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Review – Reconstructive Urology

A Systematic Review of Graft Augmentation Urethroplasty Techniques for the Treatment of Anterior Urethral Strictures

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Abstract

Context: Reconstructive surgeons who perform urethroplasty have a variety of techniques in their armamentarium that may be used according to factors such as aetiology, stricture position, and length. No one technique is recommended.
Objective: Our aim was to assess the reported outcomes of the various techniques for graft augmentation urethroplasty according to site of surgery.
Evidence acquisition: We performed an updated systematic review of the Medline literature from 1985 to date and classified the data according to the site of surgery and technique used. Data are also presented on the type of graft used and the follow-up methodology used by each centre.
Evidence synthesis: More than 2000 anterior urethroplasty procedures have been described in the literature. When considering the bulbar urethra there is no significant difference between the average success rates of the dorsal and the ventral onlay procedures, 88.4% and 88.8% at 42.2 and 34.4 mo in 934 and 563 patients, respectively. The lateral onlay technique has only been described in six patients and has a reported success rate of 83% at 77 mo. The Asopa and Palminteri techniques have been described in 89 and 53 patients with a success rate of 86.7% and 90.1% at 28.9 and 21.9 mo, respectively. When considering penile strictures, the success rate of the two-stage penile technique is significantly better than the one-stage penile technique, 90.5% versus 75.7% as calculated for 129 and 432 patients, respectively, although the follow-up of one-stage procedures was longer at 32.8 mo compared with 22.2 mo.
Conclusions: There is no evidence in the literature of a difference between one-stage techniques for urethroplasty of the bulbar urethra. The two-stage technique has better reported outcomes than a one-stage approach for penile urethroplasty but has a shorter follow-up.

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1. Introduction

The anterior urethra lies beyond the distal sphincter mechanism and comprises the bulbar and penile urethra. Management of anterior urethral strictures should involve informed decision making with the patient because many procedures are available with different implications for each patient. Less invasive procedures such as urethral dilatation, stenting, and urethrotomy clearly have a role [1]. The success of anastomotic urethroplasty, where the

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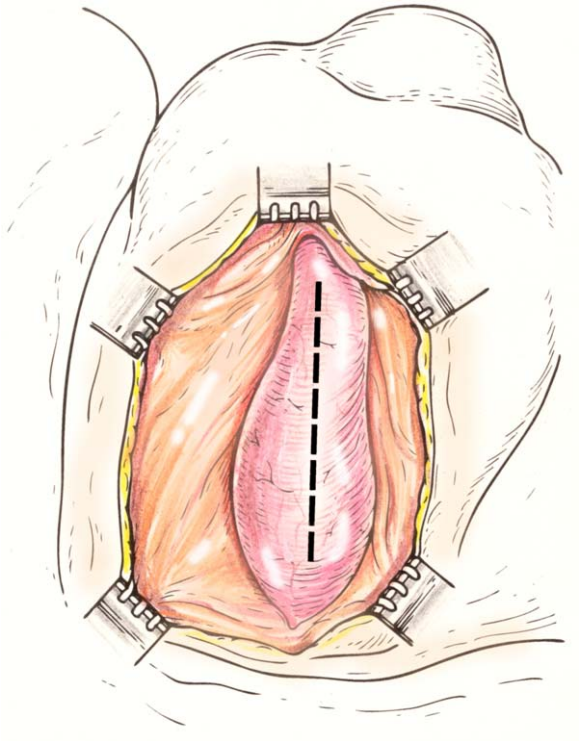

Fig. 1 – Ventral approach.

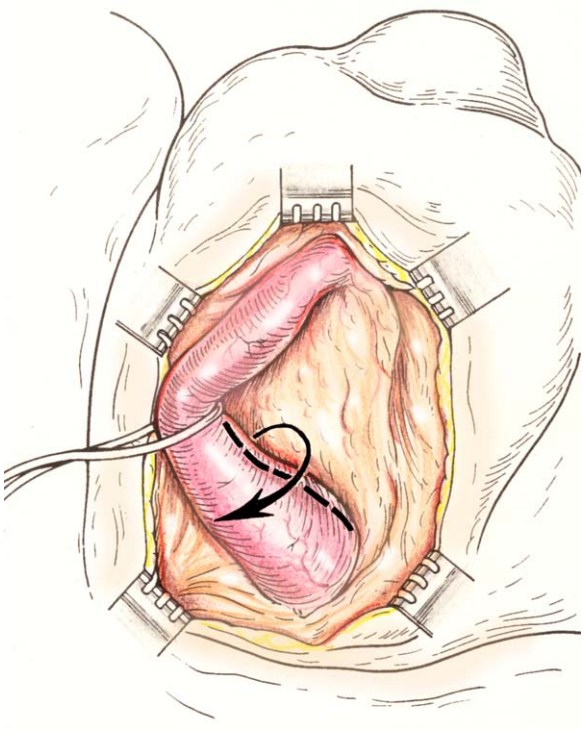

Fig. 2 – Dorsal approach.

stricture is excised and the ends sutured, in the bulbar urethra was reported at 95% and 91% in two large series [2,3]. However the anastomotic procedure may only be employed up to a stricture length of 5 cm depending on local circumstances [4].

Augmentation urethroplasty is required if the stricture is lengthy or if it affects the penile urethra. The bulbar urethra should not be mobilised extensively for this purpose distal to the penoscrotal junction due to the risk of chordee. An augmentation procedure may either be a one- or two-stage procedure.

The two potential options with a one-stage procedure are (1) an *augmented anastomotic procedure,* in which the stricture is excised and a roof strip of native urethra is augmented by a patch or a so-called *onlay augmentation procedure,* which involves a patch augmentation, or (2) an option that involves fashioning a circumferential patch, termed a *tube substitution*. The latter option is associated with a high failure rate and thus not recommended [5,6]. A two-stage procedure involves excision of the stricture and reconstruction of a roof strip that is allowed to heal before second-stage tubularisation.

The use of a flap or graft for augmentation urethroplasty was a source of much controversy in the field. But it is now clear from a review of the literature that the restenosis rate recorded in the published literature in 1998 was between 14.5% and 15.7% using either a flap or graft, respectively [7]. In a small comparative randomised study, Dubey et al confirmed equivalent success with the two techniques but with higher morbidity for the patients with a flap procedure [8].

A number of different grafts have been used including penile skin, scrotal skin, extragenital skin, oral mucosa, bladder mucosa, and colonic mucosa. In addition, there are three different approaches to the onlay augmentation procedure, which can be via a ventral, dorsal, or lateral approach (Figs. 1–3). There are many reports of the success of the dorsal (Fig. 4) and ventral onlay (Fig. 5) procedures

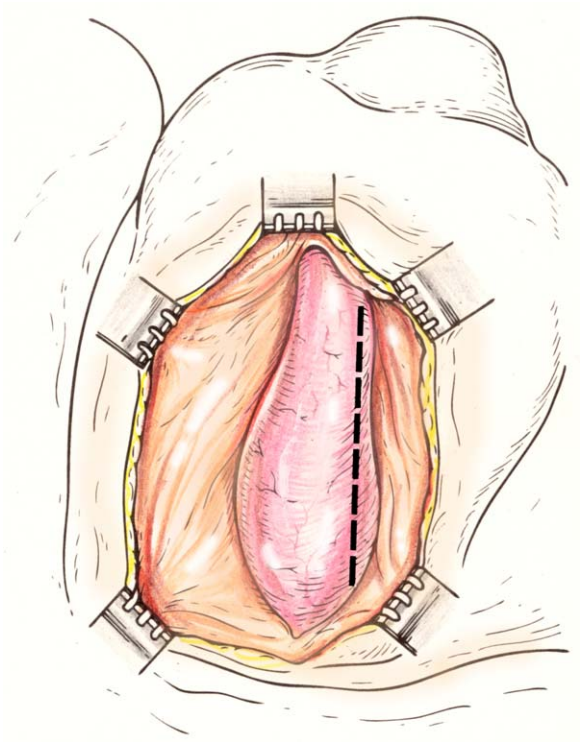

Fig. 3 – Lateral approach.

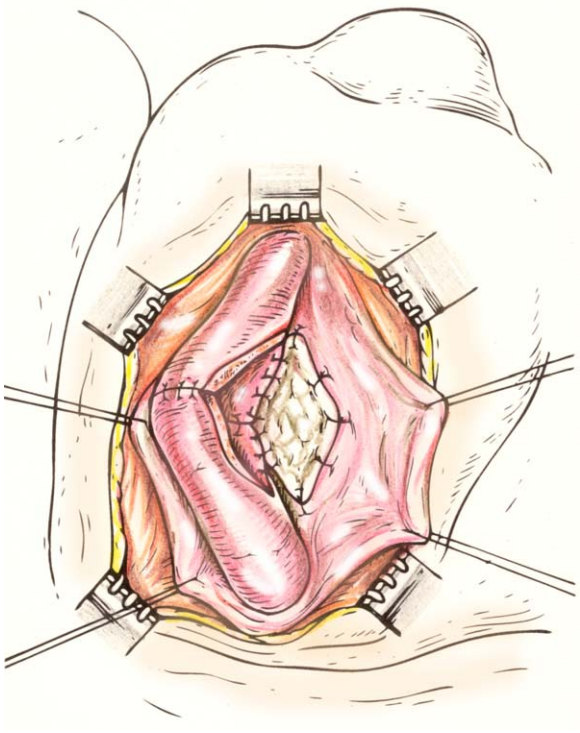

Fig. 4 – Dorsal onlay augmented anastamotic technique.

but no conclusive evidence of the benefits of one over the other. There are only limited reports in the literature of the lateral approach.

In 2001, Asopa described a ventral sagittal urethrotomy approach with placement of a dorsal inlay graft (Fig. 6) [9].

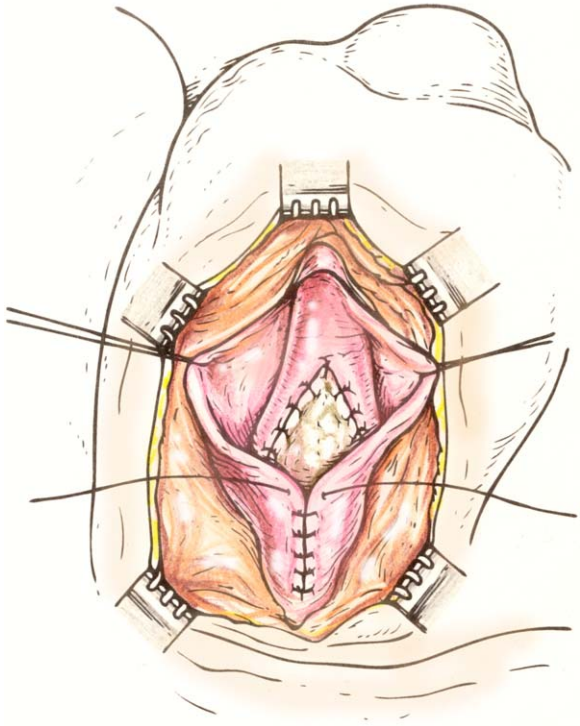

Fig. 5 – Ventral onlay technique, corpus spongiosum partially closed.

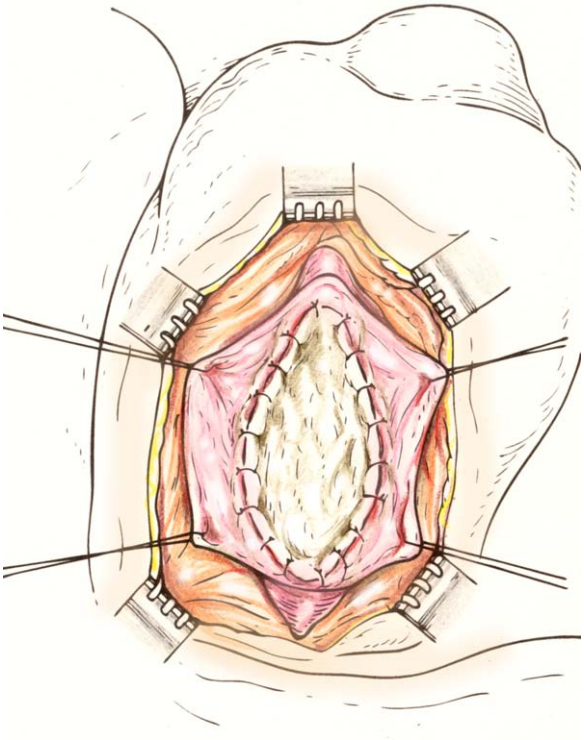

Fig. 6 – Asopa technique.

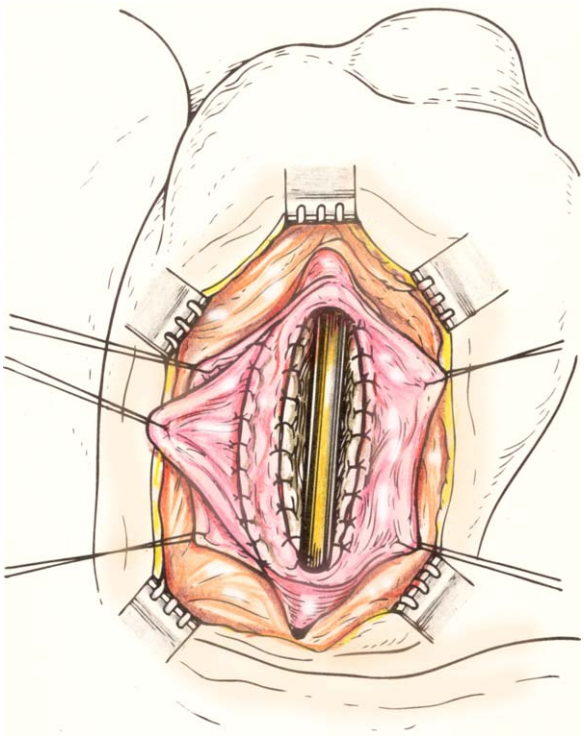

Fig. 7 – Palminteri technique.

More recently, Palminteri and colleagues suggested that in addition to placement of a dorsal inlay graft via a ventral sagittal approach, a ventral onlay could be applied as well (Fig. 7) [10]. These new techniques add to a reconstructive

Table 1 – Outcomes and follow-up of ventral onlay bulbar urethroplasty

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Morey and McAninch [11]	13	18	BM	Uroflowmetry/ symptom score Urethrography 3 and 12 mo	Any instrumentation	100
Wessells and McAninch [43]	27	23	BM 7 BLM 2 PS 21	Uroflowmetry 3 and 12 mo Urethrography 2–3 wk and 3 and 12 mo	Any instrumentation; radiographic presence of stricture	100 100 90
Pansadoro et al. [44]	7	20	BM	Uroflowmetry Urethrography 2 wk, 6 and 12 mo, then annually	Stricture recurrence on urethrography	86
Andrich and Mundy [14]; Andrich et al. [45]	29	48–60	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 6 and 18 mo Urethroscopy in last 45 cases	Development of symptoms leading to urethrogram or urethroscopy	86
Meneghini et al. [46]	20	6–28	BM	Uroflowmetry 3, 6, 9, and 12 mo Urethrography 6 and 12 mo	Any objective or subjective modification of uroflowmetry leading to urethral instrumentation	80
Palminteri et al [47]	24	18	BM	Uroflowmetry 4, 8, and 12 mo, then annually Urethrography 3 wk and 12 mo Urethroscopy 12 mo	Any instrumentation	95.8
Lewis et al. [48]	22	12–54	BM	Uroflowmetry 3 and 12 mo Urethrography 3 and 12 mo	Any instrumentation	86
Kane et al [49]	53	25	BM	Uroflowmetry 3, 6, and 12 mo, then annually with symptom score Urethrography 3 wk and 3 mo	Recurrence on radiologic studies and requiring intervention	94
Heinke et al [50]	38 (30 bulbar)	22.8	BM	Uroflowmetry 6 and 12 mo and PVRU estimation Urethrography 3 wk; repeat if deteriorating Q_{max}	Unsuccessful only if failure after repeat intervention (some patients also performing ISD)	81.6
Pansadoro et al [51]	9	41	BM	Uroflowmetry: periodic Urethrography 2 wk, 6 and 12 mo, then annually	Recurrence of symptoms	89
Elliott et al [52]	60	47	BM	Urethrography 3 wk, 3, 6, and 12 mo, then as required	If stream reduced or symptoms recurred	90
Dubey et al [53]	18	45.7	6 PS 7 BM 6 BLM	Uroflowmetry 6 mo (all patients performed ISD 16Ch up to 6 mo) Urethrography 6, 12, and 18 mo, then as required	Need for urethral calibration/dilatation with/without DVIU after 18 mo	77.8
Fichtner et al [16]	32 (15 bulbar)	82.8	BM	Uroflowmetry 6 and 12 mo with symptom score and PVRU estimation Urethrography 3wk	Symptomatic recurrence	87
Kellner et al. [54]	18	50	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3wk, then as required	Abnormal voiding Need for intervention	87 (includes 5 penile)
Berger et al [17]	7	70.7	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3 wk	If stream or symptoms deteriorate	43

Table 1 (*Continued*)

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Barbagli et al [13]	17	42	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3 wk, then as required Urethroscopy as required (Q_{max} <14 ml/s)	Any instrumentation	83
McLaughlin et al. [55]	58 (48 reported)	29.6	BM	Symptom score at 12 mo No routine urethrography Urethroscopy if deterioration in symptoms	Any recurrence found on urethroscopy if subjective deterioration in symptoms	94
Palminteri et al. [33]	1	21	SIS	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk and 12 mo or if Q_{max} <14 ml/s Urethroscopy 3 and 12 mo	Abnormal voiding Any instrumentation Evidence of stricture on urethrography	100
Fiala et al. [56]	10	31.2	SIS	Urethrography every 3 mo until 12 mo, then 6 monthly, then annually If Q_{max} <15 ml/s or IPSS >7, then urethrography	Stenosis on urethrography	90
Levine et al. [57]	12	58.1	BM	Urethrography 2 wk	Any instrumentation	83
Dubey et al. [8]	8 15 (bulbopenile)	22.6	BM	Uroflowmetry Urethrography 3 wk, then if required Urethral calibration 16Ch or urethroscopy 1, 3, 7, 10, 16 mo, then annually	Recurrence of stricture	89.9 (includes bulbar)
Barbagli et al. [3]	93	36	OM	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 2–3wk IF Q_{max} <14 ml/s, then urethrography and urethroscopy	Any instrumentation	91.4
Barbagli et al. [15]	6	15.25	OM	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk, 6 and 12 mo If Q_{max} <14 ml/s, then cystourethrography and urethroscopy	Any instrumentation	100
Dalela et al [58]	13	16.4	BM	Uroflowmetry and PVR estimation Urethrography if Q_{max} <14 ml/s Urethroscopy if Q_{max} <14 ml/s	Q_{max} <14 ml/s	84.6

BLM = bladder mucosa; BM = buccal mucosa; DVIU = direct vision internal urethrotomy; IPSS = International Prostate Symptom Score; ISD = intermittent self-dilatation; OM = oral mucosa; PS = penile skin; PVR = postvoid residual; PVRU = postvoiding residual urine; Q_{max} = maximum flow rate; SIS = small intestinal submucosa.

surgeon's armamentarium, and good success rates of 87% and 89% were reported by their respective authors.

Two-stage reconstruction is considered whenever there is concern about whether there is an adequate residual roof strip to allow a one-stage reconstruction because a full tube reconstruction has a high failure rate. The other factors worth considering in the penile urethra are previous hypospadias repair, the presence of balanitis xerotica obliterans, or when there is inadequate subcutaneous tissue cover to prevent fistula formation. The second stage only proceeds after adequate healing, which sometimes requires revisions to the first stage before final tubularisation.

Because various augmentation procedures are available to the urethral reconstructive surgeon, we conducted this systematic review of the literature to consolidate the various reports of each technique. In particular, the patients reported often have heterogeneous strictures, and we have, where possible, categorised the procedures for the site of surgery for which different outcomes would be expected.

Table 2 – Outcomes and follow-up of dorsal onlay bulbar urethroplasty

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Barbagli et al. [59]	20	46	SG	Uroflowmetry 4, 8, 12 mo Urethrography 2–3 wk and once more and if Q_{max} <14 ml/s	Recurrence on urethrography	95
Barbagli et al. [60]	37	21.5 (13.5 BM)	31 PS 6 BM	Uroflowmetry 4, 8, and 12 mo, then annually Urethrography 3 wk, repeat if Q_{max} <14 ml/s	Any instrumentation	92 (100% BM)
Pansadoro et al. [44]	23	20	BM	Uroflowmetry Urethrography 2 wk, 6 and12 mo, then annually	Stricture recurrence on urethrography	100
Iselin and Webster [61]	29	19	PS or BM	Urethrography 3 wk, 3, 12, and 18 mo	Radiographic evidence of recurrence	97
Barbagli et al. [62]	40	43	PS	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 2–3 wk, 4 mo, or if Q_{max} <14 ml/s	Any instrumentation	85
Andrich and Mundy [14]	42	48–60	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 6 and 18 mo Urethroscopy in last 45 cases	Development of symptoms leading to urethrogram or urethroscopy to confirm recurrence	95
Joseph et al. [63]	14	32	BM or PAS	Uroflowmetry 12 and 18 mo Urethrography 3 wk, 12 and 18 mo	Recurrence on urethrography	100
Pansadoro et al [51]	56	41	BM	Uroflowmetry: periodic Urethrography 2 wk, 6 and 12 mo, then annually	Recurrence of symptoms	98
Dubey et al [53]	16	22	BM	Uroflowmetry 6 mo (all patients performed ISD 16Ch up to 6 mo) Urethrography 6, 12, and 18 mo, then as required	Need for urethral calibration/dilatation with/without DVIU after 18 mo	87
Andrich et al. [21]	51	6	BM or SG	Uroflowmetry 6 wk, 3 and 6 mo Urethrography 6 mo	Restricturing on urethrography	98
Barbagli et al. [64]	45	71	PS	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3 wk, then as required Urethroscopy as required (Q_{max} <14 ml/s)	Any instrumentation	73
Berger et al. [17]	40	70.7	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3 wk	If stream or symptoms deteriorate	95
Raber et al [65]	30	51	17 PS 13 (BM)	Uroflowmetry 6, 12, and 18 mo with IPSS and IIEF scores Urethrography 3 wk, repeated if required Urethroscopy as required	Q_{max} <20 ml/s. Symptoms requiring intervention (DVIU or ISD)	76 (85)
Dubey et al [66]	41	36.2	BM	Uroflowmetry 3, 6, 9, and 12 mo with ongoing urethral calibration (16 Ch) Urethrography at 3 mo, then as required	Symptom recurrence or inability to pass 16Ch catheter	90
Barbagli et al [13]	27	42	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3 wk, then as required Urethroscopy as required (Q_{max} <14 ml/s)	Any instrumentation	85
Barbagli et al [67]	6	16	BM	Uroflowmetry 6 and 1 mo, then annually Urethrography 2 wk, 6 and 12 mo, then annually	Any instrumentation	100
Donkov et al. [68]	9	18	SIS	Uroflowmetry 6 wk, 18 mo Urethroscopy 3 mo	Decreased flow rate or stricture recurrence	89
Simonato et al. [37]	8	18	LM	Uroflowmetry 3 and 12 mo Urethrography 2 wk, 3 and 12 mo Urethroscopy 3 and 12 mo	Q_{max} <15 ml/s Need for instrumentation	87.5

Table 2 (*Continued*)

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Xu et al [69]	12	57	BM	Uroflowmetry 14–18 d, 3–6 mo (most patients) Urethrography 14–18 d Urethroscopy in some patients at 12 mo	Any complication	77 (includes tubularised BLM and CM grafts)
Palminteri et al. [33]	3	21	SIS	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk and 12 mo or if Q_{max} <14 ml/s Urethroscopy 3 and 12 mo	Abnormal voiding Any instrumentation Evidence of stricture on urethrography	100
Radopoulos et al. [22]	16	49.9	PS	Uroflowmetry 3–4 wk and 12 mo Urethrography 3–4 wk and 12 mo	Abnormal voiding Any instrumentation Evidence of stricture on urethrography	81
Foinquinos et al. [70]	7	1–5	TV	Uroflowmetry and urethrography	Poor uroflowmetry Poor urethrography	100
Levine et al. [57]	21	53	BM	Urethrography 2 wk	Any instrumentation	86
Dubey et al. [8]	4	22.6	BM	Uroflowmetry Urethrography 3 wk, then if required Urethral calibration 16Ch or urethroscopy 1, 3, 7, 10, 16 mo, then annually	Recurrence of stricture	89.9 (includes penile)
Barbagli et al. [3]	22 38	41 111	OM PS	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 2–3 wk If Q_{max} <14 ml/s, then urethrography and urethroscopy	Any instrumentation	77.3 65.8
Barbagli et al. [15]	6	15.25	OM	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk, 6 and 12 mo If Q_{max} <14 ml/s, then urethrography and urethroscopy	Any instrumentation	100
O'Riordan et al. [71]	52	34	BM	Urethrography 3 wk Symptoms/interview	Any instrumentation	86
Simonato et al 2008 [72]	11	17.7	LM	Uroflowmetry 3 and 12 mo Urethrography 2 wk, 3 and 12 mo Urethroscopy 3 and 12 mo	Inability to void, a PVR Any instrumentation	81.8
Kulkarni et al. [26]	88	56	OM	Uroflowmetry every 4, 8, 12 mo, then annually Urethrography 3 wk Urethrography if Q_{max} <12 ml/s	Any instrumentation	91
Das et al. [73]	6	9	LM	Uroflowmetry 3 and 6 mo Urethrography 3 wk, 3 and 6 mo	Q_{max} <15 ml/s; need for instrumentation	83.3 (includes penile)
Kulkarni et al. [74]	12	22	OM	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk If Q_{max} <14 ml/s then urethrography and urethroscopy	Any instrumentation	92
Manoj et al. [23]	8	21.7	PAS	Uroflowmetry 3 and 6 mo, annually in some patients Urethrography 3 wk, repeat if Q_{max} <14 ml/s	Any instrumentation	100
Fransis et al. [75]	30	23	BM	Uroflowmetry/PVRU 3, 12 mo, then yearly Urethrography 6 mo Urethroscopy when required	Abnormal voiding, stricture on urethrography and need for instrumentation	94
Schwentner et al. [76]	42	57.2	29 PS 13 GS	Uroflowmetry/PVR 3, 6, 9, and 12 mo Urethrography at catheter removal, then if required	Presence of symptoms and low flow rate	90.5
Arlen et al. [77]	22	10.5	BM	Urethrography 3–4 wk Urethroscopy if symptoms developed	Any instrumentation	83.3

BM = buccal mucosa; CM = colonic mucosa; DVIU = direct vision internal urethrotomy; GS = groin skin graft; IIEF = International Index of Erectile Dysfunction; IPSS = International Prostate Symptom Score; ISD = intermittent self-dilatation; LM = lingual mucosa; OM = oral mucosa; PAS = postauricular skin graft; PS = penile skin; PVR = postvoid residual; PVRU = postvoid residual urine; Q_{max} = maximum flow rate; SG = full-thickness skin graft; SIS = small intestinal submucosa; TV = tunica vaginalis.

2. Evidence acquisition

A Medline search was performed on September 25, 2010. Articles from 1985 to date were included with the search terms including substitution urethroplasty, dorsal onlay, ventral onlay, lateral onlay, bulbar urethroplasty, penile urethroplasty, Asopa, Palminteri, and panurethral urethroplasty. Exclusion criteria were non-English articles and articles dealing solely with paediatric cases. In total 80 articles were identified, and from these 11 were further excluded because the outcomes could not be categorised for the heterogeneous populations described. Finally, three review articles were excluded because the data were not original. The remaining 66 articles were categorised by technique for the bulbar urethra and into one- and two-stage procedures for the penile urethra. Panurethral urethroplasty outcomes were collated separately.

3. Evidence synthesis

3.1. Bulbar urethral strictures

Most of the published literature relates to bulbar urethroplasty. Traditionally urethroplasty is performed as a *ventral onlay*, with the corpus spongiosum either excised and reconstructed using a free graft applied to a dorsal native urethral roof strip or incised in the midline over the stricture to perform a ventral stricturotomy, with the free graft applied to augment the urethra [11]. Ideally the corpus spongiosum is closed over the graft to provide a well-vascularised bed.

Barbagli et al described the dorsal onlay graft for augmentation urethroplasty in 1996 [12]. The urethra is mobilised intact and the stricturotomy is performed dorsally. It has since found widespread support. The suggested benefits are less bleeding from the thinner dorsal spongiosum and application of the graft to the tunica albuginea of the corpora cavernosa, allowing a more stable base to allow better fixation of the graft, facilitating better acquisition of a richer blood supply and reducing contracture during healing. Also there should be a theoretically reduced risk of sacculation of the graft under pressure from voiding and thus a reduced risk of diverticulum formation. The lateral approach was described by Barbagli and colleagues in patients with bulbar strictures where a ventral urethrotomy may have led to serious bleeding and a dorsal urethrotomy may have affected the erectile function as the urethra is dissected from the corpora cavernosa [13].

Occasionally the segment of urethra affected by spongiofibrosis is such that a lengthy segment of urethra has to be removed, and hence augmentation of the onlay with corpus spongiosum is not possible. In these cases an augmented roof strip or one-stage circumferential mucosal replacement graft may be used; however, the latter should be avoided because of the higher failure rate [14]. In these cases a two-stage procedure using a perineal urethrostomy is more appropriate before second-stage tubularisation.

3.1.1. Ventral onlay bulbar urethroplasty

We were able to include 24 studies that described the outcome of ventral onlay bulbar urethroplasty (Table 1). In total, 563 patients have been described. The overall average success of ventral onlay bulbar urethroplasty is 88.84%, with an average follow-up of 34.3 mo. A number of different grafts have been used, with oral (buccal) mucosal grafts the most common. Success rates range from 100% with minimal follow-up [15] to 87% at 82.2-mo follow-up [16]. Worse outcomes have been reported [17], but these were only for seven patients.

Besides length of follow-up, the other factors that affect the outcome are the method of follow-up and definition of failure. Most studies used recurrence of symptoms, reduced flow rate, or recurrence of stricture as seen on cystography as a definition of failure. The need for further instrumentation including dilatation was only adopted by just over a third of the studies.

All studies except for two used uroflowmetry as a primary outcome measure of success or to prompt further investigation. The cut-off for further investigation was a Q_{max} less than 14 or 15 ml/s. Seven of the 24 studies reported continuing annual uroflowmetry after the first 12 mo. Urethrography was routinely used in 14 studies not including the voiding cystogram at 2–3 wk. This was only continued annually in three studies. Urethroscopy was used in eight studies and never routinely beyond 1 yr.

3.1.2. Dorsal onlay bulbar urethroplasty

Thirty-five articles describe the success of dorsal onlay bulbar urethroplasty in a total of 934 patients (Table 2). The average follow-up was 42.2 mo with an average success rate of 88.37%. Range of success was from 65.8% to 100%. The

Table 3 – Outcomes and follow-up of lateral onlay bulbar urethroplasty

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Barbagli et al [13]	6	42	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3 wk, then as required Urethroscopy as required (Q_{max} <14 ml/s)	Need for instrumentation	83
Barbagli et al. [3]	6 (same patients as above)	77	OM	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 2–3 wk, then as required Urethroscopy as required (Q_{max} <14 ml/s)	Need for instrumentation	83

BM = buccal mucosa; OM = oral mucosa; Q_{max} = maximum flow rate.

Table 4 – Outcomes and follow-up of one-stage penile urethroplasty

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Venn and Mundy [78]	28 (patch) 11 (tube)	36	BM	Regular uroflowmetry Urethrography 6 mo	Recurrence on urethrography	96.4 54.5
Andrich and Mundy [14]	41	24–60+	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 6 and 18 mo Urethroscopy in last 45 cases	Development of symptoms leading to urethrogram or urethroscopy to confirm recurrence	100
Metro et al [79]	14	63.6	BM	Uroflowmetry 6 and 12 mo with symptom score	Need for ISD >6 mo	57.1
Andrich et al. [21]	20	6	BM or SG	Uroflowmetry 6 wk, 3 and 6 mo Urethrography 6 mo	Restricturing	95
Fichtner et al [16]	17	82.8	BM	Uroflowmetry 6 and 12 mo with symptom score and PVRU estimation Urethrography 3 wk	Symptomatic recurrence	88.2
Dubey et al [66]	16	36.2	BM	Uroflowmetry 3, 6, 9, and 12 mo with ongoing urethral calibration (16Ch) Urethrography 3 mo, then as required	Symptom recurrence or inability to pass 16Ch catheter	85.7
Dubey et al [80]	25	32.5	BM	Uroflowmetry 3, 6, 9, and 12 mo, then every 6 mo with ongoing urethral calibration (16Ch) Urethrography 3 wk	Symptomatic recurrence	88
Kellner et al. [54]	5	50	BM	Uroflowmetry 3, 6, and 12 mo, then annually Urethrography 3 wk, then as required	Abnormal voiding Need for intervention	87 (includes 18 bulbar)
Palminteri et al. [33]	1 3 (bulbopenile)	21	SIS	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk and 12 mo or if Q_{max} <14 ml/s Urethroscopy 3 and 12 mo	Abnormal voiding Any instrumentation Evidence of stricture on urethrography	0 (33)
Fiala et al. [56]	9 31 (bulbopenile)	31.2	SIS	Urethrography every 3 mo until 12 mo, then 6 monthly, then annually If Q_{max} <15 ml/s or IPSS >7, then urethrography	Stenosis on urethrography	55.5 (84)
Radopoulos et al. [22]	5	49.9	PS	Urethrography and flow rate at 3–4 mo and at 1 yr	Abnormal voiding Any instrumentation Evidence of stricture on urethrography	30
Foinquinos et al. [70]	4	1–5	TV	Uroflowmetry and urethrography	Poor uroflowmetry Poor urethrography	100
Levine et al. [57]	13	45	BM	Urethrography 2 wk	Any instrumentation	70 Ventral onlay 66 Dorsal onlay
Barbagli et al. [19]	45	55	PS 23 (OM 22)	Uroflowmetry every 4 mo until 1 yr, then annually Urethrography 2 wk If Q_{max} <14 ml/s, then urethrography, ultrasonography, and urethroscopy	Any instrumentation	78 (82)
Kumar et al. [20]	41	18	TA	Urethrography; no description of timings	Poor calibre at urethrogram Poor urethral lumen at urethral sonogram Patient unsatisfied and dilatation required Q_{max} <20 ml/s	67
Simonato et al. [72]	8 penile 5 (bulbopenile)	17.7	LM	Uroflowmetry 3 and 12 mo Urethrography 2 wk, 3 and 12 mo Urethroscopy 3 and 12 mo	Inability to void, a post void residual Any instrumentation	100 penile 60 bulbopenile
Kulkarni et al. [26]	8	56	OM	Uroflowmetry every 4, 8, 12 mo, then annually Urethrography 3 wk Urethrography if Q_{max} <12 ml/s	Any instrumentation	100
Das et al. [73]	6	9	LM	Uroflowmetry 3 and 6 mo Urethrography 3 wk, 3 and 6 mo	Q_{max}<15 ml/s; any instrumentation	83.3 (includes bulbar)

Table 4 (*Continued*)

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Singh et al. [81]	8	19	BM	Uroflowmetry, urethrography, urethroscopy; no details on timing	Q_{max}<15 ml/s, abnormal urethrogram or urethroscopy, need for any intervention	88 (includes 8 panurethral)
Manoj et al. [23]	12	21.7	PAS	Uroflowmetry 3 and 6 mo, annually in some patients Urethrography 3 wk, repeat if Q_{max} <14 ml/s	Any instrumentation	92
Xu et al. [18]	56	17.2	LM	Uroflowmetry 2 or 3 mo, then 6 mo Urethrography when Q_{max} <15 ml/s Urethroscopy when Q_{max} <15 ml/s	Not described	87 (includes bulbar cases)

BM = buccal mucosa; IPSS = International Prostate Symptom Score; ISD = intermittent self-dilatation; LM = lingual mucosa; PAS = postauricular skin graft; PS = penile skin; PVRU = postvoid residual urine; Q_{max} = maximum flow rate; SG = full-thickness skin graft; SIS = small intestinal submucosa; TA = tunica albuginea; TV = tunica vaginalis.

lower success rate was described by Barbagli et al at a follow-up of 111 mo in patients having penile skin grafts [3]. The rate of success was reduced if the authors stated a need for instrumentation as a definition of failure.

Only 4 of 35 authors did not use uroflowmetry in the follow-up protocol, and only 1 did not describe the use of urethrography at all. The use of annual urethrography beyond 1 yr was only described by three authors. The use of urethroscopy was described by nine authors as performed when required, most commonly due to a reduction of maximum flow rate (Q_{max}), and four authors used it at predetermined intervals but none beyond 1 yr.

3.1.3. *Lateral onlay bulbar urethroplasty*

Barbagli et al described lateral onlay bulbar urethroplasty in six patients. The first reference was at 42-mo follow-up [13], and the same six patients were later described at 77-mo follow-up [3] (Table 3). The success rate remained at 83% over the follow-up period. Patients underwent regular uroflowmetry and urethrography or urethroscopy if flow rates deteriorated below 14 ml/s.

3.2. *Penile urethral strictures*

Because of the relative deficiency of covering tissues over the penile urethra, ventrally applied grafts have a reduced likelihood of survival [7]. Ventrally placed pedicled skin flaps have been advocated for the treatment of penile strictures. In addition, good results have been reported with dorsally applied grafts used as both one- and two-stage procedures.

Two-stage surgery generally is performed by quilting a strip of graft onto the corpora cavernosa, which is 2–3 cm wide, often after excision of the diseased urethra. In cases where the glans is involved, the glans cleft is widened to allow the graft to be inlaid as the first part of a two-stage procedure. Urine is diverted proximally via a urethrostomy. The graft is dressed for the initial postoperative period and then is left open to heal for the second stage. There may be a need for further surgery before final second-stage closure. The second stage only proceeds after the graft has healed, which is typically at 4–6 mo. The procedure is then completed by mobilising the graft from the skin edges to allow tubularisation of the neourethra over a catheter. This allows adequate tissue coverage to reduce the risk of fistula formation. One-stage surgery using dorsal onlay grafts in the penile urethra, including the glans, is possible as long as a sufficiently healthy urethral plate is available.

3.2.1. *One-stage penile urethroplasty*

A total of 21 studies were found (Table 4) that reported the outcomes of one-stage penile urethroplasty describing a total of 432 patients with an average 32.8-mo follow-up and an average success of 75.68%. The success rate varies a great deal between the studies, and four large studies with >40 patients reported varied outcomes of 100% (Andrich and Mundy [14], 87%; Xu et al. [18], 78%; Barbagli et al. [19], and 67%; Kumar et al. [20]). The definition of failure in these studies was not explained in the paper by Xu et al,

Table 5 – Outcomes and follow-up of penile urethroplasty via the two-stage technique

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Venn and Mundy [24]	16	36	BM	Not described		93.8
Andrich et al. [21]	58	6	BM or SG	Uroflowmetry 6 wk, 3 and 6 mo Urethrography 6 mo	Restricturing	98
Dubey et al [66]	15	24.2	BM	Uroflowmetry 3, 6, 9, and 12 mo with ongoing urethral calibration (16Ch) Urethrography 3 mo, then as required	Symptom recurrence or inability to pass 16Ch catheter	86.7
Dubey et al [80]	14	32.5	BM	Uroflowmetry 3, 6, 9, and 12 mo, then every 6 mo with ongoing urethral calibration (16Ch) Urethrography 3 wk	Symptomatic recurrence	78.6
Levine et al. [57]	5	36	BM	Urethrography 2–3wk	Any instrumentation	80
Meeks et al. [82]	6	17	SG	Not described	Failure of graft take	100
Kulkarni et al. [26]	15	56	OM	Uroflowmetry every 4, 8, 12 mo, then annually Urethrography 3 wk, Urethrography if Q_{max} <12 ml/s	Any instrumentation	73

BM = buccal mucosa; OM = oral mucosa; Q_{max} = maximum flow rate; SG = full-thickness skin graft.

Andrich et al described it as the development of symptoms leading to further imaging, Barbagli et al used the need for instrumentation, and Kumar relied on patient satisfaction and imaging as required. These differences may explain the discrepancies in outcomes.

A number of different grafts have been used including acellular grafts such as porcine small intestinal submucosa (SIS) and cellular grafts such as tunica vaginalis, but the reported outcomes are less than those seen for oral grafts, making the latter superior in terms of success for surgery on the penile urethra. Only four papers documented the use of skin grafts [19,21–23], with success ranging from 30% to 95%. Barbagli et al found a higher rate of success (82% vs 78%) when using oral mucosa compared with penile skin grafts [19]. The use of genital or extragenital skin is contraindicated in patients with urethral stricture disease secondary to lichen sclerosis. Venn and Mundy [24] and Andrich and Mundy [25] showed an increased risk of recurrence of lichen sclerosis in all skin grafts including postauricular skin. However, more recently, Manoj et al used postauricular skin grafts in 12 patients with lichen sclerosis with success rates of 90% [23]. The follow-up of 12 mo and number of patients studied were too small to make any new recommendations at present.

3.2.2. *Two-stage penile urethroplasty*

Seven studies were found that described the outcome of two-stage penile urethroplasty (Table 5). The total number of patients reported was 129. The average follow-up was 22.2 mo, and the average success rate was 90.54%. Andrich et al. [21] reported the largest study of 58 patients with a success rate of 98%; however, it must be noted the follow-up of this study was limited to only 6 mo, and studies with longer follow-up, such as Kulkarni et al. [26], showed success rates of 73% at 56 mo. Interestingly, in the same paper, Kulkarni et al described the success of one-stage procedures as 100% with the same follow-up, but because their study was not randomised, more complex cases may have had the two-stage procedure leading to worse outcomes. The definition of failure and method of follow-up also varied between the studies and may well be responsible for some of the reported differences in success rates.

3.3. *Panurethral strictures*

Panurethral strictures affect the entire anterior urethra and pose a challenge for the urethral surgeon. A one- or two-stage procedure may be undertaken, and both approaches are often combined with the two-stage approach used in the penile urethra. The length of graft required is often long and frequently may require a bilateral buccal mucosal graft harvest, or a combination of oral grafts may be used [27]. The other grafts that have been described include skin grafts (in the absence of lichen sclerosis) [21,23], bladder mucosa [28], colonic mucosa [29], tunica albuginea from the corpora cavernosa [30], and even tissue-engineered grafts [31].

Ten articles described the outcomes of panurethral urethroplasty, including 240 patients, with an average follow-up of 30.11 mo and an average success of 88.16% (Table 6). One of the 10 authors used a two-stage approach with a reported success of 91.7% at 6-mo follow-up. The longest follow-up, of 53.6 mo, was described by Xu et al using colonic mucosa, with a reported success rate of 85.7%.

3.4. *Other techniques*

In 2001, Asopa et al published their results of 12 patients with long anterior strictures that underwent urethroplasty with application of a dorsal graft via a ventral sagittal urethrotomy approach without mobilising the urethra [32]. The buccal mucosa or preputial skin graft was applied to the corporal bodies after an elliptical incision through the stricture. The augmented urethra was tubularised in one stage. This technique, known as the Asopa technique, was also reported by three others (Table 7). A total of 89 patients

Table 6 – Outcomes and follow-up of panurethral urethroplasty

Authors	No. treated	No. of stages	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Andrich et al. [21]	24	2	6	BM or SG	Uroflowmetry 6 wk, 3 and 6 mo Urethrography 6 mo	Restricturing	91.7
Gupta et al. [83]	4 8 (bulbopenile)	1	12	BM	Uroflowmetry every 3 mo Urethrography 3 wk Urethroscopy 3 mo	Q_{max} <15 ml/s Reduced calibre urethra	92
Dubey et al [66]	12	1	36.2	BM	Uroflowmetry 3, 6, 9, and 12 mo with ongoing urethral calibration (16Ch) Urethrography 3 mo, then as required	Symptom recurrence or inability to pass 16Ch catheter	83.3
Singh et al. [81]	8	1	19	BM	Uroflowmetry, urethrography, urethroscopy; no details on timing	Q_{max} <15 ml/s, abnormal urethrogram/urethroscopy, any intervention	88 (includes 8 penile)
Xu et al. [29]	36	1	53.6	CM	Uroflowmetry 3 or 4 mo Urethrography at catheter removal Most patients uroflowmetry and urethrography every 3–6 mo or if Q_{max} <15ml/s	Abnormal voiding; any intervention	85.7
Manoj et al 2009 [23]	15	1	21.7	PAS	Uroflowmetry 3 and 6 mo, annually in some patients Urethrography 3 wk, repeat if Q_{max} <14	Any instrumentation	80
Kulkarni et al 2009 [74]	12	1	22	OM	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk If Q_{max} <14 ml/s then urethrography/urethroscopy	Any instrumentation	92
Xu et al. [27]	25	1	26.8	9 BM × 2 7 LM × 2 9 LM + BM	Uroflowmetry Urethrography if problems	Any instrumentation	92
Das et al. [73]	18	1	9	LM	Uroflowmetry 3 and 6 mo Urethrography 3 wk, 3 and 6 mo	Q_{max} <15 ml/s; any instrumentation	83.3 (includes bulbar)
Mathur and Sharma [30]	86	1	36	TA	Uroflowmetry and patient satisfaction 6, 12, 24, and 36 mo Urethrography 6, 12, 24, and 36 mo Urethroscopy in 10 patients	Good calibre or partially narrowed urethra (urethrography), Q_{max} <20, requiring >1 dilatation/yr	89.5

BM = buccal mucosa; CM = colonic mucosa; LM = lingual mucosa; OM = oral mucosa; PAS = postauricular skin graft; Q_{max} = maximum flow rate; SG = full-thickness skin graft; TA = tunica albuginea.

Table 7 – Outcomes and follow-up of urethroplasty via the Asopa technique

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Asopa et al. [32]	12	8–40	10 PS 2 BM	Uroflowmetry at last follow-up Urethrography 7 wk Urethroscopy in 4 cases	Any instrumentation	91.7
Palminteri et al. [33]	7	21	SIS	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk and 12 mo or if Q_{max} <14 ml/s Urethroscopy 3 and 12 mo	Abnormal voiding Any instrumentation Evidence of stricture on urethrography	100
Singh et al. [84]	25	12	LM	Uroflowmetry 3, 6, and 12 mo Urethrography 3 wk, 3, 6, and 12 mo	Q_{max} <15 ml/s, abnormal urethrogram or urethroscopy, any intervention	80
Pisipati et al. [9]	45	42	BM	Uroflowmetry 3, 6, and every 6 mo thereafter Urethrography 3 wk Urethroscopy 3 mo	Q_{max} <15 ml/s	87

BM = buccal mucosa; LM = lingual mucosa; PS = penile skin; SIS = small intestinal mucosa.

Table 8 – Outcomes of combined ventral plus dorsal onlay bulbar urethroplasty

Authors	No. treated	Follow-up, mo	Type of graft	Follow-up method	Definition of failure	Success rate, %
Palminteri et al. [33]	5	21	SIS	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk and 12 mo or if Q_{max} <14 ml/s Urethroscopy 3 and 12 mo	Abnormal voiding Any instrumentation Evidence of stricture on urethrography	100
Palminteri et al. [10]	48	22	BM	Uroflowmetry 4, 8, 12 mo, then annually Urethrography 3 wk IF Q_{max} <14 ml/s, then urethrography and urethroscopy	Abnormal voiding; need for instrumentation	89.6

BM = buccal mucosa; SIS = small intestine mucosa.

Table 9 – Average data according to site and technique of augmentation urethroplasty

Technique	Total patients reported	Average follow-up, mo (follow-up × no. of patients)/ total no. of patients	Average success, % (success × no. of patients)/total no. of patients
Ventral onlay bulbar	563	34.42	88.84
Dorsal onlay bulbar	934	42.2	88.37
Lateral onlay bulbar	6	77	83
One-stage penile	432	32.8	75.68
Two-stage penile	129	22.2	90.54
Panurethral	240	30.11	88.16
Asopa	89	28.9	86.69
Palminteri	53	21.91	90.58

have been described with an average follow-up of 28.9 mo and an average success of 86.69%.

More recently, in 2007, Palminteri and colleagues described combined dorsal inlay and ventral onlay grafts in the bulbar urethra using SIS grafts [33]. Thereafter a publication described this technique in 48 patients using buccal mucosa [10]. In total, 53 patients have been described with an average follow-up of 21.91 mo and an average success rate of 90.58% (Table 8).

4. Discussion

It is unwise to make sweeping recommendations for best practice for reconstructive urethral surgery based on the literature because each patient clearly requires an individualised approach based on individual circumstances. Moreover, most of the evidence base is unfortunately retrospective, includes strictures of varying aetiology and different previous interventions, and lacks an agreed

definition of failure and indeed how often to assess for failure and by which method.

We have categorised the urethroplasty procedures into site and technique to give an average of success with the average reported follow-up available for all studies that we were able to categorise in this way (Table 9). When averaging data the importance of considering individuals in what is undoubtedly a heterogeneous data set is lost, and this data analysis should only be used as a rough guide to the reported success of each type of procedure.

When interpreting the specific data from these heterogeneous populations, we were unable to include aetiology, stricture length, and previous interventions in the analysis of outcome because these are often reported generally for the whole population and not specifically related to the surgical technique used for each site. This is therefore a shortcoming of our analysis. We also were unable to report on the specific complications of each procedure because again these were reported sporadically.

The average results suggest no difference in the outcomes of using a ventral or dorsal onlay technique for the bulbar urethra, although the dorsal onlay technique had a greater average follow-up reported. An important practical issue is that all patients present with different configurations of the stricture, technical aspects also have to be considered, and for the more proximal bulbar urethra a ventral approach is often easier than a dorsal approach by plicating the graft onto the thick bulbar corpus spongiosum. The lateral onlay technique has only been described in six patients with long follow-up and therefore has less evidence supporting its use; however, this is unlikely to be significantly different. The Palminteri technique was reported in 53 patients with good success at 21.9-mo follow-up and provides another technique that a urethral surgeon may employ if not wishing to mobilise the urethra. The Asopa technique may also be used for the bulbar urethra, but we were unable to separate these bulbar cases from the descriptions of its use in all penile surgery in the literature.

When considering penile surgery, the success of a one-stage urethroplasty is less than that of the two-stage procedure, but this is over a longer follow-up period. When evaluating the data, a limited number of studies reported the two-stage approach, and the most of the data were from one study [21] with limited follow-up. It is also noted that many patients having a two-stage procedure may have undergone revisions before second-stage tubularisation, and the success was only assessed from the point when final closure had taken place. A randomised study evaluating success and satisfaction outcomes will be required to address this issue further.

Panurethral surgery may be performed as a single-stage or two-stage procedure. Only one study reported the outcomes of a two-stage approach [21], reporting a success of 91.7% at 6 mo. The remaining one-stage procedures had a success of 87.8% at 32.8-mo follow-up. At present no recommendations may be made on the approach to panurethral surgery.

We further categorised the data into graft type and presented the overall outcomes with each type of graft and

Table 10 – Success rates and follow-up (months) by technique and type of graft

Technique	Full-thickness skin graft	Penile skin	Buccal mucosa	Small intestinal submucosa	Lingual mucosa	Tunica vaginalis	Postauricular skin	Bladder mucosa	Tunica albuginea	Colonic mucosa
Dorsal onlay bulbar	95 (46)	79.9 (60.8)	91.2 (39.1)	91.8 (18.8)	84 (15.7)	100(3)	100 (21.7)	–	–	–
Ventral onlay bulbar	–	90 (23)	88.4 (34)	91 (30.3)	–	–	–	100 (23)	–	–
Lateral onlay bulbar	–	–	83 (77)	–	–	–	–	–	–	–
Asopa	–	–	87 (45)	100 (21)	80 (12)	–	–	–	–	–
Palminteri	–	–	89.6 (22)	100 (21)	–	–	–	–	–	–
One-stage penile	–	69.4 (54)	90.6 (42.5)	50 (30.2)	88.2 (16.6)	100(3)	92 (21.7)	–	67 (18)	–
Two-stage penile	100 (17)	–	86 (31.5)	–	–	–	–	–	–	–
Panurethral	–	–	86.3 (26.4)	–	83.3 (9)	–	80 (21.7)	–	89.5 (36)	85.7 (53.6)
Total	96.2 (39.3)	79.8 (57.1)	87.3 (37.6)	81.1 (27.1)	84.4 (14.7)	100 (3)	88.7 (21.7)	100 (23)	82.2 (30.2)	85.7 (53.6)

Table 11 – Advantages and disadvantages of each graft

Graft	Advantages	Disadvantages
Full-thickness skin graft	Tissue plentiful, minimal donor site morbidity, easy to harvest, easy to handle	Need to find nonhairy skin; contraindicated for use in strictures secondary to lichen sclerosis; graft contraction over time
Penile skin graft	Easy to harvest, easy to handle, tissue close to surgical field	Limited availability of tissue; contraindicated for use in strictures secondary to lichen sclerosis
Buccal mucosa	Easy to harvest, easy to handle, acceptable donor site morbidity, resistant to infection, good graft take, less fibrosis in fibroblasts than skin	Limited availability of tissue; affected adversely by smoking, chewing tobacco/ betel leaves
Small intestinal submucosa	No donor site morbidity, can obtain long segments	Large donor site morbidity; graft contracture; variable host response; mixed reported success; needs vascular wound bed
Lingual mucosa	Easy to harvest, good graft take	Limited availability of tissue; donor site morbidity; thin and difficult to handle, short follow-up
Tunica vaginalis	Tissue close to surgical field	Limited data, short follow-up, limited availability of tissue
Postauricular skin	Good graft take	Limited data, short follow-up; contraindicated for use in strictures secondary to lichen sclerosis
Bladder mucosa	Can obtain long segments	Large donor site morbidity; short follow-up
Tunica albuginea (of the corpora)	Tissue available locally, length not a problem	Limited data; problems if recurrence of stricture
Colonic mucosa	Can obtain long segments	Large donor site morbidity

technique (Table 10). Buccal mucosa is the most widely used graft and has excellent results in all types of urethroplasty. It is relatively easy to harvest and has minimal complications [34]. The only drawbacks are the amount that may be harvested and donor site morbidity. It is now clear that it is unnecessary to close the donor site and this carries a higher morbidity [35,36]. To overcome the shortage of unilateral buccal mucosa harvest, it may be obtained bilaterally or combined with a lingual graft as published by Simonato [37]. Other grafts used for long complex strictures include bladder mucosa and colonic mucosa. Table 11 shows the benefits and drawbacks of each graft type.

The follow-up posturethroplasty varies a great deal between studies. Overall, 82% of studies used uroflowmetry, with 64% using it at predefined regular intervals. Urethrography was used by 77% of authors, 41% at regular predefined intervals. Urethroscopy was used by 26% of studies, 8% in a regular fashion. The definition of failure varied between studies: 2% did not define failure; 14% used a Q_{max} value; 31%, symptoms of recurrence; 56%, the need for any instrumentation; 29%, urethrographic recurrence; 3%, nonspecific definition of recurrence, and 1%, graft failure. Many used more than one definition.

The definition of failure and rigour of follow-up investigations will clearly have an impact on success. Smith has shown that the urethral calibre usually has to be <10F before flow rates diminish from normal [38]. In the presence of an anterior urethral stricture more so than with posterior strictures, abdominal straining to overcome an obstruction can give rise to an erroneously high flow rate [39]. Therefore a stricture will not be picked up until much later when relying on uroflowmetry. Chapple et al and Jordan et al advocated the use of short-term flexible urethroscopy at 6 mo and 1 yr following surgery, respectively [40,41]. Chapple et al concluded that in the absence of a progressive disease process such as lichen sclerosus, most stricture recurrences are evident by 6 mo and certainly almost all by 1 yr. In contrast, Barbagli et al suggested based on their actuarial evaluation that urethroplasties of all forms may fail after a considerable length of time postoperatively with stricture recurrences uniformly distributed over time [42].

Jordan et al. [41] also argued that urethrography in the postoperative period may be confusing and therefore should be used with caution. In our opinion, endoscopic evaluation provides the most reliable data in terms of type of recurrence and complications, and it provides information on the state of the urethra and is often easier to interpret accurately than urethrography. Recurrences can be picked up more reliably earlier than if relying on flow rates or symptom scores.

5. Conclusions

The surgical techniques described in the literature for reconstruction of the bulbar urethra have good reported success rates with long-term follow-up. The literature base for penile and panurethral augmentation urethroplasties is comparatively smaller and tends to report better success with the two-stage versus the one-stage approach but with a shorter follow-up. A variety of different graft materials have been used, and buccal mucosa is the most common. The methods of follow-up vary a great deal as do the definitions of success.

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Acquisition of data: Mangera, Patterson, Chapple.
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