Updated Outcomes of Early Endoscopic Realignment for Pelvic Fracture Urethral Injuries at a Level 1 Trauma Center

Paul H. Chung, Hunter Wessells, and Bryan B. Voelzke

OBJECTIVE To present our updated experience and discuss potential benefits of early endoscopic realignment (EER) for patients with pelvic fracture urethral injuries (PFUIs).

METHODS A retrospective review of patients treated with EER after blunt PFUIs was performed. EER was performed with a retrograde or a combined antegrade or retrograde approach with a cystoscope. Treatment success was defined as no secondary procedure or the ability to pass a cystoscope across the area of injury or surgical anastomosis.

RESULTS Thirty-two patients (mean age 38 years, range 17-73) underwent EER between 2004 and 2016 with a mean follow-up of 26 months (range 1-102). Median time to realignment was 2 days (range 0-6) and was performed concomitantly with another surgical service in 72% of cases. Median operative time for EER was 38 minutes (range 8-100). Using an intent-to-treat analysis, 29 patients (91%) failed EER. Nine patients underwent a subsequent endoscopic procedure with 22% success rate. Excision and primary anastomotic urethroplasty was performed in 24 patients as a primary or secondary treatment with 96% success rate.

CONCLUSION Our overall success rate for EER was 9%, but did not hinder subsequent urethroplasty success. The decision for performing EER should not be based on success alone. Secondary benefits of EER exist and may assist with the multidisciplinary care of a patient with complex trauma. The management of PFUI is challenging and these patients should be referred to tertiary centers. UROLOGY 112: 191–197, 2018. © 2017 Elsevier Inc.

The mainstay objectives for managing pelvic fracture urethral injuries (PFUIs) are to obtain prompt urinary drainage and reestablish urethral continuity while minimizing the risks of complications. The early treatment of PFUI with early endoscopic realignment (EER) vs suprapubic tube placement (SPT) and delayed open repair is controversial. Benefits of EER include the ability to tamponade bleeding, facilitate orthopedic procedures, allow possible early return to spontaneous voiding after initial catheter placement, and maintain sufficient urethral patency to avoid open treatment.[1-4] EER patients may also develop less severe and better aligned strictures to facilitate endoscopic or open repair.[5,6] Proponents of SPT and delayed repair report that EER patients may experience a prolonged clinical course, a delayed return to unobstructed urethral voiding, and decreased success with subsequent urethroplasty.[7,8] Regardless of the initial treatment of PFUI, providers may agree that an early referral to a reconstructive urologist is prudent.

At our institution, an attempt at EER is performed for patients who sustain PFUI. Our initial experience between 2004 and 2010 included 19 patients and reported a 21% success rate for EER with a mean follow-up of 40 months.[1] We report our updated experience with EER after PFUI (32 patients between 2004 and 2016 with a mean follow-up of 26 months) and discuss secondary benefits of EER.

MATERIALS AND METHODS

A retrospective chart review was performed in consecutive patients treated for PFUI between 2004 and 2016 at Harborview Medical Center, a level 1 trauma center serving the Pacific Northwest. This included all patients previously reported in our initial study, except for 1 patient.[1] This patient suffered from an anterior bladder neck injury extending to the proximal prostatic urethra, not a PFUI consistent with other patients in this study. The patient had been previously reported as an EER success. Patients with clinical suspicion for a PFUI after initial blunt pelvic injury underwent retrograde urethrography (RUG) or flexible cystoscopy to confirm the diagnosis as part of the initial trauma evaluation. The majority of patients underwent bedside SPT placement

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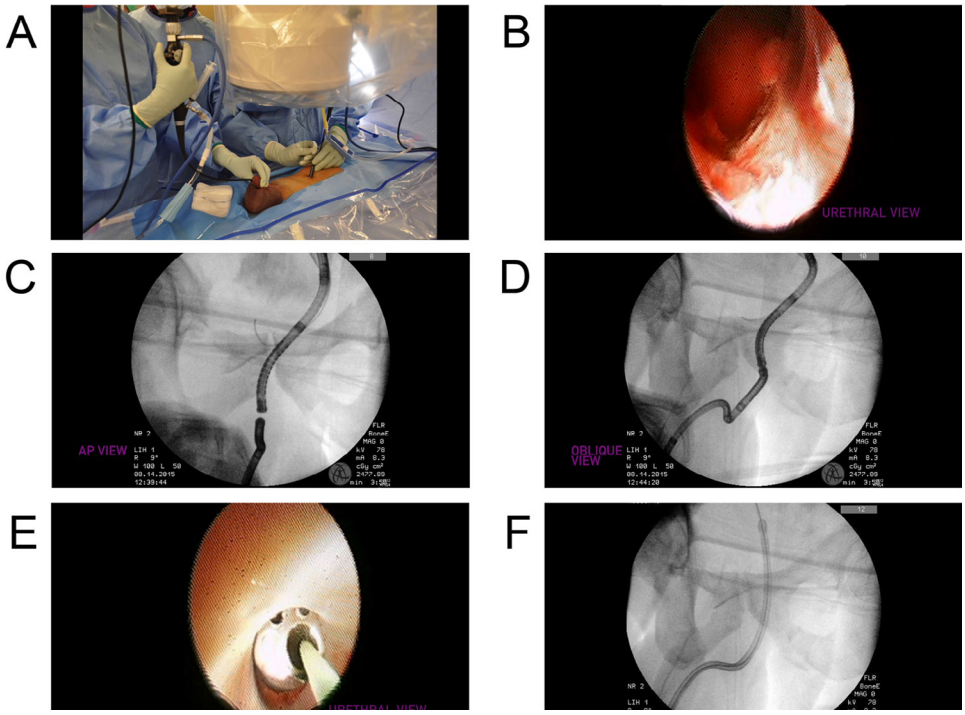

Figure 1. A two-physician approach was used for performing early endoscopic realignment in the operating room. **(A)** One urologist directed a cystoscope through the penis, whereas another urologist directed a second cystoscope through the suprapubic tube placement tract. **(B)** The urethral injury was visualized through the urethral scope. **(C and D)** Using biplanar fluoroscopy, anterior or posterior and oblique fluoroscopic views were used to align the scopes within the urethra. **(E)** Once 1 cystoscope had traversed across the urethral injury, a wire was passed through 1 cystoscope directly into the working channel of the second cystoscope. **(F)** A council catheter was placed over the wire into the bladder and the suprapubic tube was not replaced. (Color version available online.)

for urinary drainage. A minority of patients underwent EER over a wire placed during cystoscopy in the emergency room and did not require SPT placement. Delay to EER was commonly the result of clinical instability or an unstable pelvic fracture that required stabilization before EER could be safely performed. EER was commonly performed concurrently with another surgery. Urethral injury severity was graded as partial or complete based on cystoscopic evaluation.

EER was performed in the operating room using a two-physician approach with the patient in the supine position (Fig. 1). A cystogram was performed through the SPT to identify the bladder contour and facilitate dilation of the existing SPT tract. One urologist directed a cystoscope through the penis, whereas another urologist directed a second cystoscope through the SPT tract. Fluoroscopy was used to help align the cystoscopes within the urethra by first using anterior-posterior fluoroscopy imaging to align the two cystoscopes followed by an oblique image to modify discrepancies in distance between the cystoscopes. A wire was then passed through 1 cystoscope and guided into the working channel of the second cystoscope. A council catheter was then placed over the wire into the bladder to achieve urethral realignment. The SPT was not replaced. EER was discontinued if reasonable, unsuccessful attempts had been made.

Urethral catheterization was continued for a minimum 2-3 weeks for partial injuries and 6 weeks for complete disruptions. A pericatheter RUG or voiding cystourethrogram was performed to ensure healing before catheter removal. The catheter was replaced if persistent leakage from the injury site was noted. Patients were followed monthly with uroflowmetry and postvoid residual after urethral catheter removal. Patients were then followed up at 3, 12, and 24 months with uroflowmetry, postvoid residual, or cystoscopy.

An intention-to-treat analysis was used for patients who did not return for follow up after EER. For patients that failed EER, direct visual internal urethrotomy (DVIU) or urethral dilation was offered if the stricture was less than 1-2 cm and not obliterated. Posterior excision and primary anastomotic (EPA) urethroplasty was performed for the remaining patients and additional maneuvers such as corporal splitting and partial or total pubectomy were performed as necessary. Successful treatment with endoscopic realignment, DVIU of dilation, or urethroplasty was defined as no further procedures, including self-catheterization, and no stricture recurrence noted on follow-up cystoscopy. We did not perform "cut to the light" techniques for obliterated strictures or manage any patient with intermittent catheterization.

RESULTS

Patient, Injury, and EER Details

Thirty-two patients (mean age 38 years, range 17-73) underwent EER at our institution between 2004 and 2016 with a mean follow-up of 26 months (range 1-102) (Table 1). Mechanisms of injury included motor vehicle or motorcycle collisions (n = 15, 47%), motor-pedestrian collisions (n = 7, 22%), crush injuries (n = 8, 25%), and falls

Table 1. Patient, injury, and surgery demographics and follow-up data

	No.	Range/%
Patient demographics		
Number of patients	32	—
Mean age (y)	38	17-73
Mean follow-up (mo)	26	1-102
Mechanism		
Motor-vehicle or motorcycle collision	15	47%
Motor-pedestrian collision	7	22%
Crush injury	8	25%
Fall	2	6%
Concomitant genitourinary injuries		
Scrotal laceration	1	3%
Grade 4 renal injury	1	3%
Urethral injury and EER details		
Severity of urethral injury		
Partial	4	13%
Complete	28	87%
Immediate urine diversion		
Urethral catheter	3	9%
Suprapubic tube	29	91%
Median time to EER (d)	2	0-6
Median operative time for EER (min)	38	8-100
EER performed at the time of another operation	21	72%
Orthopedic infection	1	3%
Follow-up details		
Median time to urethral catheter removal (d)	56	12-98
Median time to primary urethroplasty from injury (mo)	4.8	3.3-67.3
Median time to DVIU/dilation from injury (mo)	4.5	2.2-9.4
Median time to secondary urethroplasty from injury (mo)	10.3	6.8-15.9
Urethroplasty details		
Median length of stricture (cm)	1.5	1.0-3.0
Median operative time (min)	221	131-498
Surgical dissection		
Corporal splitting	4	17%
Partial pubectomy	2	8%
Corporal re-routing	0	0%
Surgical approach		
Perineal	23	96%
Abdominal + perineal	1	4%

EER, early endoscopic realignment; DVIU, direct visual internal urethrotomy.

(n = 2, 6%). All patients suffered from pelvic fractures and 2 patients suffered from concomitant genitourinary injuries: scrotal laceration and grade 4 renal laceration. During the initial trauma assessment, 3 patients (9%) underwent EER in the emergency room with cystoscopy and complex urethral catheter placement. The remaining 29 patients (91%) underwent SPT placement with delayed EER in the operating room. Median time to delayed EER was 2 days (range 0-6). EER was scheduled with another surgical service in 21 patients (72%) and median operative time was 38 minutes (range 8-100). Urethral injury severity was classified as either complete (n = 28, 87%) or partial (n = 4, 13%).

EER Results

After EER, the urethral catheter was removed at a median of 56 days (range 12-98) after urethral healing was confirmed on RUG or voiding cystourethrogram. Three patients (9%) were successfully treated with EER (Fig. 2). Using an intent-to-treat analysis, 29 patients (91%) failed EER: 28 patients (88%) developed obstructive voiding symptoms and required further treatment and 1 patient was lost to follow-up immediately after EER.

Management of EER Failures

One patient who failed EER elected permanent SPT because of an additional diagnosis of metastatic pancreatic cancer. Nine patients who failed EER underwent primary endoscopic management with urethral dilation or DVIU with 22% success rate (n = 2). Seven patients failed primary endoscopic management: 6 patients underwent successful anastomotic urethroplasty as a secondary treatment and 1 patient was lost to follow-up. Eighteen patients who failed EER underwent anastomotic urethroplasty as a primary treatment. In total, success rate for primary and secondary urethroplasty was 96%. Our 1 patient who failed urethroplasty suffered from a traumatic brain injury and had poor follow-up care. He underwent urethroplasty 5 years after the initial PFUI in an attempt to make him catheter free because of his history of repeated, self-traumatic catheter removals managed by his nursing home. The etiology of his stricture recurrence is unclear, as the nursing home replaced his urethral catheter to manage urge incontinence. He was eventually managed with a chronic SPT.

Timing of Primary and Secondary Urethroplasty

Median time to primary anastomotic urethroplasty after failed EER was 4.8 months (range 3.3-67.3) (Table 2). Median time to secondary anastomotic urethroplasty after failed EER and subsequent endoscopic management was 10.3 months (range 6.8-15.9). Median stricture length was 1.5 cm (range 1.0-3.0) and operative time was 221 minutes (range 131-498). Corporal splitting was performed in 17% (n = 4) of patients and partial or total pubectomy in 8% (n = 2) of patients. Urethral corporal rerouting was not required. Urethroplasty was performed via a perineal approach in 96% (n = 23) patients and a combined abdominal or perineal approach in 1 patient.

COMMENT

Our updated experience with PFUI showed a decrease in success rate from 21% to 9% for EER alone and a decrease in success rate from 50% to 22% for patients who underwent subsequent DVIU or dilation after failed EER. Unfortunately, there are few data from this study or even a recent meta-analysis to identify those patients that may benefit or be harmed by EER.[9] The 3 patients in our study who were successfully treated with EER alone included a wide range of characteristics from partial to >2 cm urethral injuries and both operative and nonoperative pelvic fractures. Prospective, multi-institutional trials or registries

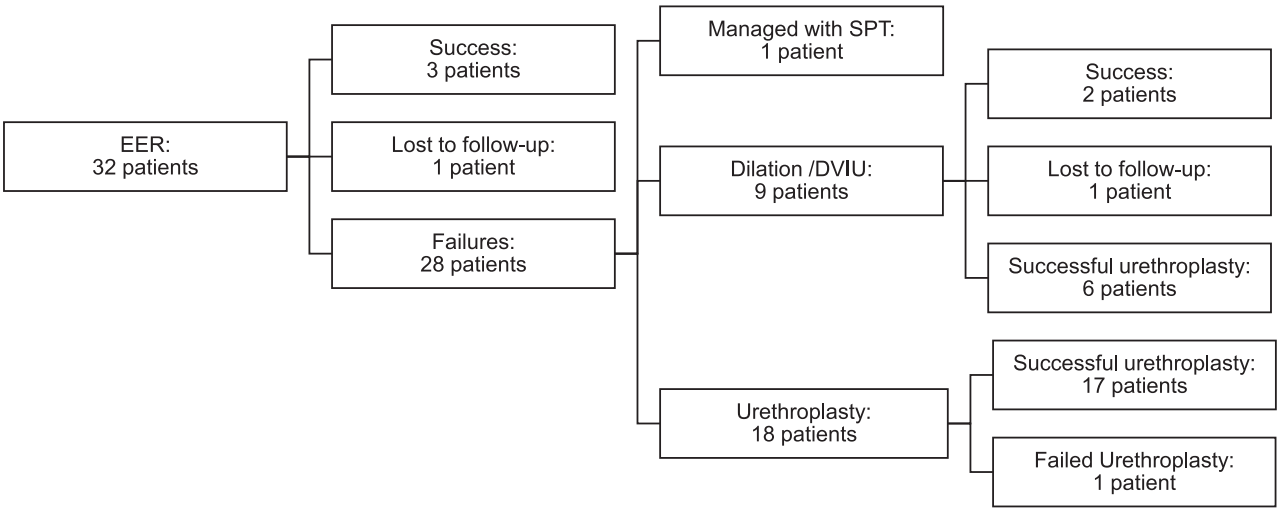

Figure 2. Patient management algorithm after pelvic fracture urethral injuries. EER, early endoscopic realignment; DVIU, direct visual internal urethrotomy; SPT, suprapubic tube placement.

Table 2. Time to urethroplasty among different EER series

Intervention	Time to Urethroplasty, mo (Range)	Endoscopic Interventions, No. (Range)	Series
Failed EER only + urethroplasty	4.8 (3-63)	—	Chung et al.
SPT only + urethroplasty	6 (3-15)	—	Tausch et al.
SPT only + urethroplasty	5.8 ± 1.6	—	Johnsen et al.
Failed EER + failed DVIU/dilation + urethroplasty	10.3 (7-16)	1 (1-2)	Chung et al.
Failed EER + failed DVIU/dilation + urethroplasty	25 (4-574)	4 (1-36)	Tausch et al.
Failed EER + failed DVIU/dilation + urethroplasty	14.6 ± 7.6	1 (1-2)	Johnsen et al.

EER, early endoscopic realignment; DVIU, direct visual internal urethrotomy; SPT, suprapubic tube placement.

with a larger patient cohort may also help to address these issues.

The patients who underwent successful EER or successful endoscopic management for failed EER were all from our previous report. EER failed in the subsequent 13 patients added in this study. Of these 13 patients who failed EER, we attempted endoscopic management for only 1 patient and were unsuccessful. Endoscopic management should be limited to patients with nonobliterated, short urethral defects or those who are unable to undergo open surgical repair.[10] Fortunately, failures in both EER and subsequent endoscopic management did not compromise the success of formal repair as our success with primary and secondary urethroplasty was 96%.[7,8]

EER Technique and Timing

Up to 10% of patients who sustain a traumatic pelvic fracture will concomitantly sustain a urethral injury.[11] Immediate primary reconstruction for PFUI is no longer performed because of lower success rates compared with delayed repair and the challenges of operating in the setting of acutely inflamed tissue, hematoma, and distorted anatomy.[4] The early realignment of acute injuries was first described in 1934 by Ormond and Cothra, and advances in endoscopic technology since that time continue to provide an alternative to SPT management and immediate primary reconstruction.[12] EER management is often performed in the operating room with high technical success and minimal morbidity. We agree with American Urological Association Urotrauma Guidelines which recommend against prolonged attempts at endoscopic realignment in patients with stable pelvic fractures.[13] In our experience, we have aborted EER for only 2 patients. As a result of the low volume of failures, we are unable to provide detailed contraindications for EER; however, we attribute these 2 failed EER attempts to large distraction defects.

Criticisms of EER include its potential morbidity and frequent need to be performed in the operating room. EER may theoretically manipulate and introduce fluid into the pelvic cavity, increasing the risk of infection; however, this has not been our experience, and descriptions of pelvic abscess after EER are rare.[7] EER may also theoretically turn a partial disruption into a complete disruption. We believe the use of endoscopy via a two-team approach and biplanar fluoroscopy should minimize an iatrogenic injury to the urethral tissue when performed under direct imaging compared with other realignment techniques that rely on interlocking sounds, catheters, or fluoroscopy alone. The timing of EER should not be a deterrent to its use. EER does not need to be performed acutely. We performed EER in a supine position at a median of 2 days and up to 6 days after the initial presentation during regular daytime hours.

We have performed EER in conjunction with another surgical procedure in 72% of cases, most of which have been orthopedic cases to stabilize the pelvis. This timing allows access to the pelvis, which is often previously covered by sheeting used for stabilization.

Secondary Benefits of EER

We believe that EER is a safe treatment option for patients with PFUI. Although the long-term success of EER is low, success should not be the only determinant to determine its use. Secondary benefits should be considered. EER may provide an opportunity to maintain urethral patency, undergo endoscopic treatment for failures, avoid open reconstructive surgery, improve urethral realignment in preparation for open surgery, and potentially avoid infection of internally placed orthopedic hardware. This is in contrary to patients treated with SPT alone who are guaranteed to develop an obliterated stricture that is not amenable to possible delayed endoscopic treatment necessitating delayed urethroplasty.[14] Whether prior EER facilitates urethroplasty remains controversial.[5,7] EER may result in shorter strictures, and maintained urethral patency from EER may assist with identifying the urethral lumen more easily during surgery and may require less extensive use of adjuvant dissection techniques (ie, corporal splitting and pubectomy). Although some studies have shown that there is no difference in success with urethroplasty regardless of whether EER was performed, a urethroplasty for a PFUI is a difficult surgery and any potential advantage of EER should not be overlooked. A recent study from Zou et al evaluated the need for ancillary procedures in patients who underwent urethroplasty after EER vs SPT with delayed repair: corporal splitting (13% vs 25%, P <.05), inferior pubectomy (13% vs 25%), and crural rerouting (4% vs 11%) were less frequently utilized during urethroplasty in the EER group.[15]

EER may also play a role in the multidisciplinary management of patients with trauma. Patients with PFUI often require surgical repair of pelvic fractures, and the level of concern for the use of an SPT in proximity to an internally fixed pelvic fracture varies across institutions and practitioners. It is our institution's practice pattern and orthopedic service's preference to attempt EER in patients with pelvic fractures who undergo operative repair. Reports of an SPT seeding an infection of an open reduction and internal fixation (ORIF) and the presence of an SPT affecting the preferred surgical approach for pelvic fracture repair have been described.[16-18] The ORIF site with internalized orthopedic hardware may be at risk of infection in patients with trauma who have complex, multiple injuries. Miskimins et al identified that patients who underwent ORIF through an extended laparotomy incision compared with external fixation had higher rates of laparotomy incision infections and pelvic abscesses and more frequently underwent procedures to address their complications.[19] A chronic SPT tract may serve as a similar risk factor as an extended laparotomy incision. Further, benefits of EER have been suggested by Alli et al. Patients with trauma treated with EER vs SPT had a shorter hospital stay and suffered from less morbidity.[18]

Clinical Course After Failed EER

We excluded any patient who was not initially managed at our trauma center to create a homogenous cohort managed in a consistent manner and to eliminate unintended negative consequences noted in previous manuscripts.[7] Patients require close follow-up as they frequently fail EER within 1 month after catheter removal. For our patients who failed EER, primary urethroplasty was performed at a median of 4.8 months after initial injury (Table 2). This interval is shorter than the 5.8 and 7.0 months noted in other series for patients to undergo delayed urethroplasty after SPT placement.[3,7] Among our patients who failed both EER and primary endoscopic management, secondary urethroplasty was performed at a median of 10.3 months after initial injury. This interval is shorter than the 14.6 and 25 months for patients in other series to undergo primary urethroplasty after EER.[3,7]

An advantage in our series is that we excluded patients who were referred from outside centers and focused on a cohort of patients managed at our institution, which is the only level 1 trauma center in Washington state and serves as the regional trauma referral center for Alaska, Montana, and Idaho. The long delay to surgery after EER reported in other studies is likely attributed to referral and institutional practices, and we acknowledge that our experience may not be equally translated to other centers. Patients with PFUI should be referred promptly to tertiary centers to combat surgical delays. Anecdotally, resolution of orthopedic and lower extremity soft tissue injuries to allow the lithotomy position was a major contributor to the delay in treatment from initial injury for select patients in our series who underwent surgery >6 months after PFUI. For referrals from outside medical centers, we strongly recommend immediate referral during the initial trauma admission, as patients would be able to follow up with the reconstructive urologist shortly after discharge to establish care and avoid delayed urethroplasty. Furthermore, if endoscopic treatments are performed for strictures after EER, they should be limited to 1 attempt as the rate of success dwindles precipitously with each subsequent treatment, as the large range of endoscopic treatments identified in the series by Tausch et al. is not standard of care and negatively affected subsequent care.

Limitations

Although we are a tertiary trauma center, our series is small, exhibiting the rarity of this disease. We were unable to perform detailed statistical analysis because of the small numbers in this single center series. Furthermore, we do not have a comparison cohort of patients who underwent SPT placement followed by delayed urethroplasty. Because of the referral nature of our trauma center, with severely injured patients, the urethral injuries we present may be different from elsewhere. Thus, a selection bias toward failure may be present. Erectile function and

incontinence were not evaluated in this study as validated outcome measures were not consistently available. Despite these limitations, this series presents a cohort of patients with PFUI who were initially managed with EER with close follow-up at 1 institution using a predefined treatment pathway. A multicenter clinical trial (NCT03195179) is currently ongoing with the principal aim to determine whether significant reduction in urethral obstruction occurs after primary urethral realignment compared with immediate suprapubic tube followed by delayed urethroplasty. This multicenter trial may overcome limitations of single-institution studies and may help clarify questions surrounding PFUI management. Urologists that treat PFUI are encouraged to contact the lead center if there is a desire to participate.

CONCLUSION

In this updated series, we identified that a small number of patients were treated successfully with EER and subsequent endoscopic management; however, urethroplasty was the most common necessary treatment and had a high success rate. The low long-term success rate of EER should be balanced with potential benefits such as a role in the multidisciplinary management of trauma patients and improved alignment in the case a subsequent urethroplasty is required. EER can be performed in an efficient manner and should be arranged in coordination with institutional practice patterns and the multidisciplinary trauma team. We encourage the early referral of patients with PFUI to centers experienced with counseling and treating patients with these complex injuries. Under the close care of a reconstructive urologist, patients with PFUI will be able to receive care without delay and close follow-up for the development of obstructive symptoms.

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EDITORIAL COMMENT

Early management of pelvic fracture urethral injuries (PFUIs) continues to be a controversy between basically 2 treatment strategies. Strategy 1 (S1) is early endoscopic realignment (EER) passing a catheter across the injury that is left for 3-6 weeks allowing the tear to heal. The other strategy (S2) is immediate placement of a suprapubic cystostomy (SPT) leaving the urethra untouched, for a subsequent delayed perineal urethroplasty. Despite many publications, this is an unresolved dilemma because of the lack of prospective comparative studies and because of selection bias and variable definitions of success.

This article provides valuable information about the outcome of S1 from a large tertiary referral centre. Thirty-two patients were prospectively treated with EER: the overall success rate (cure of the injury) was only 9% and success rate of secondary endoscopic management of EER failures was 22%. Eventually, secondary endoscopic or primary EER failures were offered a perineal urethroplasty with a 96% success rate. This is in contrast with a large number of publications reporting a universal >90% success rate of S2.

The authors state that despite this low primary curative potential, EER has some important secondary advantages because it may facilitate a subsequent urethroplasty and may avoid the potential risk of infection of orthopedic hardware given by the presence of an SPT if open reduction and internal fixation (ORIF) of the pelvic fracture is necessary. However, this is also controversial because although some reports found that EER make urethroplasty easier, there are others that conclude the contrary. Moreover, the overall success of urethroplasty is the same in

patients with or without a previous EER. On the contrary, it is true that a suprapubic tract may be an infection risk factor for ORIF; however, more information about this potential risk is needed because S2 is a standard strategy used for decades and there are almost no data about this point in the literature, suggesting that it may not be a clinically significant issue. In addition, not all pelvic fractures need an ORIF, and a large percentage can be managed with an external fixator.

From the urological point of view, "the best" strategy should provide stricture-free urethral reconstruction, with preservation of continence in the shortest possible rehabilitation time and ideally in one single surgical procedure. However, this needs to be done in coordination with the management of the other associated injuries, particularly that of the pelvic fracture.

Considering all these, management of PFUI may be selective, and if ORIF is not anticipated, S2 offers >90% cure of the urethral injury in 1 single surgical procedure. However, when ORIF is considered mandatory, S1 may provide urinary drainage and safe room for the orthopedic surgery, at the cost of limited immediate solution of the urethral problem. Knowing the outcomes of each option, the reasonable approach should be to use the right strategy for the right patient and I agree with the authors that these patients should be referred to tertiary expert centers where consolidated multidisciplinary teams can obtain "the best" results.

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REPLY

We thank Reynaldo Gomez for the editorial and positive comments toward our work. We have had a unique experience with early endoscopic realignment (EER) at our institution and appreciate the opportunity to share our results. We agree that the management of a pelvic fracture urethral injury (PFUI) may be selective with the option for EER if open reduction and internal fixation (ORIF) is considered mandatory and the option for immediate suprapubic tube (SPT) placement with delayed urethroplasty for the remaining patients. The issue with the first stem is that it is not always clear which patients will definitively undergo ORIF. In our series, some patients had external fixator initially placed to aid reduction of pelvic bleeding and to temporarily stabilize the pelvis with later plans for internal fixation. As such, we communicate directly with the orthopedic surgeons at our hospital to better understand their ultimate plans. If the orthopedic service is undecided, we proceed with EER when the patient is clinically stable.

Urologists and orthopedic surgeons from different institutions will certainly have different approaches to PFUI management. We acknowledge that our experience and trauma care philosophy may differ from other institutions. For example, our orthopedic team is aggressive with ORIF and has expressed concern for potential secondary risk from an SPT. In the absence of any published data regarding infection risk, we are unable to argue against EER in lieu of SPT alone. Further, compared with external fixation, ORIF is less cumbersome and has a lower risk of hip site infections.

We agree that the findings supporting and refuting the secondary advantages for both methods of PFUI management are multidimensional and controversial (ie, risk of infection of orthopedic hardware and influence of EER on subsequent urethroplasty). We believe that the potential benefits and harms should be considered despite not having the highest quality of evidence available. A newly initiated multi-institutional study on PFUI management may help to put some of the existing controversy to rest. Until then, we can at least agree that PFUI patients should be referred to tertiary centers for management of this challenging issue early after their injury to avoid treatment delays.

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