

PERINEAL REPAIR OF PELVIC FRACTURE URETHRAL DISTRACTION DEFECTS: EXPERIENCE IN 120 PATIENTS DURING THE LAST 10 YEARS

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ABSTRACT

Purpose: We report the long-term success of a 1-stage perineal anastomotic repair in patients with pelvic fracture urethral distraction defects.

Materials and Methods: A retrospective analysis of 120 patients undergoing perineal bulbo-prostatic anastomotic repair of pelvic fracture urethral distraction defect in a single stage using our progressive approach between May 1991 and May 2001 was performed. Patients with posterior urethral stricture due to other etiologies, or those who underwent substitution urethroplasty or abdominoperineal repair were excluded from this review. Preoperative evaluation of the urethral defect included simultaneous retrograde urethrogram and voiding cystourethrogram. Postoperative retrograde urethrogram was performed at 3 weeks, 3 months, 12 to 18 months and as indicated thereafter.

Results: Mean patient age was 32 (range 6 to 82) years. The estimated preoperative radiographic length of the distraction defect was 3.1 cm (range 0.5 to 10). Mean followup was 64 (range 9 to 128) months, mean hospital stay was 1.8 days and duration of urethral stenting was 3.4 weeks. Perineal anastomotic repair was successful in 103 of 109 (95%) adults, in 8 of 11 (73%) prepubescent boys and in 25 of 29 (86%) undergoing secondary repairs. All treatment failures were at the anastomosis and occurred within the first postoperative year. Successful management of failed repairs was accomplished endoscopically in 3 of 7 and by repeat perineal anastomotic repair in 2 of 2, resulting in a final success rate of 97% in adults, 91% in prepubescent boys and 97% in secondary repairs.

Conclusions: The overall success of our progressive 1-stage perineal anastomotic repair of pelvic fracture urethral distraction defect continues to be excellent with the majority of failures occurring in prepubescent boys and secondary repairs.

KEY WORDS: urethra, urethral stricture, pelvis, fractures, perineum

Posterior urethral injury most commonly occurs as a consequence of pelvic fracture and may occur in up to 10% of cases.¹ The surgical management of pelvic fracture urethral distraction defect (PFUDD) has evolved significantly in the last 50 years. Historically a 1-stage Badenoch pull-through procedure of the bulbar urethra was used for strictures less than 2 cm,² while longer strictures were managed by transpubic anastomotic urethroplasty^{3,4} or by 2-stage (and in practice multistaged) substitution urethroplasty by scrotourethral inlay.^{5,6} Abdominoperineal repair was reserved for complex posterior urethral defects which included those associated with bladder neck abnormalities, fistulae to the bladder base or rectum, periurethral cavities and those patients with skeletal abnormalities precluding perineal access.^{7,8}

In the 1970s Turner-Warwick popularized a delayed 1-stage perineal approach comprising urethral mobilization followed by bulbo-prostatic anastomosis to bridge defects of up to 2.5 cm.⁹ This procedure became the standard repair for short strictures while substitution urethroplasty or transpubic urethroplasty continued to be used for longer defects or complex posterior urethral defects, respectively. In the 1980s we described an elaborated 1-stage anastomotic repair

through the perineum alone involving the progressive use of up to 4 steps to achieve a tension-free anastomosis in even the longest distraction defects.¹⁰ In 1991 we reported a 96% success rate using this technique in 74 cases during a 10-year period for defects as long 7 cm.¹¹ In this communication we present our continued experience in the last 10 years with this progressive perineal approach.

MATERIAL AND METHODS

Patients. A total of 129 males underwent posterior urethroplasty at Duke University Medical Center between May 1991 and May 2001. A 1-stage perineal anastomotic repair of PFUDD was accomplished in 122 cases (120 patients) and this cohort comprises the focus of our review. Patients with bulbomembranous strictures from other etiologies and those who underwent alternative repair were excluded from this review. The excluded group was comprised of 7 patients with strictures unrelated to trauma who underwent perineal anastomotic repair (5) and substitution urethroplasty (2), and 2 patients with stricture due to gunshot wound who underwent perineal anastomotic repair (1) and abdominoperineal repair (1), the latter due to concomitant urethrorectal fistula.

Preoperative evaluation. All patients underwent simultaneous retrograde urethrography (RUG) and voiding cystourethrography, urethroscopy, and antegrade cystourethroscopy via the suprapubic cystostomy tract. Early in our experience in cases where the urethra proximal to the point of obliteration

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tion could not be visualized fluoroscopically due to patient inability to mount a detrusor contraction, the study was repeated in the operating room with the patient under anesthesia at the repair. However, we no longer perform a cystogram at repair but rather rely on intraoperative antegrade flexible endoscopic findings in these instances. This change in approach is a result of a lack of fluoroscopic findings proximal to the point of obliteration that would have precluded our perineal approach.

Management. The acute treatment of patients presenting at our institution in most instances was placement of a suprapubic cystostomy tube with no attempt at immediate realignment, even in the patient who was explored for concomitant abdominal injury. Posterior urethroplasty was then performed a minimum of 1 month and in most instances 3 months after the traumatic event, using the 1-stage perineal anastomotic technique as previously described.^{10,11} Briefly, this operative technique comprised 4 sequential maneuvers to achieve a tension-free anastomosis.

Circumferential Urethral Mobilization of the Bulbar Urethra: This maneuver was conducted proximally to the point of obliteration and distally as far as the suspensory ligament of the penis. Mobilization beyond the suspensory ligament may result in chordee. A descending urethral sound was passed through the suprapubic cystostomy tract and negotiated through the bladder neck into the prostatic urethra. Midline perineal scar incision was then performed until the tip of the sound was encountered.

Separation of the Corporal Bodies: This maneuver was performed beginning at the level of the crus and progressing distally along a relatively avascular midline plane for approximately 4 to 5 cm. Further distal separation is usually not possible due to the more intimate connection between the corporal bodies. This separation allows the urethra to lie between the separated corporal bodies, thereby shortening the distance to the anastomosis.

Inferior Pubectomy: If tension remained the dorsal vein was displaced laterally or ligated and a wedge of bone was excised from the inferior aspect of the pubis. This maneuver allows the urethra to be redirected cephalad, resulting in an additional 1 to 2 cm of apparent urethral length. It also allows for exposure of an anteriorly displaced prostate.

Supracrural Rerouting: This final maneuver involved rerouting the urethra around the corporal body through a bony defect created by further pubectomy, shortening the distance to anastomosis up to an additional 2 cm. The dissection is performed away from the surface of the corporal body to avoid the cavernous nerves.

Regardless of the maneuvers used to bridge the defect the urethra was prepared by spatulation of the distal urethral stump at the 12 o'clock position and the proximal urethra at the 6 o'clock (posterior) position to achieve an anastomosis of at least 40Fr. The anastomosis was accomplished with 8 to 12 radially placed 4-zero polyglycolic acid sutures. A suction drain was rarely placed in more recent experience. Postoperative urinary drainage was accomplished with a 12 to 16Fr fenestrated silicone urethral catheter (12Fr in the last 5 years) in addition to a 12 to 16Fr suprapubic catheter. The urethral catheter was removed if extravasation was absent on the pericatheter RUG performed 3 weeks after the repair. The suprapubic catheter was removed after a successful voiding trial, usually on the same day.

Outcome analysis. Postoperative RUG was performed at 3 weeks, 3 months, 12 to 18 months and as needed thereafter. Abnormal radiographic appearances associated with decreased flow were further evaluated endoscopically. Chart review was used to note patient demographics, length of urethral defect and number of steps used to bridge it, length of hospital stay, period of urethral catheterization, and erectile function. Surgical outcome and need for subsequent pro-

cedures were also analyzed. Univariate statistics were reported as mean and range.

RESULTS

A total of 122 perineal anastomotic repairs for PFUDD using our progressive approach were performed in a 10-year period and have been followed for a mean of 64 months (range 9 to 128). All procedures were performed entirely through the perineum in a single stage. Average patient age was 32 (range 6 to 82) years, including 109 men and 11 prepubescent boys (younger than 13). Of the 120 patients 29 (24%) were considered secondary procedures following prior posterior urethroplasty performed elsewhere in 27 of 29 patients. The estimated radiographic preoperative length of the distraction defect was 3.1 (range 0.5 to 10) cm. Mean time between injury and repair was 9 (range 1 to 96) months. Average hospital stay was 3.5 (range 1 to 8) days for the length of the review period and decreased to 1.8 days in the last 2 years of the study. Mean duration of urethral catheterization was 3.4 weeks.

Perineal anastomotic repair was successful in 103 of 109 (95%) adults, 8 of 11 (73%) prepubescent boys and 25 of 29 (86%) secondary repairs. All treatment failures were at the anastomosis and occurred within the first postoperative year. In fact all but 2 failures were identified within the first 3 postoperative months. Of the 6 failures in the adult group 2 were salvaged successfully with optical urethrotomy alone while 3 continue to require self-calibration despite urethrotomy. These 3 are considered failures but have not required reoperation. The remaining adult failure was successfully salvaged with a secondary anastomotic repair. Of the 3 failures in the prepubescent group 1 was salvaged successfully with optical urethrotomy alone while 1 continues to require self-calibration despite urethrotomy and is considered a failure. The remaining pediatric failure was successfully salvaged with a secondary anastomotic repair. Overall, successful management of failed repairs was accomplished using endoscopic techniques in 3 of 7, and re-do perineal anastomotic repair in 2 of 2, resulting in a final success rate of 106 of 109 (97%) adults, 10 of 11 (91%) prepubescent boys and 28 of 29 (97%) secondary repairs.

Data on preoperative and postoperative erectile function were available in 117 of 120 (98%) patients. A total of 52 (44%) patients reported some erectile function preoperatively, 31 (26%) reported partial erections and 21 (18%) had normal erections. After urethroplasty 6 (5%) patients had return of normal erectile function while 3 (3%) had diminished erectile function.

DISCUSSION

Optimal timing (immediate versus delayed) and surgical approach (endoscopic versus open) of PFUDD remain controversial. Some advocate immediate urethral realignment instead of a stenting catheter,^{12,13} others recommend delayed primary realignment of the defect rather than a stenting catheter in the early period after injury and some suggest suprapubic cystostomy alone at the time of injury with delayed repair of the ensuing distraction defect.¹⁴ There are 3 circumstances in which immediate surgical exploration with pelvic hematoma evacuation and urethral realignment is generally indicated. These include concomitant bladder neck injury, severe prostatomembranous dislocation with a "pie-in-the-sky" bladder or rectal injury.^{7,9,14}

These situations are uncommon in patients sustaining automobile accidents or industrial accidents. Immediate open realignment of these injuries is associated with an unacceptably high morbidity and a high incidence of recurrent stricture (69%), urinary incontinence (20%) and erectile dysfunction (40%).¹⁴ Early endoscopic urethral realignment probably does not compromise continence or erectile function and may

TABLE 1. Contemporary outcomes of delayed repair of posterior urethral stricture and defect

References	No. Pts	Defect Length (cm)	Procedure	No. Stricture Cure (%)*
Webster and Ramon ¹¹	74	1.5-7	Progressive perineal approach†	71 (96)
Morey and McAninch ¹⁶	52, 30	—	Anastomotic repair, plus pubectomy‡	79 (97)
Ennemoser et al ¹⁷	65, 21	Less than 2.5, greater than 2.5	Perineal anastomotic repair,§	62 (95), 18 (86)
Corriere ¹⁸	58, 5	—, —	2-Stage substitution urethroplasty§	58 (100), 5 (100)
Present series	120	0.5-10	Perineal anastomotic repair, abdominoperineal approach Progressive perineal approach	116 (97)

* Final outcome of repair that in some instances required secondary repair or urethrotomy to achieve a stricture-free outcome.
 † Anastomosis achieved by urethral mobilization (8 cases), corporal body separation (33), inferior pubectomy (22) and supracrural rerouting (11).
 ‡ "Most pubectomies were complete and performed early in the series," more recently inferior pubectomy alone is adequate in most instances.
 § Repair was considered a failure if the flow rate was less than 15 ml per second.
 || Data on anastomotic technique were available for 113 of 122 cases, noting anastomosis by urethral mobilization (10 cases), corporal body separation (42), inferior pubectomy in (15) and supracrural rerouting (46).

result in stricture-free healing, thereby obviating the need for delayed repair.¹³ Endoscopic realignment may also decrease the length of subsequent strictures and place the disrupted ends in better alignment, which could lessen the difficulty of delayed perineal repair. Consequently, this treatment is our preference in appropriately selected cases. However, the gold standard must continue to be placement of a suprapubic cystostomy tube with formal repair of the defect deferred until a later date.

In our experience and as reported by others, delayed repair is invariably accomplished with a perineal approach resulting in stricture-free healing and minimal associated morbidity.^{11,14-18} More recently, delayed endoscopic "cut to the light" techniques for PFUDD have been performed primarily for short strictures.¹⁹ The exact role of this approach needs to be established with respect to which distraction defects (in terms of length, etiology and prior treatment) are amenable to this management and what the optimal timing is for this intervention. Many of these patients subsequently require urethrotomy and chronic self-calibration, and this outcome must be objectively compared to contemporary series of delayed perineal repair with their predictable success rate in excess of 90% and minimal morbidity (table 1).^{11,16-18} Furthermore, as in the series of delayed perineal repairs, successful outcome should be defined as urethral patency independent of periodic self-calibration.^{11,14-18}

The majority of urethral defects can be resolved through a perineal approach using the progressive 4-step technique, which is elaborated based on intraoperative findings to accomplish anastomosis in defects as long as 10 cm. A prohibiting factor in this approach is concomitant anterior urethral stricture or hypospadias, which may compromise blood flow to the distally based urethral flap (a result of bulbar urethral transection and mobilization). Additionally, prepubescent patients may have insufficient vascular connections in the glans resulting in inadequate retrograde blood flow. This fact may explain the lower success rate in prepubescent boys (91%) compared to the adult population (97%). However, despite the lower success rate in the prepubescent subgroup we continue to use our anastomotic approach in this popula-

tion since the success rate is superior to that of alternative approaches such as substitution urethroplasty.

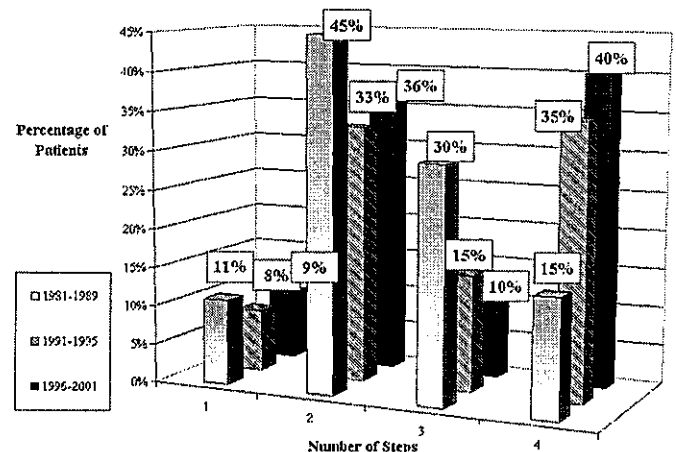
In our experience the only remaining indication for an abdominoperineal approach is the complex posterior urethral defect. These strictures would include the rare patient with concomitant urethral or bladder based fistulae to the rectum, skin or periurethral cavity requiring débridement and omentoplasty.^{11,14} We encountered only 1 such patient during the last 10 years signifying the decreased need for this classic approach. This incidence may be higher in series which include a predominance of war injuries due to explosive trauma, and in those communities where inexperienced surgeons may first "have a go." We no longer consider an open bladder neck on preoperative voiding cystography an indication for concomitant bladder neck reconstruction at posterior urethroplasty, thereby necessitating an abdominoperineal approach. Rather we elect to assess sphincteric function postoperatively, since in our experience incontinence is not an invariable outcome of bulboprostatic anastomosis.²⁰ This fact may be due to some preserved function of the distal sphincter mechanism or the inability of current diagnostic modalities to characterize bladder neck function accurately.

The magnitude of the defect is difficult to assess preoperatively by conventional radiography due to misalignment of the urethral ends and/or the inability of many patients to mount a detrusor contraction to open the bladder neck and allow the urethra proximal to defect to be visualized. In fact, the posterior urethra was seen on preoperative imaging in only 92 of 122 (75%) cases in this review (table 2). As a result we were not always able to predict accurately the number of steps needed to accomplish the repair based on preoperative imaging. In this 10-year review we noted a significant progression to more elaborate repairs. From 1991 to 1995, 35% of patients required all 4 steps to achieve anastomosis compared to 40% of patients from 1996 to 2001. Moreover, this

TABLE 2. Comparison of estimated length of urethral defect on preoperative fluoroscopy vs number of steps used in perineal repairs

	Defect Length (cm)			
	3 or Less	Greater Than 3	Unknown	Total
No.	72	20	30	122
No. step 1 (%)	7 (10)	1 (5)	2 (7)	10 (8)
No. step 2 (%)	28 (39)	4 (20)	10 (33)	42 (34)
No. step 3 (%)	8 (11)	2 (10)	5 (17)	15 (12)
No. step 4 (%)	25 (35)	12 (60)	9 (30)	46 (38)
Information not available	4 (6)	1 (5)	4 (13)	9 (7)

Estimated defect length based on preoperative simultaneous RUG and voiding cystourethrography. We were able to estimate the urethral defect length in 92 of 122 cases. In the remaining 30 cases the posterior urethra was not visualized (due to patient inability to mount a detrusor contraction), therefore the expected defect length was unknown.



Progression to more elaborate repairs during last 20 years

progression is even more apparent if the current series is compared to a previous experience from 1981 to 1989 in which only 15% of patients required all 4 steps (see figure).¹¹ We also noted in our current series a natural progression in our approach in that the majority of patients who underwent step 1 (urethral mobilization) progressed to step 2 (corporeal body separation), and those who required step 3 (inferior pubectomy) progressed to step 4 (supracrural rerouting). Thus from 1996 to 2001 only 9% of patients had step 1 performed without proceeding to step 2, and only 10% of patients progressed to step 3 without proceeding to step 4 (see figure).

It is unclear why there has been a shift toward more elaborate repairs to achieve tension-free anastomosis. One explanation is that our earlier series had a smaller percentage of prepubescent boys or secondary repairs compared to the current series.¹¹ These 2 subgroups often require more elaborate repairs as demonstrated in this review in which 73% of prepubescent patients and 68% of secondary repairs required all 4 steps to achieve anastomosis. Conversely, Morey and McAninch have not found it necessary to reroute the urethra around the corporeal body and are using pubectomy less frequently, even in cases of secondary repairs.¹⁶ Rather they rely on liberal urethral mobilization and corporeal body separation to accomplish a tension-free anastomosis.¹⁶ Alternatively, others continue to use substitution urethroplasty an abdominoperineal repair for longer defects.^{17,18} Consequently, this dissimilarity in techniques may suggest that our progression to more elaborate procedures may not be entirely explained by a change in demographics but rather a result of increasing confidence in the safety and success of our progressive perineal approach leading to a more aggressive pursuit of a tension-free anastomosis.

In the past, management of the failed anastomotic repair included the less than satisfactory staged scrotal inlay procedure or even urinary diversion in the most severe cases. However, as demonstrated in this review, most failures are short in length, occur at the anastomosis, and are responsive to optical urethrotomy (3 of 7) or re-do perineal anastomotic repair (2 of 2 patients). Similarly, other investigators have reported successful endoscopic management of recurrent anastomotic strictures and attribute this success to the short length of the stricture as well as a decrease in periurethral fibrosis after perineal repair.^{16,18}

CONCLUSIONS

The overall success of our progressive 1-stage perineal anastomotic repair of pelvic fracture urethral distraction defect continues to be excellent with the majority of failures occurring in prepubescent boys and secondary repairs. Furthermore, this versatile 4-step technique progressing sequentially through urethral mobilization, corporeal body separation, inferior pubectomy and supracrural rerouting enables tension-free anastomosis in defects as long as 10 cm. Substitution urethroplasty or abdominoperineal repair should be reserved for the occasional patient with concomitant anterior

urethral disease or a complex posterior urethral stricture, respectively. We believe that our approach to pelvic fracture urethral distraction defect can be performed with minimal morbidity and should remain the standard to which new endoscopic procedures are compared.

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