Review Article

Pelvic fracture urethral injury in males—mechanisms of injury, management options and outcomes

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Abstract: Pelvic fracture urethral injury (PFUI) management in male adults and children is controversial. The jury is still out on the best way to manage these injuries in the short and long-term to minimise complications and optimise outcomes. There is also little in the urological literature about pelvic fractures themselves, their causes, grading systems, associated injuries and the mechanism of PFUI. A review of pelvic fracture and male PFUI literature since 1757 was performed to determine pelvic fracture classification, associated injuries and, PFUI classification and management. The outcomes of; suprapubic catheter (SPC) insertion alone, primary open surgical repair (POSR), delayed primary open surgical repair (DPOSR), primary open realignment (POR), primary endoscopic realignment (PER), delayed endoscopic treatment (DET) and delayed urethroplasty (DU) in male adults and children in all major series have been reviewed and collated for rates of restricture (RS), erectile dysfunction (ED) and urinary incontinence (UI). For SPC, POSR, DPOSR, POR, PER, DET and DU; (I) mean RS rate was 97.9%, 53.9%, 18%, 58.3%, 62.0%, 80.2%, 14.4%; (II) mean ED rate was 25.6%, 22.5%, 71%, 37.2%, 23.6%, 31.9% ,12.7%; (III) mean UI rate was 6.7%, 13.6%, 0%, 14.5%, 4.1%, 4.1%, 6.8%; (IV) mean FU in months was 46.3, 29.4, 12, 61, 31.4, 31.8, 54.9. For males with PFUI restricture and new onset ED is lowest following DU whilst UI is lowest following DPOSR. On balance DU offers the best overall outcomes and should be the treatment of choice for PFUI.

Keywords: Pelvic fracture; urethral injury; classification; treatment; outcomes

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Introduction

Pelvic fracture urethral injury (PFUI) management is a source of significant debate. Primary surgical repair (1-4), delayed primary repair (5), primary open realignment (POR) (6-10), primary endoscopic realignment (PER) (11-19), suprapubic cystostomy with delayed endoscopic management (20-22) or delayed urethroplasty (DU) (23-28) all have their advocates. We present a contemporary review of PFUI analysing all literature since 1757 with particular reference to the long-term incidence of recurrent strictures (RS), erectile dysfunction (ED) and urinary incontinence (UI). The current orthopaedic classification of pelvic fracture is also detailed to provide clarity on the subject (29-32).

Pelvic fracture classification

The three commonly used orthopaedic pelvic fracture classifications are: Young-Burgess (29), Tile (30) and AO/OTA (31). They all stem from the 1990 Young-Burgess classification system (29,32). This system is based upon mechanism of injury and associated injuries. There are 4 major categories; 2 of which have subdivisions according to severity (*Table 1*) (*Figure 1*).

(I) Lateral compression (LC): These are implosion injuries from lateral impact to the innominate bone. The pelvis on the side of the impact rotates toward the midline. The anterior pelvic ligaments are shortened. The anterior pattern of LC fracture may be unilateral, contralateral or bilateral involving one or more sets of pubic rami, one set of which will always have a transverse fracture. It is the extent of the posterior pathology that differentiates the subsets. LC fractures tend to close the pelvic cavity and death, if it occurs, is due to associated non-pelvic injuries (33).

(II) Anteroposterior compression (APC): All have pubic symphysis diastasis or anterior vertical fracture of the rami. There is no cephalad shift of the hemi-pelvis. Again, it is the extent of the posterior pathology that defines the subsets. APC fractures tend to open up the pelvic cavity and death, if it occurs, is most commonly secondary to bleeding and its complications (33).

(III) Vertical shear (VS): a symphyseal diastasis or a vertical fracture pattern of the rami occurs anteriorly. VS fractures are distinguished by vertical displacement of the hemi-pelvis and are more likely to be unstable (33).

(IV) Mixed (CM): A combination of fracture patterns and grades (33).

The incidence of pelvic fracture is approximately 20/100 000 for men and 29/100 000 for women. 50% of women have uncomplicated pubic rami fractures (34,35). The majority (90%) of patients with pelvic fractures have associated injuries (36-38). The male to female ratio is 2:1 for young adults, falling to 1:3 for the over 50's. They mainly occur in the first 4 decades of life (modal age 31–33 years) (3,34,39,40). The commonest cause is motor vehicle accidents with motorist(s) affected in 54–71% and pedestrians in 12–18%. Falls and crush injuries constitute the majority of the remainder (29,38,39,41,42).

Mortality, associated injuries and resuscitation requirements may be predicted by the Young-Burgess classification (29,32,43). The most frequently occurring pelvic fracture categories are: LC1 (48.8%), APCII (11.1%), VS (5.6%) and CM (6.8%) (29,32). Orthopaedic management of unstable injuries comprises external and/or internal pelvic fixation to control fracture related bleeding, immobilise the fracture, reduce pain and facilitate mobilisation and rehabilitation (44,45). Stable fractures are generally treated similarly to facilitate recovery (46,47).

Injuries associated with pelvic fractures

Pelvic fractures resulting in PFUI are high impact injuries with mortality rates between 5–33% (4,29,32,36,45,48-53). Other associated injuries are common and include: intracranial (40–66.1%), splenic (9.3–37%), colorectal (6.8–29.1%), bladder (2.5–28%), chest (6–16.6%), liver (5.6–19%), lower limb fracture(s) (17%), pulmonary (9.3%), upper limb fracture(s) (3%) and diaphragmatic rupture (3–21%) (4,32,33,39,52,54-58). Initial medical management should concentrate on resuscitating and stabilising the patient, and then on identifying all associated injuries.

Urethral injuries associated with pelvic fractures

PFUI occurs in 1.6% to 25% of pelvic fractures; giving a frequency of 0.32–5/100,000 for men and 0.46–7.25/100,000 for women (4,41,52,54,55,59-72). Straddle fractures (fractures of all 4 pubic rami) with or without distraction of the sacro-iliac joint, fractures of the inferior pubic ramus with a widened pubic symphysis and Malgaigne fractures [double pelvic ring break fracture dislocations (73)] are most commonly associated with PFUI (39,41,59,67,73-75). Combined urethral and bladder injury occur in 1–33% of patients (16,54,59,63,73,76,77). Bladder injury is more commonly extra-peritoneal (56–85%) than intra-peritoneal (17–39%) but can be both (63,72,77-80).

Early theories on the mechanism of PFUI postulated a horizontal or shearing force through the membranous urethra at the point where it was fixed by the urogenital diaphragm (54,65,66,81). More recently the concept of a urogenital diaphragm has been rejected and it is suggested that PFUI is caused by an avulsion of the membranous urethra from the bulbar urethra at the point where they meet at the perineal membrane (24,82,83). The original term "Pelvic Fracture Urethral Distraction Defect" has duly been amended to PFUI. It was also previously thought to be a complete defect of the urethra but is now known to be a partial or complete disruption of the urethra; hence the change of terminology (84,85). The relative frequency of partial and complete disruption varies in most series from 11–90% for partial and 6–100% for complete (24,25,54,64,69,80,86-90). These wide variations may be due to variability in the use of urethrography for diagnosis and the limitations of subsequent interpretation.

Table 1 Young-Burgess pelvic fracture classification

Young-Burgess classification	Type of fracture	Associated injuries
Lateral compression		
Type I	Force is directed posteriorly Sacral crush and ipsilateral horizontal pubic rami fracture Stable	Minimal problems with resuscitation
Type II	Force is directed anteriorly Horizontal pubic rami fractures, anterior sacral crush and disruption of either the posterior sacro-iliac joints or fractures through the iliac wing Ipsilateral injury Vertical stability is maintained	Often associated head and intra-abdominal injuries
Type IIII	Force is anteriorly directed and continued across the pelvis Type I or II ipsilateral fracture and an external rotation component to the contralateral hemi-pelvis opening the sacro-iliac joint posteriorly and disrupting the sacrotuberous and spinous ligaments	Often associated head and intra-abdominal injuries
Anteroposterior compression		
Type I	Force is antero-posteriorly directed <2.5 cm diastasis Vertical fracture of 1 or both pubic rami Or disruption of symphysis, opening the pelvis Posterior ligaments are intact Stable	Minimal problems with resuscitation
Type II	Continuation of type I with disruption of posterior ligaments >2.5 cm diastasis Opening of sacroiliac joints Vertical stable Rotational instability	Minimal problems with resuscitation
Type III	Complete disruption anteriorly and posteriorly	Brain, abdominal, visceral, pelvic vascular
	Significant sacral diastasis or displacement of vertical pelvic rami fracture Completely unstable or vertical instability	Increased risk of shock, sepsis and ARDS
Vertical shear	Force is directed vertically or at right angles to support structures of pelvis Vertical fractures of all rami and disruption of all ligaments Completely unstable and rotationally unstable	Often associated head and intra-abdominal injuries
Combined mechanism of injury	Any combination of the above Unstable injury	–

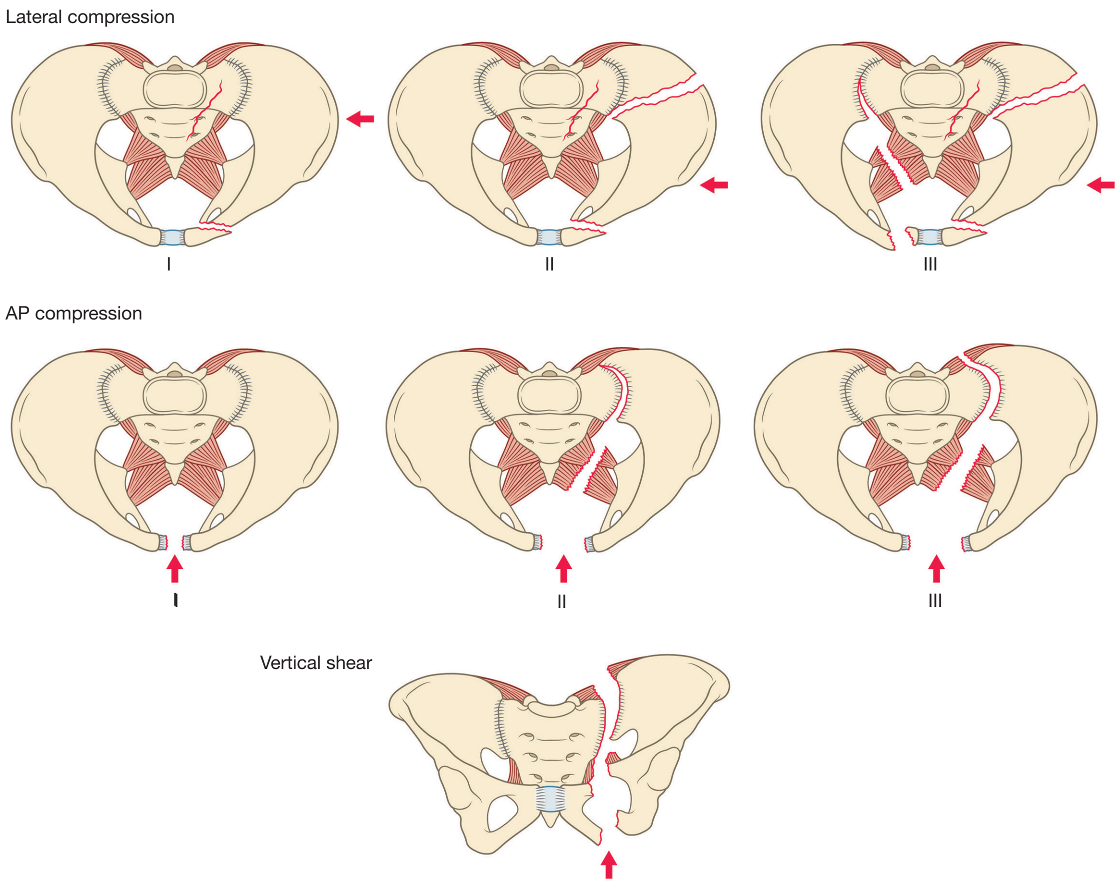

Figure 1 Young-Burgess pelvic fracture classification. LC, lateral compression; APC, anteroposterior compression; VS, vertical shear.

The usual result of complete PFUI is traumatic disruption of urethral continuity at the bulbomembranous junction with little or no loss of urethral length, variable displacement of the two ends of the urethra and some degree of damage in many instances to the urethral sphincter (91). Unusual injuries include: longitudinal tears through the bladder base and neck down into the prostatic or bulbar urethra; avulsion of the anterior prostate and/or transection above and below the prostate. Injuries to the bladder neck and prostatic urethra are seen more commonly in children (39,92-94). The presence of concomitant bladder neck or rectal injury dictate immediate laparotomy and primary repair ± defunctioning colostomy (80). Women with PFUI mainly suffer anterior longitudinal tearing of the urethra resulting in UI rather than urethral stricture (95,96).

Historical considerations

PFUI was uniformly fatal due to urinary outflow obstruction, extravasation, secondary sepsis and uraemia until Verguin determined how to perform suprapubic cystostomy with antegrade-retrograde railroading of a perineal catheter into the bladder in 1757 (97). Survival was ad hoc for the next 150 years until management of associated injuries and imaging improved—such that mortality dropped from close to 100% in 1757 to 78% in 1907 and 23% in 1942 (98).

Initial assessment

In the acute situation, management of PFUI should wait until the patient is stable, as 90–97% of patients will have associated injuries (38,99,100). A urethral injury should be suspected if one or more of the following are noted: blood at the meatus (present in 37–93%, this may take at least 1 hour to appear), difficulty or inability to void, a palpable bladder, a high riding prostate (often unreliable due to the presence of fracture haematoma) or a pelvic fracture with displacement of pubic

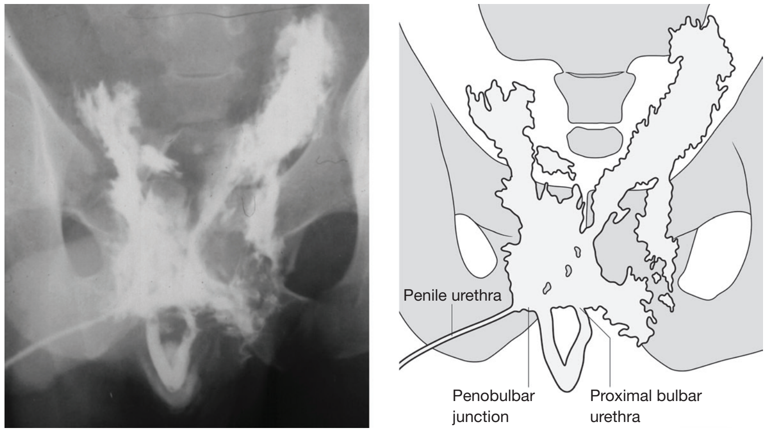

Figure 2 Complete PFUI. PFUI, pelvic fracture urethral injury.

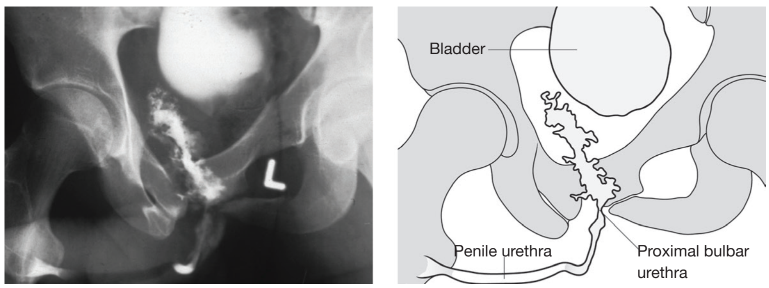

Figure 3 Partial PFUI. PFUI, pelvic fracture urethral injury.

rami. Butterfly bruising of the perineum due to haematoma confined to Colles fascia is a late finding and indicates rupture of the perineal membrane (64,66,67,101,102). Classical findings may be absent in 29–76% and a high index of suspicion should be maintained (60,103).

At this stage one gentle attempt at urethral catheterisation is reasonable, even if blood is seen at the meatus (16,54,67,104). The fear that urethral catheterisation may convert a partial tear into a complete tear (24,54,61,105) does not seem realistic, especially as a urethral catheter passes easily into the bladder in 50% of patients with partial injuries (62,106). If the catheter does not pass with ease or does not drain clear urine it should be removed immediately (107).

Early diagnosis of PFUI and prompt urinary diversion will prevent infection of extravasated blood and urine, which can lead to abscess formation. This may extend along fascial planes and across anatomical compartmental barriers into the abdomen, chest, perineum and medial thighs. This can result in urethrocutaneous fistula, peri-urethral diverticula, necrotising fasciitis and even death (9,10,102,108). If urethral catheterisation fails, a suprapubic catheter (SPC) should be inserted using ultrasound guidance or via open cystostomy (109).

In a stable patient urethrography (retrograde and/or antegrade) is the gold standard to diagnose urethral trauma. This is usually performed with 20–30 mL of water-soluble contrast media using an aseptic technique with intravenous antibiotic prophylaxis to prevent contamination of fracture haematoma. The best images are obtained with the patient in a 30o oblique position (16,66,110,111). Extravasation of contrast from the urethra without filling of the bladder is interpreted as a complete disruption (*Figure 2*), whilst extravasation of contrast from the urethra with partial filling of the bladder is interpreted as a partial disruption (*Figure 3*) (104,112,113). It is not possible to differentiate a complete from a partial disruption on urethrography in all patients, as some patients with a partial tear may have concomitant sphincter spasm preventing passage of contrast into the bladder (12,90). There is a tendency to over-diagnose complete rupture on urethrography alone. Other imaging modalities have been investigated especially prior to elective delayed repair including CT and MRI (114,115). Contrast MRI urethrography is the most promising as it shows 3D urethral anatomy and allows for advanced preoperative planning (116).

A variety of classification systems have been proposed for PFUI based on urethrographic findings (81,94,117-120). The difficulties in differentiating partial from complete disruption on urethrography prevent accurate utilisation of these classifications. The EAU classification is the most commonly used and is generic for all urethral trauma not just PFUI (119).

Management of PFUI

This remains controversial due to the paucity of comparative studies and because there is little long-term follow-up for many of the treatments. Late stricture recurrence (>10 years post treatment) and new stricture formation also occur, to confuse the issue (121).

Management options can be divided into primary versus delayed repair techniques. Both primary and delayed techniques include a range of options including; open or endoscopic repair or realignment and urethroplasty.

Primary surgical (open) repair

Young originally described primary anastomotic repair of PFUI in 1929 (1). The rationale was to evacuate the pelvic haematoma and produce a watertight repair of the urethra thus preventing urine extravasation and subsequent infection and death, which were otherwise inevitable (1,122,123).

This approach has high complication rates with RS in @54% (0–100%), ED in @23% (range, 0–100%) and UI in @14% (range, 0–50%) (1,2,4,36,61,62,80,92,124-137) (*Table 2*). It is associated with significant intra-operative blood loss (>3 L on average) and prolonged hospital stay (>28 days on average). It is now rarely used unless there is a simultaneous bladder neck or rectal injury requiring definitive reconstruction or diverting sigmoid colostomy (1,4,73,80,126,138).

Delayed acute primary repair

Originally described by Mundy in 1991 for the "pie in the sky" bladder (*Figure 4*) (5). The principle was that with a severe urethral injury, recovery was likely to be slow and the net result of conservative treatment would be a long stricture making subsequent surgery difficult and its success limited. Bulboprostatic anastomosis was performed 7–10 days after the injury to evacuate the haematoma and bring the ends of the urethral together at a time after acute bleeding had stopped and the patient was stable from their other injuries.

The aim was not to prevent a stricture but to ensure that should a stricture develop it would be easily treatable. 17 patients were reported in this series; with RS in 18%, ED in 71% and UI in 0% at 12 months (5) (*Table 3*). Whether success is attributable to the repair of the urethra or drainage of the haematoma accelerating recovery and decreasing fibrosis is unknown (28). The relatively high ED rate could be attributed to the severity of the injury rather than the repair. To date no other series on this technique have been published.

Primary open realignment (POR)

First reported by Ormond and Cothran in 1934 (3,6) as an easier alternative to Young's primary open repair, POR became popular because of its ease. Primary realignment after open cystostomy can be achieved in a number of ways: retrograde catheter placement under direct vision, sound to sound, sound to finger and combined antegrade-catheter guided retrograde catheter placement (7,8,107). Originally, traction was applied to the urethral catheter to encourage realignment (7), however ischaemic damage to the bladder neck sphincter mechanism secondary to pressure from the catheter balloon resulted in UI in some (82). Alternative techniques trialled include transprostatic Vest sutures (9,10,139) and traction-free open realignment (8,93,140). Depending on the technique used varying degrees of peri-urethral mobilisation occurs. Following all methods of POR the urethral catheter remains in-situ for 4–8 weeks prior to urethrogram and trial of void if healed (8).

POR does not actually produce anatomical realignment of the urethra; at best it re-establishes urethral continuity. Actual 3-dimensional urethral realignment requires fluoroscopic guidance to keep the proximal and distal urethra in the same cephalocaudal axis (15) and is rarely achieved. Other disadvantages of POR are increased blood loss and the potential to worsen the urethral injury. There are concerns that this technique may increase the incidence of ED and UI (80,141), although recent studies have shown similar ED and UI rates to those of DU (8,140).

Table 2 Outcomes of primary open repair

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter Time	Comments
Young 1929 (1)	1	23 y	Ua	0 (0/1)	100 (1/1)	0 (0/1)	Ua	1st Report AP BPA
Kishev 1964 (124)	3	Ua	≥12 m	0 (0/3)	0 (0/3)	0 (0/3)	Ua	AP BPA
Ragde 1969 (125)	8	Ua	(25 d–4 m)	0 (0/8)	Ua	Ua	10–18 d	Vietnamese war victims A BPA
Pierce 1972 (126)	4	Ua	Ua	50 (2/4)	Ua	Ua	Ua	A BPA
Janosz 1975 (2)	34	Ua	Ua	50 (17/34)	Ua	Ua	Ua	A BPA
Coffield 1977 (61)	9	Ua	Ua	77 (7/9)	33 (3/9)	22 (2/9)	–	A BPA
Glass 1978 (62)	71	Ua	Ua	93 (66/71)	Ua	Ua	Ua	A BPA
Cass 1978 (135)	3	(<20 y – >60 y)	14 m (1–87 m)	100 (3/3)	50 (1/2)	0 (0/2)	Ua	A BPA
Weems 1979 (127)	9	Ua	Ua	78 (7/9)	33 (3/9)	22 (2/9)	Ua	A BPA
Muhlbauer 1980 (128)	1	25y	12 m	0 (0/1)	0 (0/1)	0 (0/1)	3 m	A BPA
Webster 1983 (80)	4	Ua	(8 m –17 y)	75 (3/4)	50 (2/4)	50 (2/4)	Ua	A BPA
Cass 1984 (36)	4	Ua	Ua	75 (3/4)	50 (1/2)	0 (0/2)	Ua	A BPA
Reinberg 1989 (136)	6	9.5 y (3–17 y)	27.9 m	17 (1/6)	Ua	Ua	Ua	A BPA
Zingg 1990 (129)	13	Ua	Ua	38 (5/13)	Ua	Ua	Ua	
Tryfanos 1990 (137)	6	8.25 y (3.5–12 y)	4.45 y (6 m –8 y)	67 (4/6)	20 (1/5)	0 (0/6)	2 w	Suprapubic BPA
Boone 1992 (92)	8	(children)	(>15 y)	75 (6/8)	75 (6/8)	25 (2/8)	Ua	>2 L blood loss; all UI had BN injury
Gadhvi 1993 (130)	16	32.5 y (22–43 y)	12.4 m (7–14 m)	12.5 (2/16)	6.25 (1/16)	0 (0/16)	2 w	Lateral perineal BPA
Koraitim 1996 (131)	4	Ua	Ua	50 (2/4)	50 (2/4)	0 (0/4)	Ua	A BPA
Podesta 1997 (4)	6	Ua	(3–17 y)	67 (4/6)	Ua	50 (3/6)	Ua	BPA
Upadhyaya 2002 (132)	5 boys	(18 m –11 y)	(6 m –10 y)	40 (2/5)	0 (0/4)	0 (0/4)	3 w	Transpubic BPA
Onen 2005 (133)	8	(4–17 y)	Ua	25 (2/8)	12.5 (1/8)	12.5 (1/8)	Ua	BPA
Qu 2014 (134)	35 boys	Ua	58 m (6–192 m)	9 (3/35)	8.6 (3/35)	11.9 (4/35)	Ua	Perineal BPA

Ua, un-assessed; A BPA, abdominal bulbo-prostatic anastomotic urethroplasty; AP BPA, abdomino-perineal bulbo-prostatic anastomotic urethroplasty.

The RS rate following POR is @58% (8.5–100%) (7,25,62,129,132, 142-162), the ED rate is @37% (0–79.5%) and the UI rate is @15% (0–44%) (2,8,20,25,36,92,104,107, 131,133,135,140) (*Table 4*).

Primary endoscopic realignment (PER)

PER includes: antegrade or retrograde catheter insertion over a guidewire at flexible cystoscopy and rendezvous procedures for catheter insertion over a guidewire (11-13,163). Most rendezvous procedures involve passing a ureteric catheter or guidewire antegradely via a suprapubic tract through the lumen of a Goodwin sound or cystoscope so it can be retrieved by a cystoscope in the distal urethra. This catheter is used as a guide to pass a Foley catheter retrogradely into the bladder (11,15,17,18,163-166).

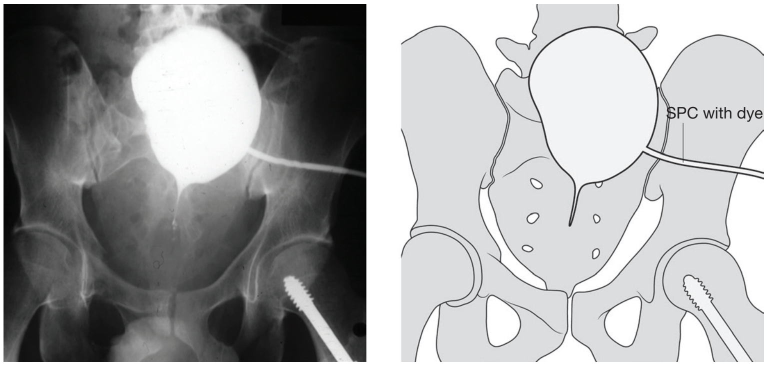

Figure 4 Pie in the sky bladder.

Table 3 Outcome of delayed primary open repair

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Comments
Mundy 1991 (5)	17	(16–42 y)	≥12 m	18 (3/17)	71 (12/17)	0 (0/17)	4–5 w	A BPA

Table 4 Outcomes of primary open realignment

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Comments
Myers 1972 (151)	22	7–71 y	≥18 m	59 (13/22)	Ua	Ua	4–6 w	Urethral traction
Jackson 1974 (152)	63 (27 FU)	32.3 y (15–65 y)	Ua	74 (20/27)	46 (23/50)	Ua	Ua	Railroading
Gibson 1974 (149)	44	37 y (13–72 y)	6 y (3–12 y)	73 (32/44)	32 (14/44)	Ua	3–4 w	–
Janknegt 1975 (153)	7	Ua	Ua	0 (0/3)	Ua	Ua	Ua	Prostatic vest suture traction
Janosz 1975 (2)	34	38 y (13–69 y)	5 y (96 m –12 y)	44 (15/34)	62 (21/34)	Ua	Ua	–
Crassweller 1977 (161)	38	Ua	(6 m –10 y)	100 (38/38)	Ua	Ua	Ua	100% required dilation
De Weerd 1977 (7)	28 (22 FU)	(7–71 y)	(>18 m)	100 (22/22)	Ua	10 (2/20)	5 w	100% periodic sounding
Malek 1977 (162)	7	(6–15 y)	14 y (8–22 y)	57 (4/7)	0 (0/7)	0 (0/7)	Ua	Functionally significant stricture
Glass 1978 (62)	8	Ua	Ua	50 (4/8)	Ua	Ua	Ua	–
Guba 1978 (154)	2	Ua	Ua	0 (0/2)	Ua	0 (0/2)	Ua	–
Islam 1978 (155)	3	45.5 y (19–61 y)	4.3 y (4–6 y)	100 (3/3)	0 (0/3)	0 (0/3)	Ua	–
Cass 1978 (135)	35 (16 FU)	(<20– >60 y)	14 m (1–87 m)	62 (11/16)	38 (3/7)	21 (3/14)	Ua	Railroading

Table 4 (*continued*)

Table 4 (*continued*)

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Comments
Morehouse Mackinnon 1980 (25)	54	Ua	Ua	100 (54/54)	43 (23/54)	44 (24/54)	Ua	–
Patterson 1983 (156)	34 (29 FU)	(68–72 y)	Ua	38 (11/29)	15 (4/27)	3 (1/29)	Ua	Functionally significant stricture
Al-Ali 1983 (159)	16 (14 FU)	Ua	(6 w –6 y)	36 (5/14)	40 (2/5)	14 (2/14)	2 w	0nly 5>12 m
Cass 1984 (36)	24 (14 FU)	Ua	Ua	79 (11/14)	75 (6/8)	11 (1/9)	Ua	–
Fowler 1986 (157)	12	45 y (18–83 y)	4 y (1–10 y)	100 (12/12)	17 (2/12)	17 (2/12)	2–8 w	Traction 100% bougiage
Murshidi 1988 (158)	3	30.7 y (20–33 y)	1.7 y (1–2 y)	100 (3/3)	Ua	Ua	4 w	All DIU
Morehouse 1988 (104)	128	Ua	Ua	11 (14/128)	38 (33/87)	23 (21/92)	Ua	–
Zingg 1990 (129)	21 (20 FU)	Ua	Ua	60 (12/20)	Ua	Ua	Ua	–
Husmann 1990 (143)	17	Ua	Ua	94 (16/17)	65 (11/17)	12 (2/17)	Ua	–
Follis 1992 (8)	20	28 y (4–65 y)	42 m (1–360 m)	15 (3/20)	20 (4/20)	0 (0/20)	Ua	10% significant haemorrhage
Boone 1992 (92)	7	(children)	(>15 y)	43 (3/7)	14 (1/7)	0 (0/7)	Ua	High blood loss
El-Abd 1995 (20)	44	Ua	24 m	100 (44/44)	79.5 (35/44)	2 (1/44)	Ua	Railroading
Koraitim 1996 (131)	23	Ua	Ua	56 (12/23)	28 (5/18)	4 (1/23)	Ua	Sounds
Routt 1996 (150)	9	Ua	Ua	44 (4/9)	16.7 (1/6)	Ua	Ua	–
Kotkin 1996 (140)	20	Ua	51 m (13–115 m)	50 (9/18)	24 (4/18)	17 (3/18)	4–8 w	Railroading 3 bladder stones
Elliott, Barrett 1997 (107)	53	31 y	10.5 y	66 (35/53)	21 (11/53)	3.7 (2/53)	Ua	Railroading
Asci 1999 (144)	12	Ua	39 m	45 (5/12)	20 (2/10)	10 (1/10)	Ua	–
Khan 2000 (160)	32	28 y (3–81 y)	6.5 y (9 m –46 y)	78 (25/32)	27 (8/30)	6 (2/32)	6–8 w	Railroad
Upadhyaya 2002 (132)	4	(18 m –10 y)	(6 m –10 y)	75 (3/4)	Ua	Ua	Ua	–
Balkan 2005 (148)	12	7.4 y (5–10 y)	4.92±2.36 y	66.7 (8/12)	Ua	8.3 (1/12)	3–4 w	Quoted stricture rate 16.7% (did not count UD or DVIU as failure)
Mouraviev 2005 (142)	57	Ua	Ua	49 (28/57)	34 (20/57)	18 (10/57)	Ua	Interlocking sounds NB all did urethral hydrodilation
Onen 2005 (133)	22	(4–17 y)	Ua	22.7 (5/22)	22.7 (5/22)	18.1 (4/22)	Ua	–

Ua, un-assessed; DVIU, direct visual internal urethrotomy; DIU, direct internal urethrotomy.

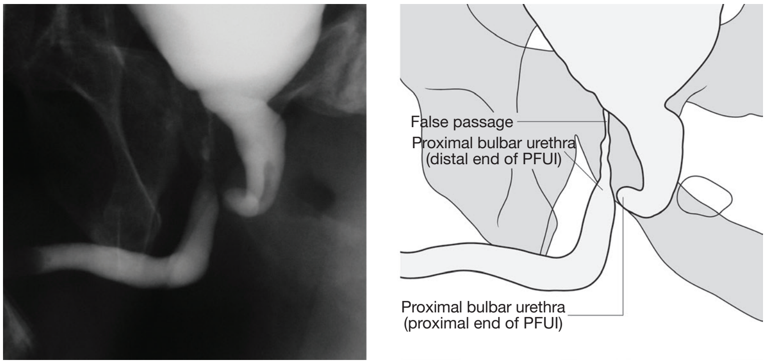

Figure 5 Epithelial lined cavity following primary realignment.

This can also be achieved radiologically using multiplane fluoroscopy (167) and has been described using magnetic catheters(14). The mean operative time is reported a 55.5–78 minutes but it can be up to 280 minutes (87,88,168). In the majority of series a SPC was initially placed and PER performed on average 2 days (0–19 days) after this (15,87,88,169).

The rationale for early endoscopic realignment is to avoid the "morbidity" of prolonged suprapubic catheterisation and to prevent/shorten any consequent strictures (12,93,147,170). As per open realignment the term realignment is a misnomer as the result is restoration of urethral continuity without actual 3D realignment (171). The theoretical advantages of endoscopic realignment are not apparent in clinical practice. Most series of urethroplasty for PFUI report increased surgical difficulty following PER because of an epithelial-lined cavity at the site of the disruption (*Figure 5*), which must be excised prior to repair and may compromise results (4,26,80,109,172-174). Tausch *et al*. [2015] and Johnsen *et al*. [2015] noted an increase in delay to definitive treatment for PER patients and an increase in the number of interval procedures (173,175). Conversely, Koraitim found primary realignment patients were significantly more likely to have a stricture <2 cm than those managed solely with SPC diversion (176). Experimentally, in a dog model of complete urethral transection, the stricture rate was the same (17%) following suprapubic catheterisation alone or combined suprapubic and urethral catheterisation (177). Duration of catheterisation post-endoscopic realignment varies; Seo *et al*. removed catheters at day 7 for partial and day 14 for complete PFUI (87) whilst the majority of surgeons remove catheters at 3 weeks for partial and 6 weeks for complete PFUI (163). In reality the average period of catheterisation is 8 weeks (range, 2–16 weeks) (12,88), which is only slightly shorter than in patients having delayed repair at 3 months.

Success in terms of PFUI treatment should be defined as absence of; symptoms, reduced flow rate and urethrographic or cystographic evidence of stricture. Any need for further intervention, including "office" urethral dilation or clean intermittent self-catheterisation, denotes failure. This reduces the reported success rates in some studies from 50% to 0% as all patients required further intervention (13). Overall the RS is @62% (range, 10–100%) (87,136,138,140,150,164,167-169,175,178-184,185), the ED rate is @24% (0–100%) and the UI rate is @4% (0–20%) (4,11-15,17,88,140,150,168,169,178-184,186-188) (*Table 5*). There is only one study with long term follow-up (>5 years),in which the RS rate was 39.2% (87).

Whether the PFUI is complete or partial is not recorded in most series. It may be more difficult to treat complete PFUI with PER. Failure or no attempt due to lack of patient suitability has been reported in up to 20% of cases (13,14,168). Other complications include perineal abscess and urethral fistulae, related to extravasation of irrigation fluid or contrast into the haematoma with consequent infection (8,15,17,189,190).

Primary SPC insertion and delayed endoscopic stricture management

This technique has been reported infrequently but is utilised commonly in general urological practice (191-193). A suprapubic cystostomy is performed at time of PFUI and then any subsequent stricture is managed by direct visual internal urethrotomy (DVIU), laser urethrotomy or "core-through" (194,195). RS developed in the DVIU series in @82% (range, 12.5–100%) (20-22). There is a 19% failure rate for initial attempt at DVIU; all such failures will require

Table 5 Outcome of primary endoscopic realignment

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter Time	Comments
Lieberman 1982 (138)	4	Ua	(2–9 m)	25 (1/4)	Ua	Ua	Ua	DVIU 1 req recurrent DVIU + 6 weekly UD
Towler, Eisen 1987 (178)	4	41.3 y (27–58 y)	1.9 y (8 m–4 y)	75 (3/4)	Ua	0 (0/5)	4–6 w	2 DIU 1 U Dilation
Chiou 1988 (164)	8	Ua	Ua	100 (8/8)	Ua	Ua	Ua	2–3 urethrotomies/pt in first 12m
Gelbard 1989 (17)	7 (6 FU)	35.4 y (9–60 y)	9.6 m (2–24 m)	50 (3/6)	17 (1/6)	0 (0/7)	4 w	2 DIU 1 U dilation
Cohen 1991 (15)	5	(17–41 y)	≤18 m	100 (5/5)	50 (2/4)	20 (1/5)	6–13 w	All had 3m CISC
Guille 1991 (179)	5	43 y (19–57 y)	12 m	75 (3/4)	20 (1/5)	0 (0/5)	3 w	–
Yasuda 1991 (180)	17	Ua	3.7 y (1–8 y)	100 (17/17)	41 (7/17)	12 (2/17)	6 w	All required UD/sounds in 1st 6m
Herschorn 1992 (12)	16	Ua	27 m (13–83 m)	63 (10/16)	42 (5/12)	Ua	8 w	–
Kotkin 1996 (140)	12	Ua	38 m (12–98 m)	10 (1/10)	30 (3/10)	20 (2/10)	1–4 w	2 stretch, 2 partial
Routt 1996 (150)	23 (9 FU)	35.3 y (17–63 y)	15.5 m (3–36 m)	44 (4/9)	17 (3/18)	20 (1/5)	Ua	–
Londergan 1997 (167)	5	Ua	(1–35 m)	80 (4/5)	Ua	Ua	Ua	–
Porter 1997 (14)	13 (10 FU)	24.8 y (10–47 y)	6.1 m (2–31 m)	50 (5/10)	10 (1/10)	0 (0/10)	8–10 w	Magnetic catheters
Podesta 1997 (4)	10	Ua	(3–17 y)	100 (10/10)	10 (1/10)	0 (0/10)	Ua	Urethral catheter
Gheiler 1997 (11)	3	(25–36 y)	6 m	100 (3/3)	0 (0/3)	0 (0/3)	6 w	Flexi insertion with guidewire, 100% CISC
Rehman 1998 (181)	6	Ua	Ua	67 (4/6)	17 (1/6)	0 (0/6)	Ua	Fluoroscopic realignment
Reinberg 1998 (136)	3	9.5 y (3–17 y)	27.9 m	100 (3/3)	Ua	Ua	Ua	–
Jepson 1999 (182)	8	(16–64 y)	50.4 m (35–85 m)	75 (6/8)	37.5 (3/8)	12.5 (1/8)	6–9 w	Above and below guidewire 1 colovesical fistula
Moudouni 2001 (168)	29	36 y (17–70 y)	68 m (18–155 m)	54 (16/29)	14 (4/29)	0 (0/29)	Ua	Antegrade and retrograde cystoscopy
Kielb 2001 (13)	10 (6FU)	36.8 y	18 m (9–27 m)	100 (6/6)	100 (6/6)	17 (1/6)	Minimum 6 w	100% CISC Flexi insertion with guidewire

Table 5 (*continued*)

Table 5 (*continued*)

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter Time	Comments
Tazi 2003 (183)	36	Ua	34 m (12–72 m)	41.7 (15/36)	19.4 (7/36)	0 (0/36)	Ua	–
Healy 2007 (184)	10	Ua	41.4 m	50 (4/8)	50 (4/8)	0 (0/8)	Ua	2 patients failed endoscopic alignment and required delayed urethroplasty
Hadjizacharia 2008 (185)	14	30 y	7 m (14 d–1.7 y)	43 (6/14)	Ua	Ua	Ua	–
Olapade-Olaopa 2010 (186)	10	Ua	36.6 m	100 (10/10)	0 (0/10)	0 (0/10)	Ua	–
Sofer 2010 (187)	11	32 y (20–62 y)	4.3 y (2–7 y)	45 (5/11)	45 (5/11)	0 (0/11)	4 w	–
Leddy 2012 (88)	19	36 y (21–73 y)	40 m (10–80 m)	78.9 (15/19)	0 (0/19)	0 (0/19)	Minimum 3 w	ED + SUI in failures
Seo 2012 (87)	51	47.8 y (23–70 y)	89.1 m (60–176 m)	39.2 (20/51)	Ua	Ua	Mean 22 d (6–63 d)	–
Kim 2013 (188)	15	Ua	31.8 m	53.3 (8/15)	46.7 (7/15)	20 (3/15)	Ua	–
Shrestha 2013 (169)	20	Ua	6 m	100 (20/20)	5 (1/20)	0 (0/20)	Ua	All pt CISC for 3m. 25% re-stricture afterwards.
Johnsen 2015 (175)	27	39 y (±14 y)	39 m (±40 m)	63.6 (17/27)	Ua	Ua	60.9 d (±36.2 d)	–

Ua, un-assessed; DVIU, direct visual internal urethrotomy; ED, erectile dysfunction; UD, urethral dilation; DU, delayed urethroplasty; CISC, clean intermittent self catheterisation; SUI, stress urinary incontinence.

a core-through procedure (20). Eventual RS is almost inevitable at 95.8–100% (20,21,196,197) with 39–41.8% requiring urethroplasty at a follow-up of 24–43 months.

The commonest delayed endoscopic method used is the "cut to the light" technique whereby the proximal end of the PFUI is illuminated via suprapubic tract cystoscopy and an antegrade stiff guidewire is passed to guide a second operator to perform DVIU from the urethral end (198). Operative times range from 45–120 minutes (20). Laser has also been used, with a failure rate of Nd: YAG laser core through of 8% and RS rates of 12.5% at a mean follow-up of 30 months. However all "successful" patients needed to perform CISC, meaning in reality the failure rate was 100% (21).

Endoscopic skin graft urethroplasty has been reported with a skin patch held dorsally following DVIU using a special retaining catheter (199-201). Early reports revealed RS rates of 25% at 2 years when performed within 3 weeks of PFUI increasing to 60–67% when performed for established PFUI. This technique has not been widely adopted (199-201).

Complications associated with delayed endoscopic management of PFUI stricture include primary and secondary haemorrhage, urinary tract infection and extravasation of irrigating fluids (20,22). Evaluating all techniques of delayed endoscopic management RS occurs in @80% (27,143,192,195,199,202-219), ED in @32% (range, 0–64%) and UI in @4% (0–40%) (8,20-22,138,164-166,180,196-198,202-205,207-210,211,213,215-217) (*Table 6*).

Primary SPC insertion and DU

Suprapubic cystostomy and DU was initially proposed by Johanson in 1953 (23). It successfully achieves urinary diversion whilst avoiding entry into the fracture haematoma

Table 6 Outcome of delayed endoscopic treatment

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Comments
Lieberman 1982 (138)	4	31.5 y (20–53 y)	4.1 m (2–9 m)	100 (4/4)	Ua	25 (1/4)	1–3 w	100% dilation
Gonzalez 1983 (202)	3	49 y (21–74 y)	17.6 m (11–28 m)	100 (3/3)	0 (0/2)	0 (0/2)	Ua	Mean 3 DIU each
Chiou 1985 (165)	1	45	Ua	100 (1/1)	0 (0/1)	0 (0/1)	3 w	DIU
Gupta 1986 (203)	10	(20–58 y)	16.2 m (6–24 m)	100 (10/10)	0 (0/10)	40 (4/10)	4–8 m	All >2 DIU
McCoy 1987 (204)	12	20–64 y	22 m (6–35 m)	100 (11/11)	0 (0/5)	25 (3/12)	3–7 m	6 DIU 12 U Dilation 58% (7/12) ED post injury
Fishman 1987 (195)	1	Ua	Ua	100 (1/1)	Ua	Ua	Ua	Goodwin sound guided DIU
Marshall 1987 (205)	5	29.8 y (13–48 y)	Ua	100 (5/5)	50 (2/4)	0 (0/5)	6–7 m	All CISC and or DIU
Peterson 1987 (206)	5	31.4 y (24–45 y)	28.8 m (18–42 m)	100 (5/5)	Ua	Ua	Ua	Forceful perforation with sound All CISC, 3DIU
Chiou 1988a (164)	9 (8 FU)	38 y (21–74 y)	3.6 m (1–6.6 m)	100 (8/8)	0 (0/4)	14 (1/7)	3–4 w	Thin trocar puncture All 2–3 DIU
Chiou 1988b (166)	3	53 y (39–68)	21.5 m (12–31 m)	67 (2/3)	33 (1/3)	0 (0/3)	3 w	Endourethroplasty FTSG prepuce
Lim 1989 (207)	20	36 y (20–75 y)	4 y (4–12 y)	100 (20/20)	5 (1/20)	10 (2/20)	Ua	100% dilation, mean of 5 each
Marshall 1989 (208)	10	5 y	NA	100 (10/10)	40 (4/10)	0 (0/10)	4–6 w	100% further DIU + CISC
Barry 1989 (198)	12	Ua	(1.5–85 m)	100 (12/12)	58.3 (7/12)	25 (3/12)	12–24 w	100% CISC + U Dilation
Leonard 1990 (209)	7	(20–75 y)	31 m (13–51 m)	57 (4/7)	14 (1/7)	14 (1/7)	4 m	Cut to the light
Kernohan 1990 (210)	7	25.8 y (7–54 y)	51.9 m (25–180 m)	100 (7/7)	Ua	29 (2/7)	Ua	Cut to the light
Husmann 1990 (143)	17	Ua	3 y (6 m –4 y)	53 (9/17)	Ua	Ua	Ua	DIU
Yasuda 1991 (180)	17	41.1 y (20–70 y)	3.7 y (1–8 y)	100 (17/17)	55 (6/11)	18 (3/17)	5–7 m	41% ED post injury 17 OPD dilation 6m
Wu 1992 (211)	15	(10–61 y)	33.5 m (1.5–5.5 y)	27 (4/15)	7 (1/15)	Ua	3–7 m	–
Jenkins 1992 (212)	33	28 y (16–81 y)	8 y (1–22 y)	33 (11/33)	Ua	Ua	Ua	Short PFUDD DIU
Follis 1992 (8)	24 (20 FU)	28 y (4–65 y)	42 m (1–360 m)	35 (7/20)	20 (4/20)	10 (2/20)	4–6 w	4 failed initial attempts

Table 6 (*continued*)

Table 6 (*continued*)

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Comments
Spirnak 1993 (213)	5	32 y (7–74 y)	31 m	100 (5/5)	0 (0/4)	Ua	5–10 m	100% CISC and 100% DIU 20% ED post injury
Quint 1993 (196)	10	40 y (7–78 y)	43 m (7–108 m)	100 (10/10)	0 (0/5)	10 (1/10)	4 m	Ante and retro fluoroscopic guided DIU and TUR 100% balloon dilation and sounds
Wu 1994 (214)	10	Ua	24.4 m	60 (6/10)	Ua	Ua	Ua	Perforation with sound, dilation and TUR
White 1994 (215)	4	21.8 y (18–26 y)	10.5 m (5–17 m)	100 (4/4)	25 (1/4)	0 (0/4)	4–8 w	Retro DIU and dilation All CISC 3 DIU
Koraitim 1995 (27)	12	(3–58 y)	Ua	42 (5/12)	Ua	Ua	3 m	–
El-Abd 1996 (20)	352	–	24 m	96 (338/352)	37.5 (132/352)	1 (4/352)	–	DIU
Al-Ali 1997 (22)	154	36 y (18–54 y)	31.5 m (3–60 m)	65 (100/154)	Ua	0.6 (1/154)	12 w	Core through DIU
Goel 1997 (197)	13	(25–45 y)	17.7 m (11–24 m)	100 (13/13)	Ua	0 (0/13)	2–5 w	Core-through DIU, 100% DIU + CISC
Naude 1998 (199)	16 (15 FU)	Ua	(2 y)	60 (9/15)	Ua	Ua	7 m	Established PFUDD
Naude 1998 (199)	10 (8 FU)	Ua	(3 y)	25 (2/8)	Ua	Ua	5 w	Recent PFUDD
Sahin 1998 (216)	5	32 y (18–32 y)	31 m (21–53 m)	100 (5/5)	0 (0/4)	20 (1/5)	3–8 m	Core-through DIU 100% CISC 4 DIU 20% ED posy injury
Dogra 1999 (217)	8	27.5 y (18–44 y)	10.25 m (7–14 m)	12.5 (1/8)	0 (0/8)	0 (0/8)	4–6 w post op	<2 cm PFUDD No ED
Levine 2001 (218)	6	48 y (17–78 y)	7 y (7–14 y)	100 (6/6)	Ua	Ua	7–8 m	Cut to the light Minimum 3 DIU each of
Dogra 2002 (21)	65	(5–62 y)	30 m	100 (65/65)	Ua	3 (2/65)	Ua	NdYAG core through 100% CISC
Ravichandran 2003 (219)	25	Ua	24 m	100 (25/25)	Ua	Ua	Ua	9 failed initial attempts 15 CISC 2 urosepsis
Islam 2010 (192)	45	(20–60 y)	(3–12 m)	31.4 (14/45)	Ua	Ua	Ua	All did CISC for 1–3 m

Ua, un-assessed; ED, erectile dysfunction; CISC, clean intermittent self catheterisation; DIU, direct internal urethrotomy; PFUDD, pelvic fracture urethral distraction defect (old terminology for PFUI).

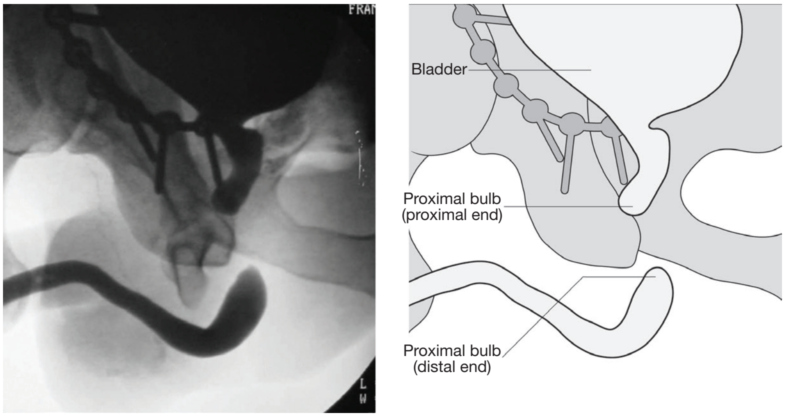

Figure 6 Stricture post SPC placement prior to delayed urethroplasty. SPC, suprapubic catheter.

and consequent infection and blood loss (8). A well-planned elective surgical procedure can then be performed for any resultant stricture (*Figure 6*) in a stable healthy patient at a later date by a Urologist experienced in urethral surgery. The disadvantage is the 3–6 months wait with a SPC in situ. There is often pressure from orthopaedic colleagues to achieve urethral drainage and avoid a SPC at the time of pelvic fracture fixation. This is prompted by the fear that an SPC will be an infection risk (220). There is no documented evidence that an SPC presents a greater infection risk than a urethral catheter over and above the nature of the associated injuries and the duration and difficulty of the pelvic fracture fixation (220-222).

Following suprapubic cystostomy alone RS occurs in @97% (80–100%) (8,80,131,142-144,164,185,223,224). ED occurs in @39% (2.5–75%) and UI in @5% (2.1–8%) (93,131,144). ED and UI following SPC insertion alone are consequent to the injury itself and are therefore the baseline against which all post-procedure ED and UI rates should be compared.

DU is performed a minimum of 3 months following PFUI to allow resolution of haematoma and any other injury (9,10,24,25,61,64,225-227). The operation now most commonly performed is transperineal bulbo-prostatic anastomotic urethroplasty (BPA) (26,228). The technique of BPA is based on the progressive perineal approach first clearly described as such by Webster (26) and the work of other authors notably Young, Marion, Turner-Warwick and Waterhouse (9,10,23,122,229,230) (*Figure 7*).

The technique capitalises on the elasticity of the urethra and the ability to straighten out the natural perineal curve of the bulbar urethra to allow a tension-free anastomosis (26,109). The length of stricture on pre-operative urethrogram is not predictive of what manoeuvres may be necessary. MRI appears to accurately predict the length of the PFUI and 3D displacement but has not as yet been correlated with operative requirement (231). Koraitim [2009] found that the "gapometry/urethrometry index" (length of urethral gap/length of bulbar urethra) was a significant predictor for technique required. A value of <0.35 predicted that a simple perineal approach could be used (232).

BPA urethroplasty RS rates are @14% (4,26,27,28,61, 86,92,99,104,113,121,133,134,160,170,173,174,212,218, 219,225,228,233-235) (range, 0–67%). Studies vary in length of follow-up but success rate appears to be maintained out to 22 years (28,236-258). Early stricture recurrence is due to technical failure or ischaemia, with recurrence rates higher in patients with ED (162,228,245,259-269). New onset ED occurs in @ 13% (0–72%) (4,27,28,61,92,99,104,113,121,133,134,160,212,225,228,234,237,238,240,242,246,251,252,253,255) and UI in @ 7% (0–20%) (164,233,241,250,257,258,261-265,269) (*Table 7*).

Interestingly 6–20% of patients have been reported to recover erectile function after BPA urethroplasty (238,249,252,270,271). New onset ED may be reduced by the newer bulbar artery sparing techniques (272).

Occasionally an abdominoperineal or transpubic approach may be required, particularly in children, in whom the perineal approach is unsuccessful in 10–26% (244), and for complex strictures, normally following failed previous surgery, severe injury or war injuries (82,109,230,248,273). The main indications for these approaches are; to improve visualisation, remove fistulous tracts or cavities, repair bladder neck sector defects and allow a tension-free BPA

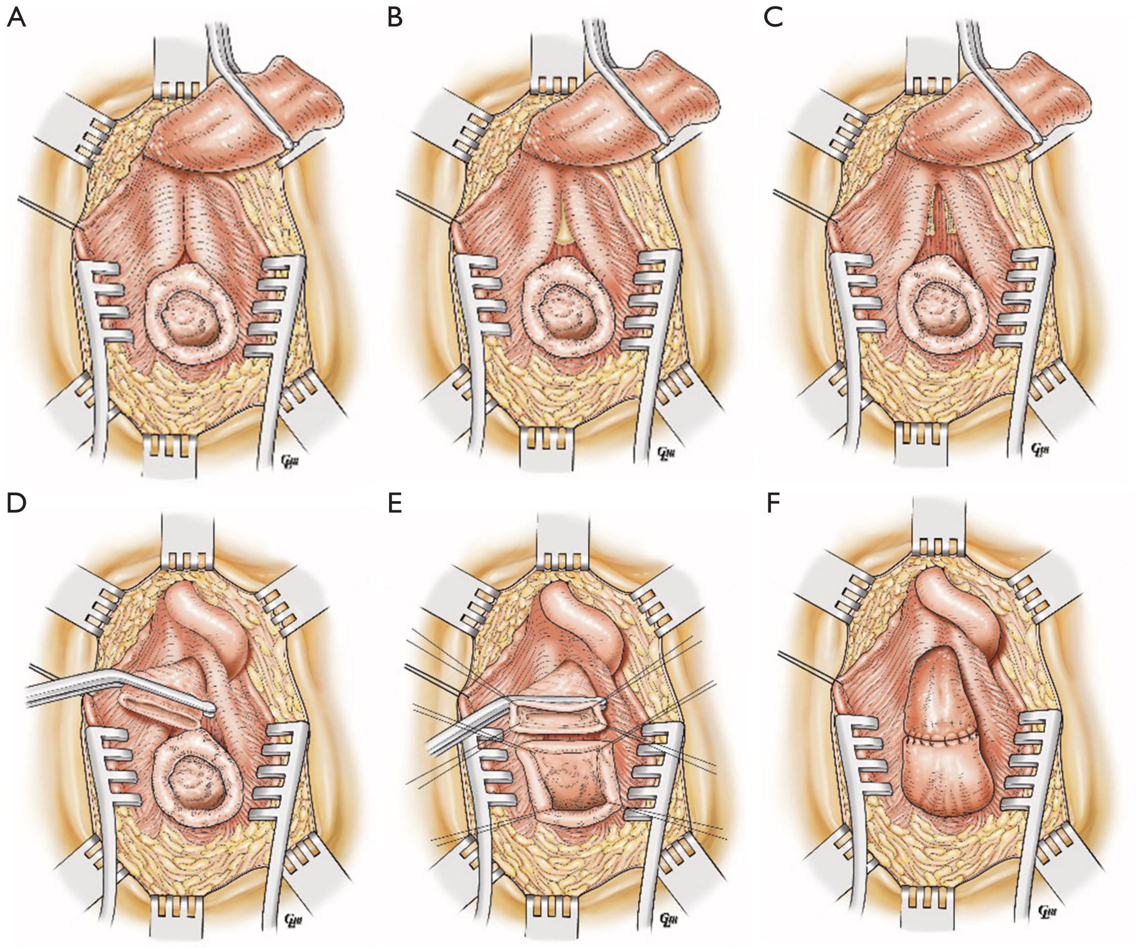

Figure 7 Method for progressive perineal bulboprosatatic anastomotic urethroplasty repair for PFUI. (A) Urethra divided at site of stricture, which is excised. All of urethra anterior to stricture is mobilised to the level of the suspensory ligament (BPA Step 1); (B) midline raphe between the corpora cavernosi bilaterally is divided anteriorly until the corpora coalesce (BPA Step 2); (C) inferior wedge pubectomy is performed (Step 3); (D) the distal urethra is rerouted under one corpora cavernosus (Step 4); (E) the bulboprostatic anastomosis is performed using interrupted small calibre absorbable sutures; (F) the final appearance. BPA, bulbo-prostatic anastomotic. PFUI, pelvic fracture urethral injury.

urethroplasty when this cannot be achieved transperineally. Some authors quote a stricture length of >2.5 cm as requiring a transpubic approach (82,232,274). This approach can cause problems with the penis dropping back into the gap in the pubis created by wedge pubectomy, gait abnormalities and pelvic girdle pain (138,260,275,276). RS rates for this procedure are 0–12% and outcomes appear durable for up to 24 years (82,248,273).

The presence or absence of pre- or post-injury ED should be recorded prior to delayed repair. Whether or not ED is present, nocturnal penile tumescence (NPT) studies should ideally be performed to document erectile function (for medicolegal reasons). Absence of erections on NPT studies should prompt a search for a surgically correctable vascular lesion by penile arterial Doppler studies followed by pudendal arteriography if indicated (277).

UI occurs rarely and is due to concomitant bladder neck injury at time of pelvic fracture. Prior to delayed BPA urethroplasty an ascending and micturating cystourethrogram or urethroscopic and suprapubic cystoscopy are useful although, in a patient with PFUI and a long-term SPC, the bladder neck does not behave necessarily in the same way as it will after urethroplasty (81,278-280). Koraitim found that of 21 patients with

Table 7 Outcomes of suprapubic catheter insertion ± delayed urethroplasty

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Other complications
Johanson 1953 (23)	120	Ua	Ua	100 (120/120)	3.3 (4/120)	0 (0/120)	Ua	SPC alone
Netto 1973 (254)	15	Ua	(2–42 m)	33 (5/15)	Ua	Ua	Ua	Pullthrough
Allen 1975 (233)	3	28 y (21–33 y)	Ua	0 (0/3)	0 (0/2)	33 (1/3)	Ua	Transpubic BPA 33% (1/3) ED post injury
Chatelain 1975 (121)	39	(adult)	(<1–16 y)	50 (19/38)	27 (7/26)	0 (0/38)	Ua	Perineal BPA
Chatelain 1975 (234)	7	26 y (19–40 y)	(4–16 m)	14 (1/7)	20 (1/5)	14 (1/7)	25–50 d	Transpubic BPA
Waterhouse 1976 (235)	7	8.7 y (5–13 y)	Ua	17 (1/6)	Ua	0 (0/6)	Ua	Transpubic BPA Children
De La Pena Zayas 1979 (236)	7	29 y (21–59 y)	24 m	0 (0/7)	0 (0/5)	14 (1/7)	Ua	Transpubic BPA
Coffield 1977 (61)	11	Ua	Ua	0 (0/11)	0 (0/11)	0 (0/11)	Ua	Scrotal inlay urethroplasty
Morehouse, Mackinnon 1980 (25)	41	Ua	Ua	0 (0/41)	10 (4/40)	3 (1/40)	Ua	Transpubic BPA 2 patients with ED >75 y
Harshman 1981 (255)	7	10 y (4–20 y)	29.8 m (3–68 m)	14 (1/7)	14 (1/7)	57 (4/7)	Ua	2AP BPA, 2 BPA, 3 Skin Inlay
McAninch 1981 (64)	21 (14 FU)	33 y (14–76 y)	Ua	7 (1/14)	14(2/14)	0 (0/14)	Ua	Transpubic BPA
Webster 1983 (80)	11	Ua	(6 m–17 y)	0 (0/11)	36 (4/11)	14 (1/7)	Ua	Transpubic BPA
Hayden 1984 (256)	7	9.3 y (7–14 y)	64 m (42–84 m)	Ua	Ua	Ua	2–3 w post op	–
Netto 1985 (257)	66 (10 children; 56 adults)	(5–64 y)	9 y* (1–11 y)	20 (2/10) child; 34 (19/56) adult	0 (0/24)	0 (0/28)	Ua	Pull through
Netto 1985 (257)	28 (9 children; 19 adults)	(5–40 y)	6 y* (1–9 y)	11 (1/9) child; 31 (6/19) adult	0 (0/22)	2 (1/28)	Ua	Transpubic BPA
Koraitim 1985 (258)	76	(3–54 y)	(6 m–25 y)	9 (5/54) BPA; 19 (4/21) AP BPA	69 (22/32)	Ua	Ua	–
Patil 1986 (259)	30 (5 FU)	9.4 y (7–10 y)	9.2 y (6–11 y)	0 (0/5)	0 (0/5)	0 (0/5)	4–6 m	Transpubic BPA. Children
Zvara 1986 (260)	10	22.6 y (9–36 y)	(29–54 m)	10 (1/10)	25 (1/4)	10 (1/10)	Ua	Transpubic BPA Gait disturbance (1/10)
Chiou 1988 (164)	6	18 y (11–24 y)	–	67 (4/6)	0 (0/5)	50 (3/6)	Ua	Transpubic BPA

Table 7 (*continued*)

Table 7 (*continued*)

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Other complications
Morehouse 1988a (104)	36	Ua	Ua	14 (5/36)	11 (4/36)	0 (0/36)	Ua	Perineal and Transpubic BPA
Morehouse 1988b (113)	92	Ua	Ua	0 (0/92)	10 (9/92)	2 (2/92)	Ua	2 stage
Redman 1988 (237)	16	29 y (17–62 y)	Ua	6.25 (1/16)	25 (2/8)	0 (0/8)	7 m	Perineal and Transpubic BPA
Singh 1988 (223)	45	Ua	Ua	100 (45/45)	44.4 (20/45)	Ua	Ua	36 req urethroplasty
								6 –BPA
								30 –transpubic
Dhabuwala 1990 (225)	26	34 y (7–62 y)	≥18 m	Ua	56 (15/26)	Ua	Ua	Transperineal BPA
Webster 1990 (26)	20	Ua	Ua	5 (1/20)	Ua	Ua	Ua	14 BPA, 1 PIPS, 5 staged skin inlaies
Husmann 1990 (143)	64	Ua	Ua	95 (61/64)	52 (33/64)	12.5 (8/64)	Ua	SPC alone (eventually underwent BPA)
Webster 1991 (249)	74	Ua	(2–10 y)	10.8 (8/74)	0	0	Ua	1.4% gained potency
								BPA
Al Rifae 1991 (250)	20	(2–15 y)	(1–7 y)	10 (2/20)	Ua	25 (4/20) All associated BN injury	Ua	16 Transpubic BPA 4 Perineal BPA
Jenkins 1992 (212)	73	Ua	Ua	20 (15/72)	38.9 (28/72)	Ua	Ua	Skin inlay urethroplasty
Follis 1992 (8)	13	31 y (18–64 y)	37 m (1–147 m)	100 (13/13)	46 (6/13)	Ua	Ua	Stricture rate SPC alone
Boone 1992 (92)	7	(4–16 y)		14 (1/7)	14 (1/7)	0 (0/7)	–	–
Flah 1992 (251)	4	5.75 y (3–9 y)	(3–22 m)	0 (0/4)	0 (0/4)	0 (0/4)	Ua	Posterior sagittal approach
Baskin 1993 (261)	7	10 y (4–16 y)	2.2 y (0.8–5 y)	14 (1/7)	0 (0/6)	0 (0/7)	Ua	A BPA
								Perineal BPA
Corriere 1994 (252)	50	34 y (15–61 y)	≥12 m	36 (18/50)	32 (16/50)	14 (7/50)	10 (5/50) CISC due to areflexic bladder	Transpubic and perineal BPA
								8 recovered potency post BPA
								48 % ED post injury

Table 7 (*continued*)

Table 7 (*continued*)

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Other complications
Koraitim 1995 (27)	80	(3–58 y)	Ua	5 (4/80)	17.5 (14/80)* combined evaluation of perineal and Transpubic approach	Ua	7 m	Perineal BPA 40% (32/80) ED post injury
Koraitim 1995 (27)	32	(3–58 y)	Ua	3 (1/32)	see above	Ua	7 m	Transpubic BPA 40% (32/80) ED post injury
Koraitim 1995 (27)	23	(3–58 y)	Ua	57 (13/23)	Ua	Ua	7 m	Scrotal inlay 40% (32/80) ED post injury
Mark 1995 (238)	113 (92 FU)	Ua	12 m	15 (12/92)	6 (6/92)	2 (2/92)	Ua	6% regained potency post op perineal BPA ED post PFUDD 68% (62/92)
Mundy 1996 (228)	82	Ua	10 y	12 (10/82)	7 (6/82)	0 (0/82)	Ua	BPA
Koraitim 1996 (131)	73	(3–62 y)	(4–15 y)	97 (71/73)	18 (9/50)	2/7 (2/73)	Ua	SPC alone
Ennemoser 1997 (262)	42	46.4 y	42 m	0 (0/42)	4.7 (2/42)	0 (0/42)	Ua	–
Koraitim 1997 (239)	42	3–15 y	Ua	7 (3/42)	Ua	Ua	Ua	BPA
Koraitim 1997 (239)	24	3–15 y	Ua	9 (2/24)	Ua	Ua	Ua	Transpubic BPA
Koraitim 1997 (239)	13	3–15 y	Ua	54 (6/13)	Ua	Ua	Ua	2 stage scrotal
Martinez-Pineiro 1997 (240)	150 (57 FU)	35.7 y (5–73 y)	44.4 m (3–168 m)	5.6 (3/54)	19 (28/150)	1.3 (2/150)	Ua	12 A BPA Rest perineal BPA
Morey 1997 (263)	82	Ua	12 m	15 (12/82)	0 (0/82)	5 (2/82)	Ua	BPA/transpubic (30) 16% regained potency postop
Podesta 1997 (4)	19	Ua	(3–17)	15 (3/19)	8.5 (1/12)	16 (3/19)	Ua	BPA
Podesta 1998 (241)	15	9.2 y* (5.8–15 y)	6 y* (2.6–14 y)	27 (4/15)	Ua	6.7 (1/15)	6 m	Perineal BPA
Podesta 1998 (241)	15	8.2 y* (3.8–15.4 y)	10 y* (2–15 y)	0 (0/15)	Ua	20 (3/15)	6–12 m	AP BPA
Asci 1999 (144)	18	Ua	37 m	83.3 (15/18)	17.6 (3/18)	5.6 (1/18)	Ua	SPC alone 44.4% req BPA

Table 7 (*continued*)

Table 7 (*continued*)

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Other complications
Khan 2000 (160)	10	28 y (3–81 y)	6.5 y (9 m–46 y)	40 (4/10)	0 (0/2)	20 (2/10)	Ua	AP BPA
Tunc 2000 (242)	77	24.2 y (7–62 y)	47 m (15 m–14 y)	5.2 (4/77)	16.2 (7/43)	9.1 (7/77)	12 m	BPA 1 regained potency pot BPA
Corriere 2001 (99)	60	35 y (15–61 y)	12 m	38.3 (23/60)	35 (21/60)	20 (12/60)	3–4 w + 6–26 w preop	15% regained potency post op
Levine 2001 (218)	9	37 y (19–72 y)	(3–6 y)	22.2 (2/9)	Ua	Ua	Ua	BPA
Basiri 2002 (243)	10	6 (4–13 y)	2.5 y (0.5–4 y)	0 (0/10)	0 (0/10)	0 (0/10)	Ua	Transpubic BPA
Flynn 2003 (244)	120 (11 boys)	32 y (6–82 y)	64 m (9–128 m)	7.5 (9/120)	Ua	Ua	3.4 w	All strictures in 1st yr post–op
Ku 2002 (264)	20	Ua	Ua	65 (13/20)	15 (3/20)	5 (1/20)	Ua	–
Andrich 2003 (28)	100	3.6y	Ua	5 (5/100)	0 (0/100)	0 (0/100)	Ua	42% ED after PFUDD BPA
Ravichandran 2003 (219)	25	Ua	24 m	24 (6/25)	Ua	Ua	Ua	–
Koraitim 2005 (246)	155	3–58 y (21 y)	13 y (1–22 y)	9.6 (11/115) perineal BPA 2 (1/40) Perineo-abdominal	15.4 (17/110)	1.3 (2/110)	2–3 w post-op	115 perineal BPA 40 perineo-abdominal
Mouraviev 2005 (142)	39	Ua	8.8 y (1–22 y)	100 (39/39)	42 (16/39)	25 (10/39)	3 m	Stricture rate for SPC alone 18 eventually had BPA—no outcomes given
Onen 2005 (133)	16	(4–17 y)	Ua	25 (4/16)	18.8 (3/16)	18.8 (3/16)	Ua	Transpubic and perineal BPA
Culty 2007 (247)	23	Ua	(>10 y)	53 (12/23)	Ua	Ua	Ua	BPA
Hadjizacharia 2008 (185)	7	29y (+/–14 y)	7 m (+/–6 m)	100 (7/7)	Ua	Ua	6 m (±3 m)	SPC alone All req BPA eventually
Lumen 2009 (265)	61	34y (14–68 y)	67 m (19–173 m)	14.8 (9/61)	32.8 (20/61)	1.6 (1/61)	<3 m	Inf Pubectomy in 4 21 had prev intervention
Koraitim 2010 (248)	64	(5–40 y)	(1–24 y)	1.6 (1/64)	3.1 (2/64)	Ua	Ua	Partial transpubic BPA with wedge pubectomy

Table 7 (*continued*)

Table 7 (*continued*)

Author	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)	Catheter time	Other complications
Singh 2010 (174)	58	27 y (6–65 y)	31.5m (6–146 m)	25.9 (15/58)	Ua	Ua	Ua	If previous intervention failure rate 50%
Onofre 2011 (266)	11	11 y (1.5–23 y)	41 m (10 m –10 y 9 m)	18.2 (2/11)	Ua	Ua	Ua	1 inf pubectomy 10 BPA
Sunay 2011 (267)	75	12.3 y (6–17 y)	43.2 m (12–94 m)	30.7 (23/75)	Ua	Ua	Ua	BPA 54 pts
								Pull through 20pts
								Graft 1pt
Voelzke 2012 (268)	18	15 y	2.9 y	10.5 (2/18)	Ua	Ua	Ua	BPA
Fu 2013 (253)	573	36 y (7–71 y)	36 m (18–47 m)	12 (69/573)	<0.1 (5/573)	9.1 (52/573)	Ua	537 had previous interventions
Qu Y 2014 (134)	142 boys	Ua	58 m (6–192 m)	11.9 (17/142)	21.8 (31/142)	17.7 (25/142)	6 m	–
Fu 2015 (170)	186	35.3 y (4–79 y)	>12 m	19.4 (36/186)	Ua	Ua	Ua	BPA
Koraitim 2015 (86)	86	23 y (5–50 y)	5.5 y (2–8 y)	12 (10/86)	Ua	Ua	Ua	Previous interventions in 44%
								All presented with SPC in situ
Podesta 2015 (269)	49 boys	9.6 y (3.5–17.5 y)	6.5 y (5–22 y)	10.2 (5/49)	20 (9/49)	6.1 (3/49)	Ua	ED present before urethroplasty
								4 cases UI resolved at puberty
Tausch 2015 (173)	23	Ua	35 m (5–64 m)	7 (2/23)	Ua	Ua	Ua	BPA

Ua, un-assessed; BPA, bulbo-prostatic anastomotic; ED, erectile dysfunction; SPC, suprapubic catheter.

known bladder neck injury, 12 became continent after urethroplasty alone (280).

Abdalla described a posterior sagittal pararectal approach for BPA urethroplasty to improve access and vision during the procedure with RS rates of 14% at 13 months (281). Substitution urethroplasty is contraindicated as a primary procedure in PFUI (228).

As PER becomes more popular there are now series of patients undergoing PFUI urethroplasty after failed endoscopic realignment. There is no consensus as to whether or not previous treatment has an effect on the success of future urethroplasty—some series quote good results with RS rates of 9.6–24% whilst others indicate higher RS rates of 57% dropping to 37% at 10 years (170,247,253,265,282).

Post-pelvic fracture ED

ED following pelvic fracture with or without associated urethral injury occurs in @56% (2.5–80%) of patients (8,25,39,131,238,263,270,271,277,283-287). The wide range of incidence of ED is related to the variability in the complexity and severity of injury and the variability in the definition of ED. Generally post-pelvic fracture ED (PPF-ED) is a consequence of the injury causing the PFUI rather than its treatment (140). ED may be neurogenic, vasculogenic or psychogenic—alone or in combination. Vasculogenic ED can be further divided into; arterial insufficiency, venous leak or both. Reporting of the aetiology of PPF-ED is also variable due to the differing diagnostic techniques (284). PPF-ED is due to vascular injury in @45% (11–80%) and neurological injury in @71% (20–89%) (238,263,277,283,284,288,289).

The majority of cases of PPF-ED are associated with vascular or neural injury at the apex of the prostate following complete urethral rupture and prostatic dislocation (238,277,283,289,290). Neurogenic ED can occur following damage at any point from the S2–S4 nerve roots, via the pelvic plexuses to the cavernous nerves (93,277,290). ED can occur following pelvic fracture without associated PFU, although this is rare, occurring in only @5% (2–27.7%) (62,290,291).

Arteriogenic ED may occur from fracture-related injury to the main trunk of the internal pudendal artery, to the penile artery as it passes through the perineal membrane, or to the accessory pudendal artery. Venogenic ED is consequent to damage to the corporal bodies resulting in corpora-veno occlusive dysfunction and/or penile venous leakage (231,284,289,292,293).

Factors that appear to significantly increase the risk of ED are pubic diastasis, lateral prostatic displacement and a long urethral gap (294-296). Spontaneous recovery from ED has been reported in up to 23% of patients following injury (93,225,271,283,290). This recovery may be secondary to the development of arterial collaterals or the regeneration of nerves. Arterial collateral development has been shown to occur experimentally in a dog model (297). In some cases, recovery of erectile function is delayed by a "psychogenic" component.

Blaschko *et al.* found a base rate of ED after PFUI of 34%. This dropped to 16% for patients having primary realignment (endoscopic or open), most likely due to the tendency to treat less severe urethral injuries in this way. In patients undergoing DU the ED rate increased to 37% (285). The authors postulated that there is significant under-reporting of ED in this cohort (285). It is unusual for patients who have adequate erections before urethroplasty for PFUI to develop ED post-operatively although a small number do (<7%) (28,239,270,285,288). Conversely 6–20% of patients have recovery following BPA urethroplasty (99,290).

ED is far commoner in children with PFUI and is present in 31–75% (92,294). This may be attributable to the greater degree of force required to cause PFUI in a child and the higher incidence of supraprostatic or transprostatic injury (92,225,238,271).

Oral therapy for ED in the PFUI patients is successful in 46.4–81%. There is no difference in response rates between neurogenic or vasculogenic ED (287,298-300). Neurogenic ED can be successfully treated with self-injection therapy (80–100% success) or a vacuum constriction device (225,289). Vasculogenic ED does not respond to self-injection therapy but has been managed by revascularisation in selected cases (84.6% success) or penile prosthesis (301,302).

Problems with emission and/or ejaculation often present as infertility and occur in up to 90% of post-PFUI patients despite the majority of patients have antegrade ejaculation (161,270,303-305). This is usually due to damage to the lumbar sympathetic nerves and the hypogastric and pelvic plexus in those with loss of emission, or secondary to reduced perineal muscle function in those with ejaculatory problems (161,271).

UI after PFUI

UI after PFUI is often related to concomitant bladder neck injury and more severe trauma (4,144). The urethral sphincter mechanism may be overtly destroyed or poorlyfunctional and continence depends on bladder neck function (82), although some patients do have preservation of urethral sphincter function (91,306).

If bladder neck and detrusor function are normal the patient will be continent following re-establishment of urethral continuity although a degree of stress and/or urge incontinence may be present, especially when the patient has a full bladder and in the first few months after urethroplasty (228,252).

UI occurs in @5% (2.1–8%) of men following PFUI (39,99,131,144). A further 8.3% report mild urgency UI and 7.8% report mild stress UI (99,162). Conversely @8% (1.5–10%) of men are unable to void post-PFUI, secondary to sacral nerve damage, and need to perform clean intermittent self-catheterisation (99,162,252).

Bladder neck injury at the time of original trauma should be repaired as soon as possible (80). Bladder neck injury is more common in children, secondary to the relative intra-abdominal position of the bladder and immature prostate (92,109,144,239). UI is also more common in children with high (supra-prostatic) injuries than in those with a standard PFUI (92,109,236,239).

An open bladder neck on a pre-operative cystourethrogram does not predict post-BPA incontinence. It may be open due to a generalised detrusor contraction or fibrosis around the bladder neck rather than bladder neck injury (278,307). The average length of proximal urethra seen associated with bladder neck opening is significantly longer in incontinent patients (>1.5 cm) (278). Despite the poor association, an open bladder neck at rest on cystourethrogram should result in antegrade cystoscopy to assess the bladder neck prior to BPA urethroplasty. If circumferential integrity of the bladder neck is confirmed then continence is maintained after BPA urethroplasty. If a deficiency is noted then urinary continence is less likely (307) although even in patients with bladder neck injury, some do become continent after BPA urethroplasty (57%) (280).

Treatment options for incontinent patients include bladder neck reconstruction or bladder neck artificial urinary sphincter (AUS) (278,280). In general, if there is a clearly defined sector defect in the bladder neck, then this should be reconstructed. In all other cases BPA urethroplasty should proceed and post-operative UI managed by subsequent bladder neck AUS insertion.

Male children and PFUI

PFUI is rare in boys, with a reported frequency of less than 2/year in the UK, and occurs in association with 0–3.5% of pelvic fractures in this age group (308-312). Pelvic fractures in children have the same mechanism of injury as in adults but LCII/III and APCI (the fractures that are most commonly associated with PFUI) occur more commonly (29,32). Children have more proximal PFUIs than adults and a higher frequency of concomitant bladder neck injury (7–33%) (39,92,109,239,241,250,269,280). Childhood PFUIs occur at the level of the bladder neck or through the prostate in 15–57%, although the majority are still below the level of the verumontanum (92,133,250,255,269,313,314). The more proximal the injury, the greater is the risk of UI, ED and stricture.

The results of treatment of PFUI appear to be worse in children with RS rates between 0–31% (134,255,256,267,268). The complication rates after supraprostatic and transprostatic injury are significantly higher than after lower injuries with ED in 75%, UI in 25–100%, and RS in 75% (92,250,269,314). ED is difficult to assess in children and may be consequent to the primary injury rather than the treatment. It is more likely when the urethral gap length is >2.5 cm and with lateral prostatic displacement (294). ED in children after PFUI is arteriogenic in the majority and in 75% it is secondary to PFUI proximal to the prostatomembranous region. Both ED and UI may present at puberty (92,294).

Delayed BPA urethroplasty is the most popular operative technique (133). Perineal BPA can be difficult due to the small and relatively inelastic urethra in children (314,315). A transpubic or perineo-abdominal route is required in 10–42% of children (269,316,317). As a result, the success rates for childhood DU (by any technique) are not as good as in those for adults with 62.5–85% 5-year stricture free rates (4,28,133,243,250,269,318,319). An anterior sagittal transanorectal approach has been reported with good results (82% success) but only in 1 series with small numbers (266).

Conclusions

Acute PFUI is a rare urological emergency. The mean re-stricture, ED and UI rates after SPC only are 97.9%, 25.6% and 6.7% at a mean of 46.3 months follow-up, those after primary open surgical repair (POSR) are 53.9%, 22.5% and 13.6% at a mean of 29.4 months follow-up, those after delayed primary open surgical repair (DPOSR) are 18%, 71% and 0% at a mean of 12 months follow-up, those after POR are 58.3%, 37.2% and 14.5% at a mean of 61 months

Table 8 Overall PFUI treatment outcomes

Treatment	Number	Age, mean (range)	Follow up, mean (range)	Stricture, % (N)	Erectile dysfunction, % (N)	Incontinence, % (N)
SPC alone	379	30 y (3–64 y)	46.3 m (1 m –15 y)	97.9 (/371/379)	25.6 (91/349)	6.7 (21/314)
Primary open repair	258	19.6 y (3–>60 y)	29.4 m (25 d –17 y)	53.9 (139/258)	22.5 (25/111)	13.6 (16/118)
Delayed primary open repair	17	(16–42 y)	>12 m	18 (3/17)	71 (12/17)	0 (0/17)
Primary open realignment	883	32.4 y (18 m–83 y)	61 m (1 m –46 y)	58.3 (484/830)	37.2 (238/640)	14.5 (83/571)
Primary endoscopic realignment	401	34.4 y (3–73 y)	31.4 m (2 m –17 y)	62.0 (232/374)	23.6 (62/263)	4.1 (10/245)
Delayed endoscopic treatment	955	33.9 y (4–74 y)	31.8 m (2–360 m)	80.2 (759/946)	31.9 (160/501)	4.1 (31/748)
Delayed urethroplasty*	3,520	23 y (2–82 y)	54.9 m (3–46 y)	14.4 (480/3,334)	12.7 (292/2304)	6.8 (148/2,166)

*, NB. BPA urethroplasty alone stricture rate, 367/2,563 (14.3%).

follow-up, those after PER are 62%, 23.6% and 4.1% at a mean of 31.4 months follow-up, those after delayed endoscopic treatment (DET) are 80.2%, 31.9% and 4.1% at a mean of 31.8 months follow-up and those after DU are 14.4%, 12.7% and 6.8% at a mean of 54.9 months follow-up (*Table 8*).

Where stricture is defined as any clinical, endoscopic or radiological evidence of stricture or any requirement for further intervention (including CISC, dilatation or calibration); ED as the inability to achieve an erection sufficient for penetrative sexual intercourse without requiring medical intervention; and UI as any involuntary leak of urine of whatever volume, delayed repair with BPA urethroplasty appears to be the most successful mode of PFUI treatment with the least side effects.

Take home message

Suprapubic cystostomy is a relatively simple procedure, familiar to all urologists and other surgeons, that allows diversion of urine away from the PFUI and safeguards against associated complications from this and should be the initial treatment of choice for PFUI unless complicated by bladder neck or rectal injury. Following recovery from all other associated injuries the patient should be referred to a centre of excellence for expert delayed BPA urethroplasty and can then expect to achieve long-term excellent results.

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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