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REVIEW

Pelvic fracture urethral injuries revisited: A systematic review

Mamdouh M. Koraitim *

Department of Urology, Faculty of Medicine, University of Alexandria, Alexandria, Egypt

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Abstract Purpose: We attempted to determine the unresolved controversies about pelvic fracture urethral injuries and to present a treatment plan for this lesion.

Materials and methods: A systematic review was conducted on all contemporary pelvic fracture urethral injury articles published in the last 60 years. Studies were eligible only if data were complete and conclusive.

Results: Pelvic fractures associated with urethral injuries are usually caused by vehicular accidents or falls from heights. The risk of urethral injury is influenced by the number of broken pubic rami and the involvement or non-involvement of the posterior pelvic arch. Urethral rupture is assumed always to be preceded by stretching of the membranous urethra cephalad and usually to occur at the bulbomembranous junction. In children, the urethra and bladder neck may be directly torn by the sharp edge of bone fragments. Retrograde urethrography remains the cornerstone for the diagnostic appraisal of posterior urethral injury. Of the three conventional treatment methods primary suturing has the greatest complication rates of incontinence and impotence (21% and 56%, respectively) and primary realignment has double the incidence of impotence and half that of stricture compared to suprapubic cystostomy alone (36% vs. 19% and 53% vs. 97%, respectively, $p < 0.0001$).

Conclusions: Inflexible policies of one procedure or another are inappropriate for the treatment of pelvic fracture urethral injuries. The key to a good result lies in avoiding under-management of serious injuries as well as over-management of minor injuries. Partial rupture may be managed by either endoscopic urethral stenting in the first place or by suprapubic cystostomy. Complete rupture

* Tel.: +20 123409512.

E-mail address: koraitim_mm@yahoo.com



with minimal urethral distraction may be treated by either endoscopic realignment or suprapubic cystostomy. Complete rupture with marked urethral separation may be explored for primary realignment. Associated injury to the bladder, bladder neck or rectum dictates immediate exploration for repair.

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Of all injuries to the entire urinary tract the most debilitating is that which affects the posterior urethra. This is not only because of its location deep in the pelvis but mainly because it includes the sphincter-active urethra as well as its intimate relation to the *nervi erigentes* responsible for sexual potency. If not managed properly it may lead to a lifelong condition with deleterious consequences comprising not only the ability to void and maintain urinary continence, but also the ability to reproduce.

Several methods have been used to treat this serious injury, each of which has been claimed to be the best solution. The oldest of these methods is primary suturing of the disrupted urethral ends, which was first performed via the perineal route by Young in 1929.¹ Later investigators, however, advocated the retropubic route and rejected the perineal approach in the belief that the lithotomy position is hazardous in patients with pelvic fractures. The second method is primary realignment by which correction of the displaced prostate and close apposition of the torn ends of the urethra are achieved and maintained by a urethral catheter with concomitant suprapubic cystostomy.² More recently, innovative combined transurethral and transvesical endourological and radiological procedures have been suggested to achieve primary realignment without the risk of exploring the disrupted urethra.³ Then, primary realignment has lost favor at many centers which allowed for the use of suprapubic cystostomy and delayed repair, which was first advocated by Johanson.⁴ In this method no attempt is made to evacuate the hematoma and explore the urethra. Urine is simply diverted with a suprapubic tube and the subsequent urethral stricture is repaired electively several months later. In this communication we attempted to resolve the long-standing debate and reach definite conclusions regarding development of a treatment plan for pelvic fracture urethral injuries.

1. Etiology

Pelvic fractures associated with urethral injuries are usually caused by vehicular accidents (68–84%), or falls from heights (6–25%) with the first being more than four times as likely to produce serious urologic injuries compared to the latter.⁵ The risk of a patient sustaining a traumatic pelvic fracture to

have an associated urethral injury is greatly influenced by the type of fracture. The type of fracture as a risk factor for urethral injury is influenced by the number of broken pubic rami and the involvement or non-involvement of the posterior pelvic arch with fractures of the anterior arch.⁶

2. Pathogenesis

Posterior urethral injuries may be in the form of complete rupture when the urethra is transected with no trace of continuity between the two ends, partial rupture when a full thickness tear involves only part of the urethral circumference and incomplete rupture when contusions or lacerations are not full thickness. Urethral injury in male patients is usually due to a force producing soft tissue disruption, rather than laceration by the sharp edge of fractured bone. With any of the major forces causing pelvic fracture, the pelvis is compressed and its soft contents, including the bladder and prostate, are squeezed. Because the membranous urethra is fixed to the tough perineal membrane which is attached firmly to the pubic arch, and conversely, the bladder and prostatic base are loosely attached to the bony pelvis, the only way for the squeezed prostate to go is upward. This causes a sudden and severe stretch–strain of the membranous urethra which is necessarily stretched cephalad. If the maximum elasticity is reached and the force of trauma continues, the urethra would be disrupted either partially or completely at the fixed and weak bulbomembranous junction.⁵

Thus, urethral rupture is assumed always to be preceded by stretching of the membranous urethra cephalad and usually to occur at the bulbomembranous junction. In cases of partial rupture the membranous urethra is still stretched and extravasation is usually localized to the urogenital diaphragm. In cases of complete rupture the proximal urethral end retracts upward while the distal end remains fixed to the perineal membrane and extravasation is seen in the pelvis. After complete rupture, the prostate will be displaced upwards with loss of alignment of the urethra itself. Associated with this unfortunate occurrence is the disruption of the periprostatic venous plexus, resulting in a large hematoma which frequently displaces the prostate gland upward and posteriorly.⁷ Occasionally, the urethra and bladder neck are directly torn by the sharp edges of bone

fragments. This direct injury is encountered only in children whose small prostates offer less protection for these parts than in adults.⁵

3. Diagnosis

A patient presenting at the emergency room after a motor-vehicle accident or fall from a height with inability to void and blood at the urethral meatus or gross hematuria should raise the suspicion of the occurrence of a posterior urethral injury.⁸ Abdominal examination usually shows muscle guarding and suprapubic dullness due to a pelvic hematoma which may mask a full bladder. On digital rectal examination a boggy mass is usually felt without recognition of a prostate gland.

Retrograde urethrography endures as the cornerstone for the diagnostic appraisal of posterior urethral injury. It will not only demonstrate the presence or absence of a urethral injury but also will show the type of this injury: stretching, partial or complete rupture of the urethra. Extravasation of contrast medium without its presence in the bladder and proximal urethra is diagnostic of a complete rupture. Partial rupture is diagnosed in the presence of extravasation with partial filling of the bladder and proximal urethra.⁹ It is now well established that diagnostic catheterization is to be condemned as the catheter may be ploughed into the area of partial rupture converting it into a complete one, it may be passed easily into the bladder missing the detection of a partial rupture, may exit through the torn urethra to lie in the periprostatic region, and may introduce infection into a previously formed hematoma.⁵

4. Treatment

In posterior urethral injuries associated with pelvic fracture the key responsibilities are: stabilization of the patient, assessment of associated injuries, and then assessment of urethral injury. Diagnostic measures of urethral injury should be delayed until higher priority systems have received appropriate attention. Only when the patient is hemodynamically stable and no other surgery is imminent that management of urethral injury be undertaken.

The major concern surrounding the immediate management of posterior urethral injury is the potential risk of three main complications: stricture, incontinence, and sexual impotence. These complications may result directly from initial trauma and/or iatrogenic trauma induced by the immediate treatment. Therefore, treatment should be directed toward minimizing the risk of late complications to achieve a patent continent urethra while maintaining pre-traumatic sexual potency.¹⁰ Current options for management include:

(1) *Primary suturing*: This necessarily involves exploration of the site of injury with release of the tamponade effect of the hematoma. Also, dissection in an effort to perform urethral anastomosis may damage the neurovascular bundles and increase the risk of impotence. Furthermore, any surviving elements of the urethral sphincter may be damaged by mobilizing and trimming the torn urethral ends before suturing.¹¹ Another consideration is that incomplete ruptures may be converted to complete ruptures during the course of attempt repair.

(2) *Primary realignment*: This includes different techniques of "railroading" to manipulate a catheter across the urethral gap at open operation. The urethral catheter is left in place for 4–8 weeks and is removed only when a pericatheter urethrogram demonstrates healing of the urethral injury with no extravasation of contrast medium.¹² The aim of realignment is to pull the proximal urethra down snugly against the distal stump so that healing will occur with minimal stricture. The drawbacks of primary realignment include the risk of accelerating blood loss, damage to the neurovascular bundles with an increased incidence of impotence and the increased incidence of incontinence by denervation or direct injury of the urethral sphincter.¹³ Accordingly, endourologic and radiologic procedures have been suggested to achieve primary realignment without the risk of exploring the injured urethra.³ These procedures should not adversely affect erectile function. Also, by endoscopy the surgeon may identify partial urethral rupture which can be stented safely under vision.

(3) *Suprapubic cystostomy alone*: No attempt is made to explore or manipulate the urethra, but urine is simply diverted with a suprapubic catheter. This principle accepts the inevitability of stricture formation following complete urethral rupture which is repaired electively several months later. Should the rupture be incomplete, spontaneous urethral voiding may ensue as early as 10–14 days after the injury on clamping the suprapubic catheter.¹⁴ Perceived advantages of this technique include avoiding entry into the pelvic hematoma, speed and simplicity of suprapubic catheter placement, and avoiding mobilization of the prostate and urethra with resultant lower impotence and incontinence rates.¹² The drawbacks include the need for suprapubic drainage for 3–6 months and the approximately 100% risk of stricture formation, many of which are complex.¹⁰

Of the three conventional treatment methods primary suturing of the disrupted urethral ends has the greatest complication rates of incontinence and impotence (21% and 56%, respectively). Primary realignment has double the incidence of impotence and half that of stricture compared to suprapubic cystostomy and delayed repair (36% vs. 19% and 53% vs. 97%, respectively, $p < 0.0001$).¹⁰

The available data suggest that inflexible policies of one procedure or another are inappropriate for the treatment of pelvic fracture urethral injuries. The key to a good result lies in avoiding under-management of serious injuries as well as over-management of minor injuries.¹⁰ Success depends on proper selection and assignment which in turn is dependent on certain factors including type of injury (stretching, partial rupture, or complete rupture), separation of urethral ends (narrow or wide), associated injuries (inside or outside the urinary tract), patient condition, available facilities, and experience of the treating surgeon. Treatment options include:

- (1) Urethral injury in the form of a stretch does not require more than an indwelling catheter for a few days.
- (2) Partial rupture may be managed by either endoscopic urethral stenting in the first place or by suprapubic cystostomy. This may result in a patent urethra or at most a

very short stricture easily correctable by optical urethrotomy.

- (3) For complete rupture with minimal urethral distraction, the benefit of over-management by realignment is outweighed by the inherited drawbacks of this procedure. Such cases may be treated by either endoscopic realignment or suprapubic cystostomy.
- (4) For complete rupture with marked urethral separation there is a high risk that under-management by a suprapubic cystostomy or endoscopic procedure will result in a complex stricture requiring an extensive transpubic repair. Such injuries should be explored for primary realignment. It is unreasonable to suppose that realignment in these cases will significantly increase the already high chance of impotence.
- (5) Associated injury to the bladder, bladder neck or rectum dictates immediate exploration for repair but does not necessarily indicate exploration of the urethral injury site.

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