

# Application of the prior exposure maneuvers urethroplasty in complex posterior anastomotic urethroplasty

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**Objectives:** Current surgical interventions for pelvic fracture urethral injury (PFUI) are constrained by multiple limitations. This study aimed to introduce the prior exposure maneuvers urethroplasty (PEM-U) in complex posterior anastomotic urethroplasty for PFUI.

**Methods:** From February 2018 to March 2023 at Shanghai Ninth People's Hospital, 78 patients with complex PFUI underwent transperineal anastomotic urethroplasty, 39 patients of whom underwent classic Webster urethral urethroplasty in which bodies splitting or an inferior pubectomy after transection of bulbar urethra (Group A), and the other 39 patients underwent improved urethral urethroplasty (Group B), in which using PEM-U (corporeal bodies splitting or an inferior pubectomy before transection of bulbar urethra). Post-

operative evaluations were performed at 1, 3, 6, and 12 months after catheter removal. Success was defined as a urine flow rate  $\geq 15$  mL/s, no difficulty in urination, and no further intervention was required.

**Results:** There was no statistical difference in the length of urethral defect between 39 patients (mean age 43.7 years) in Group A and 39 patients (mean age 41.3 years) in Group B. The average operation time of Group A was 115 min (range, 90–150 min), and that of Group B was 93 min (range, 85–115 min) ( $p = 0.012$ ). The blood loss was 265 mL (range, 100–650 mL) in Group A and 214 mL (range, 90–350 mL) in Group B ( $p = 0.015$ ). The success rate was 89.7% in the classical group and 92.3% in the improved group.

**Conclusion:** The PEM-U was effective for treating complex PFUI cases, improving surgical efficacy, reducing the operation time, and the amount of blood loss.

**Key Words:** Prior exposure maneuvers urethroplasty, posterior anastomotic urethroplasty, pelvic fracture urethral injury

## Introduction

Transperineal anastomotic urethroplasty is the standard treatment of pelvic fracture urethral injury (PFUI).<sup>1–4</sup> The critical surgical goals are complete excision of the existing fibrotic scar and achievement of a tension-free anastomosis.<sup>5,6</sup> For some relatively simple patients with PFUI, tension-free anastomosis

can be achieved without the corporeal bodies splitting or an inferior pubectomy if the bulbar urethra is mobilized from the peno-scrotal junction and the scar around the proximal urethra is completely removed.

However, especially in the developing countries, more than 60% of patients with PFUI were complex, requiring corporeal bodies separation or an inferior pubectomy to achieve tension-free anastomosis because of the longer scar length and/or the bladder floats up.<sup>7–9</sup> In these cases, finding the normal proximal urethra could be challenging because the operating space is limited, and it bleeds repeatedly while removing the scar. This step will take the surgeon a lot of time. Most of the bleeding is at this step. To solve this problem, we present our experience with the prior exposure maneuvers urethroplasty (PEM-U) in anastomotic urethroplasty for complex PFUI.

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## Methods

### *Study design*

All procedures performed in studies involving human participants were in accordance with the Ethics Committee of Shanghai Ninth People's Hospital, affiliated to Shanghai Jiao Tong University School of Medicine (No. SH9H-2024-T965-4), and with the 1964 Helsinki declaration. Informed consent was obtained from all individual participants included in the study. This is a retrospective, single-centre, non-randomised study about the transperineal anastomotic urethroplasty for the surgical treatment of PFUI.

From February 2018 to March 2023, this study excluded patients with simple posterior urethral anastomosis (without corporeal bodies splitting and the inferior pubectomy), bladder neck stenosis, posterior urethral fracture with false canal and rectal fistula, younger than 14 years old, overt bladder neck incompetence or prior transurethral prostate surgery, and severe proximal–distal urethral misalignment or extensive urethral loss who required combined abdomino-perineal or transpubic approaches were not included in this series. All operations were performed by the same senior reconstructive urologist (Minkai Xie), assisted by a stable team within our department. This study included 78 eligible patients in Shanghai Ninth People's Hospital.

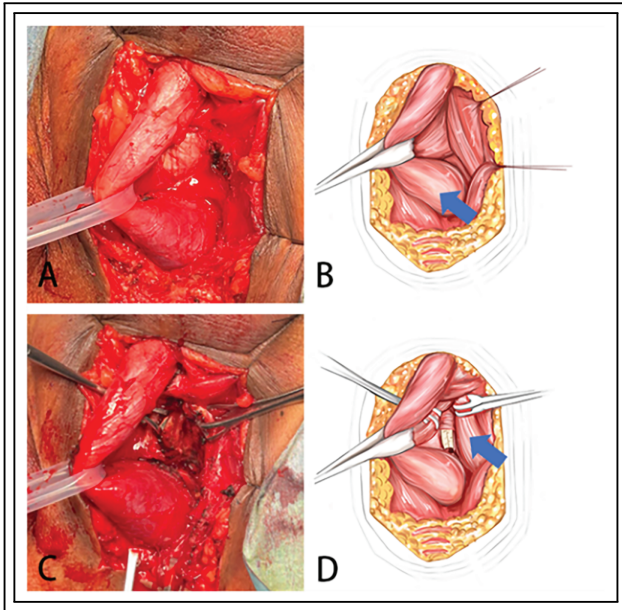
### *Surgical procedure*

In order to achieve a tension-free anastomosis, it is necessary to split the corporeal bodies or the inferior pubectomy. Preoperative retrograde urethrography (RUG) and voiding cystourethrogram (VCUG), and cystoscopy were routinely performed to evaluate the length and location of the urethral defect. Urethrography showed that the length of the urethral defect was greater than 2 cm, and the corpora bodies were splitting, or the inferior pubectomy was likely required. Preoperative penile erectile function was assessed using the International Index of Erectile Function-5 (IIEF-5) questionnaire, and postoperative degree of urinary incontinence was assessed using the pad test.

Thirty-nine patients underwent a classic Webster posterior urethral urethroplasty (Group A). In brief, the patient was placed in the lithotomy position. The inverted Y-shaped incision was made, and the bulbospongiosus muscle was split. The bulbar urethra was fully mobilized, the pubicoprostatic ligament was transected, and the stenotic urethral segment was further circumferentially mobilized, reaching the proximal urethral end. Then the distal urethra was transected, and the remaining proximal urethra scar

was removed layer by layer with electric knives, scissors, and a knife until the normal prostatic urethra mucosa was reached. This step was under the guidance of a urethral bougie or an endoscopy in the proximal urethra, passed through the suprapubic cystostomy (SPC). For accomplishing a tension-free urethral anastomosis, then separate the corporeal bodies or the inferior pubectomy. A mucosa-to-mucosa urethral anastomosis was then performed over a catheter with 8 interrupted sutures, using 4-0 polyglactin sutures, to achieve urethral reconstruction. Then we sutured the bulbous cavernous muscle, subcutaneous tissue, and skin layer by layer. An indwelling negative pressure drainage tube is placed on the outer layer of the bulbar cavernous muscle.

In the other group of 39 patients, the PEM-U (Group B) was adopted. Through an inverted Y-shaped perineal incision, the bulbar urethra was fully mobilized (Figure. 1A,B), and the puboprostatic ligament was incised. From this point on, unlike the classical group, we used a urethral bougie or endoscopy and found that the proximal urethral end was relatively deep, predicting that corporeal bodies separation would be required. We first used a needle electrode and a knife to separate corporeal bodies (Figure. 1C,D). With the help of traction from the distal urethra, the scar is more easily removed completely. In order to avoid damage to the rectum as much as possible, we chose to excise the scar from 12 o'clock. After separating corporeal bodies. The operation exposure was larger. At this point, if the location of the proximal urethra is still unknown with the help of a urethral bougie or an endoscope, a section of the inferior pubic margin can be excised (the inferior pubectomy), and the scar can be further excised until the proximal urethra end can be clearly touched (Figure. 2A,B). The bulbar urethra was now transected (Figure. 2C,D). The PEM-U was performed after the separation of the corporeal bodies and resection of the inferior margin of the pubis. At this point, two scenarios could happen. First, the normal mucosa of the posterior urethra could be exposed directly. There is another scenario, where there is still a small amount of scar residue, which can be excised with blades and scissors until the normal proximal urethral mucosa is reached. The distal urethral scar was excised, and tension-free urethral anastomosis was performed (Figure. 2E,F). Finally, the muscle of the cavernous body, subcutaneous tissue, and skin were sutured layer by layer. A negative pressure drainage tube was also indwelled outside the bulbocavernosum muscle.



**FIGURE 1.** Conventional surgical exposure. (A,B) The bulbar urethra was fully mobilized; Blue arrow, bulbar urethra. (C,D) The corporeal bodies were separated. Blue arrow points corporeal body

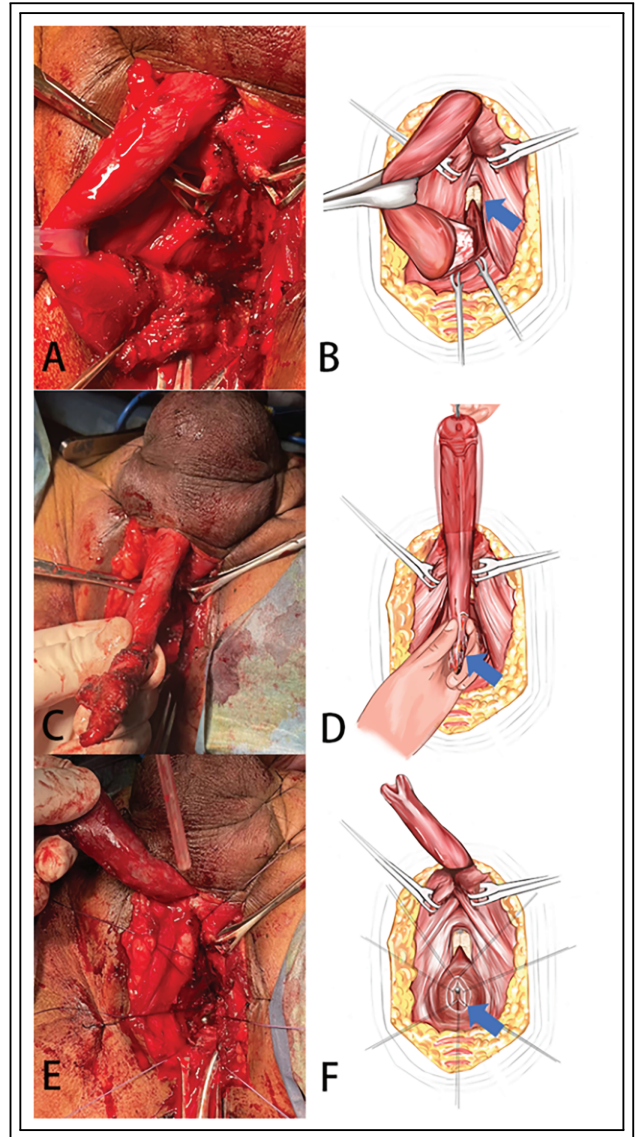
*Postoperative evaluation and definitions*

The negative pressure drainage tube was removed 3 days after the operation, the catheter was removed 3 weeks later, and the cystostomy tube was removed 2 weeks after normal urination. Postoperative evaluations were performed at 1, 3, 6, and 12 months after the operation. Urethrography and urine flow rate were performed 1 month after the operation, and urine flow rate was examined again 6 months, 12 months after the operation, and the IIEF-5 questionnaire was used to evaluate the erectile function before and after the operation at 6, 12 months after the operation.

We defined “no erectile dysfunction (ED)” as preoperatively IIEF-5  $\geq 22$  and ‘decreased erectile function’ as a reduction of  $\geq 5$  points in the IIEF-5 score compared with baseline in this study. The degree of urinary incontinence was evaluated by the pad test. Urethrography and cystoscopy were performed for postoperative dysuria or anal leakage. Success was defined as a urine flow rate  $\geq 15$  mL/s, no difficulty in urination, and no further intervention was required.

*Statistical analysis*

All the data were processed by SPSS 24.0 (IBM Corp., Armonk, NY, USA). The Student’s *t*-test analysis was utilized for comparisons between groups.  $p < 0.05$



**FIGURE 2.** Key surgical maneuvers of the PEM-U. (A,B) A section of the inferior pubic margin was excised; Blue arrow, inferior pubic margin. (C,D) The bulbar urethra was transected; Blue arrow, bulbar urethra. (E,F) The tension-free urethral anastomosis was performed. Blue arrow points proximal urethra

represents statistical significance. Data are expressed as mean (range).

**Results**

There was no statistical difference in age and length of urethral defect between 39 patients in Group A and 39 patients in Group B, as shown in [Table 1](#). In

Group A, 24 patients had corporal body splitting, and 15 also underwent inferior pubectomy; in Group B, the corresponding numbers were 22 and 17. The average operation time of Group A was 115 min (from 90–150 min), and that of Group B was 93 min (85–115 min). There was a statistical difference ( $p = 0.012$ ). The blood loss was 265 mL (100–650 mL) in Group A and 214 mL (90–350 mL) in Group B. It was statistically significant ( $p = 0.015$ ). In Group A, there were 3 cases of postoperative anastomotic stenosis, 1 case of urethrorectal fistula, and 2 cases of anastomotic stenosis that were cured by internal urethrotomy, and the patients with urethrorectal fistula were cured by perineal repair surgery 6 months after the operation. In Group B, there were 3 patients with postoperative anastomotic stenosis and no urethrorectal fistula, and 2 patients were cured by internal urethrotomy. The success rate was 89.7% in Group A and 92.3% in Group B. Preoperatively, no erectile dysfunction was noted in 25 patients in group A and 26 in group B; postoperatively, two patients in each group experienced decreased erectile function. There were 7 cases of mild to moderate urinary incontinence in Group A and 8 cases of mild to moderate urinary incontinence in Group B. These patients regained urinary control within 6 months, and no further surgical treatment was performed.

## Discussion

The management of PFUI remains a formidable challenge within the realm of urological practice.<sup>10,11</sup> A spectrum of therapeutic approaches has been proposed, encompassing dilatation, endoscopic urethrotomy, and anastomotic urethroplasty. However,

a multitude of studies have substantiated that the long-term success of treating PFUI with dilatation and endoscopic urethrotomy is not assured.<sup>12–15</sup> Certain surgeons endorse the approach of primary realignment (PR) following urethral disruption. Mouraviev et al.<sup>16</sup> documented the implementation of realignment in 57 out of 96 cases of pelvic injuries accompanied by urethral disruption, and reported a urethral patency rate of 51% during the 2-year follow-up period. The subjects were carefully selected, indicating that they likely sustained less severe injuries; only 19% exhibited prostatic or membranous urethral disruptions, with the majority presenting with bulbar urethral injuries. Early intervention can be impeded by factors such as bleeding and hematoma, concomitant injuries, potential instability, and the edema and friability of the traumatized tissues. The American Urological Association (AUA) guidelines recommend that, in most instances of PFUI, surgeons should opt for immediate suprapubic-cystostomy tube (SPT) placement instead of PR.<sup>17</sup> At our institution, instances necessitating PR are infrequent, with the majority of cases being those of PEM-U. Following patient stabilization, delayed repair is typically scheduled for 3 to 6 months post-rehabilitation. The initial diagnostic approach invariably involves a combination of RUG and VCUG to ascertain the defect's length, exclude the presence of fistulae, and evaluate the position of vital landmarks and bony structures. Preoperative RVCUG is routinely conducted to assess the urethral defect's dimensions and location. It is often observed that the actual defect length exceeds that indicated by urethrography. Magnetic resonance imaging (MRI) or computed tomography (CT), which

**TABLE 1. Comparison of classic Webster posterior urethral urethroplasty and PEM-U for pelvic fracture urethral injury**

Characteristic	Group A	Group B	<i>p</i>
Age (years), mean (range)	43.7 (24–61)	41.3 (25–63)	0.28
Length of urethral defect (cm), mean (range)	3.7 (3.2–5.0)	3.8 (3.0–5.5)	0.26
Corporal body splitting only (n, %)	24 (61.5)	22 (56.4)	N/A
Corporal body splitting + Inferior pubectomy (n, %)	15 (38.5)	17 (43.6)	N/A
Operational time (min), mean (range)	115 (90–150)	93 (85–115)	0.012
Blood loss (mL), mean (range)	265 (100–650)	214 (90–350)	0.015
Complications, n	Anastomotic stenosis	3	N/A
	Urethrorectal fistula	1	0
Success rate (%)	89.7	92.3	N/A
Decreased erectile function, n	2	2	N/A

can provide three-dimensional visualization, offers distinct advantages in this assessment.<sup>18,19</sup>

For PFUI, delayed anastomotic urethroplasty has been extensively adopted and is recognized as the gold standard procedure globally.<sup>6,20-22</sup> In the conventional approach, the Webster technique typically initiates by thoroughly mobilizing the distal bulbar urethra. Subsequently, the pubicoprostatic ligament is transected to facilitate the descent of the stenotic posterior urethra. Following this, the bulbar urethra is divided, and the proximal end of the stricture is delineated using a urethral bougie or endoscopic examination via the suprapubic cystostomy. The surrounding scar tissue of the proximal urethra is then meticulously excised to expose the healthy proximal urethral mucosa.

Despite its efficacy, delayed anastomotic urethroplasty remains a procedure that is not commonly encountered and poses a challenge for the majority of urologists. Studies have indicated that a significant proportion, approximately 60%, have operated on fewer than three patients throughout their professional lives, with a mere 5% having performed the surgery on more than ten patients.<sup>23</sup> Therefore, a simpler surgical method is necessary to improve the success rate of surgery. We also found that there were disadvantages to this procedure. First, the space is relatively small, the operation is more difficult; Second, there are a lot of residual scars in the proximal end. Each time a layer of scars is removed, there will be bleeding, and then we need to stop bleeding, which leads to more blood loss and a longer operation time. Therefore, we changed the program and used a urethral dilator and cystoscope evaluation behind the puboprostatic ligament.

Preoperative urethrography found that the normal proximal prostatic urethra was more than 1 cm behind the pubic anterior border. Second, according to the intraoperative endoscope and urethral dilator, the prostatic urethra was relatively deep, and intraoperative tense-free anastomosis required corporeal bodies separation or an inferior pubectomy. We used needle electrodes and blades to separate the corporeal bodies to fully expose the surgical space. Starting from 12 o'clock, an electric knife was used to gradually cut the scar on both sides. Finally, at 6 o'clock, it was relatively easy to remove the scar because the bulbar urethra could be pulled at the time. Starting at 12 o'clock and ending at 6 o'clock is also meant to reduce the likelihood of injury to the rectum. If it is found that there is still some distance between the bulbar urethra and the posterior urethral mucosa at this time, a part of the lower pubic margin can be excised, and the bulbar urethra can be cut off

as deeply as possible. At this time, there are two scenarios: one is that the normal mucous membrane of the posterior urethra is directly exposed, which is the result that surgeons most hope to see; the other is that there is still scar residue, but because the surgical space is larger at that time, this allows the surgeon to remove the remaining scar more easily, the remaining scar is as small as possible, which will also reduce the repeated bleeding caused by repeated scar removal.

Of course, there are concerns about whether this method is "excessive" and whether it could impair erectile function. First, while previous studies have shown that patients with pelvic fractures and posterior urethra ruptured have erectile dysfunction problems in more than 68% of cases,<sup>8</sup> in the study did not show a greater impact on erectile function with its more classical approach. In terms of urine incontinence, there was also no significant statistical difference between the two groups. In fact, more failures are due to the inability to achieve a tension-free anastomosis because of inadequate excision of the inferior pubic margin. In order to avoid a false path, we still use a cystoscope during the operation to confirm the correct path. Although similar cases have been reported before, our study still has some differences. Xie et al.<sup>24</sup> reported non-transecting spongiosum anastomotic urethroplasty for PFUI, focusing mainly on preservation of erectile function in relatively short (<2.5 cm) strictures. More recently, Gómez et al.<sup>25</sup> and Katsuta et al.<sup>5</sup> described non-transecting or vessel-sparing posterior urethroplasties, again emphasising urethral vascular preservation and functional outcomes rather than operative efficiency. We emphasize that the integrity of the bladder neck and external sphincter plays a vital role in postoperative continence after PFUI repair, and we acknowledge that occult damage caused by pelvic trauma may still lead to temporary urinary incontinence, even when the bladder neck appears radiologically intact.

Although our results revealed some advantages, we emphasise that the PEM-U should not encourage more liberal use of corporal splitting or pubectomy, but rather aims to make these inevitable steps safer and more efficient in patients who already require them. This study has some defects. Firstly, it is a retrospective single-center study, which has research bias; secondly, causality between the modified sequence and improved intraoperative parameters cannot be firmly established due to the different learning curve; thirdly, during the early learning phase, insufficient exposure and aggressive use of cautery around the corpora might increase bleeding risk, and we

emphasise careful step-by-step dissection and identification of key landmarks; Fourthly, the modest sample size and the exclusion of patients with pre-injury ED limit the power of our erectile-function analysis; postoperative changes must therefore be interpreted cautiously, and larger studies with longer prospective follow-up are required to determine the technique's true impact on both erectile function and urinary continence.

## Conclusions

We improved the traditional posterior anastomotic urethroplasty in patients who needed corporeal bodies separation with or without an inferior pubectomy through preoperative and intraoperative evaluation. Before the bulbar urethra is dissected, we do a corporeal bodies separation, even a subpubic resection, which gives us more space to maneuver, and as much scar can be taken away. The technique appears feasible and may reduce operative time, blood loss, and occurrence of rectal fistula, but further prospective and ideally multi-centre validation would be required.

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## Author Contributions

Minkai Xie: project development, manuscript writing, manuscript editing, images drawing. Chong Liu: protocol development, data management. Ziwei Wei: data collection, manuscript editing. Bin Xu: supervision, manuscript editing. All authors reviewed and approved the final version of the manuscript.

## Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Ethics Approval

This study was approved by the Ethics Committee of Shanghai Ninth People's Hospital, affiliated to Shanghai Jiao Tong University School of Medicine (No. SH9H-2024-T965-4).

## Informed Consent

Informed consent was obtained from all individual participants included in the study.

## Conflicts of Interest

The authors declare no conflicts of interest to report regarding the present study.

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