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Single-stage segmental urethral replacement using combined ventral onlay fasciocutaneous flap with dorsal onlay buccal grafting for long segment strictures

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Abstract

- To present our experience with repairing long-segment urethral strictures in a single-stage using a combined tissue-transfer technique.
- In all, 14 men underwent urethroplasty where a segment of urethra was completely replaced using a dorsal onlay buccal mucosa graft and a ventral onlay fasciocutaneous flap in a single stage.
- Primary success was defined as an open urethra at >6 months follow-up with no need for additional surgical intervention.
- Secondary success was defined as the need for a single postoperative endoscopic procedure before stricture stabilization.
- Failure was the need for multiple endoscopic procedures, repeat urethroplasty, urinary diversion or intermittent dilatation.
- The mean (SD) stricture length was 9.75 (4.6) cm. The mean (SD) neourethral length was 5.4 (2.7) cm. Stricture location was penile/bulbar in 12 men, and bulbar alone in two. Primary success was achieved in nine of the 14 men at a median (range) follow-up of 2.5 (0.5 – 9.43) years.
- The mean (SD) time to recurrence in the five initial failures was 340 (376) days.
- Secondary success was achieved in two men after a single endoscopic procedure for an overall success in 11 of 14 men.
- Patients that recurred had longer strictures (12.8 vs 8.7 cm, $P = 0.04$) than initial successes, but neourethral lengths were similar (6.2 vs 5.1 cm, $P = 0.5$).
- In all, three of the 14 men failed, two of whom required a repeat urethroplasty.
- Our initial outcomes were favourable using the combined tissue-transfer technique for segmental urethral replacement with initial and secondary success rates similar to those reported for two-stage repairs.
- This technique is not suitable for all patients as it requires healthy penile skin, but appears to be effective when a single-stage repair is desirable.

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CONFLICT OF INTEREST

None declared.

Keywords

urethral stricture; fasciocutaneous flap; buccal mucosa; single-stage

INTRODUCTION

Long-segment pendulous urethral stricture disease is a very difficult surgical problem. This is especially true in men where part of the existing urethral plate is unsalvageable. In this group, standard reconstructive techniques, using either ventral fasciocutaneous penile flaps [1] or dorsal buccal mucosa grafts (BMGs) [2] are not always possible, as these techniques require the graft or flap to be anastomosed to the healthy edges of an existing urethral plate. Options in this group then become either tubularization of the graft or flap in a single-stage, which has been shown to have uniformly poor outcomes [1,3], or resorting to a multi-stage procedure using the Johansson principles [4]. While the later technique has been shown to be successful in some men, it renders these patients with a hypospadiac urethra for at least 6 months [5]. Additionally, while this technique is often described as a two-stage repair, a large percentage of men undergoing this type of repair will either require multiple additional revisions [3], or will simply choose to not undergo their second stage at all [6].

The limiting factor in single-stage procedures for these severe strictures in which a complete segment of urethra must be replaced, seems to be the lack of a reliable blood supply that is capable of providing for the entire neourethra [3]. In our attempt to solve this problem, in select men we have performed a single-stage operation using both a dorsal onlay of buccal mucosa and a ventral distal penile fasciocutaneous flap, which when combined, can completely replace a diseased segment of urethra. This repair incorporates two separate and independent sources of blood supply to the neourethra and we herein present our initial experience with the technique.

PATIENTS AND METHODS

A review of a large, Institutional Review Board-approved prospectively maintained urethral stricture database was performed, looking for cases where a segment of urethra was replaced in one stage by using combined tissue transfer techniques. Patients without recent follow-up were contacted by telephone call to assess current status of their urethra, including updates on additional urethral surgery or need for intermittent catheterization or urethral dilations.

SURGICAL TECHNIQUE

All patients were evaluated preoperatively with a combined retrograde urethrogram (RUG)/voiding cystourethrogram (VCUG) to evaluate the extent of the stricture disease. Most then underwent preoperative urethral ultrasonography after the induction of general anaesthesia to further characterize the extent of the stricture and the amount of spongiositis present, to help determine which parts of the urethral plate were salvageable [7].

Patients are initially positioned in low lithotomy using Allen stirrups. A 2 cm wide, circumferential fasciocutaneous flap is harvested first, using a previously described technique [8]. The flap is generally 12 – 15 cm in length after it is split dorsally depending on penile circumference and skin laxity. A 22 F red-rubber catheter is then placed in the urethra to delineate the most distal aspect of the stricture. A ventral urethrotomy is made over the distal tip of the catheter and extended proximally until the normal calibre urethra is encountered. In patients with bulbar components of their stricture, the scrotum is either split at this point, or a second incision is later made in the perineum with the patient in high lithotomy after the both the flap and graft have been harvested. This mid-procedure

repositioning avoids prolonged amounts of time in high lithotomy when working on the bulbar urethra for these often complex and lengthy procedures.

Urethral segments that are unusable (in general, urethral plates < 0.5 cm wide with significant spongiofibrosis) are then resected along with the surrounding, diseased spongiosum tissue (Figs 1,2). The segmental defect is then measured and an appropriately sized, 1.5–2 cm wide buccal segment is harvested from the cheek. The graft is then secured to the proximal and distal urethra and then the underlying corpora cavernosum using 5-0 polyglyconate sutures (Fig. 3). The remaining ventral urethral defect is repaired using the previously harvested fasciocutaneous flap (Figs 4,5). In many cases, the stricture will extend both proximal and distal to the area of unusable urethra that has been completely resected. In these cases the stricture is incised ventrally and repaired with the fasciocutaneous flap. The most proximal and distal portions of the flap are secured to the normal urethra using interrupted 5-0 polyglyconate sutures. The remaining length is secured using a running 6-0 polyglyconate suture (Figs 6,7). At the area of the BMG where the circumferential neourethra is being formed, we are careful that all sutures placed secure the flap to both the graft and the underlying corpora to help prevent contraction in this area.

A 16 F Foley catheter is left *in situ* for a minimum of 3 weeks, at which time a VCUG is performed to look for extravasation. Repeat RUG/VCUG studies are performed at 3 and 12 months (Fig. 8). Uroflowmetry is performed at all initial postoperative visits, then yearly thereafter with changes in flow rate or the shape of the curve prompting repeat RUG/VCUG studies.

Initial success was defined as any patient that did not require additional surgical procedures, endoscopic or open, including the need for periodic urethral dilatation during a minimum follow-up period of 1 year. Secondary success was defined as any patient requiring a single endoscopic revision only with a stable repair of >1 year in the subsequent follow-up period. Failure was defined as any patient that required multiple endoscopic procedures for stricture recurrence, a repeat urethroplasty was required or periodic urethral dilatation was currently being performed to keep the stricture open.

RESULTS

From May of 1998 to March of 2010, 14 men underwent procedures that met the inclusion criteria. During that same period, 14 additional men underwent two-stage repairs for similar types of strictures. The median (range) surgical age was 52.9 (23.1–83.9) years. The median (range) follow-up was 2.5 (0.5–9.43) years. The mean (SD) stricture length was 9.8 (4.6) cm. Operative information is shown in Table 1.

Initial success achieved in nine of the 14 men. Of the five patients with an initial failure, the mean (SD) time to recurrence was 340 (376) days. Patients that recurred had longer strictures (12.8 vs 8.7 cm, $P = 0.04$) than initial successes, but neourethral lengths were similar (6.2 vs 5.1 cm, $P = 0.5$). Two men required a single endoscopic procedure for the recurrence, both of which were located at proximal anastomosis of the fasciocutaneous flap and the normal urethra, bringing final success to 11 of 14 men (78%). Three men ultimately failed their procedure. Patient #1 (Table 1) initially had stricture recurrence at two locations, one at the distal anastomosis of the BMG, fasciocutaneous flap and normal urethra and the other in an area proximal to the reconstructed urethra. This patient elected initial management with direct visual internal urethrotomy (DVIU), which failed. He is currently managing the stricture with intermittent catheterization. Patient #4 had a 3.5 cm breakdown of his fasciocutaneous flap at the penoscrotal junction requiring a revision urethroplasty using a local rotational penile skin flap. He subsequently developed a urethrocutaneous

fistula at this area, which was ultimately repaired using a second BMG 1 year later. He is now recurrence free at last follow-up (18 months). Patient #12 was found to have a recurrence immediately after urethroplasty both distal and proximal to the reconstructed urethra. The distal recurrence in the fossa navicularis was repaired with a dorsal BMG, but this also failed. The proximal recurrence was proximal to the repaired neourethra and was managed with a DVIU. The patient is currently performing periodic self-dilatations.

DISCUSSION

Long-segment urethral stricture disease is a challenge for even the most accomplished reconstructive urological surgeon and the best set of techniques required to repair them has not been adequately established. However, what is generally agreed upon is that in cases where a portion of the strictured urethra is severely diseased and narrowed, complete removal of the segment is a requirement for a successful long-term outcome. In the bulbar urethra, excision of the diseased segment can often be followed by a relatively straightforward, anastomotic urethroplasty, as the urethra is quite elastic in this area [9]. However, in the pendulous urethra extensive mobilization of the non-diseased urethra after excision is not as simple, as the blood supply distally is less reliable [10,11] and anastomotic procedures will usually lead to problems with penile chordee. This makes replacement of the entire excised penile urethral segment a requirement.

Single-stage operations to replace circumferential segments of the urethra have been described before and results have been generally unfavourable. Tubularization of free (buccal/posterior auricular) grafts lead to a nearly 50% short-term re-stricture rate, the cause of the poor results hypothesized to be the unreliable blood supply the healing graft receives at its lateral edges [12]. Tubularization of fasciocutaneous flaps have equally poor outcomes, despite that these grafts bring with them their own, generally reliable blood supply [1]. These findings have led many to abandon the single-stage repair when complete segments need to be replaced, and performance of a two-stage repair, originally described by Johanson, is now more commonly performed [3–5,13].

The principles of the two-stage repair include excision of the diseased tissue and then grafting of the underlying, exposed corpus cavernosum with a free graft, most commonly a BMG. The graft is usually left to heal for 6 months, over which time the blood supply to the graft matures. At the second-stage, the lateral edges of the graft are lifted with its new underlying blood supply, and a tube is rolled. This technique has the advantage of ensuring that the tissue being used to replace the urethral tissue has a reliable blood supply before it is rolled into a tube. This improved blood supply is probably why the two-stage repair has been retrospectively shown in the literature to have superior outcomes for re-stenosis rates, as compared with any previously described one-stage tubularization procedures [3]. However, the two-stage repair leaves the patient with an open, hypospadiac urethra for at least 6 months, and for many patients, this is unacceptable. Additionally, while the original Johansson technique is described as a two-stage repair, a large percentage of men will ultimately require three or more operations before their definitive urethroplasty [3].

In the present study, we describe our experience with single-stage segmental urethral replacement using combined tissue-transfer techniques. This technique has previously been described in a few patients by Morey [14], and more recently, has been shown to be effective in the paediatric population for complex hypospadias repairs [15]. We find that there are distinct advantages to this technique vs other single-stage operations. For one, the segment of circumferential neourethra relies on two distinct blood sources during the healing process. The dorsal BMG relies on inosculation from the underlying tunica, which has been shown to be extremely reliable [2], while the ventral fasciocutaneous flap brings

with it its own versatile blood supply. Unlike tabularized single-stage repairs, the healing of the ventral and dorsal aspects of the neourethra are, then, effectively independent of each other. Secondly, both the flap and the BMG can be sutured to the lateral edges of corpora, which gives the replaced segment improved stability as compared with tubularized grafts, and possibly helps prevent contracture of this segment.

The results from our early experience with this technique are encouraging. Initial success was nine of 14 men at moderate-term follow-up and after two patients that initially failed underwent a single endoscopic procedure for short anastomotic strictures, the final success rate was 11 of 14 men (78%). These outcomes are significantly better than our previously reported experience with fasciocutaneous flap tubularization in a similar population of patients, in which success was achieved less than half of the time [1].

The single-stage repair we have described is not appropriate in some men that require segmental pendulous urethral replacement. Men with significant lichen sclerosus severely affecting the distal penile skin would not usually be suitable candidates for a fasciocutaneous flap, and therefore, might best be managed in two stages using extragenital skin. This may also be true in hypospadias failures where reliable skin to form the fasciocutaneous flap is often absent. Additionally, in some men with long strictures, a first-stage Johanson procedure performed without the second stage may be their best option. We have found that it is not unusual for men with these severe strictures, especially in those with a history of multiple prior operations, to be completely satisfied with a unobstructed, hypospadiac urethral meatus after the first stage has been performed, and this phenomenon has previously been described [6]. Therefore, in men that are unwilling to accept treatment failure or the need for additional procedures, a single-stage operation might not be appropriate. Still, we have been very satisfied with this surgical option for a select group of men, and feel it offers a reasonable alternative to the traditional two-stage repair, without compromising overall success rates. This, we believe, is because of its incorporation of a dual-blood supply to the neourethra, although this has not been clinically proven. A prospective trial comparing this type of single-stage operation to a two-stage operation would be feasible and appropriate.

In conclusion, we have shown that single-stage, segmental urethral replacement surgery is possible using the combination of a dorsal onlay BMG and a ventral onlay circular fasciocutaneous flap. This technique incorporates a dual blood supply to the neourethra, which is probably responsible for the favourable outcomes as compared with the historical success rates of single-stage tubularization procedures.

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Abbreviations

BMG	buccal mucosa graft
RUG	retrograde urethrogram
VCUG	voiding cystourethrogram
DVIU	direct visual internal urethrotomy

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

Single-stage urethral segment replacement has historically poor outcomes and two-stage repairs are now more common. We present a novel approach to the single-stage repair with initial outcomes similar to two-stage repairs.

FIG. 1.
Excision of the diseased urethral segment, leaving a 6 cm urethral defect.

FIG. 2.
Excision of the diseased urethral segment, leaving a 6 cm urethral defect.

FIG. 3.
Dorsal onlay of buccal mucosa (6 cm) to replace the excised urethral plate.

FIG. 4.
Rotation of the fasciocutaneous flap.

FIG. 5.
The fasciocutaneous flap has been secured to one side of the BMG and the proximal and distal portions of the remaining urethra with 5-0 and 6-0 polyglyconatesutures.

FIG. 6.
The fasciocutaneous flap has been secured to one side of the BMG and the proximal and distal portions of the remaining urethra with 5-0 and 6-0 polyglyconate sutures.

FIG. 7.
The neourethra is completed over a 16 F Foley catheter using 6-0 polyglyconate sutures.

FIG. 8. Pre- (**a**) and postoperative (**b**) RUG of the surgical case shown above, depicting the severely diseased preoperative urethra and the open neourethra after a successful surgery.

TABLE 1

Cause, location and outcomes of the 14 study participants

N	Stricture cause	Location	Dorsal graft segment, cm	Flap length, cm	Initial failure	Time to recurrence, days	Secondary procedure	Final outcome
1	Unknown	P, B	4	13	+	173	DVIU	Periodic dilatation
2	LS	P, B	5	10				
3	Trauma	B	4	7				
4	Trauma	P, B	5	12	+	489	Urethroplasty	No recurrence
5	Hypospadias	P, B	2	14				
6	Urolume	P, B	8	15				
7	Urolume	B	7	7				
8	Unknown	P, B	10	14	+	934	DVIU	No recurrence
9	Trauma	P, B	5	11				
10	Trauma	P, B	10	10	+	80	Urethral dilatation	No recurrence
11	Unknown	P, B	5	7				
12	Trauma	P, B	2	15	+	27	1. DVIU 2. Urethroplasty	Periodic dilatation
13	Urolume	P, B	5	12				
14	Unknown	P, B	9	11				

LS, Lichen Sclerosus; P, pendulous; B, bulbar.