Evaluation of Immediate Endoscopic Realignment as a Treatment Modality for Traumatic Urethral Injuries

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Background: **Traumatic urethral injuries have been traditionally managed by suprapubic drainage with a delayed repair. Advances in endoscopic techniques have facilitated early realignment and transurethral catheterization of the injured segment as a new management option. The purpose of this study was to investigate the outcomes of patients undergoing immediate endoscopic realignment (IER) compared with delayed treatment (DT).**

Methods: **Trauma patients sustaining a traumatic urethral injury admitted to a level I trauma center were prospectively identified and followed through their course of treatment. Injury demographics and outcomes were compared for IER versus DT. The primary outcome measures were time to spontaneous voiding and urethral stricture rate.**

Results: **Of 21 patients with acute urethral injuries, 14 (67%) had IER and 7 (33%) had DT (4 IER failures and 3 primary DT). The 4 IER failures represent 22% of the patients in the immediate realignment attempt group that failed and went on to delayed therapy. Mean follow-up was 7 months (range, 14 days to 1.7 years). IER and DT groups were similar with regards to age (30 ± 16 vs. 24 ± 6), mechanism of injury (blunt vs. penetrating), location of urethral injury (anterior vs. posterior), Glasgow Coma Scale score (13 ± 3 vs. 12 ± 6), ISS (14 ± 11 vs. 20 ± 6), and associated injuries (pelvic fractures and intra-abdominal injuries). Mean time to IER from admission was 32 ± 80 hours (range, 1 hour–2.8 days). Patients undergoing IER had a significantly shorter time to spontaneous voiding (35 ± 23 vs. 229 ± 79 days, $p = 0.001$) and had a significantly decreased rate of stricture formation (14% vs. 100%, $p < 0.0001$). All DT patients required formal surgical urethroplasty whereas the 2 (14%) IER patients with strictures only required outpatient clinic dilatation.**

Conclusion: **Compared with the traditional DT approach, IER results in a significantly reduced time to spontaneous voiding with less risk of urethral stricture, possibly avoiding the need for surgical urethroplasty and long-term suprapubic urinary diversion.**

Key Words: **Urethral injury, Urethral surgery, Urologic surgical procedures, Complications, Urethra, Urethral stricture, Wounds and injuries.**

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The optimal management strategy for urethral injuries remains controversial.[1] Failure to accurately diagnose and treat urethral injuries may lead to significant long-term sequelae such as strictures, incontinence, and erectile dysfunction.[2,3] Traditionally, initial management consisted of the placement of a suprapubic cystostomy tube and delayed repair. This provides simple and effective urinary drainage until the associated injuries are stabilized and local edema has resolved allowing formal urethral reconstruction. Though effective for urinary elimination, long-term suprapubic tube drainage is associated with wound infection, urinary tract infection, bladder calculi, discomfort, leakage and dislodgment. In addition, for patients with a concomitant pelvic fracture, the presence of a suprapubic tube may also compromise the anterior exposure for internal fixation of the pelvis and may increase the rate of hardware infection.[4]

Several reports have demonstrated success with early endoscopic realignment as the initial management strategy for acute urethral injuries.[1,2,4] The goal is to provide early definitive transurethral catheter drainage and avoid the need for open reconstruction.[2] There exists limited data on the success of endoscopic realignment and a lack of familiarity with realignment techniques at this time.[3–7]

The purpose of this study was to investigate the outcomes of patients undergoing immediate endoscopic realignment (IER) when compared with delayed treatment (DT) for the initial management of acute urethral injuries.

PATIENTS AND METHODS

All adult patients presenting to the Los Angeles County/University of Southern California Medical Center, a Level I trauma center, between September 2000 and September 2006 with traumatic urethral disruption (either partial or complete) documented on retrograde urethrogram were identified prospectively. Patients were excluded from analysis if they were admitted after more than 24 hours from injury, expired before

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attempted urethral injury management, had a concomitant bladder neck injury, or had other life-threatening injuries that precluded an attempt at endoscopic realignment. Patient variables collected included age, gender, mechanism of injury, admission vitals (heart rate, systolic blood pressure), Glasgow Coma Scale (GCS) score, associated injuries, operative procedures, Abbreviated Injury Score, Injury Severity Score (ISS), hospital, and intensive care unit length of stay and complications. The characteristics of the urethral injury, imaging results, timing of management of the urethral injury, and outcomes were also collected prospectively.

The following guidelines were used for the IER of urethral injuries (Fig. 1). Hemodynamically stable patients underwent flexible cystoscopy with room temperature irrigant and attempted retrograde passage of a guidewire followed by placement of a council tipped Foley catheter over the wire.

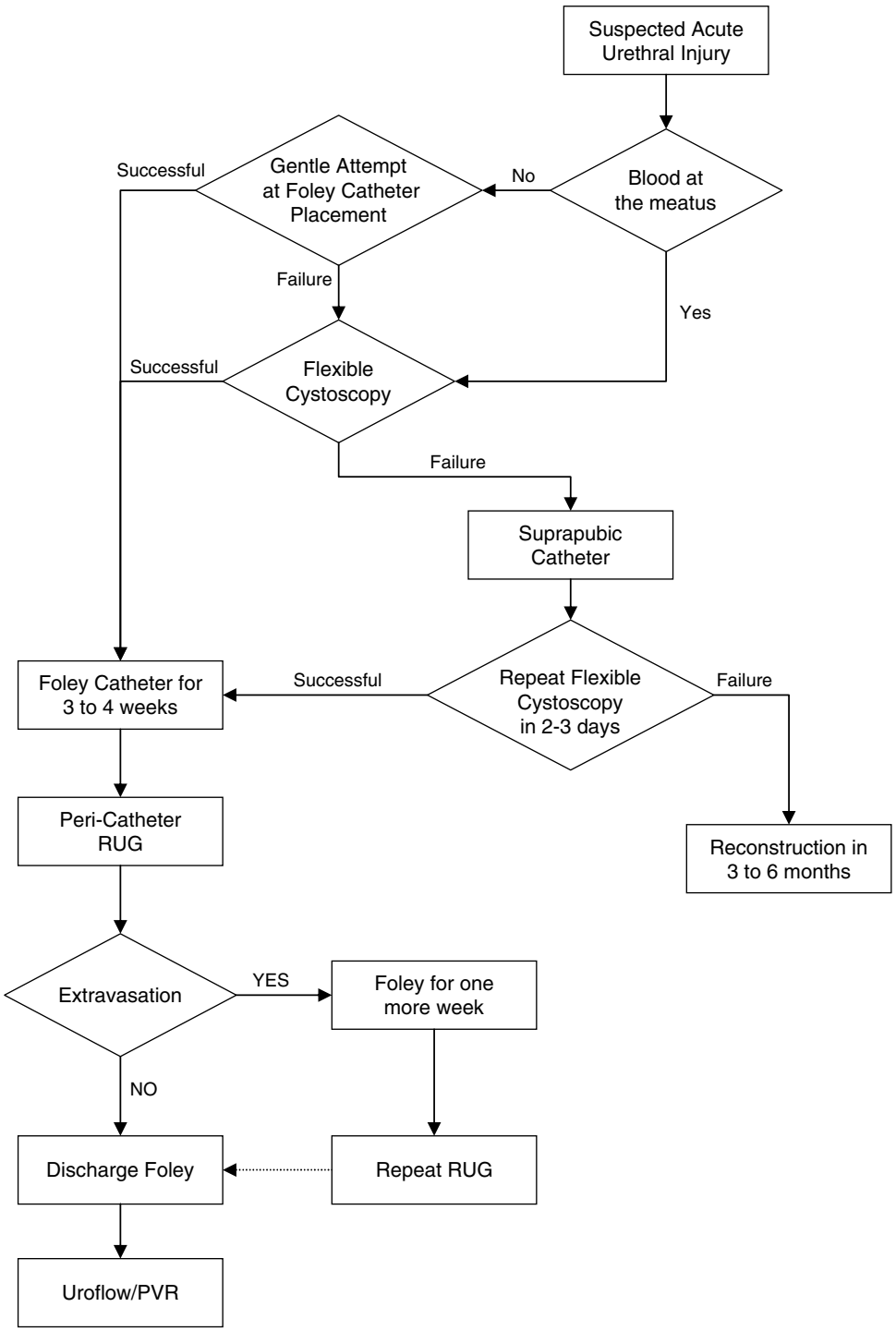

Fig. 1. *Immediate endoscopic realignment algorithm for acute urethral injury.* RUG*, retrograde urethrogram;* PVR*, post-void residual.*

All patients received prophylactic antibiotics. Patients with significant nonurologic injury requiring emergent operative intervention either had attempted endoscopic realignment in the operating room or intraoperative placement of a suprapubic catheter (SPT) followed by attempted realignment postoperatively. No delay in the treatment of nonurologic injuries occurred as a result of the attempted IER. Patients who failed the initial attempt at IER underwent a repeated endoscopic attempt once physiologically stabilized at 24 hours. Successful IER patients underwent pericatheter retrograde urethrogram at 3 weeks after realignment, and if no leaks were noted the catheter was removed. If a leak was detected, the catheter was left in situ and the test was repeated in 2 to 4 weeks. Patients were scheduled for follow-up at 1 month, 3 months, and every 6 to 12 months thereafter. Patients who failed endoscopic realignment underwent delayed treatment with suprapubic catheter drainage and a planned open reconstruction of the urethra at 3 to 6 months after injury. Patients undergoing IER were compared with DT utilizing the following primary outcome measures: time to spontaneous voiding, urethral stricture rate, and need for additional intervention.

We performed all statistical analysis using SPSS 12.0 for Windows (SPSS, Inc., Chicago, IL). Bivariate analysis was performed to compare patients with IER and patients with DT. Comparisons between the two groups were made using student's t test or the Mann-Whitney U test for continuous data and χ^2 or Fisher's exact test for categorical data. Differences were considered statistically significant at $p < 0.05$. This study was approved by the Institutional Review Board and adhered to established guidelines on the treatment of human subjects.

RESULTS

Thirty one patients with acute urethral injuries were identified during the study period. Of these, 10 patients were excluded: 3 patients had delayed transfer from an outside hospital; 1 patient was transferred early to an outside hospital before definitive management of their urethral injury; 2 patients died early because of their associated torso injuries; 2 patients were younger than 18 years of age; 1 patient had an associated cardiac injury, necessitating delayed treatment; and the final patient had a concomitant bladder neck injury.

During the 6-year study period, 21 trauma patients with urethral injuries met inclusion criteria. They had a mean age of 29 ± 14, mean Glasgow Coma Scale score 13 ± 3, 76% sustained blunt trauma, and the mean ISS score was 14 ± 9. Twenty patients were diagnosed with a urethral injury in the emergency department, and the remaining patient had a 4-hour delayed diagnosis in the intensive care unit. Overall, 17 patients (81%) had acute signs of urethral injury in the emergency department, with the most frequent sign being blood at the urethral meatus (9 patients; 43%), followed by groin avulsion (5 patients; 24%), and a high-riding prostate (3 patients; 14%). The remaining patients were diagnosed because of the inability to pass a Foley catheter. Motor vehicle crashes and gunshot wounds accounted for almost half the patients sustaining a urethral injury (Fig. 2).

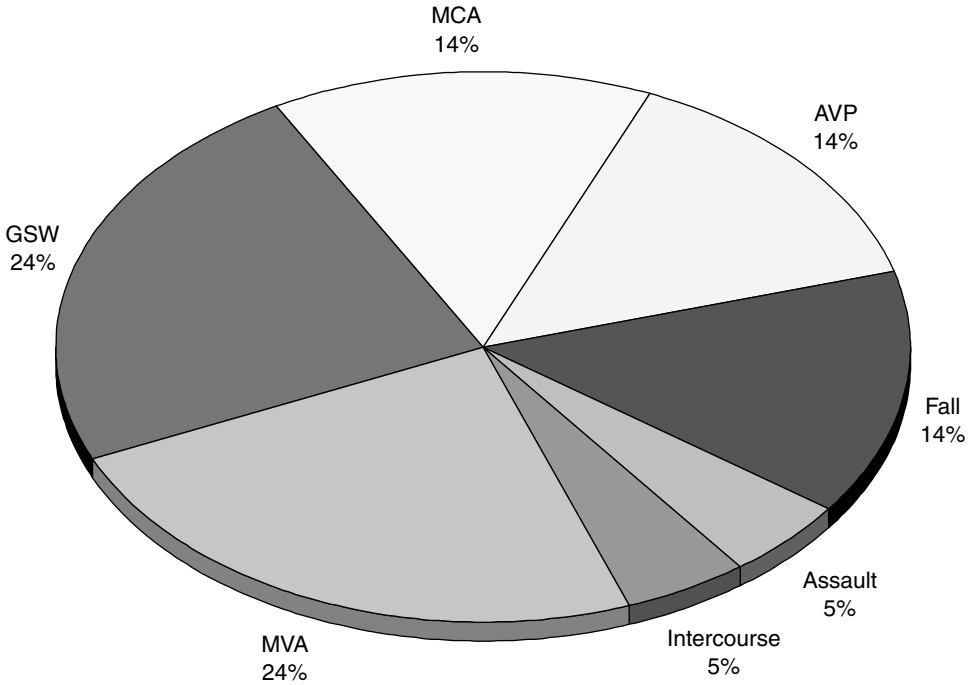

Fig. 2. *Mechanism of urethral injuries.* GSW*, gunshot wound;* MVC*, motor vehicle crash;* MCA*, motorcycle accident;* AVP*, automobile versus pedestrian.*

Table 1 Immediate Endoscopic Realignment Failure Patients

Patient	Age	Mechanism	Injury Type	Location of Injury	Number of Attempts
1	18	MVA	Complete	Bulbar	Two
2	33	GSW	Partial	Bulbar	Two
3	19	AVP	Complete	Prostate	One
4	21	MVA	Complete	Bulbar	One

GSW indicates gunshot wound; MVC, motor vehicle crash; AVP, automobile versus pedestrian.

Eighteen patients underwent IER attempt, which was successful with transurethral bladder catheterization in 14 (78%) patients (IER Group) and unsuccessful in the remaining 4 patients (22%), which required SPT placement followed by delayed urethroplasty. Table 1 describes the immediate endoscopic realignment failure patients. Three additional patients had no attempt at IER because of attending urologist preference and underwent delayed treatment. Patients with unsuccessful endoscopic realignment attempt and patients in which endoscopic realignment was not attempted were combined to form the DT group. The study population and treatment groups are described in Figure 3.

No delay in the treatment of nonurologic injuries occurred as a result of the attempted IER. Routinely, the IER attempt was performed whereas the patient was awaiting transport to additional diagnostic imaging or the operating room for nonurgent orthopedic fixation.

Admission characteristics of the two groups are shown in Table 2. The IER and DT groups were similar with regards to age, admission vital signs, mechanism of injury, location and degree of urethral injury, associated injuries (Fig. 4), and ISS. Of the 14 patients undergoing IER, 10 patients (71%) required one endoscopy attempt, and the remaining 4 patients required multiple procedures (two attempts in 3 patients; three attempts in 1 patient). Overall, mean time to successful flexible cystoscopy from time of admission was 31:54 ± 80:29 hours (median 7:20 hours; range, 1:00 hour to 2.8 days).

Initially, seven of the patients undergoing IER had both a Foley and SPT placement. All patients in the DT group required SPT diversion. The average length of SPT placement in the IER group was 19 ± 16 days in comparison with the DT group, which had an average of 219 ± 77 days ($p < 0.001$).

The stricture rate in the IER group was 14% compared with 100% in the DT group (Table 3). There was no statistical difference in the time from initial treatment to stricture formation (106 ± 122 days IER vs. 139 ± 81 days DT; $p = 0.68$) or the time from stricture development to last follow-up (71 ± 71 days vs. 220 ± 87 days; $p = 0.36$).

All patients developing a stricture after DT required urethroplasty at an average of 6 ± 3 months. The 2 patients who developed a stricture after IER had urethral narrowing

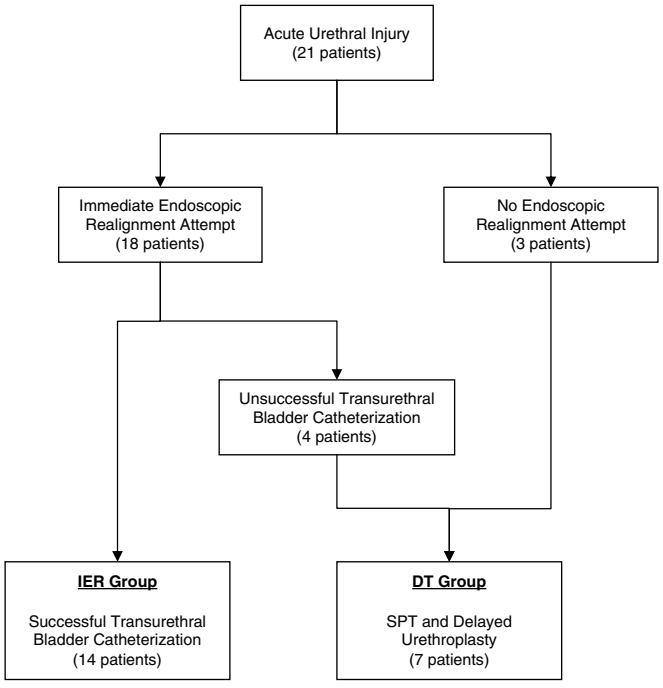

Fig. 3. *Study outline.* IER, *immediate endoscopic realignment;* DT, *delayed treatment;* SPT, *suprapubic tube.*

Table 2 Comparison of Admission Characteristics Between IER and DT Patients

Variables	IER (n = 14)	DT (n = 7)	*p* Value
Age (yrs), mean ± SD	30.9 ± 16.3	24.0 ± 5.8	0.29
ER vitals, mean ± SD			
Systolic BP	138.5 ± 27.8	124.4 ± 25.5	0.28
Heart rate	94.0 ± 25.7	87.0 ± 25.7	0.56
GCS	13.5 ± 2.9	13.1 ± 4.5	0.83
Injury Severity Score, mean ± SD	13.3 ± 10.6	15.3 ± 7.1	0.66
Type of urethral injury, n (%)			
Posterior	7 (50.0)	3 (42.9)	1.00
Anterior	7 (50.0)	4 (57.1)	1.00
Location of urethral injury, n (%)			
Prostatic	4 (28.6)	2 (28.6)	1.00
Membranous	2 (14.3)	1 (14.3)	1.00
Bulbar	6 (42.9)	4 (57.1)	0.66
Pendulous	2 (14.3)	0	0.53
Degree of urethral injury, n (%)			
Partial	11 (78.6)	3 (42.9)	0.16
Complete	3 (21.4)	4 (57.1)	0.16

ER indicates emergency room; BP, blood pressure; GCS, Glasgow coma scale score; SD, standard deviation.

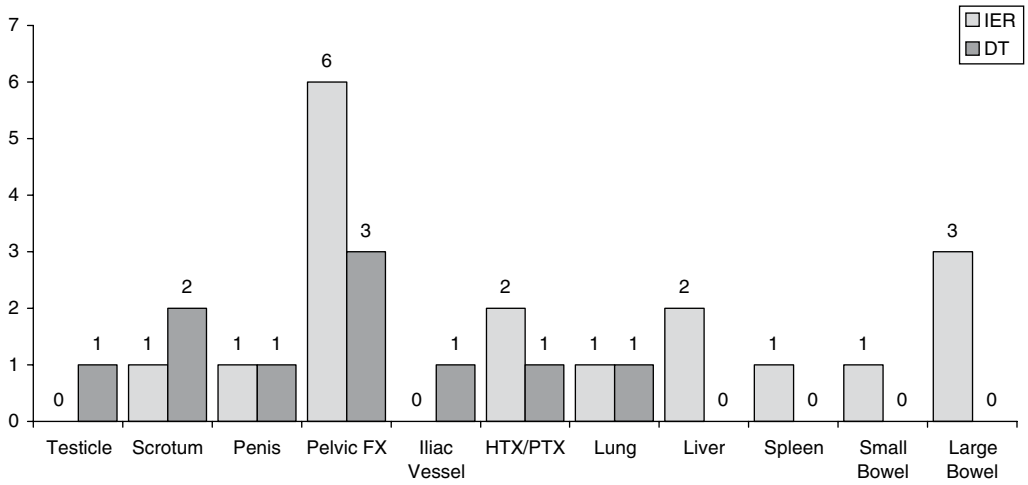

Fig. 4. *Comparison of associated injuries between IER and DT patients.* FX*, Fracture;* HTX/PTX*, hemothorax/pneumothorax.*

Table 3 Comparison of Outcomes Between IER and DT Patients

Variables	All, n = 21	IER, n = 14	DT, n = 7	*p* Value
Complications, n (%)				
Stricture	9 (42.9)	2 (14.3)	7 (100)	<0.001
UTI	2 (9.5)	2 (14.3)	0	0.53
Urethroscrotal fistula	1 (4.8)	1 (7.1)	0	1.00
Time to spontaneous voiding, mean days ± SD		35 ± 23	229 ± 79	0.002
Length of stay, mean days ± SD				
ICU	4.7 ± 10.6	6.3 ± 12.7	1.4 ± 2.5	0.80
Hospital	13.4 ± 16.8	14.3 ± 17.6	11.6 ± 16.3	0.69

UTI indicates urinary tract infection; SD, standard deviation; ICU, intensive care unit.

but did not require urethroplasty. One patient performed intermittent self catheterization with a Red-Robinson catheter for approximately 1 month and the other patient required a total of two urethral treatments with S-dilators over a period of approximately two and a half months and has remained asymptomatic since. The IER group had a significantly shorter time to spontaneous voiding in comparison with the DT group (35 ± 23 days vs. 229 ± 79 days; $p = 0.002$). Overall, follow-up for all patients was for 7 ± 6 months (median, 5.2 months).

DISCUSSION

The mainstay of treatment for traumatic urethral injuries is the reestablishment of urethral continuity while minimizing the risk of complications such as incontinence, impotence, and stricture formation.[7] Because urethral injuries are uncommon and present with a wide range of different patterns, there is limited experience with the management of this injury and several treatment strategies exist.[1–7] As a result, the optimal management strategy for traumatic urethral injuries remains controversial and the debate regarding immediate versus delayed definitive treatment is currently unresolved.

After resuscitation and management of life-threatening associated injuries, the next step in the management of the injured urethra is bladder drainage. This will prevent further soft tissue infiltration by urine and allow for urinary output monitoring. Definitive treatment options once bladder drainage has been achieved include primary suture repair, primary realignment of the urethra utilizing a surgically or endoscopically inserted stent and suprapubic cystostomy followed by delayed urethroplasty.[7]

Immediate primary reconstruction of the urethra can be technically challenging as it invariably will require surgical dissection through the site of injury. The acutely inflamed tissue, hematoma, and distorted anatomy increase the potential for further neurovascular damage and may increase the risk of impotence.[1,7] This technique is, therefore, usually reserved for patients with a simple penetrating partial injury to the anterior urethra.[1]

Because it is performed after the associated injuries have been managed and the local tissue damage and hematoma have resolved, cystostomy followed by delayed urethroplasty has classically been considered superior to immediate primary surgical repair. However, the drawbacks of the delayed technique include the prolonged suprapubic catheter use, the delay to spontaneous voiding,[1] and the exceedingly high incidence of urethral stricture (up to 97%), which are oftentimes complex and require sophisticated reconstructions.[7]

Early realignment of acute urethral disruption is not new. Since it was first described in 1934 by Ormond and Cothran,

several techniques have been used to pass a stent across the urethral injury.[8–11] The early attempts at early urethral realignment, however, were performed without the benefit of advanced endoscopic technology and involved the retrograde catheterization of the injured urethra through a cystostomy and entailed varying levels of paravesical dissection. These early reports of primary surgical realignment demonstrated a high rate of complications, including a significant risk of impotence and incontinence.[12] Subsequent series of primary surgical urethral realignment with limited paravesical dissection showed lower rates of these complications. Asci et al.[13] found no significant difference in impotence and incontinence rates in 38 patients undergoing early surgical realignment when compared with DT. They noted in addition that the early realignment group had a lower rate of stricture requiring urethroplasty. Other studies showed that, when compared with delayed repair, immediate surgical urethral realignment results in equivalent or better rates of impotence and incontinence without the need for multiple surgical procedures.[10,14] Mouraviev et al.[15] reviewed their experience of 96 patients (57 early realignment, 39 delayed urethroplasty) noting a reduced frequency of stricture, impotence, incontinence, and average number of procedures in the patients managed with early surgical realignment.

Modern endoscopic instrumentation and minimally invasive techniques have facilitated a progression from early surgical urethral realignment to the immediate reestablishment of urethral continuity as a therapeutic option.[4,16–20] This endourologically performed primary realignment has emerged as an attractive method for immediate urethral stenting avoiding the risks associated with complex open urethral reconstructions. This has the potential advantage of reducing stricture rates, shortening the time to spontaneous voiding and eliminating the morbidity associated with suprapubic cystostomy. In a series of 29 patients with urethral disruption, Moudouni et al.[17] demonstrated that endoscopic urethral realignment is associated with minimal morbidity and, moreover, the failure of endoscopic realignment did not compromise delayed formal urethral reconstruction.

In this study, the stricture rate was significantly lower in patients undergoing immediate endoscopic realignment when compared with DT (14% vs. 100%, $p < 0.001$). Similar results were observed in a study comparing 65 patients managed with primary endoscopic realignment to 30 patients managed with delayed treatment, which showed a significantly reduced rate of urethral strictures in the primary endoscopic realignment group (19% vs. 40%, $p = 0.025$).[21] When they do occur, strictures after realignment were less severe[21] and more amenable to minimally invasive treatment, infrequently requiring formal urethroplasty. In a study of 29 patients undergoing primary endoscopic urethral realignment, 83% of the patients who developed stricture were successfully managed with one internal urethrotomy and only 17% required secondary urethroplasty.[17] In this study, the two patients who developed stricture after immediate endoscopic realignment were managed in the outpatient clinic setting. All patients in the DT group developed a stricture requiring formal urethroplasty.

Successful IER, as we have demonstrated in this study, greatly reduces the need for urethroplasty in the long term. For patients who fail the initial attempt at IER, they will eventually go on to delayed urethroplasty. The attempted IER has no effect on future reconstruction. For patients who had initial successful IER, who later failed, delayed reconstruction is potentially made easier. This is most likely because of the anatomic realignment performed initially. This will reduce the gap that needs to be reconstructed, thus allowing for increased likelihood of successful end-to-end anastomosis and potentially decreasing the need for substitution grafts.

There are two major limitations to this study. First, the patient numbers are small. Second, this crossover design resulted in the comparison of the IER patients to a hybrid control group of failed IER and primary DT. Analysis of baseline demographics and injury patterns, however, showed that both groups were similar except for their urethral injury management.

In summary, IER of traumatic urethral injuries can be successfully accomplished without increasing the risk of additional complications. Contrary to the traditional DT approach, IER in our experience results in a significantly reduced time to spontaneous voiding with less risk of urethral stricture, decreasing the need for surgical urethroplasty and long-term suprapubic urinary diversion.

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DISCUSSION

Dr. Richard A. Santucci (Detroit, Michigan): Thank you for that very nice presentation. I will just remind the audience that these really are troublesome problems for the patient.

They often persist years after the original injury. Patients are all better except for their urethra. They often require movement to a center of excellence in urethral reconstruction, of which there are about a dozen in the country.

And it's really a very troublesome complication that we should invest the time in the acute phase to try and fix. You will end up with a much happier patient one-to-two years down the line.

My discussion basically involves four separate questions. I believe these data stand for themselves. And so I will ask Dr. Best to approach these four questions for us.

The first is that the great Richard Turner Warwick who basically codified this disease in the '60s described both severe and less-severe forms of urethral injuries and then hypothesized that you had severe and less-severe sequella.

And what I would ask Dr. Best is how do you know that some of your poor results weren't due to the fact that they had more significant distractions, you couldn't get a catheter across and therefore they had more serious injuries?

My second question, you had an 86 percent stricture-free rate which was really quite high. It's probably the lowest ever reported in the literature which runs in the 32 percent range, 49 percent range, 75 percent range, and 86 percent range in previously reported studies.

And I want to know if you think that your excellent results will still bear out with larger numbers, if there is something different than you're doing than others have done.

My third question is timing. What's the best point in time to perform a urethral realignment? And, also, what's the longest delay in which you would attempt urethral realignment?

Sometimes you get patients from the outside that have had, it's been a long time since their injury, and sometimes patients are simply too ill to attempt urethral alignment even at bedside.

My final question, you were able to get realignment by flexible cystoscopy about 55 percent of the time on the first try—that's actually pretty remarkable—and 23 percent on the second try for a total success rate of 77 percent.

I want to know the mechanism and characteristics of your attempts. How long do you persist with scoping? How long is too long? When do you look at the clock and say, "We need to stop this today?"

And, finally, when you fail from below to pass the flexible cystoscope, what other mechanisms do you try from above or other, you know, perhaps magnetic sounds and the others that have been described in the past have you used to achieve success?

Dr. Bryan Troop (St. Louis, Missouri): Do you attempt to do these in the first hour? And do you require an operating room, ICU or ER? How are you mechanically doing this?

Dr. Richard Mullins (Portland, Oregon): Are you advocating that a surgeon in the trauma bay conducting an initial evaluation of patient with a suspected urethral injury can attempt to pass the Foley catheter as the first step?

Dr. Charles D. Best (Los Angeles, California): No, I am not advocating that. If there is no blood at the meatus and just by the ideology you suspect it, I think it is probably worthwhile to take one gentle attempt.

But I think if you know there is a urethral injury or there is significant findings like blood at the urethral meatus that you risk taking that partial and making it into a complete and you're much better off probably putting in a super pubic tube and then dealing with the acute issue later.

Dr. Charles D. Best: That was a very excellent discussion. I'll try to address Dr. Santucci's and the other question and see if I can incorporate them as best I can.

In regards to the severity of urethral injury and whether those affect our results, I mean certainly a more severe injury is going to be more difficult to bridge endoscopically.

But I don't think that this should preclude attempting to do an endoscopic realignment. We were successful in almost 50 percent of our patients that had a complete urethral injury.

And so I think that despite the severity of the injury I think it's still valid to attempt. Essentially, you're not going to lose anything.

As far as addressing our success with our stricture-free rate and will this bear out, I think that's a yes or no answer and that I think that part of our success rate that is unique is the immediacy of our realignment.

You see a median of 7.2 hours. And the fact that we do this under direct vision as opposed to other fluoroscopy or other mechanical means and so there is no risk of it taking a partial and converting it to a complete.

The larger studies may show this. In fact there is data out of Korea that has a larger number of patients and a longer follow-up that has a very similar success rate, although they don't describe their timing or the nature of their technique and it is for blunt injuries only.

But on the other hand our study has a relatively short follow-up. It's now only 18 months. And so a longer follow-up may show that some of these immediate realignments may have a higher stricture rate.

But, again, of ours that did have strictures, none of them require open reconstruction. And I still think that that shouldn't really preclude you from attempting this due to the significant benefits of patient voiding and comfort.

And as far as the timing, the sooner the better, I think. And I can address these questions together. You know we will do this as early as an hour. We can do this in the emergency room.

We can do this in the operating room. We can do this in a urology suite. It takes about five minutes. And, again, depending on the patient's injuries, how soon we can get this done.

All right, and I would, as far as the number of attempts, depending on the patient's status I will, you know, if we do it once, great.

If we can't we'll put a super public tube, let them settle out, do it a couple days when there is less active bleeding and try it again. And we really don't spend more than about 8 minutes trying to do this.

Beyond a week, I think it's really not, if a patient presents that late or he's had other issues beyond a week, I think that then you have fibrosis starting to set in and the framework for stricture is already starting to be laid in.

So I think if you don't get it across within the week, you're going to have a much lower success rate.