

# A comparison of one-stage procedures for post-traumatic urethral stricture repair

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## OBJECTIVE

To compare the results and complication rates of various one-stage treatments for repairing a post-traumatic urethral stricture.

## PATIENTS AND METHODS

The medical records of 153 patients who had a post-traumatic urethral stricture repaired between 1977 and 2003 were evaluated retrospectively, and analysed for the different types of urethral reconstruction.

## RESULTS

The procedures included direct end-to-end anastomosis in 86 (56%) patients, free dorsal

onlay graft urethroplasty using preputial or inguinal skin in 40 (26%), ventral onlay urethroplasty using buccal mucosa in seven (5%) and ventral fasciocutaneous flaps on a vascular pedicle in 20 (13%). At a mean (median, range) follow-up of 75.2 (38, 12–322) months, 121 (79%) patients had no evidence of recurrent stricture, while in 32 men (21%) they were detected at a mean follow-up of 30.47 (1–96) months. Patients having a dorsal onlay urethroplasty had the longest strictures. The re-stricture rate was lowest after a dorsal onlay urethroplasty (5% vs 27% when treated with end-to-end anastomosis, 15% after fasciocutaneous flaps and 57% after a ventral buccal mucosal graft). The surgical technique used had no effect on

postoperative incontinence or erectile dysfunction rates.

## CONCLUSION

In patients with strictures which are too long to be excised and re-anastomosed, tension-free dorsal onlay urethroplasty is better than ventral graft or flap techniques. In patients with short urethral strictures direct end-to-end anastomosis remains an option for the one-stage repair of urethral stricture.

## KEYWORDS

urethral stricture, dorsal onlay urethroplasty, end-to-end anastomosis, buccal mucosa graft, ventral fasciocutaneous flap

## INTRODUCTION

Lesions of the urethra, occurring in 3–25% of patients with pelvic fractures or after iatrogenic manipulation [1], constitute serious injuries that may be complicated by recurrent stricture formation, incontinence, recurrent UTIs or erectile dysfunction. In addition to appropriate initial management, careful selection of the operative technique and the experience of the urologist in urethral reconstructive surgery are crucially important for successful repair of post-traumatic urethral stricture (PTUS). The decision as to which operative technique should be used is determined by various factors, including stricture length and location, and the general health and age of the patient. To date there are only a few reports on the long-term results of urethral repair and none of them includes a comparison of different one-stage procedures. In the present study the results and complications of various one-stage procedures for PTUS repair (direct end-to-end anastomosis, free dorsal onlay graft urethroplasty using preputial or inguinal skin, ventral onlay buccal mucosa urethroplasty

and ventral fasciocutaneous flaps on a vascular pedicle) were evaluated.

## PATIENTS AND METHODS

Between 1977 and 2003, 153 patients had a one-stage repair of a PTUS; men with strictures after previous hypospadias repair were excluded from the study. The posterior urethra was involved in 78 men (51%); in the remaining 75 the penile and/or bulbar urethra was involved, 14 (9%) presented with complete posterior urethral disruption caused by trauma. The mechanism of injury and stricture length were evaluated. The number of previous urethral operations, mean and maximum urinary flow rates before and after surgery, residual urine volumes, re-stricture rates and incontinence, impotence, penile curvature and recurrent UTI after surgery, were assessed separately for the different types of urethral reconstruction.

Direct end-to-end anastomosis was by an approach via the perineal body [2]. The strictured portion of the urethra was exposed

and excised together with surrounding fibrous tissue. The distal urethra was generously dissected to allow for a tension-free anastomosis and subsequently re-anastomosed.

Free dorsal onlay graft urethroplasty using preputial or inguinal (after circumcision) skin was as described previously [3]. The bulbar urethra was mobilized circumferentially and the strictured portion incised dorsally at the 12 o'clock position. The incision was then continued 1.5 cm into healthy urethral tissue proximal and distal to the stricture. A preputial (or alternatively inguinal) skin graft was harvested and the urethra sutured to the margins of the graft.

The technique of ventral onlay urethroplasty using buccal mucosa was described in detail by Heinke *et al.* [4]. After obtaining an appropriate graft from inside the cheek, the bulbocavernosal muscles were incised along the midline to expose the corpus spongiosum. The strictured portion of the urethra was incised and the incision extended proximally and distally into healthy urethral tissue, then

**TABLE 1** The baseline characteristics and operative data of 153 patients undergoing a one-stage urethral reconstruction for PTUS

Median (SD, range) variable	End-to-end anastomosis	Dorsal onlay urethroplasty	Ventral buccal mucosa graft	Ventral fasciocutaneous flap
Age, years	33 (14.4, 6–71)	53 (19.6, 16–81)	35 (23.6, 17–80)	52 (19.3, 6–81)
Follow-up, months	108.6 (90.9, 10–322)	24.5 (7, 15–38)	70.7 (32.3, 19–105)	34.1 (19.7, 12–60)
Stricture length, cm	2 (2.2, 0.5–6)	6.5 (4.3, 1.5–16)	3 (2.1, 2–8)	3 (2.3, 1–10)
Urinary flow, mL/s: maximum baseline at 3 months	9 (5, 0–27) 22 (7.4, 9–45)	8 (4.7, 0–16) 23 (10.3, 6.3–50)	7 (4, 0–12) 23 (8, 14–40)	8 (5.8, 0–22) 21 (7.1, 8.5–32)

the tailored mucosal graft sutured to the urethral mucosa.

A genital ventral fasciocutaneous island flap on a vascular pedicle was only used in patients who had not had previous surgical procedures and thus presented with intact penile and scrotal circulation.

A grooved 20 F silicone catheter was left in place for 3 weeks after surgery; a suprapubic tube was inserted in all patients. All patients had a peri-catheter urethrogram taken 21 days after surgery to ensure that healing was satisfactory before removing the catheter. The routine follow-up was at 3 and 6 months and thereafter annually or on demand. Patients were followed by an assessment of their symptoms and urinary flow rates. If the stream deteriorated they had further urethrography or urethroscopy.

The Mann-Whitney *U*- and Kruskal-Wallis tests were used to assess significant differences, with  $P < 0.05$  considered to indicate statistically significant differences.

## RESULTS

Between 1977 and 2003, 153 men had a one-stage reconstruction of PTUS at our department; the surgical procedures included direct end-to-end anastomosis in 86 (56%), free dorsal onlay graft urethroplasty using preputial or inguinal skin in 40 (26%), ventral onlay buccal mucosa urethroplasty in seven (5%) and ventral fasciocutaneous flaps on a vascular pedicle in 20 (13%). The strictures occurred after car or motorcycle accidents in 49 patients, industrial accidents in 46, iatrogenic manipulation in 18, straddle trauma in 18, and as a result of other injuries in 22; 36 (24%) patients had previously had

surgery for urethral stricture and 33 (22%) were lost to follow-up.

The median (range) age of the patients at the time of surgery was 39.0 (6–81) years, and the median stricture length (measured during surgery) 3.0 (0.5–16) cm. At a mean (median, range) follow-up of 75.2 (38, 12–322) months, 121 of the 153 patients (79%) had no evidence of recurrent stricture, while in 32 (21%) recurrent strictures were detected at a mean follow-up of 30.47 (1–96) months.

The median peak flow rate before surgery improved from 8.8 (0–27) to 22.0 (6–50) mL/s afterward, and the median average flow rate from 5.0 (0–13) before to 13.0 (5–33) mL/s after surgery. The median residual urine volume as determined by ultrasonography was reduced from 110 (0–1300) to 21 (0–200) mL. After surgery, eight (5%) men reported penile curvature that was not present beforehand, whereas six (4%) men had incontinence. Four men (3%) reported erectile dysfunction and 19 (12%) had at least one UTI after surgery.

The patients were stratified into four groups according to the surgical technique used, and the results compared (Table 1). Patients in the dorsal urethroplasty and fasciocutaneous groups were significantly older than in those undergoing end-to-end anastomosis. In the dorsal onlay group the strictures were significantly longer than in the end-to-end anastomosis ( $P < 0.001$ ) and fasciocutaneous flap group. The stricture in men treated with buccal mucosa grafts was not significantly longer than in the dorsal onlay group ( $P = 0.07$ ).

Of the 86 patients treated with end-to-end anastomosis 23 (27%) had a recurrent stricture at a mean follow-up of 38 (1–96)

months, compared with three of 20 (15%) in the fasciocutaneous flap group at 6 (3–8) months. In the dorsal onlay group two of 40 (5%) men developed re-stricture after a follow-up of 15 (6–24) months, whereas in the buccal mucosa group four of seven required surgical revision for stricture recurrence at 11 (6–14) months. The differences between the dorsal onlay or end-to-end anastomosis and the buccal mucosa group were statistically significant ( $P = 0.003$  and  $<0.001$ , respectively).

The median increase in urinary peak flow rate after surgery was higher in the dorsal onlay than in the end-to-end and the buccal mucosa groups (Table 1). In the fasciocutaneous flap group the peak urinary flow improved by a median of 10.0 (5.5–22) mL/s. There was a statistically significant difference in improvement in peak flow rates between the dorsal onlay and the fasciocutaneous flap group only ( $P < 0.001$ ). The median average urinary flow did not differ significantly among the surgical techniques. There were no significant differences in the reduction in residual urine volume either (median 137.8, 135.2, 67.4 and 50.0 mL in the dorsal onlay, fasciocutaneous flap, end-to-end and buccal mucosa groups, respectively), although there was a clear trend to a less pronounced reduction in the last two groups.

There was a history of previous surgery in 15 patients (17%) treated by end-to-end anastomosis, one in the ventral buccal mucosa group, six (30%) in the fasciocutaneous group and 10 (25%) in the dorsal onlay group.

The rates of incontinence, impotence and newly developed penile curvature did not correlate with the surgical technique used. Unlike the other three subgroups, patients

undergoing end-to-end anastomosis were treated by several surgeons, three of whom performed more than 10 of the 86 procedures; the re-stricture rates for these three surgeons were 18–40%.

## DISCUSSION

Various surgical techniques have been described for the one-stage repair of PTUS, including stricture excision and urethral re-anastomosis, and various flap and graft techniques. The success rates for single-stage repairs have been reportedly >90% [5,6]. The choice of reconstructive technique depends on stricture length, the degree of spongiositis, and the surgeon's preference and experience. Stricture excision and anastomosis of the urethral stumps often has been reported to be the procedure of choice in short strictures, whereas free grafts and pedicled flaps are used in more complex cases and longer strictures.

In the present study, 86 of the 153 (56%) men having a PTUS repaired were treated with direct end-to-end anastomosis, but in the late 1970s and early 1980s this procedure was used not only in men with strictures of <2 cm long but also in those with strictures that were considerably longer.

The relatively high re-stricture rate of 27% (23/86) in the present series might be attributable to the anastomosis not being tension-free, which may have led to ischaemia and, in turn, to scar formation and re-stricture. Interestingly, most of these re-strictures occurred unusually late (mean 38 months, range 1–96). The present re-stricture rate was much higher than that of a historical series evaluated at our department (14.8%) but in the latter study the follow-up was shorter [7]. This emphasizes the need for long-term studies to determine the entire range of morbidity.

On the contrary, re-strictures occurred early after surgery in all other subgroups, typically at ≈1 year, with the lowest rate (5%) in the dorsal onlay group, followed by 15% in the ventral fasciocutaneous flap group and four of seven treated with buccal mucosa grafts. These re-stricture rates confirm recent data showing that re-strictures are common within ≈1 year after surgery [4]. Although the mean follow-up was shorter in the dorsal onlay group the re-stricture rates are nevertheless

better, as these patients had longest (median) strictures of all the groups (6.5 vs 3.0 cm in the ventral buccal mucosa and fasciocutaneous flaps, and 2.0 cm in the end-to-end anastomosis groups). The excellent stricture-free rate of 95% after a mean follow-up of >2 years in the dorsal onlay group is in line with that of smaller studies of this technique [8–10]. The re-stricture rate in the ventral fasciocutaneous group is comparable with that of a study using pedicled skin flaps in 10 patients with long urethral strictures (mean 7.7 cm).

However, the re-stricture rate of four of seven in the ventral buccal mucosa group, which is clearly higher (although with very few patients) than that reported in a study assessing the outcome of buccal mucosa onlay grafting in patients with a shorter follow-up [4], is unacceptably high. There is strong evidence that the ventral graft technique has a significant disadvantage over dorsal onlay urethroplasty. If applied ventrally, the graft often lacks the mechanical support of a fixed bed, which carries the risk of the graft folding on itself, thus impeding neovascularization, which eventually leads to shrinkage of the reconstructed urethra. The most feared complication of free-graft urethroplasty is patch necrosis caused by failure of vascularization, which leads to urethroperineal fistula. These complications are much more unlikely if the dorsal graft is apposed. The good results reported for the dorsal onlay technique using buccal mucosa grafts [8] indicates that it is probably the site of graft application rather than the type of graft material which is responsible for the high rates of graft failure.

Why the re-stricture rate in patients treated with ventral buccal mucosa grafts was so much higher than in men receiving ventral pedicled fasciocutaneous grafts (four of seven vs 15%) is unclear. However, it might be assumed that in this demanding procedure the skill and experience of the surgeon are crucial factors. Analysis of the 86 patients undergoing end-to-end anastomosis showed that the re-stricture rates of three surgeons who performed >10 of these procedures was 18–40%.

In patients presenting with severe urethral trauma, urinary continence is a major concern. Six of the 153 (4%) patients undergoing urethral reconstruction developed stress incontinence (defined as requiring one or more

pads) after surgery (three had end-to-end anastomosis, two fasciocutaneous flap and one dorsal onlay urethroplasty). These results contrast with those of a small series including 24 patients in whom there was no new onset of incontinence [10].

Erectile dysfunction was reported in 17 (11%) men after trauma and in four (3%) after surgery but there was no difference after surgery in the incidence of erectile dysfunction among the techniques. The complication rate of 2.6% is slightly lower than that reported by others [11]. However, the true incidence of erectile dysfunction might be higher, because in earlier years patients were not routinely questioned about this after surgery, and erectile function was assessed on the basis of the patient's history, which is a limitation of the study.

In conclusion, the present results suggest that in patients with strictures too long to be excised and re-anastomosed a tension-free dorsal onlay urethroplasty provides better results than ventral flap and graft techniques. However, in patients with short strictures, in whom a completely tension-free anastomosis can be achieved, direct end-to-end anastomosis remains an option for the one-stage repair of PTUS.

## CONFLICT OF INTEREST

None declared.

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**Abbreviations:** PTUS, post-traumatic urethral stricture.