

Supplementary Figures and Tables

3. DEFINITION, EPIDEMIOLOGY, AETIOLOGY AND PREVENTION

Table S3.1: Aetiology in females

	Simonato <i>et al.</i> 2010 [1]	Sharma <i>et al.</i> 2010 [2]	Onol <i>et al.</i> 2011 [3]	Blaivas <i>et al.</i> 2012 [4]	Rijal <i>et al.</i> 2013 [5]	Xu <i>et al.</i> 2013 [6]	Kowalik <i>et al.</i> 2014 [7]	Onol <i>et al.</i> 2014 [8]	Spilotros <i>et al.</i> 2016 [9]	Powell & Daniels 2017 [10]	Mukhtar <i>et al.</i> 2017 [11]	Tao <i>et al.</i> 2018 [12]	Romero- Maroto <i>et al.</i> 2018 [13]	Total
Pelvic Trauma	0	0	0	2	2	35	0	0	0	0	0	2	0	41
Idiopathic	4	9	8	8	49	2	5	5	11	3	7	6	4	121
Local inflammation or Infection	2	0	0	0	0	3	1	0	0	0	0	0	0	6
Urinary tract infection	0	0	0	0	0	0	0	0	0	0	7	9	0	16
Local injury	0	0	0	0	0	4	0	0	0	0	0	0	0	4
Lichen Planus	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Iatrogenic injury unspecified	0	0	0	6	0	0	2	0	0	3	0	5	0	16
Urethral catheter	0	3	0	0	0	0	0	0	11	0	1	0	3	19
Endoscopic Injury	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Obstetric Trauma	0	2	0	0	0	0	1	0	4	0	0	0	2	9
Urethral caruncle surgery	0	1	1	0	0	0	0	2	0	0	0	0	0	4
Excision of MUT	0	0	1	0	0	0	0	0	0	0	1	0	0	2
Excision of Urethral Diverticulum	0	0	2	1	0	0	0	0	0	0	2	0	0	5

Previous Urethral Reconstruction	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Cervical Cautery	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Urethral Radiotherapy	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Total	6	15	14	17	51	44	10	7	26	6	22	22	9	249

Table S3.2: Location of strictures in females

Paper	Proximal	Mid	Distal	Pan
Rehder <i>et al.</i> 2010 [14]	8	0	0	0
Simonato <i>et al.</i> 2010 [1]	0	4	0	2
Onol <i>et al.</i> 2011 [3]	0	13	4	0
Blaivas <i>et al.</i> 2012 [4]	8	3	5	1
Xu <i>et al.</i> 2013 [6]	10	25	9	0
Singh <i>et al.</i> 2013 [15]	0	16	0	0
Kowalik <i>et al.</i> 2014 [7]	0	6	4	0
Onol <i>et al.</i> 2014 [8]	1	6	0	0
Romero-Maroto <i>et al.</i> 2018 [13]	0	5	1	3
Total	27 (20%)	78 (58%)	24 (18%)	6 (4%)

6. DISEASE MANAGEMENT IN MALES

Table S6.1: Result of series using adjuvant Mitomycin C after DVIU

Author, year	Type	N	Follow-up (mo)	Stricture-free rate DVIU + MMC	Stricture-free rate DVIU only	P-value
Moradi <i>et al.</i> [16]	RCT	40	12	90% (18/20)	50% (10/20)	P=0.001
Ali <i>et al.</i> [17]	RCT	151	18	86% (67/78)	63% (46/73)	P=0.002
Farrell <i>et al.</i> [18]	Retrospective case series	44	26 (IQR: 13-47)	75%	NA	NA
Kumar <i>et al.</i> [19]	Prospective cases series	103	14 (range: 3-18)	81%	NA	NA

DVIU = direct visual internal urethrotomy; IQR = interquartile range; MMC = mitomycin C; mo = months; N = number; RCT = randomised control trial.

Table S6.2: Outcome of urethroplasty for failed urethral stents

Study	Type of stent	FU (months)	Location	Type of urethroplasty	N	Stricture-free
Angulo <i>et al.</i> [20]	Thermo-expandable nitinol	26 (22)	Bulbar	BMG urethroplasty	6	6 (100%)
				Augmented anastomotic repair	1	1 (100%)
				EPA	1	1 (100%)
Angulo <i>et al.</i> [21]	Self-expandable super alloy mesh	60 (63)	Predominantly bulbar	BMG urethroplasty	27	26 (96.3%)
				EPA	14	12 (85.7%)
				Augmented anastomotic repair	5	4 (80%)
				Pediced flap urethroplasty	6	3 (50%)
				Staged repair	4	2 (50%)
				Perineostomy	7	4 (57.1%)
Buckley <i>et al.</i> [22]	Self-expandable super alloy mesh	54 (>12)	Predominantly bulbar	Dorsal onlay substitution urethroplasty	8	10 (83.3%)
				Ventral onlay substitution urethroplasty	3	
				Perineostomy	1	
Chapple <i>et al.</i> [23]	NR	37 (14-72)	Posterior: 4	Penile skin substitution urethroplasty	6	1 (16,7%)
			Penile: 2	EPA	4	1 (25%)
			Bulbar: 8	BMG urethroplasty	4	4 (100%)

BMG = buccal mucosa graft; EPA = excision and primary anastomosis; NR = not reported.

Table S6.3: “Failed hypospadias repair”

Study	Patient characteristics	Length of stricture	Previous interventions	Intervention	Outcomes	Complications / Other
Studies on FHR patients only						
Aldamanhori <i>et al.</i> [24]	79 adults with FHR-related strictures Mean age 35 years range (16-69)	Mean 4 cm range (1-12)	NR	Single-stage BMG 31/79 (40%), Staged BMG 48/79 (60%)	Stricture-free rate: Single-stage BMG 80.7% (25/31) Two-stage BMG 79.2% (38/48) Mean FU 48 mo (12-96)	Single-stage: 6/31 (19%) UCF (9/9 primary closure), time point not reported Two-stage: 9/48 UCF (8/9 primary closure), time point not reported) At 3-6 mo FU: 8/48 (16%) contracture / scarring of graft requiring revision after 1 st stage Single-stage Redo 0% 2-stage Redo Urethroplasty 2/48 (6.5%) (24 and 36 mo) ISD 0%
Barbagli <i>et al.</i> 2017 [25]	345 patients with FHR (200 pts with penile stricture + 145 pts with fossa navicularis strictures At least 22 patients with UCF (at least 6.4%)	NR	Median number of previous operations 3 (IQR 2–5).	Meatotomy 70 (17%), Meatoplasty 11 (3%), End-to-End anastomosis 6 (1%), Single-Stage oral mucosa 39 (10%), Single-stage skin 29 (7%), 1 st Stage urethroplasty 46 (11%), Two-stage urethroplasty 61 (15%), Two-stage oral graft 90 (22%), Perineal urethrostomy 27 (7%), Cold-knife urethrotomy 7 (2%), UCF closure 22 (5%)	Overall failure-free survival rate 48% (95% CI 41–54%) in the urethroplasty group at 5-yr FU	Survival analysis in the urethroplasty group showed that staged techniques had lower treatment failure-free survival compared to single-stage techniques (Treatment failure-free rate at 5-yr FU: Single-stage OMG: 16/39, 41%, Single-stage PSG 17/29, 58.6%, Staged urethroplasty 20/61, 32.8%, Staged OMG urethroplasty 22/90, 24.4%, p < 0.001)

						Multivariable analysis: length of stenosis and presence of LS were associated with a higher risk of treatment failure, while number of previous operations was not
Barbagli <i>et al.</i> 2009 [26]	8 pts with FHR Median age 48 yrs	Mode length of stricture: 3-4 cm	Mean number of previous operations 4.5	Perineal urethrostomy	Stricture-free rate: 87.5% (7/8), Median duration free of stricture: 52.5 mo. Median (range) follow-up: 67mo. (15-118)	2/8 (25%) progressed to second stage urethroplasty, overall 100% satisfied, all 100% would have the same procedure
Barbagli <i>et al.</i> 2010 [27]	1176 pts with FHR (stricture +/- penile defect from FHR), Mean age 31 yrs (1-76) , Site of hypospadias: Glans in 193 cases (16.4%), penile in 702 (59.7%) and penoscrotal in 281(23.9%), at least 244 patients with UCF (at least 21%)	NR	Median number of previous operations 3 (1-23)	Single-stage repair 760 pts (64.6%) (meatotomy/meatoplasty: 31, UCF closure:244, end-to-end anastomosis: 18, single-stage repair: 179 skin flap, OMG: 211, SG:11, corporoplasty: 84, Perineal urethrostomy: 9, glans reconstruction: 58, other: 64) Staged repair: 416 patients (35.4%) (OMG: 357, SG: 11, Johanson stage 1: 18, Johanson 2-stage: 30, glans reconstruction: 305, penile skin reconstruction: 305, corporoplasty: 230) All patients underwent 1-8 procedures (median 2) to repair FH	Stricture-free rate not clearly reported for patients with FHR-related urethral stricture disease Follow-up 12-137mo (mean 60.4) (Overall group)	Functional urethra and acceptable cosmesis: Overall: 88.1%, (1036/1176) Single-stage repair: 90.4%, (687/760). Staged repair: 83.9%, (349/416) Main complications (overall group) were urethral stricture, residual hypospadias, UCF, meatal stenosis and residual penile curvature. Hair, diverticula and stones were observed less commonly
Li <i>et al.</i> 2016 [28]	56 pts with FHR	NR	Mean number of previous procedures 1.9 range (1-6)	Single-stage LMG onlay repair (42/56, 75%):	Stricture-free rate: Overall: 91.1 (51/56) LMG onlay 90.5% (38/42), LMG inlay 92.3% (13/14)	12/56 (21.4%) complications in total: 7 UCF 7, 5 urethral strictures (meatal 2, proximal anastomotic 2, neourethral 1)

	Mean age 21.8 (4-45) - UCF 35/56 (62.5%) Patients with multistaged repairs with BMG/SG or direct repairs were excluded			(Urethral stricture 17 Meatal stenosis 5, Diverticula 3, UCF 28, Penile curvature 32) Single-stage modified Snodgrass inlay repair using LMG (14/56, 25%): Urethral stricture 8, Meatal stenosis 3, UCF 7	Mean FU 38.1mo (9-90)	Meatoplasty in 2 (successful), dilatations in strictures (successful), 6 UCF: 4 successful 2 failed, no other complications
Morrison <i>et al.</i> 2017 [29]	32 pts with FHR Median age 32 (16-63) 31 with strictures (25 penile, 5 bulbar, 1 meatal), 7 UCF (22%)	Median 7 cm range (1-14)	Multiple procedures in the past	30 urethroplasties: 27/30 (90%) Staged repair (16 required augmentation of the urethral plate and 11 needed excision and replacement of a portion of the urethral plate) 3/30 (10%) Single-stage (adequate plate); 2 ventral onlay, 1 EPA BMG in 72.4% of patients	Stricture-free rate: Overall: 86.7 (26/30) Single-stage: 100% (3/3) Staged: 85.2% (23/27) Median FU 9.5ys (4.8-14.2)	5 failures (all 5 in staged group, 4 strictures and 1 UCF), UCF patient elected not to have additional operations - 4 stricture recurrences had successful reoperations Skin grafts had significantly higher complications (3 abdominal SG and 1 composite posterior auricular skin and BM) no strictures in BMG No association between number of stages and complication rates
Myers <i>et al.</i> 2012 [30]	50 FHR patients: urethral strictures in 36/50 (72%), UCF 12/50 (24%), persistent hypospadias 7/50 (14%), hair in the	NR	66% multiple operations (78% in childhood)	50 patients, Stage 1 urethroplasty: 16 men, 19 procedures (BMG in 47% of procedures) Single-stage urethroplasty (PSF, PU, EPA, tubularised plate, 1-stage BMG onlay and combined techniques): 29 patients, 35 procedures in total, Stage 2 urethroplasty: 11 patients,	Stricture-free rate: Overall: 78 (39/50), Unclear for each type of intervention Median FU: 89mo, range 6-198	11 strictures recurrences, 11 UCF, 1 peri-urethral infection, 1 BMG contracture, 1 ventral urethral erosion 18 patients reoperated, (15 repeat urethroplasties, 14 endoscopic procedures), 13 patients had successful outcome.

	urethra 6/50 (12%) and severe penile chordee 7/50 (14%) Mean age 38 +/- 14.3 years (range 19 to 71),			UCF closure: 9 patients		UCF closure: 9 men (1 lost to FU,), success 3/8 (37%) Penile skin flap had higher complications (9/12, 75%) and higher failure rate (5/12, 42%)
Pandey <i>et al.</i> 2017 [31]	35 pts with FHR - 5/35 (14%) had proximal stricture as well, Median age 33 (6-61),	Median 8cm range (2-11)	Median number of procedures in the past 3.3 (range 1–19) , Procedures in the past: failed hypospadias corrections (35/35); DVIU (n = 13; 37.1%); failed UCF excision (n = 14; 40%) and failed urethroplasty (n = 8; 22.8%)	35 pts in total: 20/35 (57%) had staged ventral onlay BMG urethroplasty using scrotal flap to tubularise the urethra 5/35 (14.3%) had staged ventral onlay BMG urethroplasty and BMG bulbar urethroplasty due to strictures 10/35 had staged ventral onlay BMG urethroplasty followed by normal 2 nd stage 43% of patients also had penile deformity correction with plication	Stricture-free rate: 94.2% (33/35) (at last FU) Median FU 40.2mo (3-117)	8/35 (23%) Clavien Dindo 1-2, (1 haematoma, 6 UTIs, 1 epididymitis) 4/12 (11.5%) Clavien Dindo 3 (2 recurrences, 1 UCF (fixed), 1 flap necrosis, lost to FU) Recurrences 2/35 (6%): re-operated (urethroplasty), stricture-free
Snodgrass <i>et al.</i> 2014 [32]	61 adults with FHR (Initial cohort, 69 adults, 1140 overall) Age NR for this group Overall study adults	NR	up to 20 previous operations	61/61 redo hypospadias repair - (19 TIPs, 14 inlay grafts, 28 staged oral grafts)	Stricture-free rate: Overall: 95.1% (58/61) Unclear for single/staged repairs. FU NR for subgroup	16/61 (26%) with complications (8 UCF, 5 glans dehiscence, 3 meatal stenosis) Reoperation, a mid-shaft meatus and a proximal meatus increased the risk of complications

	group: mean 23 yrs (13-62)					
Wu <i>et al.</i> 2018 [33]	56 patients with FHR Age: Group 1 median 19ys (16-33) / Group 2: median 22.5ys (16-41) UCF: 49/56 (87.5%)	NR	Number of previous interventions: Group 1: median 4.2 +/- 1.1 (3-14) / Group 2: median 4.5 +/- 0.8 (3-6)	Staged BMG Bracka urethroplasty 27/56 (48%) Two-stage BMG urethroplasty with additional BMG augmentation of the dorsal urethral plate 29/56 (52%) Length of graft: Bracka Group: 7.8 ± 1.46cm // Augmentation Group: 6.7 ± 1.28cm	Stricture-free rate: Total: 53/56 (94.6%) Bracka: 26/27 (96.3%) // Augmentation Group: 27/29 (93.1%) FU: Total: Median 27.7 ± 7.6mo (12-59) Bracka: 26.5 ± 3.9mo (14-59) Augmentation: 28.6 ± 9.7mo (12-59)	Meatal stenosis: Total 1/56 (1.8%) (Bracka patient), Urethral stricture: Total 2/56 (3.6%, all Augmentation patients), UCF 7/56 (12.5%, 3 Bracka patients and 4 Augmentation ones) Cosmetic complications (meatus not on at top of penis): Total: 5/56 (8.9%, 3 Bracka patients, 2 Augmentation ones) All complications within 6 months post-op No revisions in both groups All strictures managed with dilatations - All 7 UCF patients re-operated but no further info
Studies on mixed FHR / non-FHR patients						
Bastian <i>et al.</i> 2012 [34]	19/35 of study cases (53%) with FHR, age NR for subgroup			Single dorsal inlay with foreskin/ penile skin/ thigh/inguinal skin graft	Stricture-free rate: 12/14 (86%) FU NR for subgroup	Complications NR for subgroup
Blaschko <i>et al.</i> 2012 [35]	7/130 study cases (5%) with FHR, age NR	NR	At least 1 previous urethroplasty	EPA, Onlay graft, Fasciocutaneous flap, Combined, Tubularised flap– NR for the subgroup of FHR patients	Stricture-free rate: 1/7 (14%, unclear whether this was after reoperation) FU NR for subgroup	History of hypospadias was associated with Increased odds of repeat urethroplasty failure and remained a risk factor for failure when controlling for age, stricture length and a history of 2 or more failed prior urethroplasties

Castagnetti <i>et al.</i> 2009 [36]	115 urethroplasties reported - 38 hypospadias urethroplasties, median age 12 yrs range (1.5-40 as mixed group); of them, 33 FHR	NR	NR	Single-stage Labial MG (onlay or tube)	Stricture-free rate: Unclear FU NR for this subgroup	At least 1 patient had a stricture recurrence (unclear primary/FHR) Complications NR in FHR - 23 complications in overall hypospadias group (complications not significantly higher in hypospadias group)
Ekerhult <i>et al.</i> 2015 [37]	109 urethroplasties in total - 39 in patients with hypospadias history (most probably FHR)	NR	NR	25 single-stage urethroplasties (13 pediculated PSF, 9 BMG, 3 SG) 14 2-stage urethroplasties with 1-2 BMGs	Stricture-free rate: Unclear FU NR for this subgroup	Hypospadias was not a risk factor for failure, no additional data Complications NR for this subgroup
Kozinn <i>et al.</i> 2013 [38]	91 patients in total – of them, 51 pts with FHR (of them, 10 with LS) – age NR for this subgroup	Mean 8.8cm	14/51 patients single repair and endoscopic management – 36/51 multiple repairs in the past)	Staged BMG urethroplasty (2/91 initial pts required additional BMG or TVF) at 2 nd stage	15/51 (29%) FHR patients required revision: 8 after 1 st stage (revision urethroplasty for recurrence of LS in the graft, contracture of the graft and stomal stenosis) 7 after 2 nd stage (3 meatal stenosis, 1 panurethral fibrosis) FU NR for this subgroup	3 UCF (after 2 nd stage) Revision rate in patients with previous hypospadias without evidence of LS was lower than that of the overall cohort, but the second stage tended to be more problematic. The post-revision stricture rates were also much higher in the patients with hypospadias alone (40/41, 97.5%).
Liu <i>et al.</i> 2014 [39]	87 patients in total (age 9–72 years old; mean 35.6 years old) - unclear how many of them had FHR	NR	NR	Single-stage dorsal inlay urethroplasty with BMG	Stricture-free rate: Unclear	All 3 study stricture recurrences had FHR All 6 study UCFs had PHR Complications NR for this subgroup

Liu <i>et al.</i> 2015 [40]	238 patients in total; of them, 41 patients with FHR age NR for this subgroup	NR	NR	AWS and non-AWS (buccal, penile skin) graft	Stricture-free rate: Unclear	Multivariate regression showed that FHR was not a RF for recurrence Complications NR for this subgroup
Warner <i>et al.</i> 2015 [41]	19pts with FHR out of 466 patients in total – age NR for this subgroup	NR	NR	Unclear in the FHR group - Study patients were offered one from: FC flap, 1-stage BMG, 2-stage Johanson urethroplasty, definitive first-stage Johanson urethroplasty (including PU), and a combination of grafts and flaps (12 FHR patients were offered 2-stage Johanson)	Stricture-free rate: 15/19 (79%) recurrences (but unclear whether this was following revision) FU NR for this subgroup	3/4 recurrences in 2-stage Johanson Hypospadias NS factor for recurrence Complications NR for this subgroup
Xu <i>et al.</i> 2017 [42]	11 pts with FHR out of 81 with complex strictures age NR for this subgroup	NR	NR	Single-stage dorsal onlay LMG urethroplasty	Stricture-free rate 90.9% (10/11) FU not reported for this subgroup	1 meatal stenosis recurrence repaired with meatoplasty (9%) Complications NR for this subgroup
Xu <i>et al.</i> 2010 [43]	34 pts with FHR out of 92 strictures age NR for this subgroup	NR	NR	Single-stage dorsal onlay LMG urethroplasty (at least 2 also had foreskin flap at the same time)	Stricture-free rate: 94.1% (32/34) FU not reported for this subgroup	2 recurrences with meatal stenosis - had successful meatoplasty subsequently 3/34 UCFs (8.82%)
Xu <i>et al.</i> 2009 [44]	7 pts with FHR out of 25 stricture patients average age 21 yrs	Average 10.7 cm	NR	Study patients were offered either single-stage OMG (dual BMG or LMG) dorsal onlay urethroplasty or single-stage combined BMG and LMG urethroplasty – unclear what procedures were offered to FHR pts	Stricture-free rate: 85.7% (6/7) FU not reported for this subgroup	1 stricture recurrence after dual BMG urethroplasty; 5 dilatations to fix it 2/7 UCFs (28.6%)

BMG = buccal mucosa grafts; CI = confidence interval; EPA = excision and primary anastomosis; FHR = failed hypospadias repair; FU = follow-up; ISD = intermittent self-dilatation; LMG = labial minora graft; LS = Lichen sclerosus; MG = mucosa graft; NR = not reported; OMG = oral mucosa graft; PSF = penile skin flap; PU = perineal Urethrostomy; RF = risk factor; TVF = tunica vaginalis flap; UCF = urethrocutaneous fistula; UTI = urinary tract infection.

Table S6.4: Summary and comparison of urethral strictures (meatal/distal, penile, LS-related)

Authors/ Year	Study/Patient characteristics	Length of stricture	Previous interventions	FHR / LS	Intervention	Stricture-free rates – Follow-up	Complications / other outcomes
Meatal/Distal Urethral strictures							
Babu <i>et al.</i> 2017 [45]	25 patients with navicularis stenosis, mean age 64 yrs (28-72)	NR	NR	NR	Jordan meatoplasty (100%)	Stricture-free rate: 96% (24/25) mean follow-up 30mo range (6-54)	HOSE score ≥ 14 in all patients (100%): good cosmetic and functional result Meatus at top of glans 100% pts: 84% slit-shaped, 16% circular 1 recurrence at 12mo: dilatation Single stream 88%, straight erections 100%, UCF 0% Superficial flap necrosis in 4% conservatively managed
Bastian <i>et al.</i> 2012 [34]	34 pts with glandular/penoglandular stenosis mean age 51.5 yrs (14-85)	NR	Endourological : 68% urethroplasty 15%	53% / 6%	Single-stage dorsal inlay foreskin graft 14/34 (41%, 1 patient had BMG too) Single-stage dorsal inlay penile skin 6/34 (18%) Single-stage dorsal inlay inguinal/thigh skin 14/34 (41%)	Stricture-free rate: 91% (31/34) Mean follow-up 70 mo (3-86)	3/34 recurrences at average 4 mo (3-4 mo)-> dilatation x1, redo-urethroplasty x2) 100% happy with cosmesis Post-operative voiding parameters were significantly improved (P < 0.001).
Meeks <i>et al.</i> 2012 [46]	91 men with fossa navicularis/meatal strictures, 93 procedures Mean age 44.2ys	(substitution urethroplasty pts): mean	42% (9% meatoplasty, 11% urethro	0% / 42%	Meatoplasty 20 patients (22%, 3 De Sy, 3 Blandy, 1 Barcat, 13 single-stage ventral onlay urethroplasty (4 PSG, 9 OMG)	Stricture-free rate: 75% (15/20) single-stage OMG 56% (5/9), single-stage PSG 100% (4/4), Other meatoplasties 86% (6/7)] at last follow-up	Complications NR for meatoplasty group More recurrences in LS group

		3.2cm range (2-6cm)	tomy, 13% circumc ision, 14% meatotomy, 54% dilatation)			median follow-up 50 or 61 months	
Onul <i>et al.</i> 2012 [47]	19 men with distal urethral strictures Median age 41.8yrs, range (21-58)	Median 1.5cm (1-2)	13/19 (81.25%), all LS patients	0 / 84%	Single-stage reconstruction with circular BMG 19/19 (100%) median length of graft 2cm (1.5 - 2.5)	Stricture-free rate: 84.2% (16/19) at last follow-up Median follow-up 38 mo (12-96)	Early graft loss 1/19 (5.2%, LS pt), stricture at proximal anastomosis 2/19 (10.4%, DVIU and ISD) IPSS: 26.7 +/- 3.9 preop to 7.3 +/- 3.8 postop (P 0.001) / 100% happy with cosmesis / 100% mild splaying, improved after 6 mo.
Tijani <i>et al.</i> 2015 [48]	21 patients with fossa navicularis and meatal strictures	mean 2.0cm (1.2 - 3.1)	Previous dilatations 76.1%, SPC 52.4% SPC, circumc ision 100%	4.8% / 0	21/21 (100%) dorsal island penile fasciocutaneous flap and penile cap urethroplasty	Stricture-free rate: 100% (21/21) mean follow-up 25.9+/- 4.1mo (11-92)	1/21 (4.8%) partial dorsolateral skin necrosis (conservatively managed) Mild splaying in all 21 after catheter removal, all pts happy with QoL
Penile Strictures							
Aldağadossi <i>et al.</i> 2013 [49]	47 patients in total, 26 with penile strictures (RCT)	NR	NR	NR for penile group	Single-stage dorsal onlay BMG 14/26 (53.8%) Single-stage dorsal inlay BMG 12/26 (46.2%)	Overall Stricture-free rate: 96% (25/26) (NR separately for penile subgroups)	Complications NR for penile group, however no major complications in total study group

						Follow-up NR for penile group	
Barbagli <i>et al.</i> 2008 [50]	63 patients 100% penile strictures (26 distal urethra, 37 middle penile shaft) mean age 51ys range: (15-78)	NR	81%: DVIU 18%, dilatation 13%, urethroplasty 5%, multiple interventions 48%	0 / 0	Single-stage PSF (dartos fascial flap with skin-island) 18/63 (29%) Single-stage dorsal PSG 23/63 (36%) Single-stage dorsal OMG 22/63 (35%)	Stricture-free rate: Overall: 76% (48/63) (Single-stage PSF 67%, Single-stage PSG 78%, Single-stage OMG 82%) Distal urethral strictures: 77% Middle penile shaft strictures: 75% mean follow-up 50.6mo	15 failures: 14 reoperations with satisfactory final outcome, 1 opted for PU
Barbagli <i>et al.</i> 2014 [51]	359 patients in total 54 pts had penile urethroplasty (15%)	NR	NR	0% / NR for penile group	Single-stage OMG 20/54 (37%) Single-stage PSF 13/54 (24%) Single-stage SG 21/54 (39%)	Stricture-free rate: Overall: 74.1% (40/54) OMG 85%, PSF 77%, SG 62% Mean follow-up 117mo (75-206)	Complications NR for penile group Overall study result: OMG had higher failure-free survival than penile skin
Blaschko <i>et al.</i> 2012 [35]	130 redo urethroplasty patients in total / 14 pts redo penile urethroplasties	NR	100%	NR for penile group	NR for penile group	Stricture-free rate: NR Follow-up NR for penile group (all > 6 mo)	Primary and secondary success in 10/14 pts (71.4%) Two or more failed prior urethroplasties and comorbidities associated with urethral stricture disease (FHR, LS) were associated with an increased risk of repeat urethroplasty failure (total cohort) Complications NR for penile group

Dogra <i>et al.</i> 2011 [52]	78 patients in total, 25 with penile strictures Mean age 38.12ys +/- 13.08 range (22-64),	Mean 4.78+/- 0.747cm, range (3-6)	Mean: 2.48 +/- 0.875	8% / NR for penile group	Single-stage ventral longitudinal penile flap urethroplasty 14/25 (56%) Single-stage dorsal inlay graft urethroplasty 11/25 (44%) (BMG 6, LMG 2, PSG 3)	ED rates using IIEF at 3 mo postop NS Mean 16.08+/-2/59 (12-21)	4/25pts (16%) had ED after urethroplasty (4% mild-to-moderate, 12% moderate) – all patients recovered within 6 months of surgery
Ekerhult <i>et al.</i> 2015 [37]	90 patients 100% penile strictures Group 1 mean age 50ys (19-79), Group 2 mean age 54ys (20-77)	Mean length: G1 3.4cm range (0.5-12), G2 4.5cm range (0.5-13)	Previous DVIU: 44/109 (40.4%) / G1 36/80 (45%) / G2 8/29 (28%) Previous Urethroplasty: 56/109 (51.4%) / G1 37/80 (46%) / G2 19/29 (66%)	35.8% (G1 31%, G2 48%) / 27.5% (G1 23%, G2 41%)	90 patients, 109 urethroplasties Single-stage urethroplasty: 80/109 (73%, 68 pediculated penile skin flap, 9 free BMG, 3 free SG, grafts dorsally or laterally) 2-stage BMG urethroplasty: 29/109 (27%)	Stricture-free rate: Overall 76.1% (83/109) G1: 71.3% (57/80) G2: 89.7% (26/29) Mean follow-up: G1 63 mo (13-114) G2 40 mo (15-118)	Revision rates NR G1: 5 UCF postoperatively (6.3%), G2 5 UCF postoperatively (17.2%) BMI and previous urethral surgery significant risk factors for failure in the single-stage group. Failure over time significantly decreased during the study period
Fu <i>et al.</i> 2017 [53]	293 patients in total, 252 pts with penile strictures	NR	Previous urethroplasty was exclusion criterion	0% / 0%	184 Single-stage PSF (73%) 68 Single-stage dorsal onlay LMGs (27%)	Stricture-free rate: PSF Group: Distal: 86.7% (136/155) - Proximal 69% (20/29) LMG Group: Distal: 82.1% (46/56) - Proximal 83.3% (10/12) Follow-up NR for penile group	No difference between LMG and PSF

Goel <i>et al.</i> 2011 [54]	20 penile stricture patients (100%) Mean age G1 35.3+/-9.96ys (19-58), G2 38.7+/-10.3ys (21-61)	Mean G1 7.23+/-1.25cm (5.5-9.4), G2 7.56+/-1.12cm (5.8-9.5)	NR	NR / 25%	G1: Single-stage dorsal inlay BMG10/20 (50%) G2: Single-stage combined (dorsal/ventral) BMG 10/20 (50%)	Stricture-free rate: G1: 70%, G2: 80% Mean follow-up G1 35.7+/-20.4mo (8-68), G2 31.8+/-20.8mo (3-64)	Wound infection G1 10%, G2 10% Hypo-esthesia G1 10% Increased salivation G1 10% Wound haematoma G2 10% Oral numbness G2 10%, Decreased mouth opening G2 10%
Iqbal <i>et al.</i> 2015 [55]	46 penile stricture patients (100%) mean age 23.3+/-2.4ys, range (15-45)	Mean 6cm, range (4-12)	Patients with multiple operations excluded	NR / NR	Single-stage onlay urethroplasty (fasciocutaneous PSF) 23/46 (50%) Single-stage circumferential urethroplasty (tubular fasciocutaneous PSF) 23/46 (50%)	Stricture-free rate: G1 95.7% (22/23) G2 87% (20/23) Follow-up 2 years, no additional details provided, time points not reported	ED: G1 0%, G2 8.68% UCF G1: 4.34%, G2 8.68% Post-mict. dribbling G1: 4.34%, G2 8.68%
Jiang <i>et al.</i> 2015 [56]	77 patients with penile strictures Mean age G1: 41.2±16.9 years (range 17-71 yrs), G2: 48.9±17.7 yrs (range 16-82).	G1: 3.0±1.6cm, G2: 3.0±1.9cm (NS)	NR	NR / 2/77 (2.6%)	G1: Single-staged dorsal onlay only (51/77, 66.2%, PSG 17, SSG 13, OMG 21) G2: Single-staged double (dorsal/ventral) onlay (26/77, 33.8%, PSG 14, SSG 8, OMG 4)	Stricture-free rate: G1 72.5% (37/51) vs. G2 88.5% (23/26) NS, Mean follow-up: G1: 39.5 mo, range 15-59 mo, G2: 15.6 mo, range 4-33 (p<0.05)	Wound infection: G1 (2/51, 3.9%), G2 (1/26, 3.8%) NS UCF: G1 (2/51, 3.9%), G2 (1/26, 3.8%) NS Double onlay was better in penoscrotal strictures (stricture-free rate: 14/23 (60.9) 16/18 (88.9) < 0.05)
Jinga <i>et al.</i> 2013 [57]	27 patients with penile strictures (100%)	Medium 3cm, range (2-12)	NR	0 / 0	Single-stage ventral onlay BMG 100%	Stricture-free rate: 92.6% (25/27) Average follow-up 21mo (4-35), no time point	UCF 1/27 (3.7%) Stricture recurrence 2/27 (7.4%)

Joshi <i>et al.</i> 2017 [58]	38 patients with complex penile strictures (100%) median age 49 yrs (34-69)	Mean 4.5cm, range (3-8)	17/38 (44.7%) previous urethroplasty, 17/38 (44.7%) DVIU and 2/38 (5.4%) dilatation	42.1% / 0	38 (100%) Two-stage urethroplasty with BMG at the 2 nd stage (dorsal inlay)	Stricture-free rate: 89.5% (34/38) No time point, most probably after last follow-up, mean follow-up 44 mo (12-158)	Glans dehiscence 2/38 (5.3%), full dehiscence 1/38 (2.6%), UCF fistula, 1/38 (2.6%), 0% revision before 2 nd stage
Lumen <i>et al.</i> 2010 [59]	235 patients in total, 59 with penile strictures, age NR for penile group	NR	NR	NR for penile group	Two-stage urethroplasty /Perineostomy 8/59 (13.6%) Combined Urethroplasty 7/59 (11.9%) Pedicled Flap Urethroplasty 24/59 (40.7%) FGU 16/59 (27.1%) EPA 4/59 (6.8%)	Stricture-free rate: 76.6% AR: 75%, (3/4) Ventral longitudinal island flap 86.7%, (13/15) Dorsal longitudinal island flap 60%, (3/5) NR for the remaining techniques Follow-up NR for penile group	Complications NR for penile group
Mellon <i>et al.</i> 2014 [60]	Retrospective Case series 114 patients in total, 20 penile strictures	NR for penile group	NR for penile group	NR for penile group	Single-stage ventral onlay BMG urethroplasty (20/20, 100%)	Stricture-free rate: 55% (11/20) Follow-up NR for the penile group	Complications NR clearly for penile group but 5% (1/20) developed diverticulum (LS patient) / 0% penile numbness
Pfalzgraf <i>et al.</i> 2013 [61]	33 pts in total - 16 with penile strictures (all redo) Median age 39 yrs range (17-72)	>= 2cm - < 6cm 37.5%, > 6cm 62.5	100% previous interventions: Dilatations 68.8%,	NR for penile group	Redo urethroplasty (100%) Single-staged ventral onlay BMG 2/16 (12.5%), Single-staged Dorsal onlay BMG 5/16 (31.3%), Single-stage BMG inlay 3/16 (31.3%), 2-stage BMG 4/16 (25%),	Stricture-free rate: 68.8% (11/16) at last follow-up Follow-up NR for the penile group	5 recurrences after single-staged urethroplasty Revisions before 2 nd stage not clearly reported but most probably 0%

			DVIU 50%, 1 Urethro plasty 56.3%, > 1 Urethro plasties 43.8%,		2-stage MESH graft 2/16 (12.5%)		Dribbling (43.8%, sometimes/always), USI (6.3%) Gr1, mild/moderate penile curvature (25%), penile shortening (37.5%), penile sensitivity (50%), slightly reduced Ejaculatory function (18.8%), Overall satisfaction (56.2%), QoL: strong improvement 31.3%, improvement 31.3% improvement, unchanged 18.8%, slightly reduced 6.3%, EQ5D median 5/15 (range 5-9) IIEF median 26.5/30 (IQR 8.25 - 27.25), IIEF orgasm median 10/10 (IQR 6.5 - 10) IIEF desire median 7/10 (IQR 4.5 -8) IIEF satisfaction median 9.5/15 (IQR 0.75 - 12.25)
Salako <i>et al.</i> 2013 [62]	34 pts with penile strictures, mean age 53.6 yrs, range (28-89),	Mean 3.9cm range (2.5- 6.5)	NR	NR for penile group	Single-stage urethroplasty with longitudinal distal penile island flap 34/34 (100%) 1 patient had concurrent bulbar stricture as well and was offered a EPA at the same time	Stricture-free rate: 100% (34/34) Follow-up range 12-36 mo	Wound infection 2/34 (5.9%), penile skin necrosis 1/34 (3%) (Abx and wound dressings), UCF 1/34 (3%) (closed after 4/12)
Shakir <i>et al.</i> 2018 [63]	14 pts with isolated penile strictures (12/14 penile trauma)	Media n 1.0cm (IQR	NR	14.2% / NR	EPA 14/14 (100%)	Stricture-free rate: 92.9% (13/14) median follow-up 43 mo (IQR 26-121)	1/14 failure (failed hypospadias and 4 urethroplasties)

	Median age 51 yrs (IQR 30-60)	1.0-1.4)					Patient-reported improvement 85% (55%-99%) PGI-I median/IQR 2 (1-3), Postoperative IIEF median/IQR 21 (19-25) Postoperative IPSS median/IQR 4 (2-14) QoL subscore median/IWR 1 (0-2) – 0 penile curvature post-operatively
LS-related strictures							
Kulkarni <i>et al.</i> 2009 [64]	215 patients in total, 46 pts with meatal/penile urethral strictures Mean (range) age: meatotomy 38 yrs (11-68), circumcision and meattomy 46 yrs (36-65), penile urethroplasty 57 yrs (37-85)	NR	Previous operations: meatotomy patients 14/15 (93.3%), circumcision and meatotomy: 6/8 (75%), penile urethroplasty 21/23 (91.3%)	NR / 100%	Single-stage dorsal OMG penile urethroplasty 8/23 (34.8%) 2-stage OMG penile urethroplasty 15/23 (65.2%) Dorsal graft in 87.5% of cases	Stricture-free rate: Penile urethroplasties (all) 82.6% (19/23) at last follow-up / Single-stage 100% (8/8) at mean 38 mo, two-stage 73.3% (11/15) at mean 46 mo (20% revision before 2 nd stage) Follow-up: mean (range): penile urethroplasty 42mo (12-65)	Complications NR for penile group
Singh <i>et al.</i> 2015 [65]	306 LS patients in total; of them 85 of interest: 22 penile urethra with	NR	NR	NR / 100%	Single-stage BMG urethroplasty 17	NR for BMG subgroup with penile strictures only	4 recurrences in the total cohort of BMG

	glans or meatus or foreskin LS				Two-staged BMG urethroplasty 5		repairs (including panurethral strictures)
	Age NR for penile group						
Xu <i>et al.</i> 2014 [66]	36 pts with LS-related strictures Median age 52 yrs range (32-80)	Total cohort: median 12.5+/-1.6 cm range (6-18), LMG: range 6-14, Dual BMG 9.5-11, LMG+BMG 13-18	Previous procedures in all patients mean 1.5 procedures (1-3, circumcision 12, meatotomy 6, SPC 20)	0 / 100%	Single-stage, single-sided dorsal onlay OMG urethroplasty: LMG 22/36 (61%) Dual BMG 5/36 (14%) LMG+BMG 9/36 (25%) Length of graft LMG: 7-15, NR for the others	Stricture-free rate: Overall: 88.9% (32/36) LMG 90.91%, Dual BMG 80%, LMG+BMG 88.89% mean (range) follow-up 38.7 mo (12-110)	4/36 (11.1%): 1 UCF requiring operation, 3x meatal stenosis (3-11 mo) requiring meatoplasty (successful)

BMG = buccal mucosa grafts; CI = confidence interval; EPA = excision and primary anastomosis; FGU = free graft urethroplasty; FHR = failed hypospadias repair; FU = follow-up; ISD = intermittent self-dilatation; IPSS = international prostate symptom score; LMG = labial minora graft; LS = Lichen sclerosus; MG = mucosa graft; NR = not reported; OMG = oral mucosa graft; RGI-I = patient global impression of improvement PU = perineal Urethrostomy; QoL = quality of life; RF = risk factor; SPC = Suprapubic catheterisation; UCF = urethrocutaneous fistula; UTI = urinary tract infection.

Table S6.5: Outcomes of recent transecting EPA series

Paper	No. patients	Age in years Mean / median (Dispersion)	Stricture aetiology	Prior interventions	Length of stricture in cm Mean / median (Dispersion)	FU in months Mean / median (Dispersion)	Stricture Free Rate (%)
Ekerhult T. <i>et al.</i> 2018. [67]	45	41 (R 16 - 75)	Mixed (Idiopathic 69% / Iatrogenic 7% / Trauma 18%)	Not reported	< 2	21 (R 7 - 54)	76%
Kahokehr 2018. [68]	226	Adults (not detailed)	Mixed	94.6% DVIU	Not reported	28 (R 3 - 112)	95.6% -10 months time to recurrence-
Sawant A <i>et al.</i> J 2018. [69]	29	35.3 (R 32 - 37)	Mixed (Idiopathic / Straddle injury / Iatrogenic-catheterisation / LS)	Not reported	1.8	21 (R 1-48)	86%
Waterloos M <i>et al.</i> 2018. [70]	112	49 (IQR 34- 66)	Mixed (Idiopathic 51% / Iatrogenic 36% / trauma 10%)	17% U-plasty	1.5 (IQR 1- 2)	118 (IQR 93-148)	88.5%

IQR = interquartile range; R = range; LS = lichen sclerosus; SD= standard deviation.

Table S6.6: Outcomes of transecting EPA using anatomic definition for failure

Paper	Number patients	Age in years Mean/median (Dispersion)	Length of stricture in cm Mean/median (Dispersion)	FU in months Mean/median (Dispersion)	Stricture Free Rate (%)	Evaluation method for success
Erickson B. <i>et al.</i> 2014 [71]	136	Adults (> 18 years)	Not reported	13.1 (SD 1.2)	85.5% - 9.8 months time to recurrence-	Cystoscopy (16 Fr. passage)
Chapman D. <i>et al.</i> 2017 [72]	165	44.4 (SD 15.8)	3.9 (SD 2.3)	65.4 (R 12 -149)	97%	Cystoscopy (16 Fr. passage)
Chapman D. <i>et al.</i> 2018 [73]	258	44.1 (SD 17.2)	1.7 (SD 0.6)	74.1 (SD 45.4)	93.8%	Cystoscopy (16 Fr. passage)
Sawant A <i>et al.</i> 2018 [69]	29	35.3 (R 32 - 37)	1.8	21 (R 1-48)	86%	No further interventions and no anatomic recurrence

Fr = French; FU = follow-up; R = range; SD = standard deviation.

Table S6.7: Outcomes of recent Non-Transecting EPA series

Paper	No. patients	Technique	Operation time in minutes Mean/median (Dispersion)	Age in years Mean/median (Dispersion)	Stricture aetiology	Prior interventions	Length of stricture in cm Mean/median (Dispersion)	FU in months Mean/median (Dispersion)	Stricture Free Rate (%)
Virasoro R. 2015 [74]	68	Vessel-sparing EPA	148 (R 61 - 239)	51.2 (R 3 - 82)	Mixed (Idiopathic 42% / Iatrogenic 21% / straddle injury 19%)	65% Endoscopic	1.8 (R 1 - 3)	17.6	95.6 %
Ivaz SL. 2017 [75]	101	Non-transecting	Not reported	Adults (Not detailed)	Non-traumatic (idiopathic / iatrogenic)	Not reported	Not reported	> 18	99%
Waterloos M <i>et al.</i> 2018 [70]	88	Non-transecting	87 (IQR 71 - 100)	47 (IQR 30 - 64)	Mixed (Idiopathic 51% / Iatrogenic 36% / trauma 10%)	20.5% U-plasty	1.25 (IQR 1 - 2)	32 (IQR 17 - 57)	93.2 %
Chapman D. 2018 [73]	94	Non-transecting	Not reported	45.9 (SD 19.4)	Non-traumatic (Mixed aetiologies)	70% Endoscopic 4.8% U-plasty	1.6 (SD 1.1)	37.1 (SD 20.5)	97.9 %

FU = follow-up; IQR = interquartile range; R = range; SD = standard deviation.

Table S6.8: Results of FGU of the bulbar urethra derived from systematic reviews and prospective studies

Author	Year	Study	Technique	N	Follow-up (months)	Patency
Mangera <i>et al.</i> [76]	2011	Systematic review	Bulb grafts	1500	40	88%
Vasudeva <i>et al.</i> [77]	2015	Randomised-control trial	BM bulbar	80	12	91%

BM = buccal mucosa; N = number.

Table S6.9: Outcomes of augmented anastomotic repair in adult population

Paper	Number of patients	Technique	Stricture aetiology	Length of stricture in cm Mean/median (Dispersion)	FU in months Mean/median (Dispersion)	Stricture Free Rate (%)	Evaluation method for success
Granieri MA. <i>et al.</i> J Urol 2015. [78]	85	AAR	Mixed (not detailed)	Not reported	12.1 (SD 7.3)	92.9%	No further interventions
Kahokehr A. <i>et al.</i> J Urol 2018. [68]	146	AAR	Mixed (Idiopathic / Straddle injury / Iatrogenic-catheterisation / LS)	Not reported	28 (R 3 - 112)	91.1%	No further interventions

AAR = augmented anastomotic repair; FU = follow-up; LS = lichen sclerosus; R = range; SD = standard deviation.

	49 Revision Urethroplasty 31 bulbar stricture (63.3%) 2 (4.1%)	Staged/PU 11 (22.4%)	49.1 (13.6) Mean (SD) Whole group	49 (25) Mean (SD) Whole group	Idiopathic 17 (34.7%) Trauma 18 (36.7%) Radiotherapy 2 (4.1%) Iatrogenic 9 (18.4%) Inflammation 11 (22.4%)		45 (91.8%)
Warner <i>et al.</i> 2015 [41]	466 urethroplasty	162 1 st stage Johanson /PU 56 1 st and 2 nd stage Johanson	51.3 (16-82) Mean (range) Whole group	20 (12-344) Mean (range) Whole group	Idiopathic 104 (22.3%) Lichen Sclerosus 234 (50.2%) Trauma 13 (2.8%) Failed hypospadias 19 (4.1%) Iatrogenic 92 (19.7%) Infection 4 (0.9%)		123/162 (75.9%) 36/56 (64.3%)
Sawant <i>et al.</i> 2018 [69]	76 43 bulbar strictures 18 bulbo-penile strictures	Staged 33	35.2 Mean Whole group	21 (-48) Mean (range) Whole group	NR	4.5 Mean	28 (84.8%)

BMG = buccal mucosa graft; MG = mucosa graft; NR = not reported; PU = perineal urethrostomy; SD = standard deviation; TURP = transurethral resection of prostate.

Table S6.11: Outcomes of Perineal Urethrostomy

Study	Number of Patients	Technique	Age (years)	Successes	Follow Up (months)	Stricture Aetiology	Success (%)	Stricture Length (cm)	Success (%)	Previous Treatment	Success (%)	Overall Success (%)								
Barbagli <i>et al.</i> 2009 [26]	173	Blandy	55 (22-85)	67 (61.2%)	62 (12-361)	Idiopathic 87 (50.3%)	73.6	1-<2	50	None	73.9	121 (70%)								
			Median (range)			Median (range)	Lichen Sclerosus 30 (17.3%)	63.3	2-<3	66.7	Urethral dilatation 23(13.2%)		75							
			23-49				Catheter 23 (13.3%)	65.2	3-<4	71.4	12(6.9%)		64.7							
			50-69				Instrumentation 15 (8.7%)	73.3	4-<5	70.8	Urethrotomy 17(9.8%)									
			>70				Failed 20 (80%)	87.5	5-<6	76.9	Urethroplasty 16(9.2%)									
			Hypospadias 8 (4.6%)				57.1	>6	85.7	Multiple 105(60.6%)	43.3									
			Trauma 7 (4.1%)				33	Pan-urethral 100(57.8%)	24(13.9%)	Urethral stent 24(13.9%)										
			Infection 3 (1.3%)				No previous urethroplasty 82 (47.4%)	73.2												
			Previous urethroplasty 91 (52.6%)											67						
															-1 stage Bladder MG 1(1.1%)	100				
																	-Hypospadias repair 8(8.8%)	83.3		
																			-1 stage Oral MG 6(6.6%)	83.3
64																				

										-2 Stage 25(27.5%) -Penile 15(16.4%) -1 stage skin graft 14(15.2%)	60 57.1	
Warner <i>et al.</i> 2015 [41]	162	Johanson	51.3 (16-82) Mean (range)		20 (12-344) Mean (range)	Idiopathic 104 (22.3%) Lichen Sclerosus 234 (50.2%) Trauma 13 (2.8%) Failed hypospadias 19 (4.1%) Iatrogenic 92 (19.7%) Infection 4 (0.9%)						123 (75.9%)
Lumen <i>et al.</i> 2015 [81]	51	Johanson 35	60.5 (14.7) Mean (SD)		36 (11-75) Mean (IQR)	Idiopathic 6 (17.1%) Iatrogenic 17 (48.6%) Traumatic 2 (5.7%) Inflammatory 5 (14.3%)		9.3 (5).0 Mean (SD)		None 8 (22.96) Urethrotomy/dilatation 87(20.0%) Urethroplasty 31 (60.8%)		26 (74.3%)

		Blandy 16	59.2 (16.4)		9 (6-13) Mean (IQR)	Urethrectomy 5 (14.3%) Idiopathic 2 (12.5%) Iatrogenic 4 (25%) Traumatic 3 (18.8%) Inflammatory 2 (12.5%) Urethrectomy 5 (31.2%)		7.1 (4.8) Mean (SD)		None 5 (31.2%) Urethrotomy/ dilatation 0 (0%) Urethroplasty 11 (68.8%)		14 (87.5%)
DeLong <i>et al.</i> 2017 [82]	44	Dorsal (42) +/- Ventral (2) BMG Augmented Blandy	60 (44-81) Mean (range)		45(6-136) Mean(range)	Idiopathic 16 (36%) Failed Hypospadias 6 (14%) Lichen Sclerosus 10 (23%) Iatrogenic 7 (16%) Fournier's 3 (7%) Urethral cancer 1 (2%)						35 (80%) Dorsal augment 33/42 (79%) Dorsal + ventral augment 2/2 (100%)

						Penile cancer 1 (2%)						
Fuchs <i>et al.</i> 2018 [83]	77/403 complex anterior urethroplasty	Not specified	62.6 (13.3) Mean (SD)		38.9 (34.2) Mean (SD)	Iatrogenic 5 (6.5%) Trauma 9 (11.7%) Lichen Sclerosus 17 (22.1%) Radiation 1 (1.3%) Hypospadias 11 (14.3%) Idiopathic 34 (44.2%)						73 (94.8%)
McKibben <i>et al.</i> 2018 [84]	62	Loop 20 "7 flap" 42	62.8 (median)		13.0 (median)	Lichen Sclerosus 6(30.0%) Idiopathic 6(30.0%) Failed hypospadias 4(20.0%) Iatrogenic 3(15.0%) Penile cancer 0(0%) Trauma 1(5.0%)	8.5 cm Median					20 (100%) 39 (92.9%)

			61.9 (median)		53.6 (median)	Lichen Sclerosus 18(42.9%) Idiopathic 6(14.3%) Failed hypospadi s 9(21.4%) Iatrogenic 4(9.5%) Penile cancer 2(4.8%) Trauma 3(7.1%)		8.0cm Median			
Viers <i>et al.</i> 2018 [85]	38	Not specified	69 (64-75) Median (IQR) In success 31 (10- 55) Median (IQR) In failure < 50 50-59	14/14 (100%)	63 (39-84) Median (IQR)			2.0 (1.5- 3.0) Median (IQR) Includes 154 men with Anterior Urethral Studies			35 (92.1%)

			60-69 70+	7/8 (88%) 10/12 (83%) 4/4 (100%))								
Klemm <i>et al.</i> 2024 [86]	76	y-shaped	73 (63-77) Mean (IQR)		55 (7.4-100) Mean (IQR)	Iatrogenic 42 (55%) Idiopathic 12 (16%) Hypospadias 8 (11%) Infectious 6 (7.9%) Trauma 4 (5.3%) Lichen Sclerosus 4 (5.3)		Pan (>8cm) 28 (37%) Multiple segments 58 (76%) Bulbar 36 (47%) Proximal Bulbar 9 (12%) Concomitant fistula 1 (1.3%) Median (IQR) 3cm (2-6)		Urethrotomy 41 (55%) Urethroplasty 38 (50%) Urethral Dilation 20 (26%) TURP 18 (24%) TURBN 3 (3.9%) Endoenucleation prostate 1 (1.3%) [SPC 40 (55%)]		64 (84%) 2 year 68 (90%) 5 year 63 (83%) 10 year 54 (71%)
Ponce de Leon <i>et al.</i> 2023 [87]	115	Blandy 88 (76.5%) Incomplete Blandy 27 (23.5%)	71 (Median)		61 (53-68) Median (IQR)	Lichen sclerosus 35 (30.4%) Iatrogenic 31 (27%) Idiopathic 29 (25.7%)		Pan 62.6%		Urethroplasty 42 (36.5%) Urethrotomy 39 (35.7%) Dilatation 52 (45.2%) SPC 43 (37.4%)		59 (51.5%)

						Hypospadias 8 (7%) Urethritis 5 (4.3%) External trauma 4 (3.5%) Penile Cancer 2 (1.7%) Fournier's gangrene 1 (0.9%)					
Rahav <i>et al.</i> 2024 [88]	57 PU 75 anterior urethroplasty	Anterior Urethroplasty PU by intention NA First-staged U NA Graft 48 (64%) Flap 6 (8%) Combined technique 16 (21.3%) Staged U 5 (6.7%) PU PU by	Mean age PU 49y Anterior urethroplasty 43.13y		Median 46 m (min 12 m)	Anterior Urethroplasty Hypospadias 17 (23.3%) Idiopathic 18 (24.7%)* Traumatic cathzn 23 (31.5%) Lichen Sclerosus 3 (4.1%) Inflammatory 8 (11%) Trauma 4 (5.5%) PU		Mean PU 7.53 cm Anterior urethroplasty 7.93 cm		Anterior Urethroplasty Hypospadias Repair 16 (24.6%) U Diln 52 (80%) VIU 26 (40%) U 23 (35.3%) PU 0 (0) CIC 2 (3.1%) Prostatectomy 5 (7.7%) PU Hypospadias Repair 23 (40.4%) U Diln 39 (68.4%) VIU 16	Anterior urethroplasty 48 (63.8%) PU 44 (77.4%)

		intention 30 (52.6%) First- staged U 27 (47.4%) Graft NA Flap NA Combined Technique NA Staged U NA				Hypospadias 25 (44.6%)* Idiopathic 6 (10.7%) Traumatic cathzn 12 (23.2%) Lichen Sclerosus 10 (17.9%)* Inflammatory 1 (1.8%) Trauma 1 (1.8%) *=P<0.05				(28.1%) U 21 (36.8%) PU 4 (7%)* CIC 4 (7%) Prostatectomy 3 (5.3%)9		
Total	855		49-71 (16-85)		9- 62 (6- 361)							653 (76.4%)

BMG = buccal mucosa graft; EPA = excision and primary anastomosis; IQR = interquartile range; MG = mucosa graft; SD = standard deviation.

Table S6.12: Dilatation for posterior non-traumatic stenosis

Study	Type	etiology	N	Follow-up (months)	Patency (%)	De novo urinary incontinence (%)	complications
Ramchandani <i>et al.</i> [89]	Balloon	VUAS	27	31.5 (12-84)	59	0	0
	Cystoscopic assisted	VUAS	8	NR	38	0	0
Ishii <i>et al.</i> [90]	Balloon	VUAS	10	24 (7-67)	80	10	0
Kumar <i>et al.</i> [91]	Balloon	VUAS	9	33	89	0	0
Hayashi <i>et al.</i> [92]	NR	VUAS	15	NR.	40	NR	NR
LaBossiere <i>et al.</i> [93]	Cystoscopic assisted	VUAS	17	10	0	NR	NR

Kravchick <i>et al.</i> [94]	Cystoscopic assisted	VUAS	32	NR	9	NR	NR
Merrick <i>et al.</i> [95]	NR*	Radiation-induced BMS	29	NR	69	NR	NR
Sullivan <i>et al.</i> [96]	NR*	Radiation-induced BMS	35	16 (2-48)	51	11	NR

Table S6.13: Study characteristics and outcomes of endoluminal treatment followed by intralesional injections for posterior non-traumatic strictures

Study	Endoluminal treatment	Antifibrotic agent	Etiology	N	FU (months)	Patency ^o (%)	Complications (%)
Eltahawy <i>et al.</i> [97]	Holmium laser DVIU	Triamcinolone	VUAS	24	24 (6-72)	83	Incontinence: 71*
Kravchick <i>et al.</i> [94]	Dilatation	Methylprednisolone	VUAS	14	63 (±27)	80	Incontinence: 0*
	TUR			7	47 (±23)	100	Incontinence: 57*
	Cold knife DVIU			8	49 (±23)	50	Incontinence: 13*
Vanni <i>et al.</i> [98]	Cold knife DVIU	MMC	VUAS (n=17)/ BNS (n=1)	18	12 (4-26)	72	Incontinence: 6
Nagpal <i>et al.</i> [99]	Cold knife DVIU	MMC	VUAS BNS	40	21 (3-55)	75	Incontinence: 5
Lyon <i>et al.</i> [100]	Bipolar TUR	MMC	VUAS (n=8) BNS (n=2) Prostatic stenosis (n=3)	13	17 (14-18)	66	<i>De novo</i> Incontinence: 8 Worsened incontinence:15 Retention: 8
Farrell <i>et al.</i> [101]	Cold knife DVIU + ISD	MMC	Membranous (n=6)/ BNS (n=11)	17	23 (12-39)	65	NR

Sourial <i>et al.</i> [102]	Dilatation	MMC	VUAS	29	12	79	0
Redshaw <i>et al.</i> [103]	Cold knife DVIU	MMC	BNS	30	9 (IQR 4-15)	50**	Osteitis pubis: 4 Recto-urethral fistula: 2 Bladder neck necrosis and bladder pain: 2
	Hot knife DVIU			16		63**	
	TUR			9		78	

BNS = bladder neck stenosis; DVIU = direct vision internal urethrotomy; ISD = intermittent self-dilatation; MMC = mitomycin C; NR = not reported; TUR = transurethral resection; VUAS = vesico-urethral anastomosis stricture; IQR = interquartile range.

°patency rate after 1st endoluminal treatment evaluated in the study.

*no data on continence status before endoluminal treatment.

**p=0.03.

Table S6.14: Outcomes of bladder neck reconstruction for bladder neck stenosis after surgery for BPH

Study	technique	N	BPH surgery	FU (months)	Patency (%)	incontinence (%)	Complications (%)
Rosenbaum <i>et al.</i> [104]	open T-plasty	30	TURP: 83 HoLEP: 10 Green light: 7	45 (18-64)	100	<i>De novo</i> : 4 Unchanged: 7	NR
Shu <i>et al.</i> [105]	Lap'scopic T-plasty	9	TURP: 100	15 (3-32)	89	0	0
Musch <i>et al.</i> [106]	Robot-assist VY-plasty	12	TURP: 75 TURP + HIFU: 8 Simple prostatectomy: 17	23	83	<i>De novo</i> : 8 Unchanged: 8	G1-2: 50 >G2: 0
Kirshenbaum <i>et al.</i> [107]	Robot-assist VY-plasty	7	TURP: 57 PVP: 43	14 (5-30)	86	<i>De novo</i> : 14 Unchanged: 14	G1-2: 29

BPH = benign prostatic hyperplasia; FU = follow-up; HIFU = high-intensity focused ultrasound; HoLEP = Holmium laser enucleation of prostate; PVP = photo-selective vaporisation; TURP = transurethral resection of prostate.

Table S6.15: Outcomes of urethroplasty for radiation-induced BMS

Study	Technique	N	Length (cm)	FU (months)	Patency (%)	De novo incontinence (%)	Complications (%)
Lumen <i>et al.</i> [108]	EPA	3	1.5-2	62-74	67	33	NR
Fuchs <i>et al.</i> [109]	EPA	72	2.3 (1.6-3)	34 (21-52)	76	35	NR
Chung <i>et al.</i> [110]	EPA	36	2.5	18	NR	33	NR
Hofer <i>et al.</i> [111]	EPA	66	2.4 (1-6)	42 (10-134)	70	36	Fistula: 1.5 New onset ED: 7
	Graft/flap	6	4.3 (3-7)	66 (24-120)	83	50	NR
Ahyai <i>et al.</i> [112]	BMG VOU	38	3 (1-8)	27 (1-50)	71	11	New onset ED: 6.3
Rourke <i>et al.</i> [113]	EPA	23	2.1	51 (15-120)	91	26	New onset ED: 35 any other AE: 30
	Graft/flap	12	6.1		75	25	New onset ED: 0 Any other AE: 33
Glass <i>et al.</i> [114]	EPA	22	2.6 (±1.6)	40 (12-83)	95	7	Wound infection: 3
	BMG	5			80		
	flap	2			50		
Meeks <i>et al.</i> [115]	EPA	24	2.9 (1.5-7)	21 (19-69)	73	50	New onset ED: 3
	BMG	2					
	flap	4					

BMG = buccal mucosa graft; VOU = ventral onlay urethroplasty; ED = erectile dysfunction; EPA = excision and primary anastomosis; FU = follow-up, AE = adverse event.

Table S6.16: stricture-free rates of direct vision internal urethrotomy (DVIU) after failed urethroplasty

Study	N	Follow-up (months)	1 st DVIU	2 nd DVIU	3 rd DVIU
Ali <i>et al.</i> [116]	7	10	5/7 (71,4%)	0/2 (0%)	-
Helmy <i>et al.</i> [117]	22	98 (38-210)	17/22 (77.3%)	3/5 (60%)	0/2 (0%)
Hong <i>et al.</i> [118]	35	53 (17-148)	8/35 (22.9%)	5/25 (20%)	0/14 (0%)
Hussain <i>et al.</i> [119]	7	NR	2/7 (28.6%)	0/5 (0%)	-
Koraitim M. [120]	7	228 (48-288)	5/7 (71.4%)	1/2 (50%)	-

DVIU = Direct vision internal urethrotomy; N = number; NR = not reported.

Table S6.17: Outcomes of bulbar artery sparing EPA

Study	N	Follow-up (months)	Stricture-free rate	Post-operative complications			Incontinence	Erectile dysfunction
				G1	G2	G3		
Gomez <i>et al.</i> [121]	26	20 (2-69)	26 (100%)	0 (0%)	6 (23.1%)	1 (3.8%)	1 (3.8%)	16 (61.5%)
Verla <i>et al.</i> [122]	26	45 (32-77)	23 (88.5%)	3 (11.5%)	2 (7.7%)	0 (0%)	NR	NR
Xie <i>et al.</i> [123]	59	25 (12-60)	57 (96.6%)	NR	NR	NR	NR	NR

NR = not reported.

Table S6.18: Outcomes of Badenoch pull-through technique for urethral anastomosis

Study	N	Follow-up (months)	Previous manipulations	Stricture free	Wound infection	Incontinence	<i>de novo</i> ED
Wang <i>et al.</i> [124]	113	48.5 (12-86)	52 (46%)	109 (96.5%)	11 (9.7%)	2 (1.8%)	5 (4.4%)
Kulkarni <i>et al.</i> [125]	9	126	NR	3 (33.3%)	NR	NR	NR
Yin <i>et al.</i> [126]	76	42.5 (14-74)	31 (41%)	68 (89.5%)	NR	0 (0%)	2 (5%)

ED = erectile dysfunction; NR = not reported.

Table S6.19: Risk of rectal injury during urethroplasty.

(based on studies that specifically reported intra-operative complications)

Study	N	Secondary cases	Rectal injury	Remark
Fu <i>et al.</i> [127]	573	537 (93.7%)	28 (4.9%)	-
Garg <i>et al.</i> [128]	50	50 (100%)	1 (2%)	-
Hosseini <i>et al.</i> [129]	320	139 (43,4%)	0 (0%)	-
Hussain <i>et al.</i> [119]	26	0 (0%)	0 (0%)	-
Hwang <i>et al.</i> [130]	49	20 (40,8%)	5 (10,2%)	All complex cases requiring gracilis muscle flap
Ibrahim <i>et al.</i> [131]	55	0 (0%)	0 (0%)	-
Gelman <i>et al.</i> [132]	85	34 (40%)	0 (0%)	-
Koraitim M. [133]	64	36 (56%)	0 (0%)	-
Lumen <i>et al.</i> [134]	61	21 (34.4%)	2 (3,3%)	Only rectal injuries in secondary cases
Kulkarni <i>et al.</i> [135]	15	15 (100%)	0 (0%)	-
Mehmood <i>et al.</i> [136]	80	7 (8.8%)	0 (0%)	-

Table S6.20: Results of visually controlled dilatation

Study	Technique	N	FU (mo)	recurrence	Definition of failure	Complications			
						Haematuria	False passage	Procedural failure	UTI
Hosseini <i>et al.</i> [137]	Nelaton urethral catheters	333	43 (36-52)	138 (41.4%)	Need for additional intervention	12 (3.6%)	2 (0.6%)	NR	15 (4.5%)

Kallidonis <i>et al.</i> [138]	Coaxial S-curved	310	12	90 (33%)	No recurrence @1 yr with maximum one additional procedure	11 (3.5%)	0 (0%)	7 (2.2%)	33 (10.6%)
Nomikos <i>et al.</i> [139]	Amplatz + DVIU + ISD (1 yr.)	34	12	8 (23.5%)	Stricture recurrence on urethroscopy/ urethrography	2 (5.8%)	NR	NR	3 (8.8%)
Yu <i>et al.</i> [140]	Balloon	31	15 (5-36)	20 (64.5%)	Need for subsequent urethroplasty	2 (6.5%)	0 (0%)	NR	1 (3.2%)
Beeder <i>et al.</i> [141]	Balloon dilation (UroMax)	91	12 (3-40)	46 (50%)	Symptom recurrence or need for further stricture treatment	2 (2%)	NR	NR	7(8%)

DVIU = direct vision internal urethrotomy; FU = follow-up; ISD = intermittent self-dilatation; mo = months; N = number of patients; NA = not applicable; NR = not reported; UTI = urinary tract infection; yr = year.

Blaivas et al 2012 [4]	1	1	-	-	1	-	1	-	-	-	-
Patil et al 2013 [151]	-	-	1	-	-	-	-	-	-	-	-
Singh et al 2013 [15]	1	1	1	-	-	-	-	-	-	-	-
Akman et al 2013 [152]	-	-	-	-	-	1 (< 14 Fr.)	-	-	-	-	-
Kowalik et al 2014 [7]	-	-	-	PRN	-	-	1	-	-	-	-
Heidari et al 2014 [153]	1	1	-	-	-	-	1	1	-	-	-
Goel et al 2014 [154]	1	1	1	-	-	1 (< 14 Fr.)	-	-	-	-	-
Onol et al 2014 [8]	1	1	1	-	-	-	1	-	-	-	-
Popat and Zimmern 2016 [146]	1	1	PRN	PRN	-	-	1	-	-	-	PRN
Spilotros et al 2017 [9]	1	1	-	-	1	-	1	-	-	-	PRN
Powell and Daniels 2017 [10]	1	1	-	-	-	-	1	-	-	-	-
Mukhtar et al 2017 [11]	1	1	-	-	1	-	1	-	-	-	PRN
Kaushal et al 2018 [155]	1	1	1	-	-	-	-	-	-	-	-
Tao et al 2018 [12]	1	1	1	1	-	-	1	-	-	-	-
Romero-Maroto et al 2018 [13]	1	1	1	If > 14 Fr.	-	-	If > 14 Fr.	-	-	-	-
Manasa <i>et al.</i> 2019 [156]	1	1	-	-	1	9F	1	-	-	-	-
Nayak <i>et al.</i> 2019	1	1	-	-	-	-	1	-	-	-	-
Sussman <i>et al.</i> 2020	-	-	-	-	1	-	1	-	-	-	-
Lane <i>et al.</i> 2020 [157]	-	-	1	1	-	-	1	-	-	-	-
Chakrabarty <i>et al.</i> 2021	1	1	1	-	-	1	1	-	-	-	-

TOTAL	18	17	15 + 1 PRN	4 + 7PRN	4	3 (< 14 Fr.)	13 + 2 PRN	2	1	2	4 PRN
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IVU = intravenous urography; MRI = magnetic resonance imaging; PRN = if required ; PVR = post-void residual; TRUS = transrectal ultrasound; UDS = urodynamics; USS = ultrasound; VCUG = voiding cystourethrogram; VUDS = video-urodynamics.

Table S7.3: Urethral Dilatation Outcomes

Paper	Mean (Median) Age years (range)	Technique	Number	Post Op ISC	Recurrent Stricture	% Stricture Free As Per Study	% Stricture Free as Per Definition	FU mean (median) months(range)	Complications	Pre-op Mean/Median Q _{max} ml/s	Post Op Mean/Median Q _{max} ml/s	Pre-op Mean/Median PVR ml/s	Post Op Mean/Median PVR	New Onset SUI
Smith <i>et al.</i> 2006 [149]	41 (22-67)	34 Fr.	7	Yes	3	57	0	21 (6-34) 1	All failures none compliant with ISC	-	-	-	-	0
Blaivas <i>et al.</i> 2012 [4]	62 (32-91) Complete series	Not specified	7	No	6	14	14	29(3-144) 203 Complete series	0	-	-	-	-	0
Romman <i>et al.</i> 2012 [145]	Success 52.4 (+/- 14.4) Failure	Sequential dilation 25 Fr. to 41 Fr.	93	No	46	51	51	46 (+/-47) success 2162	0	13.0 +/- 4.9	20.7 +/- 7.8	44.8 +/- 58.9	13.6+/- 30	2

	50.2 (+/- 16.1)							12 (=-/ 15) Failure 552		13.4 +/- 6.7	16.3 +/- 7.2	92.00 +/- 114.4	114.8 +/- 174.4	
Rijal <i>et al.</i> 2013 [5]	59 (23-87) Complete series	Not specified	53 (includes 2 DVIU)	No	49	7.5	7.5	-	-	-	-	-	-	-
Akman <i>et al.</i> 2013 [152]	72.3 (65-83)	30 Fr.	6	Yes – weekly for 2 months	0	100	0	17.67 (4-30)	0	6.55 (4.2-8.3)	25.43 (23.7 - 27.2)	90 (80-150)	30 (30-40)	0
Heidari <i>et al.</i> 2014 [153]	48.13 (14-79)	24Fr	86	Repeat dilatation	0	100	0	6	0	8.2	12.7	92.07	48.88	
Popat and Zimmern 2016 [146]	55 (23-86)	39-43 Fr.	30	No	18	40	40	59 (7-151) 1770	Duration symptoms 12.8 y in failure cf 4 y in success	-	-	-	-	-
Spilotros <i>et al.</i> 2017 [9]	45.8 (30-71) Complete series	30 Fr.	8	5	4	37.3	0	35.6(15-96) Complete series	-	-	-	-	-	-
Tao <i>et al.</i> 2018 [12]	54 (37-83)	Gradual dilation to 30 Fr. weekly initially reducing	10	Yes repeat planned dilatation	0	100	0	12 (6-15)	0	8.8(5.4-11.6)	12(9.1-15.0)	57 (21.0-330.0)	33.5 (0-46.0_	-

		to 3 monthly												
Lane <i>et al.</i> 2020 [157]	56 (SD 15)	Not specified	66	No	31	36 (Missi ng data 23%)	Not specifie d	18 (IQR 2-39)	Not specified	-	-	-	-	3 (4.5)
Total	41-72.3 (22- 87)	30-41 Fr.	214	-	126	41.1	0-51	12-59 (3- 144)	0	6.55- 13.4 (4- 20.1)	12- 25.4 3 (9.1- 27.2)	44.8- 92 (0- 330)	13.6- 114.8 (0- 292.2)	2/123

DVIU = direct visual internal urethrotomy; ICS = International Continence Score; PVR = post-void residual; PVR = post-void residual; y = year.

Table S7.4: Meatoplasty

Paper Title	Number patients	Mean/median Age (Range) Years	Technique	Mean/Median FU (Range) months	Stricture Free Rate N (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range) ml/s	Post Mean/Median Flow Rate (Range) ml/s	Pre Mean/Median PVR (Range) mls	Post Mean/Median PVR
Heising <i>et al.</i> 1978 [158]	58	2-13	Ventral Meatotomy	12	56 (97)	0	0	-	-	-	-
Total	50	-	-	-	48 (96)	-	0	-	-	-	-

FU = follow-up; PVR = post-void residual.

Table S7.5: Vaginal Graft Urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedure	Stricture Free N/Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range) ml/s	Post Mean/Median Flow Rate (Range) ml/s	Pre/ Mean/Median PVR (Range) mls	Post Mean/Median PVR (Range) mls
Tsvian, Sidi 2006 [159]	2	60 (60)	0	DOVG	27	0	2 (100)	0	0	-	-	-	-
Petrou <i>et al.</i> 2012	11	60.6 (35-79)	0	DOVG	23	0	7 (73)	0	0	7.3	21.8	187.1	75.8
Singh <i>et al.</i> 2013 [15]	16	47.5 (38-58)	0	DOVG	24.65 (6-36)	0	15(94)	0	0	6.2	27.6	160	20
Manasa <i>et al.</i> 2019 [156]	13	43.8 (28-62)	Nor specified	DOVG	8.5 (6-14)	0	10 (77)	0	0	8.23	16.64	113.2	90.31
Chakrabarty <i>et al.</i> 2021	24	46.54 (38-55)	20 dilatations	DOVG	22.62 (12-36)	0	21 (87.5)	0	0	6.35 (3.8-8.4)	22.62 (12-36)	148.12	41.67
Kore RN, Martins FE 2022 [160]	11	55 (25-75)	NA	DOVG	26 (13-62)	0	11 (100%)	0	0	4 (1.9-6)	24 (14-31)	204 (158-260)	24 (10-40)
Total	75	43.8-60.6			8.5 -24.65		64 (85.3)	0	0	4-8. 23	16.64-27.6	113.2-204	20-90.31

DOVG =dorsal onlay ventral grafts; FU = follow-up; PVR = post-void residual.

Table S7.6: Vaginal Flap Urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedure	Stricture Free N/Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range) ml/s	Post Mean/Median Flow Rate (Range) ml/s	Pre/ Mean/Median PVR (Range) mls	Post Mean/Median PVR (Range) mls
Schwender 2006 [143]	8	Not specified	Dilatation 8 Urethrotomy 2	VIUVF	34	0	7 (88)	4 (50)	0	-	-	96.25(0-500)	3.75 (0-20)
Gormley 2010 [144]	12	Not specified	Dilatation 12 Urethrotomy 11	VIUVF	30	PVS 2	10 (83)	1	Rec UTI 2 (17)	-	-	112.5 (0-500ml)	27 (0-220)
Onol <i>et al.</i> 2011 [3]	17	46 (23-67) Complete series	Dilatation 5 Urethrotomy 3	VIUVF	34 (6-60)	0	12 (100)	0	Inward directed stream (2)	10.8 Complete series	28.9 Complete series	120 Complete series	30 Complete series
Blaivas <i>et al.</i> 2012 [4]	10	62 (32-91) Comple	Dilatation 17	VIUVF	52.7 (12-144)	PVS 5 MFPF 4	8 (80)	0	0	-	-	-	-

		te series				U Div 1							
Kowalik <i>et al.</i> 2014 [7]	6	50.8 (42-61)	Dilatation 6	VIUVF 5 IVF 1	41.83 (10-75)	1 PVS (IVF)	4 (67)	0	0	4.5	10.5	163	25
Romero-Maroto <i>et al.</i> 2018 [13]	9	56 (41-78)	Not specified	VILVF	80.7 (12-198)	0	9 (100)	0	0	6.8 (3-11)	21 (14-35)	-	-
Hajebrahimi <i>et al.</i> 2019 [147]	14	54.4 (35-75)	Dilatation in majority	VIUVF	16.2 (3-37)	0	14 (100)	4 (28.6)	0	4.6 (0-8.0)	15.8 (11.4-21.0)	195.8 (107->300)	27.4 (3-37)
Lane <i>et al.</i> 2020 [157]	68	56 (SD 12)	Dilatation 48 Urethroplasty 3	30 VIUVF 38 VILVF	12 (IQR 2,31)	Not specified	55 (81)	5 (7%) 44 (59%) Missing	10 (15)	-	-	-	-
Waterloos <i>et al.</i> 2025 [161]	17	52 (13)	6 – 1 dilatation or DVIU. 5 - > 1 dilatation or DVIU. 4 - > 1 dilatation or DVIU + urethroplasty	VOVF	10 (5-48).	2 MFPP	12 (73%)	1 (6.3)	0	-	-	-	-
Total	161	46-67.5			10-80.7		131 (81.4)	15 (9.3)	14 (8.7)	4.5-10.8	10.5-28.9	96.25-533	3.75-30

PVR = post-void residual; VILVF = ventral inlay lateral vaginal flap; VIUVF = ventral inlay U vaginal flap; IVF = island vaginal flap.

Table S7.7 Labial/ Vestibular Graft Urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedures	Stricture Free Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range)	Post Mean/Median Flow Rate (Range) ml/s	PreMean/Median PVR (Range) mls	Post Mean/Median PVR (Range) mls
Rehder <i>et al.</i> 2010 [14]	8	45 (28-67)	0	VLMG*	24	0	6 (75)	0	0	-	-	-	-
Simsek <i>et al.</i> 2021 [162]	13	48.2 (SD 7)	Not specified 2 SPC	DLMG	19 (SD 5.3)	0	13 (100)	1 (7.7)	0	7.5 (SD 1.1)	20.9 (SD 5)	141.9 (SD 44.2)	24.5 (SD 20.9)
Sahin <i>et al.</i> 2022 [163]	14	45 (36-55)	All urethral dilatation or urethrotomy	DLMaG	12	0	14 (100)	0	0	13	24	-	-
Tahra <i>et al.</i> 2022 [164]	22	55 (40-66)	16 DVIU or dilation	VLMG	37 (13-52)	0	20 (90.3)	UUI 8 (36.3%) Resolved by 6 months	0	4 (0-5)	27.5 (8-55)	52.5 (0-120)	20 (0-60)
Total	57	45-49.6			15-24		53 (93)		0	4-13	20.9-27.5	52.5-141.9	20-24.5

DLMG = Dorsal labial minora graft; FU = follow-up; PVR = post-void residual; VLMG = Ventral labial minora graft.

**Mislabelled by authors as Dorsal BUT is actually ventral with stricturotomy at 6 o'clock.*

Table S7.8: Labial/Vestibular Flap Urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedures	Stricture Free Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range) ml/s	Post Mean/Median Flow Rate (Range) ml/s	Pre Mean/Median PVR (Range) mls	Post Mean/Median PVR (Range) mls
Montorsi <i>et al.</i> 2002 [165]	17	41.2	0	DVF	12	0	15(88)	0	0	13.2	36	120	20
Tao <i>et al.</i> 2018 [12]	12	54 (37-83)	Not specified	DLM F	6-15	0	12 (100)	0	0	8.2 (4.7-13.4)	17.9 (11.3-22.4)	88.5 (15-390)	35.5 (0-89)
Total	29	41.2-54			6-15	0	27 (93)	0	0	8.2-13.2	17.9-36	88.5-120	20-35.5

DVF = Dorsal vestibular flap; FU = follow-up; PVR = post-void residual; VLMF = ventral labial minora flap.

Table S7.9: Dorsal Onlay Buccal/Lingual Graft Urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedures	Stricture Free Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range)	Post Mean/Median Flow Rate (Range)	Pre Mean/Median PVR (Range) mls	Post Mean/Median PVR (Range) mls
Sharma <i>et al.</i> 2010 [2]	15	42 (25-65)	Dilatation or Urethrotomy 15	DOLMG	12		14 (93)	0	1 (7)	7.2	26.86		
Hampson <i>et al.</i> 2019	39	50 (29-81)	Dilatation 87% DVIU 21% ISD 18% Urethroplasty 5%	DOBMG	33 (7-106)	1 (anti-stress urinary incontinence surgery)	30 (77)	0	7 (18) All UTI	10.2	22.0 (N=23 /mean FU 15.1 m)	157.6	74.0 (mean FU 13.2m)
Lane <i>et al.</i> 2020	67		Dilatation 54 (80%) Urethroplasty 5 (7%)	DOBMG	14 (IQR 4,41)	5 (7%) 1 anti-incontinence Other not specified	46 (69)	3 (4) 22 (33) - missing	12 (18)	-	-	-	-
Katiyar <i>et al.</i> 2021*	12	45	Not specified	DOBMG	6	0	11 (92)	0	0	7.4	18.8	101	28.2

		(27-68)											
Kore and Martins 2022	21	45 (25-75)	3 SPC Nil other detail	DOBMG	26 (13-62)	0	19 (90.5)	0	2 UTI (5)	4 (0-10)	28 (17-46)	166 (100-250)	10 (0-25)
Khawaja <i>et al.</i> 2022	25	46 (26-66)	Not specified	DOBMG	25.5 +/- 31.82	0	23 (92)	0	0	5	23.3	178	18.5
Higgins <i>et al.</i> 2023	23	50 (34-84)	20 (87%) median 3 dilatation (1-20) ISD 9 (39%)	DOBMG	12.2 (1-81)	0	19 (83)	2 (8.7)	0	10.8 (2 - 18.2)	15.9 (6.6-26)	-	-
Prabhuswamy <i>et al.</i> 2024	37	47.8 (SD 11.3)	20 dilatation. 3 SPC	DOBMG	30.2 (SD 18.3, range 18-44)	0	33 (89.2)	0	0	7.79 (SD 3.73)	23.2 (SD 8.25)	139 (SD 147.24)	30.5 (SD 10.7)
Gaur <i>et al.</i> 2024	27	45 (37-52)	3 >=1 dilatation 5 urethroplasty	DOBMG	14 (7-17)	0	24 (88.9)	0	0	6 (3.8-10)	25 (22-29)	156 (82-349)	21 (12 - 27)
Mandal <i>et al.</i> 2025*	20	42 (36.5-51)	8 urethral dilatation	DOBMG	>12	0	19 (95)	0	0	5.7 (IQR 3.8-7.95)	26 (IQR 24-30.75)	132.5 (IQR 85-210)	11 (IQR 4-19.75)
Waterloos <i>et al.</i> 2025	33	54 (12)	12 -1 urethrotomy or dilatation 11 - > 1 dilatation or DVIU 7 - > 1 urethrotomy or dilatation + urethroplasty	DOOMG	20 (15-53)	0	26 (80)	2 (6.3)	0	-	-	-	-
Total	319	42-55			6-33	2 anti-SUI procedures	264 (83)	7 (2.2)	22 (7)	5.0-10.8	15.9-28	101-178	10-74

*PRT DOBMG v VOBMG

DOBMG = dorsal onlay buccal mucosa graft; FU = follow-up ; PVR = post-void residual.

Table S7.10: Ventral Onlay Buccal/Lingual Graft Urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedures	Stricture Free Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range) ml/s	Post Mean/Median Flow Rate (Range) ml/s	Pre Mean/Median PVR (Range) ml/s	Post Mean/Median PVR (Range) ml/s
Mukhtar <i>et al.</i> 2017 [11]	22	50 (34-72)	Dilatation 22	VOBMG	21.5 (6-51)	MFP 22	21 (95.5)	0	0	7 (3.5 - 11.2)	18 (5-37)	100 (0-300)	15 (0-150)
Gulpinar <i>et al.</i> 2021 [166]	36	56.1 (29-74)	Dilatation 35 Urethroplasty	VOBMG 28 VIBMG 8	24.5 (6-54)	0	33 (92)	0	5	6.9 (3-9)	25 (14-32)	123.7 (30-228)	17.7-28.5 (0-71)
Katiyar <i>et al.</i> 2021** [167]	12	45 (27-68)	Not specified	VOBMG	6	0	11 (92)	0	0	6.8	19.8	100	23.2
Berdondini <i>et al.</i> 2024 [168]	42	53.6 +/- 12.8	U Dil 42 DVIU 2 urethroplasty	VIBMG	38.1 +/- 14.9	0	41 (98)	0	0	7.7 +/- 3.2	25.9 +/- 5.9	107.5 +/- 40.7	9.1 +/- 13
Waterloos <i>et al.</i> 2025 [161]	115	51 (11)	12 – 1 dilatation or DVIU 60 - > 1 dilatation/DVIU 21 - > 1 dilatation or DVIU + urethroplasty	VOOMG	30 (14-48)	MFP in 102 (89)	99 (86)	8 (7)	0	x	x	x	x

Mandal <i>et al.</i> 2025** [169]	20	48.5 (38-52)		VIBMG	>12m	0	19 (95)	0	0	7.8 (5.3-10.25)	28 (25.25-32)	144 (84 - 236)	8.5 (4.25-14)
Total	247	45-56.1			6-38.1		224 (90.7)	8 (3.2)	5 (2)	6.8-7.8	18- 28	100-144	8.5-23.2

FU = follow-up ; PVR = post-void residual; VOBMG =ventral onlay buccal mucosa graft.

**PRT VOBMG versus DOBMG

Table S7.11: Circumferential Buccal Mucosal Graft Urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedures	Stricture Free Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range) ml/s	Post Mean/Median Flow Rate (Range) ml/s	Pre Mean/Median PVR (Range) mls	Post Mean/Median PVR (Range) mls
Onol <i>et al.</i> 2011 [3]	2	46 (23-67)	Dilatation 2	Circumferential BMG 2 Results for whole series	21(6-36)	MFP 2	2 (100)	0	0	10.8	28.9	120	30

BMG = buccal mucosa grafts; FU = follow-up; PVR = post-void residual.

Table S7.12: Anastomotic urethroplasty

Paper	Number patients	Mean/median Age (Range) years	Previous Surgery	Technique	Mean/Median FU (Range) months	Concomitant Procedures	Stricture Free Rate (%)	Urinary Incontinence Rate (%)	Acute Complications Detail/N (%)	Pre Mean/Median Flow Rate (Range)	Post Mean/Median Flow Rate (Range)	Pre Mean/Median PVR (Range) mls	Post Mean/Median PVR (Range) mls
Onol <i>et al.</i> 2011 [3]	1	46 (series mean)	Unknown	Proximal dilated ureter used for AU	24 (series mean)	0	1 (100)	0	0	-	-	-	-
Patil <i>et al.</i> 2013 [151]	1	35	Dilatation Multiple SPC	AU	4	0	1 (100)	0	0	0	18	-	15

FU = follow-up; PVR = post-void residual; AU= Anastomotic urethroplasty; SPC = Suprapubic catheter.

9. TISSUE TRANSFER

Table S9.1: Comparative studies of grafts vs. flaps used in urethroplasty for anterior urethral strictures

Study	Type of study	LS	Follow-up (months)	Flap		Graft		p-value*
				Type	Urethral patency	type	Urethral patency	
Barbagli <i>et al.</i> [50]	Retrospective	Excl.	55	LIF	12/18 (67%)	OMG/PSG	36/45 (80%)	0.32
Dubey <i>et al.</i> [170]	RCT	Excl.	22-24	LIF	22/26 (84.6%)	BMG	24/27 (88.9%)	0.70
Fu <i>et al.</i> [53]	Retrospective	Excl.	>12	All types	166/199 (83.4%)	LMG	80/94 (85.1%)	0.71
Hussein <i>et al.</i> [171]	RCT	Excl.	36	TIF	15/19 (78.9%)	PSG	13/18 (72.2%)	0.25
Lumen <i>et al.</i> [59]	Retrospective	NR	42-43	All types	23/29 (79.3%)	OMG/PSG	63/75 (84%)	0.57
Sa <i>et al.</i> [172]	Retrospective	Excl.	28 (18-60)	TIF	28/34 (82.3%)	BMG	67/82 (81.7%)	0.851

BMG = buccal mucosa graft; Excl. = excluded; LIF = longitudinal island flap; LMG = lingual mucosa graft; LS = lichen sclerosus; mo = months; NR = not reported; OMG = oral mucosa graft; PSG = penile skin graft; TIF = transverse island flap; RCT = randomised controlled trial.

* if not reported: recalculated by EAU Urethral Strictures Panel with χ^2 -statistics.

Table S9.2: Outcome of case series evaluating genital skin flaps

Study	Type	N	Follow-up (months)	stricture length (cm)	LS	Urethral patency (%)	Complications				
							Skin necrosis (%)	Fistula (%)	Penile deformity (%)	Postvoid dribbling (%)	Sacculation (%)
El Dahshoury [173]	Transverse distal penile (zigzag modification)	30	24	18 (15-20)	excl.	85.8	3.3	3.3	6.7	6.7	6.7
Mostafa <i>et al.</i> [174]	Ventral longitudinal (twin modification)	43	31 (22-36)	17.5 (14-21)	excl.	95.4	NR	7	7	79	16.5
Olajide <i>et al.</i> [175]	Transverse distal penile	55	12-60	4.9 (2.5-14)	NR	98.2	3.6	5.5	NR	0	5.5
Onol <i>et al.</i> [47]	Transverse distal penile	26	30(4-96)	<1.5 (0.6-1.4)	NR	100	3.8	3.8	0	0	0
Schwentner <i>et al.</i> [176]	Transverse distal penile	36	97 (86-117)	5.9 (3-12)	excl.	97.2	0	0	5.6	25	NR
Whitson <i>et al.</i> [177]	Transverse distal penile	124	88 (1-234)	8.2 (0.5-24)	excl.	74.2	3.2	NR	NR	NR	0.8
Fu <i>et al.</i> [53]	Ventral longitudinal	155	>12	NR	excl.	87.7	NR	NR	NR	NR	NR
	scrotal	29	>12	NR	excl.	69	NR	NR	NR	NR	NR
	perineal	15	>12	NR	excl.	66.7	NR	NR	NR	NR	NR

Excl. = excluded; LS = Lichen Sclerosus; NR = not reported.

Table S9.3: Effect of non-closure compared to closure on oral morbidity after buccal mucosa harvesting

Study	Early oral pain	Eating/drinking problems	Altered taste	Altered salivation	Oral tightness	Perioral numbness	Oral bleeding	Slurred speech
Soave <i>et al.</i> [178]	=	=	=	=	=	=	=	=
Rourke <i>et al.</i> [179]	=	↓	NR	NR	↓	↓	=	NR
Muruganandam <i>et al.</i> [180]	↓	=	NR	=	=	=	=	NR
Wong <i>et al.</i> [181]	=	↑	NR	NR	=	=	=	NR
Lumen <i>et al.</i> [182]	↑	NR	NR	NR	NR	NR	NR	NR

↓ = less morbidity with non-closure; ↑ = more morbidity with non-closure; = = no significant difference; NR = not reported.

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