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REVIEW

Classification of pelvic fracture urethral injuries: Is there an effect on the type of delayed urethroplasty?

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ABBREVIATIONS

PFUI, pelvic fracture urethral injury; AAST, American Association of Surgery of Trauma

Abstract The posterior urethral injury due to pelvic fracture is a challenging problem. Because pelvic fractures are widely varying in severity, direction and mechanism, a wide spectrum of pelvic fracture urethral injuries (PFUIs) is clinically identified. Previously published data indicate that the proposed classifications of PFUIs are neither ideal nor universally acceptable. Moreover, these classifications might not have a significant effect on the delayed definitive techniques of urethral reconstruction. The currently available classifications and management strategies of PFUIs lack consensus and are based on accumulated surgical experience and clinical case studies. In the current era of evidence-based medicine there should be clear and appropriate guidelines for managing PFUIs, based on meta-analysis of well-designed controlled studies and evidence-based surgical science. In this way several controversies in the management of PFUIs will be resolved and the quality of life of patients who have sustained PFUIs will be improved.

Introduction

Generally the classification of a disease entity into clinical and/or pathological subcategories is usually done to help clinicians to grasp easily the definitive diagnosis and to decide the appropriate treatment. Thus the classification of pelvic fracture urethral injuries (PFUIs) should not be merely cosmetic, for the subject in an article or a book chapter, but should be substan-

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tive and contribute to the optimal management and the best level of quality of patients' lives. Also, a practical classification of PFUIs should have a pivotal role in the optimization of treatment guidelines from evidence-based data.

Currently, classifications of PFUIs are based on the anatomical, radiological, mechanistic and/or functional findings [1–3]. In this review the available classifications of PFUIs and their effect on the ultimate treatment decision are highlighted. Also, I attempted to delineate the scientific requirement to establish the appropriate management guidelines for PFUIs and to achieve the best quality of life for patients sustaining these injuries.

Radiological classification

Colapinto and McCallum [1] classified posterior urethral injuries into three categories based on radiological findings from retrograde urethrography:

Type 1: the membranous urethra is stretched but not severed.

Type 2: the membranous urethra is ruptured above the urogenital diaphragm, the contrast material extravasates into the pelvic extraperitoneal space above the urogenital diaphragm.

Type 3: the membranous urethra is ruptured and the injury extends into the bulbous urethra due to a tear in the urogenital diaphragm. Contrast material leaks above and below the urogenital diaphragm.

Types 1 and 2 are relatively uncommon [3,4]. The series of Colapinto and McCallum [1] did not include type 2 injuries. Sandler et al. [2] reported type 1 and 2 injuries in only 15% of cases, and type 3 in 85% of cases. Another point is that in type 3, which is more common, the injury extends into the bulbous urethra, which is a part of the anterior urethra [3]. However, this classification is commonly used, probably because it is simple [2,3].

Extended anatomical classification

Goldman et al. [3] proposed a classification of urethral injuries based on the anatomical description of traumatic urethral injuries:

(I) Posterior urethra is stretched but still intact (Colapinto-McCallum type 1).
(II) Partial or complete pure posterior urethral injury with tear of the membranous urethra while the urogenital diaphragm is intact. Contrast medium extravasates only above the urogenital diaphragm (Colapinto-McCallum type 2).
(III) Partial or complete anterior and posterior urethral injury with disruption of the urogenital diaphragm; contrast agent leaks above and below the urogenital diaphragm (Colapinto-McCallum type 3).
(IV) Bladder neck injury extending into the urethra. The extravasation of contrast medium is around the bladder neck.
(V) Bladder base injury with periurethral extravasation similar to posterior urethral injury.
(VI) Partial or complete isolated anterior urethral injury.

Thus, the classification of Goldman et al. [3] has retained the Colapinto-McCallum classification but with the addition of the injuries to the bladder neck, bladder base and anterior urethra, attempting to include all possible urethral injuries, bladder injuries and bladder neck injuries. It is not commonly used, probably because it is more complex. However, Chapple et al. [5], in a committee consensus report, adopted and endorsed this classification because it might help to predict the integrity of the continence mechanism after pelvic trauma. The striated sphincter is most probably intact in type 1 and 2, and might be injured in type 3.

Bladder neck injury can jeopardize the continence mechanism after definitive urethral reconstruction, but Chapple et al. believe that there is no absolute correlation between the radiological or endoscopic appearance of the bladder neck and subsequent functional status. In an attempt to simplify the Goldman classification, Chapple et al. suggested the following modifications [5].

Anterior urethra

1. partial disruption;
2. complete disruption;

Posterior urethra

1. posterior urethra stretched but intact;
2. partial disruption;
3. complete disruption;
4. complex injury involving bladder neck or rectum.

American association of surgery of trauma (AAST) classification

In contrast to the Colapinto-McCallum and Goldman classifications that determine the anatomical site of injuries, the concept of partial and complete urethral wall disruption (irrespective of the site of injury) has been emphasized by the AAST scale, with the addition of the measurement of the gap of urethral separation [6]:

(I) Contusion: blood at urethral meatus and retrograde urethrography is normal.
(II) Stretch injury: elongation of the urethra with no extravasation on urethrography.
(III) Partial disruption: extravasation of urethrography contrast medium at the injury site, with visualization in the bladder.
(IV) Complete disruption: extravasation of urethrography contrast medium at the injury site with no visualization in the bladder; < 2 cm of urethra separation.
(V) Complete disruption; complete transection with > 2 cm of urethral separation or extension into the prostate or vagina.

Urethral contusion and laceration refers to partial injury involving part (but not the full thickness) of the urethral wall. Partial injury refers to injury involving the full thickness of a part of the circumference of the urethra, and complete injury refers to injury involving the full thickness and the whole circumference of the urethra, with no trace of continuity between the ends that can be gapped for variable distances [7]. It is assumed that partial and complete urethral injuries are usually preceded by stretching of the membranous urethra at bulbomembranous junction, while in partial injury the membranous urethra is still stretched in the urethrogram and extravasation is localized above the uro-

genital diaphragm [8]. However, a clear differentiation between a partial tear and complete rupture might be difficult and might explain the wide variations in the incidence of complete disruptions [9]. Mitchell [10] reported complete rupture of the posterior urethra in 6% of cases; Morehouse et al. [11] reported complete posterior urethral rupture in 97%. Webster et al. [12] reviewed several series and found an average of 34% partial tears and 65% complete disruption. Ennemores et al. [9] reported partial tears in 59% and complete rupture in 41%. Thus, previous publications indicated that the Colapinto-McCallum classification and AAST grading are commonly used [13]. However, Crane and Santucci [14] believed that the AAST classification is the most valuable, and if a urethral catheter could be introduced, urethral realignment might be successful. If realignment fails, suprapubic diversion is mandatory, with delayed definitive reconstruction after 3–6 months.

However, because it is difficult to distinguish a partial from complete urethral rupture on urethrography, even on urethroscopy, there is no ideal, comprehensive, clinically relevant and applicable classification of posterior urethral injuries associated with pelvic fractures [14].

Anatomical and functional classification

Al Rifaei et al. [15] developed a new combined anatomical and functional classification of posterior urethral injuries secondary to pelvic fractures:

Type 1: Prostatic injury; 1a: proximal avulsion of the prostate. 1b: partial or complete transprostatic rupture.

Type 2: Stretching of the membranous urethra (Colapinto-McCallum type 1).

Type 3: Incomplete or complete supradiaphragmatic rupture of the prostatomembranous urethra (Colapinto-McCallum type 2).

Type 4: Incomplete or complete infradiaphragmatic rupture of the prostatomembranous urethra (Colapinto-McCallum type 3).

Type 5: Variable combined urethral injuries affecting more than one level, injury to the proximal sphincteric mechanism (bladder neck) combined with prostatic and/or membranous urethral injury.

This classification also retained the previous classifications and added prostatic injuries, including avulsion at the level of bladder neck (which constitutes bladder neck injury) in the type 1 category. It then includes bladder neck injuries (proximal sphincter) in type 5. The classification considers prostatic injury and prostatic urethral injury as two separate entities, which is illogical and difficult to reconcile with the anatomical, radiological and operative evidence. The injuries proximal to the membranous urethra (bladder neck and prostatic urethra) occur only in children [16–18]. In type 5 the authors tried to collect all unclassified and heterogeneous urethral injuries in one category. This classification is not widely accepted [4], a fact that emphasizes the difficulty in classifying the wide spectrum of posterior urethral injuries associated with pelvic fracture. Bladder and bladder neck injuries are included in other organ-specific classification systems of the AAST [6].

All of the classifications described lack Level of Evidence 1 and 2 studies, and are totally based on studies of Level of Evidence 3 or 4, according to the Oxford 2011 Levels of Evidence system [19]. Table 1 summarizes the basis, the Level of Evidence and reports used for each classification. The vast majority of guidelines established and reported in conference committee consensus are considered expert opinions, and have Level of Evidence 5, some of these guidelines have Level of Evidence 3 and 4 and none has Level of Evidence 1 or 2 [5].

Clinical effect of classifications of PFUIs

Because pelvic trauma is an abdominal emergency, immediate imaging is mandatory to exclude associated bladder injury (with urine leakage into the peritoneal cavity) or rectal injury (a condition that necessitates immediate exploration for the repair of such injuries). In such circumstances the surgical management of posterior urethral injury can be immediate, but immediate repair is usually associated with a higher incidence of recurrent and more fibrotic stricture, incontinence and impotence [5]. Thus, in the vast majority of cases a suprapubic catheter is fixed and delayed urethroplasty (after 3–6 months) is preferred. A radiological reassessment, mainly by urethrography and combined cystography and urethrography of the urethral injury, is mandatory after relief of pelvic haematoma, resolution of oedema and stabilization and scarring of deposited collagen at the area of trauma [7,8,20].

Is there a correlation between the classification of PFUI and type of definitive urethral reconstruction?

Although the AAST classification differentiates partial or complete urethral disruption and measures the gap between urethral ends after complete urethral disruption, the final picture can be different a few months later after the stabilization of scarred tissue. For several years, surgeons have believed that the surgical approach for urethroplasty is ultimately determined during surgery [21,22]. Recently, Koraitim [23,24] studied the preoperative factors predictive of the appropriate surgical approach, using univariate and multivariate analysis of several factors that might affect and/or dictate the strategy of reconstructive urethroplasty. He found strong evidence that gapometry (urethral gap length), gapometry/urethrometry index (urethral gap length/bulbar urethral length) and lateral prostatic displacement (vs. upward displacement) independently predicted the appropriate surgical approach for urethral reconstruction. The findings of Koraitim are considered a major step towards establishing new treatment guidelines for PFUI.

Nevertheless, these findings indicated that the currently used classifications of PFUI have little or no effect on determining the definitive surgical approach for urethral reconstruction and subsequently on the outcome of surgery.

Associated bladder neck injury due to pelvic trauma is relatively rare. It usually occurs in children aged $\leqslant$15 years and can be diagnosed early by leakage of contrast medium around the bladder neck on urethrography (Goldman type IV). However, bladder neck injury can be suspected in cases of fractured ipsilateral ischiopubic rami even if the bladder neck is apparently intact. Also, in patients who were initially managed by primary realignment, the bladder neck can be traumatized, especially if this was performed with catheter traction. In the last two conditions the immediate radiological tests have no role in the diagnosis of bladder neck injury. Thus, the above mentioned

Table 1 Classifications of pelvic fracture urethral injuries.

Classification	Basis	Level of Evidence	Acceptance
Radiological classification [1]	Retrograde urethrography	3	Commonly used
Extended anatomical classification [3]	Radiological anatomy of the whole urethra, bl. Neck and bladder base	3	Not commonly used
AAST classification [6]	Clinical Exam. and urethrography	4	Commonly used
Anatomical and functional classification [15]	Clinical exam, catherization; urethrography operative findings, sphincter integrity	3	Not widely accepted

classification methods cannot detect or diagnose all cases of bladder neck trauma. However, delayed investigations can diagnose bladder neck dysfunction by the rectangular shape of the opened bladder neck on cystography, or by the finding of a fixedly opened bladder neck on suprapubic cystoscopy [16].

Because urinary continence after posterior urethroplasty depends mainly on the integrity of the bladder neck, and to a lesser extent on the preserved external sphincter, bladder neck reconstruction might be required either in conjunction with urethroplasty, or in a separate subsequent session, to restore urinary continence [16,25].

For an optimal classification of PFUIs to be established there must be a consensus on the meaning of the terminology used, with no confusion or controversy, and studies should categorize urethral injuries associated with pelvic fractures according to a single, well-known, universal and practical system. The ideal classification must be comprehensive and practical, rather than theoretical, to easily direct the surgeon's attention to the optimal diagnostic tools and appropriate reconstructive techniques. None of the current classifications has gained universal acceptance, which might be due to them having little or no significant effect on the management of posterior urethral injury associated with pelvic fractures. When there are several good-quality well-designed prospective studies of the management of such conditions, based on appropriate and widely accepted classification, the optimum and shortest way to the best functional outcome could be established.

Conclusion

Traumatic pelvic fracture can be associated with a wide spectrum of injuries involving the posterior urethra, urogenital diaphragm, external sphincter, bladder neck, bladder base and rectum. Currently the available classifications of PFUIs reflect the severity and anatomical extent of the urethral trauma, and can help in decision making for the immediate management of the emergency condition. However, none of these classifications has gained universal acceptance and none has strong evidence derived from meta-analysis or from good quality controlled trials. Moreover, it seems that these classifications have no effect on decision making for delayed definitive surgical reconstruction of the urethral defect, and cannot predict the functional outcome of surgery. Every effort should be exerted to obtain clear guidelines of assessment and management of PFUIs through universally accepted definitions of terminology, clear measures of the functional outcome and thresholds for the definition of success and failure of reconstructive urethroplasty.

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