Fr ureteric catheter or a hydrophilic glidewire was placed to enable identification of the urethral lumen during the procedure. The procedure was initiated with a subcoronal incision on the ventral aspect of the distal penile shaft [Figure 1a and b]. The skin and dartos fascia overlying the distal urethra were incised and mobilized distally towards the glans, while meticulously elevating the glans cap from the underlying urethra. This maneuver helps in identifying the fossa navicularis. Subsequently, a ventral midline urethrotomy incision was made and extended proximally to identify the normal urethral mucosa, and adequate traction sutures were applied [Figure 1c and d]. A tourniquet was placed over the proximal penile shaft with vascular loops. A dorsal midline urethrotomy was performed over the urethral plate, initially executed through the meatus, and subsequently extended proximally to the normal urethral mucosa through the ventral urethrotomy incision [Figure 1e and f]. The stricture length was measured, and an appropriate graft was harvested. In our study cohort, the following grafts were harvested for augmentation of the urethral plate: OMG from the upper lip or buccal mucosa and IPG. The graft used for augmentation was based on the surgeon's preference and availability. The free graft was placed over the meatus on the dorsal aspect and fixed using three interrupted sutures (5-0 polyglactin or 5-0 polydioxanone). The free graft was then transposed through the meatus and aligned with the normal proximal urethral

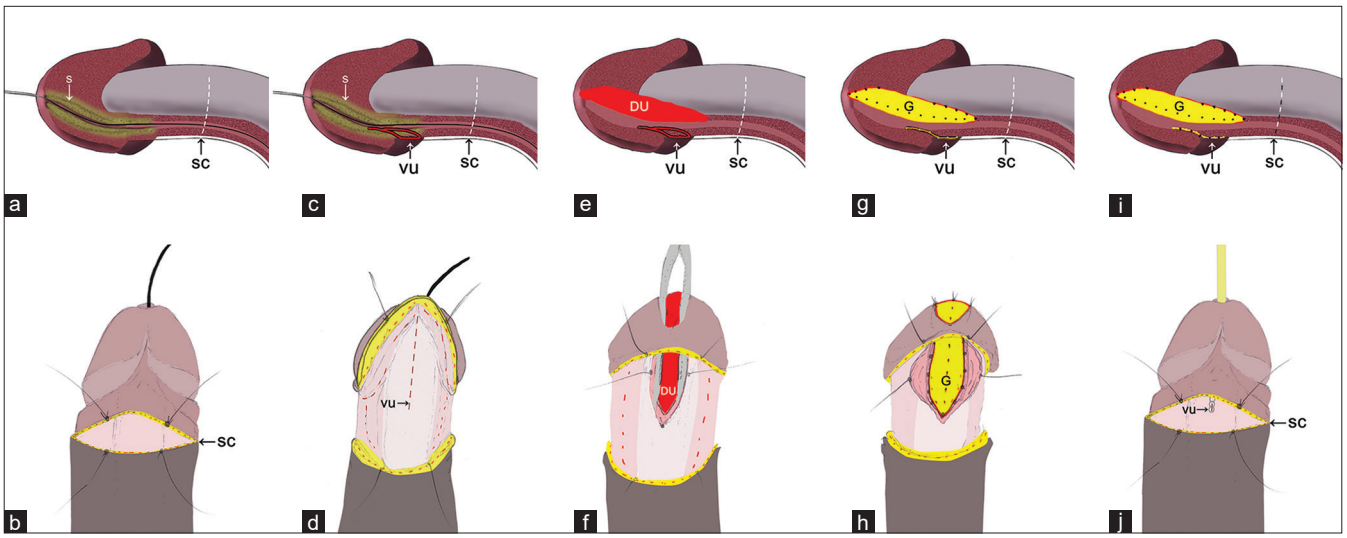

Figure 1: (a-j) Illustrations of glans cap-preserving dorsal inlay-free graft augmentation in sagittal (a, c, e, g and i) and ventral (b, d, f, h and j) views. (a and b) Subcoronal incision, (c and d) Glans cap mobilized and ventral urethrotomy incision made at the stricture, (e and f) Dorsal urethrotomy incision over the urethral plate, (g and h) Dorsal inlay-free graft augmentation, (i and j) Skin closure. DU = Dorsal urethrotomy, G = Free graft, S = Stricture segment, SC = Subcoronal incision, VU = Ventral urethrotomy

mucosa over the dorsal urethral plate [Figure 1g and h]. Thereafter, the free graft was fixed to the proximal and the lateral urethral mucosa using interrupted sutures. Single-row quilting sutures were used to fix the free graft to the underlying urethral plate [Figure 1g and h]. The tourniquet was released, and hemostasis was achieved. A 14 Fr silicone catheter was inserted through the meatus and placed in the bladder for drainage. The ventral urethrotomy incision was approximated using absorbable sutures. The ventral dartos and skin were approximated [Figure 1i and j], followed by application of a compressive dressing. The patients were discharged 24–48 h after the surgery. In the postoperative period, antibiotics were administered for 3 days, and surgical site and catheter care were provided. The urethral catheter was removed after 2 weeks. At follow-up, symptom scores, complications, and UFR-Qmax were assessed periodically. Patient-reported outcome measures and cosmesis (satisfied or unsatisfied) were assessed during the follow-up [Figure 2a and b]. Patient-reported outcome measures comprised symptom scores and satisfaction with the surgery (satisfied or unsatisfied). Additionally, an extra question assessed whether the cosmesis (satisfied or unsatisfied) was maintained as observed in the preoperative state. Symptom scores were assessed using the International Prostate Symptom Score and the Boyarsky dysuria score for lower urinary tract symptoms. Complications were recorded according to the Clavien–Dindo classification (CDC).[7] Failure was defined as persistent bothersome symptoms with poor UFR-Qmax (<10 mL/s) and the inability to calibrate the meatus or the urethra with a 14 Fr catheter.

Statistical analyses

Statistical analyses were performed using IBM SPSS Statistics for Macintosh, Version 28.0. IBM Corp, Armonk, NY, US. Continuous variables were presented as the mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. The student *t*-tests were used to compare the preoperative and postoperative follow-up data. Statistical significance was set at $P < 0.05$.

RESULTS

Of the initial cohort of 42 patients who underwent this procedure, 26 were eligible for inclusion in the study and 16 patients were excluded, with one succumbing to the recent pandemic and three being lost to follow-up. In 12 patients who were excluded from the study, all had lichen sclerosus, and the described technique was converted to a staged repair (patients underwent the first stage involving ventral extended meatotomy, followed by dorsal inlay-free augmentation after 6 months) in eight patients and dorsal onlay free graft urethroplasty in four patients. This conversion was an intraoperative decision based on the endoscopic findings that showed chronic inflammation (characterized by squamous metaplasia, indicated by a cloudy white appearance of the mucosa) in the proximal urethral mucosa, despite a normal urethral caliber. In all the cases, intraurethral steroid instillation and application were initiated empirically 2 weeks after the catheter removal.

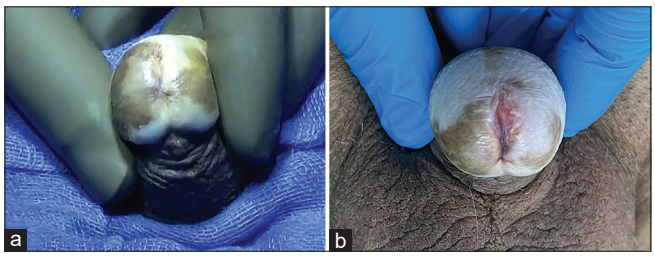

Figure 2: (a) Preoperative picture of an index case showing meatal scarring and stenosis, (b) Postoperative picture of the meatus following glans cap-preserving dorsal inlay-free graft augmentation at 15-month follow-up

The mean age of the study population was 45 ± 15 years. Out of the 26 patients enrolled in the study, lichen sclerosus was the etiology of the stricture in 15 cases (58%). Among the seven (27%) patients diagnosed with iatrogenic strictures, four had undergone transurethral resection of the prostate, while three developed strictures following a history of catheterization. The remaining four patients developed stricture following hypospadias repair. Nine patients in the study had diabetes mellitus, and two patients were diagnosed with chronic kidney disease.

Notably, 19 patients in our study had a history of circumcision, primarily performed for phimosis associated with lichen sclerosus in 14 (74%) of the cases. All the patients underwent multiple unsuccessful endoscopic interventions for the stricture. Of these, 11 patients underwent periodic self-intermittent calibration of the stricture. Additionally, four patients experienced two or more episodes of urinary tract infections during the study period.

Perioperative parameters, complications, and functional outcomes are summarized in Table 1. Most procedures were performed under general anesthesia, with a mean duration of surgery of 67 min. The mean stricture length was 3.8 cm, and the most common tissue used for augmenting the urethral plate was the buccal mucosal graft (54%), followed by the upper lip mucosal graft (31%) and IPG (15%). After harvesting the oral mucosa from the upper lip, the donor site was left open for healing, while the donor site of buccal mucosa was approximated in all the patients.

No intraoperative complications were observed. The catheters were removed postoperatively after a mean duration of 14 ± 2 days. One patient presented with meatal hemorrhage at the junction of the graft and dorsal meatotomy site, requiring suture placement on the 10th postoperative day under local anesthesia (CDC, Grade 3A). Another patient developed a painful suture granuloma at the level of the meatus 1 month after the

surgery, requiring excision (CDC, Grade 3A). No obstructive voiding symptoms were observed.

At a mean follow-up of 40 months, four patients had a recurrence of the stricture, all of whom had lichen sclerosus. Among them, one patient presented with poor UFR and bothersome symptoms attributed to flimsy meatal adhesions 6 months postsurgery and underwent successful management with urethral dilatation and local steroid application. The remaining three patients developed recurrence at 13, 18, and 22 months in the distal penile region proximal to the augmented urethra. Initially, the patients were managed with urethral dilatation and intraurethral steroid instillation for 3 months. Following unsuccessful urethral dilatation, one patient underwent dorsal onlay repair after 8 months of failed urethral dilatation. The remaining patients were regularly followed up.

Two patients reported glans hyposensitivity and numbness during the follow-up period, which did not affect the erectile function. Functional outcomes, including symptom scores and uroflowmetry, showed significant improvements compared with the preoperative parameters ($P < 0.05$). Overall, 20 (77%) patients reported satisfactory outcomes at the follow-up. Six patients reported dissatisfaction following the surgery, attributed to stricture recurrence in four cases and glans hyposensitivity in two cases. All patients had satisfactory cosmetic outcomes despite the recurrence of the stricture in four patients.

DISCUSSION

This study highlights the surgical technique and functional outcomes of glans cap preservation surgery for meatal stenosis and FNS. This technique represents a modification of the dorsal inlay augmentation urethroplasty for penile urethral strictures.[5,8] It avoids the need to split the glans and preserves its natural contour while facilitating a successful reconstruction of the meatal stenosis and FNS. In this technique, overlapping sutures are avoided, thereby minimizing the risk of urethrocutaneous fistula formation and ensuring a cosmetically favorable skin incision.

The primary challenge has consistently revolved around the reconstruction of a near-normal caliber of the urethra while adhering to the physiological principles pertaining to the function of the meatus and fossa navicularis.[9] Any reconstruction procedure that involves splitting of the glans and repair of the FNS carries a risk of deformed glans and undesirable splaying of the stream of urine. Here, we discuss the merits of glans preservation surgery as a viable option for such scenarios. The anatomy of the fossa navicularis region of the urethra reveals a fibrous septum that plays a crucial role in maintaining both the flexibility and rigidity of the glans penis during the sexual intercourse.[9] Moreover, the fibrous septum glandis serves as a control mechanism, functioning as a valve to regulate the flow of urine as it exits the urethra.[9] Consequently, the glans preservation technique presented here aims to reproduce the physiological outcomes of the fossa navicularis, while safeguarding the core structures of the glans penis.[10]

Technical considerations pertaining to the augmentation of the urethral plate with a free graft are of paramount importance. Numerous techniques involve placing the free graft ventrally or dorsally, either as an onlay or inlay, to augment the urethral plate.[3-6] In this approach, we opted for a dorsal inlay placement of the free graft because of adequate availability of space on the dorsal aspect and the presence of a vascularized bed for graft support and fixation.

However, one drawback of placing the graft dorsally is the potential risk of bleeding. This can be prevented by applying a tourniquet to the proximal aspect of the penis.[3,5,6] Occasionally, there may be instances of delayed bleeding in the postoperative period, which are typically self-limiting owing to the splinting effect of the urethral catheter and the application of a compressive dressing. In our study, we encountered one patient who experienced bleeding from the meatus, which was subsequently managed by placing an additional suture to control the bleeding.

Selection of suitable patients for this technique is essential to minimize the risk of early stricture recurrence and failure. The following criteria should be considered: (1) strictures limited to the meatus, fossa navicularis region, and the distal penile urethra not exceeding 5 cm; (2) absence of

Table 1: Perioperative parameters, complications, and surgical outcomes in the study cohort

Parameter	Mean±SD, *n* (%)
Duration of surgery (min)	67±14
Augmentation tissue	
Buccal mucosa graft	14 (54)
Upper lip mucosa graft	8 (31)
Inner preputial graft	4 (15)
Stricture length (cm)	3.8±0.5
Postoperative complications	
Meatal hemorrhage (CDC-Grade 3A)	1 (4)
Urinary tract infections (CDC-Grade 2)	4 (15)
Glans hyposensitivity (CDC-Grade 1)	2 (8)
Glans suture granuloma (CDC-Grade 3A)	1 (4)
Functional outcomes	
Follow-up (months)	40 (13)
Stricture recurrence (CDC-Grade 3)	4 (15)
IPSS (P<0.05)	
Preoperative	20±4
Follow-up 2 years	10±3
Boyarsky dysuria score (P<0.05)	
Preoperative	2.6±0.5
Follow-up 2 years	0.8±0.8
Uroflowmetry (mL/s) (P<0.05)	
Preoperative	6±4
Follow-up 2 years	19±10

SD=Standard deviation, IPSS=International Prostate Symptom Score, CDC=Clavien–Dindo classification

changes suggestive of squamous metaplasia in the proximal urethral mucosa; and (3) presence of a conical glans. Caution is warranted, especially in cases of lichen sclerosus where persistent active inflammation is noted during the surgery. In such cases, endoscopic inspection of the proximal urethral mucosa to identify the squamous metaplasia is imperative. However, this technique should be avoided in obliterative strictures, particularly in patients with lichen sclerosus, owing to the increased risk of early recurrence.

In our study, we observed four failures attributed to lichen sclerosus. One patient had a near-obliterative stricture, in which only a glidewire could be accommodated, resulting in the development of flimsy meatal adhesions that were managed with dilatation and local steroid applications. In the remaining three cases, recurrence occurred due to the presence of ongoing inflammation in the proximal urethral mucosa, a factor that was overlooked during the surgery. Most failures were noted in the initial cases in the series; however, as the study progressed, meticulous case selection based on the previously outlined criteria significantly reduced such occurrences. Consequently, we encountered numerous cases where the described procedure was deferred, and alternative procedures were planned based on the specific stricture characteristics.

This study has several limitations, including a small cohort size, heterogeneous etiological factors, selection bias, and short follow-up period. To address these limitations, a randomized study comparing different techniques for these strictures with stringent case selection criteria should be considered.

CONCLUSION

Glans cap-preserving dorsal inlay-free graft augmentation is a safe and feasible technique with satisfactory short-term functional outcomes for the management of meatal stenosis and FNS in carefully selected patients.

REFERENCES

1. Fenton AS, Morey AF, Aviles R, Garcia CR. Anterior urethral strictures: Etiology and characteristics. Urology 2005;65:1055-8.
2. Morey AF, Lin HC, DeRosa CA, Griffith BC. Fossa navicularis reconstruction: Impact of stricture length on outcomes and assessment of extended meatotomy (first stage Johanson) maneuver. J Urol 2007;177:184-7.
3. Sterling J, Daneshvar M, Nikolavsky D. Transurethral ventral inlay buccal mucosa graft urethroplasty: Technique and intermediate outcomes. BJU Int 2023;132:109-11.
4. Favre GA, Villa SG, Scherñuk J, Tobia IP, Giudice CR. Glans preservation in surgical treatment of distal urethral strictures with dorsal buccal mucosa graft onlay by subcoronal approach. Urology 2021;152:148-52.
5. De Laet C, De Win G. Glans preserving buccal mucosa urethroplasty for glandular and distal urethral strictures. Turk J Urol 2022;48:309-14.
6. Wayne G, Perez A, Demus T, Nolte A, Mallory C, Boyer J, *et al.* Ventral onlay glanuloplasty for treatment of fossa navicularis strictures. Int Braz J Urol 2022;48:798-804.
7. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205-13.
8. Asopa HS, Garg M, Singhal GG, Singh L, Asopa J, Nischal A. Dorsal free graft urethroplasty for urethral stricture by ventral sagittal urethrotomy approach. Urology 2001;58:657-9.
9. Lee SH, Ha TJ, Koh KS, Song WC. Ligamentous structures in human glans penis. J Anat 2019;234:83-8.
10. Özbey H, Kumbasar A. Glans wings are separated ventrally by the septum glandis and frenulum penis: MRI documentation and surgical implications. Turk J Urol 2017;43:525-9.

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