

Better defining the optimal management of penile urethral strictures: A retrospective comparison of single-stage vs. two-stage urethroplasty

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Abstract

Introduction: We aimed to compare single-stage and two-stage urethroplasty techniques for the treatment of penile urethral strictures.

Methods: We performed a retrospective review of all penile urethroplasties performed at a single center between 2003 and 2017. The primary outcome was urethral patency, defined as the ability to easily pass a 16 Fr flexible cystoscope at six and 18 months of followup, and development of 90-day complications.

Results: Overall, 101 single-stage procedures (48 buccal mucosal graft [BMG] and 53 penile fasciocutaneous flap [PFF]) and 53 two-stage procedures were performed. There was no difference in median stricture length between groups ($p=0.25$). Cox regression analysis did not identify stricture etiology, length, age, obesity, prior reconstruction, or urethroplasty technique to be associated with failure. Log-rank testing did not demonstrate a difference in success rates between surgical techniques (91% [48/53] PFF vs. 83% [40/48] BMG vs. 87% [46/53] two-stage). Thirty-nine percent (60/154) of patients experienced a complication (51% [27/53] PFF vs. 29% [14/48] BMG vs. 36% [19/53] two-stage). Multivariate analysis found urethroplasty technique to be the only factor associated with development of complication ($p=0.02$); odds ratio relative to BMG was 3.1 ($p=0.009$) for PFF and 1.4 ($p=0.43$) for two-stage.

Conclusions: There appears to be little difference in success between penile urethroplasty techniques. The shift in technique to a single-stage BMG, when appropriate, appears to be founded on the basis of fewer operations for the patient relative to a two-stage repair, and a lower complication profile relative to single-stage PFF, without compromising success rates.

Introduction

The optimal management of penile urethral strictures is a controversial topic for reconstructive urologists. At the heart of the debate lie two issues — whether a flap is superior to a graft and when a single-stage repair should be preferentially employed over a two-stage repair.

Within the past few decades, there has been a surge in use of buccal mucosa grafts (BMG) for bulbar urethroplasties.¹ Excellent long-term outcomes in the bulbar urethra have resulted in a subsequent paradigm shift in penile urethroplasty technique from pedicled penile fasciocutaneous flaps (PFF) to grafts, without substantial evidence to support this transition. Proponents of PFF argue that the pendulous urethra lacks the robust vascularity of the bulbar urethra to support a graft, while a PFF brings its own blood supply to compensate for this lack of vascularity.² Contrastingly, grafts are much easier to harvest, with minimal donor site morbidity, faster to use, and the fears of poor graft take in the penile urethra are unfounded based on several reports.^{1,3,4}

Traditionally, two-stage repairs were used in complex cases involving lichen sclerosus, prior hypospadias repairs, and prior urethral reconstructions. However, this exposes patients to the morbidity of two procedures.⁵ Accordingly, there has been an expansion of indications for single-stage repairs for more complex strictures in an attempt to minimize the discomfort and risks of a second procedure, plus the typical six months of waiting between stages.

The study objectives were to compare BMG and PFF techniques, and single-stage and two-stage urethroplasty for the repair of penile urethral strictures. We hypothesized that single-stage urethroplasty with BMG offers similar success, with reduced morbidity, compared to staged and flap techniques. The approach to penile urethral strictures at our center has mirrored this wider paradigm shift, allowing us a unique opportunity to assess the impact this has had on urethroplasty outcomes.

Methods

We performed a retrospective review of penile urethroplasties performed at a single center between 2003 and 2017. Analysis included all patients who underwent penile urethroplasty. Ethics approval was obtained from our institutional review board. The primary outcome was urethral patency, defined as the ability to easily pass a 16 Fr flexible cystoscope at six and 18 months followup. The secondary outcome was the development of 90-day complications

during followup (classified by Clavien-Dindo system). For two-stage procedures, complications for both the first and second stages were included.

Surgical techniques

Single-stage PFF

The penis is typically degloved via a circumcising incision. The urethra is spatulated ventrally beyond the proximal extent of the stricture. Stricture length is measured and an appropriately sized PFF is outlined. The flap margins are sharply incised through the dermis and the pedicle is mobilized from the dartos fascia. The proximal anastomosis is performed and an onlay reconstruction is completed. A 16 Fr catheter is placed and the flap pedicle is spread fixed. The penile skin is closed and a dressing with occlusive gauze and gently compressive Coban™ wrap is applied. A voiding trial is performed three weeks postoperatively.

Single-stage BMG

A dorsal inlay or dorsal onlay technique is used depending on stricture location. A dorsal inlay is favored for distal strictures while dorsal onlay is typically preferred for proximal strictures. The distal extent of the stricture is marked using a bougie-a-boule, followed by a semicircular subcoronal incision with dissection to Buck's fascia. An incision is made into the glans through the corpus spongiosum into the penile urethra. Distally, the urethra is spatulated to greater than 28 Fr. A stricturotomy is performed. The urethral plate is incised dorsally and spread fixed to the corpus cavernosum. A graft of appropriate dimensions is harvested. The BMG is spread fixed into the dorsal incision or dorsal corpus cavernosum. The corpus spongiosum is reconstructed and closed. Glans reconstruction, if necessary, after mobilizing glans wings, is completed. A 16 Fr catheter is placed. A dressing of non-adherent gauze, regular gauze, and a Coban™ wrapping is applied. A voiding trial is performed three weeks postoperatively.

Two-stage BMG

The first stage is performed similar to the one-stage BMG up to the stricturotomy step. At this point, a urethrostomy is created at the proximal portion of the stricturotomy. The urethral plate and the dartos fascia and tunica albuginea alongside the plate are exposed. Bilateral BMGs are harvested based on the stricture length. These are secured along either side of the urethral plate. A 16 Fr catheter is placed. A bolster dressing composed of Xeroform™ gauze, surgical cotton soaked in mineral moisture, and regular gauze is then applied and secured with chromic sutures for five days. A trial of void is also performed on postoperative day 5.

The second stage is undertaken six months later if there are no complications with graft maturation. A suprapubic catheter is placed under cystoscopic guidance. The urethral

plate is outlined and the edges sharply incised. The urethral plate is closed over a 26 Fr sound. Glanuloplasty is completed with advancement of the glans flaps to the midline and the meatus is matured. A similar dressing to the one-stage PFF is then applied after a 14 Fr urethral stent is placed with a suprapubic catheter. A voiding trial is performed three weeks postoperatively.

Statistical analysis

Baseline patient and stricture characteristics were compared with Chi-square or Mann-Whitney testing where appropriate. Cox regression analysis was used to analyze factors associated with treatment failure. Kaplan-Meier regression modelling was used to demonstrate freedom from failure as a function of time. Binary logistic regression was then used to determine independent predictors of complications. Statistical tests were two-sided and a p value <0.05 was considered significant. All analysis was performed on SPSS Software v24.0 (IBM Corp., Armonk, NY, U.S.).

Results

In total, 154 penile urethroplasties were included — 101 single-stage procedures [48 BMG and 53 PFF] and 53 two-stage procedures. Cohort demographics are outlined in Table 1. Lichen sclerosus was the most common etiology for BMG repairs (56% [19/48]), compared to idiopathic for PFF repairs (26% [14/53]) and hypospadias in the two-stage repair (68% [36/53]). There was no difference in median stricture length between groups at 5.0 cm (interquartile range [IQR] 3.5–10) for PFF, 6.0 cm (3.6–9.8) for BMG, and 5.5 cm (4.0–7.0) for two-stage (p=0.25) (Table 1).

Penile urethroplasty outcomes and complications are demonstrated in Table 2. Overall, success rates were comparable between the three groups at 91% (48/53) vs. 83% (40/48), and 87% (46/53) for PFF, BMG, and two-stage techniques, respectively. Complications were experienced by 51% [27/53] of the PFF group vs. 29% [14/48] for the BMG group vs. 36% [19/53] of the two-stage group. Within the PFF group, 17 complications were Clavien grade I–II and included seven wound infections managed with antibiotics and 10 cases of ventral epidermolysis managed conservatively. Ten cases required re-intervention: one case of epidermolysis debrided under local anesthetic, seven urethrocutaneous fistulas (UCF) surgically repaired, one ventral glans dehiscence requiring glanuloplasty, and two cases of flap necrosis debrided under a general anesthetic. In the BMG group, the 13 Clavien I–II complications included a urinary tract infection (UTI), pneumonia, hematoma, wound infection managed with antibiotics, two UCF, and seven cases of epidermolysis managed conservatively. The single re-operative case was a combined UCF and ventral skin

Table 1. Baseline clinical characteristics

Clinical characteristic	One-stage PFF, n (%), IQR)	One-stage BMG, n (%), IQR)	One-stage overall, n (%), IQR)	Two-stage, n (%), IQR)	p
n	53	48	101	53	—
Mean age at urethroplasty (years)	49	50	49	35	0.0001
Median stricture length (cm)	5.0 (3.5–10)	6.0 (3.6–9.8)	5.0 (3.5–10.0)	5.5 (4.0–7.0)	0.25
Stricture etiology					
Idiopathic	14 (26.4)	8 (16.7)	22 (21.8)	1 (1.9)	0.001*
Traumatic	7 (13.2)	4 (8.3)	11 (10.9)	1 (1.9)	0.048*
Lichen sclerosus	1 (1.9)	19 (39.6)	20 (19.8)	14 (26.4)	0.35
Radiation	1 (1.9)	1 (2.1)	2 (2.0)	0 (0)	0.30
Hypospadias	13 (24.5)	7 (14.6)	20 (19.8)	36 (67.9)	0.0001*
Iatrogenic	16 (30.2)	9 (18.8)	25 (24.8)	1 (1.9)	0.0003*
Infectious/inflammatory	1 (1.9)	0 (0)	1 (0.99)	0 (0)	0.47
Prior urethral reconstruction	8 (15.1)	9 (18.8)	17 (16.8)	35 (66.0)	0.0001*
Median length of followup (months)	93 (60–113)	32 (18–50)	56 (28–103)	87 (45–121)	

*p<0.05 denotes statistical significance. BMG: buccal mucosal graft; IQR: interquartile range; PFF: penile fasciocutaneous flap.

separation repair. The 12 Clavien I–II complications experienced in the two-stage urethroplasty group were two cases of epididymitis, hematuria requiring manual irrigation, UTI, occluded suprapubic catheter requiring exchange, painful BMG exposure, wound infection, three minor wound dehiscences, and two hematomas all managed conservatively. The complications requiring surgical intervention included a wound dehiscence, excision of symptomatic granulation tissue, and repair of four UCF.

Cox regression analysis did not find stricture etiology ($p=0.76$), length (0.29), age ($p=0.24$), obesity ($p=0.07$), prior reconstruction ($p=0.36$), or urethroplasty technique ($p=0.35$) to be associated with failure (Table 3). Kaplan-Meier plots and log-rank testing did not demonstrate a difference in success rates between surgical techniques (91% [48/53] PFF vs. 83% [40/48] BMG vs. 87% [46/53] two-stage).

Binary logistic regression analysis found urethroplasty technique to be the only factor associated with development of complications ($p=0.02$). The odds ratio for compli-

cations relative to BMG was 3.1 (95% confidence interval [CI] 1.33–7.30; $p=0.009$) for PFF and 1.4 (95% CI 0.59–3.4; $p=0.43$) for two-stage urethroplasty (Table 4).

Discussion

This retrospective cohort study represents the largest series comparing three different penile urethroplasty techniques. Available literature is fraught with limitations, including inadequate followup, inaccurate specification of the stricture location (penile vs. bulbar), and heterogeneity in flap and graft origins.⁶ In our current study, success rates were similar across techniques, ranging from 83% for BMG to 91% for PFF.

BMG vs. PFF

There are two prospective trials randomizing patients to single-stage BMG or PFF for anterior urethral strictures, including

Table 2. Urethroplasty outcomes and complications

Outcome	One-stage PFF, n (%)	One-stage BMG, n (%)	One-stage overall, n (%)	Two-stage, n (%)	p
Successful urethroplasty	48 (90.6)	40 (83.3)	88 (87.1)	46 (86.8)	0.95
Complication experienced	27 (50.9)	14 (29.2)	41 (40.5)	19 (35.8)	0.57
Clavien grade					
I	10 (18.9)	9 (18.8)	19 (18.9)	7 (13.2)	0.38
II	7 (13.2)	4 (8.3)	11 (10.9)	5 (9.4)	0.79
IIIa	1 (1.9)	0 (0)	1 (1.0)	0 (0)	0.47
IIIb	9 (17.0)	1 (2.1)	10 (9.9)	6 (11.3)	0.93
IVa	0 (0)	0 (0)	0 (0)	0 (0)	—
IVb	0 (0)	0 (0)	0 (0)	0 (0)	—
V	0 (0)	0 (0)	0 (0)	0 (0)	—
Re-operation for complication	10 (18.9)	1 (2.1)	11 (10.9)	6 (11.3)	0.94

BMG: buccal mucosal graft; PFF: penile fasciocutaneous flap.

Table 3. Cox regression analysis of variables associated with treatment failure

Clinical variable	Hazard ratio	95% CI	p
Age (years)	0.99	0.95–1.01	0.24
Obesity (BMI ≥ 35 kg/m ²)	2.6	0.94–7.10	0.07
Stricture length (cm)	1.1	0.94–1.24	0.29
Previous urethroplasty	0.62	0.23–1.72	0.36
Technique			0.36
1-stage BMG	Referent	—	—
1-stage PFF	0.44	0.14–1.40	0.15
2-stage	0.64	0.23–1.80	0.39
Stricture etiology			0.98
Idiopathic	Referent	—	—
Traumatic	1.6	0.22–11.0	0.66
Lichen sclerosus	1.9	0.39–9.60	0.42
Radiation	1.0	0.9–1.01	0.99
Hypospadias	1.3	0.26–6.10	0.77
Iatrogenic	1.1	0.19–6.80	0.89
Inflammatory/infectious	1.0	0.99–1.01	0.99

BMG: buccal mucosal graft; BMI: body mass index; CI: confidence interval; PFF: penile fasciocutaneous flap.

both penile and bulbar stricture locations.^{7,8} No difference in success was found in these studies; 90% BMG vs. 86% PFF in Dubey et al, and 83% BMG vs. 90% PFF in Soliman et al. Results from both trials are hampered by small sample sizes and heterogeneity between groups. If bulbar urethral strictures are excluded, the group sizes were only 19 for PFF and 20 for BMG in the first trial, and 11 for PFF and 13 for BMG in the second trial. The most common complications seen in these studies were post-void dribbling (PVD) in 15–32%, superficial skin necrosis in 17–21%, skin loss (6%) and penile hypoesthesia in (11%).^{7,8} PVD and penile hypoesthesia were not reported in our series, while focal flap necrosis rate was 4% and the epidermolysis rate was comparable at 21%. The most common BMG complications in the Dubey trial were oral in 26%, including increased salivation and perioral numbness.⁷ In the Soliman series, oral complications were seen in 32%.⁸ In this present study, there were no reported oral complications, though a complication such as perioral numbness would depend on how patients were counselled regarding the donor site and length of followup. We did not consider it a complication if it resolved within 90 days. These series, and our data, highlight the advantages of BMG and shortcomings of PFF. The PFF is a complex flap with long suture lines that predispose to UCF (13%), epidermolysis (32%), and rarely, dehiscence (2%) and necrosis (4%). Oral BMG complications are generally transient and our rates of UCF and epidermolysis were lower than with PFF (4% and 15%, respectively). Technically, harvesting and performing a BMG is easier than a PFF. On balance, it appears that single-stage BMG techniques offer similar success rates to PFF procedures, but incur lesser morbidity.

Table 4. Binary logistic regression examining factors independently associated with postoperative complications

Clinical variable	Odds ratio	95% CI	p
Age	0.98	0.96–1.00	0.07
Stricture length	1.00	0.89–1.11	0.93
Etiology	0.95	0.79–1.15	0.63
Obesity (BMI ≥ 35 kg/m ²)	0.60	0.20–1.73	0.34
Previous urethroplasty	0.69	0.34–1.40	0.30
Technique			0.02*
One-stage BMG	Referent	—	—
One-stage PFF	3.1	1.33–7.30	0.009*
Two-stage	1.4	0.59–3.40	0.43

*p<0.05 denotes statistical significance. BMG: buccal mucosal graft; BMI: body mass index; CI: confidence interval; PFF: penile fasciocutaneous flap.

Single-stage vs. two-staged penile urethroplasty

In the largest series comparing single-stage and two-stage techniques, Andrich et al reported their experience with 103 two-stage repairs (n=92 after pure bulbar strictures excluded) and 139 single-stage repairs (20 PFF).⁵ A two-stage technique was employed for lichen sclerosus, after previous failed hypospadias surgery, or when the urethral lumen was obliterated. The six-month recurrence rate was 3% with single-stage compared to 4% with two-stage. Explanations for these lower failure rates include a shorter length of followup, inclusion of a significant number of bulbar strictures in both groups, and strict use of a two-stage repair for all hypospadias revisions and lichen sclerosus. Another notable difference is the revision rate of the Andrich series. It was highest for two-stage repairs at 38% and 20% for PFF.⁵ Though our PFF revision rate was similar (19%), the main indications in our series were for UCF repairs and focal flap necrosis, whereas all the PFF revisions were for hematomas in the comparative study. Contrastingly, our two-stage repair revision rate was only 11%. The most common indication for revision in the referenced study was urethrostomy stenosis (18%) and deepening of the glans cleft (13%).⁵ The most common indication for re-operation in this series was for UCF after the second stage. The authors postulate the high revision rate may be secondary to erections in the early postoperative period, leading to reactive hemorrhage and causing tension on the skin edges. It is our practice to leave patients on diazepam 5 mg orally three times daily for 48 hours postoperatively, then discharge them on 5 mg nightly for three weeks. Though it is unlikely this would account for the entirety of the discrepancy, it may lead to a lower revision rate. The main reason we have moved away from stringently using two-stage repairs is twofold. Firstly, all patients are subjected to at least two procedures and for some, left with a cosmetically unsatisfactory penis for six months while awaiting the second stage. Secondly, approximately 11–50% will receive three or more operations as a

result of complications requiring revisions.⁵ It appears the move from two-stage urethroplasties has been validated by similar outcomes, while reducing the total number of surgeries required.

Study strengths

A strength of our study is the use of Cox regression analysis to determine factors associated with treatment failure. Studies of penile strictures generally have a relatively heterogeneous population with respect to stricture length, etiology, and prior surgeries. We were able to demonstrate that, despite the heterogeneity in these variables, none proved to be associated with treatment failure. Likewise, binary logistic regression confirmed urethroplasty technique, namely PFF, to be the only factor predictive of complications. Another strength of this study is the robust followup. As the only reconstructive center in a large catchment area, we had a relatively captive cohort and were able to document long term followup ranging from 2.5 years for BMG to seven years for the PFF and two-stage groups. Overall, this represents one of the largest series of patients with penile urethral strictures and avoids the inclusion of any pure bulbar strictures.

Study limitations

Though our practice has shifted towards using a single-stage BMG preferentially to a PFF and two-stage repair, there is still significant selection bias. A two-stage repair remains our treatment of choice for failed single-stage repairs, an obliterated urethral plate, and for cases with a poorly developed glans. The challenge in generalizing these decision criteria are that the latter two are subjective surgeon assessments. There was baseline heterogeneity in stricture etiology between groups. However, on our regression analysis, stricture etiology was not associated with failure. A prospective, randomized trial comparing these three techniques will likely never be feasible due to this being a relatively uncommon condition, resulting in small numbers necessitating the combination of varying stricture etiologies, and inherent surgeon biases in selecting two-stage repairs for those strictures they deem to be more complex.

Conclusions

There appears to be little difference in success for penile urethroplasty between single-stage BMG, PFF, and two-stage urethroplasties. Complication rates were highest with single-stage PFF. The shift in technique to a single-stage BMG, when appropriate, appears to be founded on the basis of less operations for the patient relative to a two-stage repair, and a lower complication profile relative to single-stage PFF, without compromising success rates.

Competing interests: Dr. Rouke has been an advisory board member for and is a shareholder of Boston Scientific; he is also a study investigator for Red Leaf Medical. The remaining authors report no competing personal or financial interests related to this work.

This paper has been peer-reviewed.

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