An update on urotrauma

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Purpose of review
The subject of genitourinary trauma was recently reviewed as an American Urologic Association guideline as well as recently updated as a European Association of Urology guideline. These guidelines, while complete and authoritative, deserve review, amplification and clarification. Also, notably absent from the guidelines is a section on the management of renovascular injuries, which will be reviewed here.

Recent findings
In the 2014, the American Urologic Association and updated European Association of Urology guidelines were published with highlighted features or changes described here.

Summary
We report the updated features of the guidelines as well as sections of update from our own experiences in which the guidelines remain vague or are absent.

Keywords
bladder trauma, genital trauma, genitourinary trauma, renal trauma, ureteral trauma

INTRODUCTION

Trauma is a growing global problem. In the USA, it is the leading cause of death in people between the age of 1 and 44 years of age, and is the 6th leading cause of death worldwide [1▪].

Over the past year, the American Urologic Association (AUA) and the European Association of Urology (EAU) have both published updates on genitourinary trauma [1▪–3▪]. The AUA guidelines reviewed scientific articles published during a 22-year period from 1990 to 2012. By removing the small studies with less than 10 patients, only 372 articles were left for the analysis.

Rather than summarizing the guidelines, we set forth to highlight the updated features of the guidelines as well as include sections of update from our own experiences in which the guidelines remain vague or are absent.

RENAL

The historic trajectory of the response to renal trauma has steadily focused on more conservative management, especially over the past few decades. It is clear that both blunt and penetrating trauma can be managed conservatively to spare the patient unnecessary intervention and hopefully spare renal units, in selected patients. The major determinate of who can be managed conservatively has to do with the stability of the patient. Simply stated, those who are bleeding to death from the kidney need speedy intervention. Those who are not bleeding to death from the kidney may undergo observant management. A secondary consideration is to diagnose problems such as renal pelvis injury, which may need surgical repair. Additional consideration for the acute management of renal trauma involves diagnosing significant urinary leakage (such as from a shattered kidney) which may require percutaneous or stent drainage.

Evaluation

Cross-sectional imaging with computed tomography (CT) is warranted when there is gross hematuria or microhematuria with hypotension [systolic blood pressure (SBP) <90mmHg]. However, there is evidence that nearly one-third of multisystem trauma patients may have renal injury in the absence of hypotension and hematuria [4]. This is particularly common in patients with renal artery thrombosis, but the lack of hematuria can be found

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KEY POINTS

- Over the past year, both the AUA and EAU have published updates on the guidelines of management of urotrauma.
- We highlight the updated features of the guidelines as well as include sections of update from our own experiences.
- Specific genitourinary trauma evaluation and management are reviewed and discussed.

in any renal injury. CT imaging is also warranted when the mechanism of injury or physical examination is consistent with renal injury [such as a blow to the flank, rib fracture and flank bruising (Fig. 1)], rapid deceleration, (as in a fall from a height or high-speed auto accident) or penetrating injury to the region [1▪].

Management

In stable patients, conservative management is often warranted, even in the setting of evidence of urinary extravasation. The call for wider use of conservative management is prevalent in both the EUA and AUA guidelines and patients generally do well. It should be noted that there is a higher rate of delayed complications for penetrating trauma with high-grade injury (grade IV and V) (Fig. 2*)* after conservative treatment [2▪]. Conservative management of gunshot in the stable patient without renal pelvis injury is possible, but the level of monitoring and vigilance for complications should remain high in these patients (Fig. 3).

Urinary extravasation is easily seen on films and often gets people's attention. However, the mere presence of urinary extravasation does not necessarily require intervention. Medial extravasation of urine may portend a potential worse outcome (Fig. 4), and clinicians should consider at least a retrograde pyelogram to assess for undiagnosed renal pelvis injury. If present, these may require open exploration/repair or maximal drainage with stents and percutaneous nephrostomy in order to avoid complications. In any case, if urinomas continue to grow, cause worsening pain, fever or ileus, the clinician should consider drainage via stent, urinoma drain, renal percutaneous drainage or any combination of these.

If patients become unstable or only transiently respond to resuscitation, then immediate intervention is warranted. Intervention may be surgical or angioembolization. Angioembolization should only be attempted if there is a capable angiography team available immediately, the patient is monitored during transport and during the procedure, and can be moved to the operating room urgently if needed [1▪,2▪].

FIGURE 1. Flank ecchymosis following trauma.

Follow-up

Routine follow-up imaging is not warranted on lower grade injuries (grade I–III). Cross-sectional imaging may be obtained on patients with worsening symptoms such as fever, increasing pain or hematuria, abdominal distension or ongoing blood loss. AUA guidelines are clear that routine imaging is not required after renal injury, although prudence, and the EAU favors a lower threshold for imaging in those with the highest grade injuries (grade IV–V) [1▪]. It should be noted that the data are not strong for the latter in the absence of symptoms.

Renovascular injury

Segmental branch vascular injuries do not require repair unless they are persistently bleeding leading to hemodynamic instability as these injuries rarely if ever result in negative sequelae [5]. Injury to the main renal artery and vein is relatively uncommon in acute trauma; however, their injury results in significant renal loss. The success rates for renal salvage with primary vascular repair are abysmal ranging from 6% up to only 40% in the most expert hands [6–9]. Subsequent delayed nephrectomy and renal loss despite repair were commonly reported in series [7,9]. In a large multicenter report, poor outcomes were reported irrespective of whether patients were treated with primary vascular repair or observation. Only, immediate nephrectomy appeared to be associated with an improved outcome [6]. As such, renal artery or vain injury repair should likely only be attempted in the setting of a solitary kidney, otherwise management by

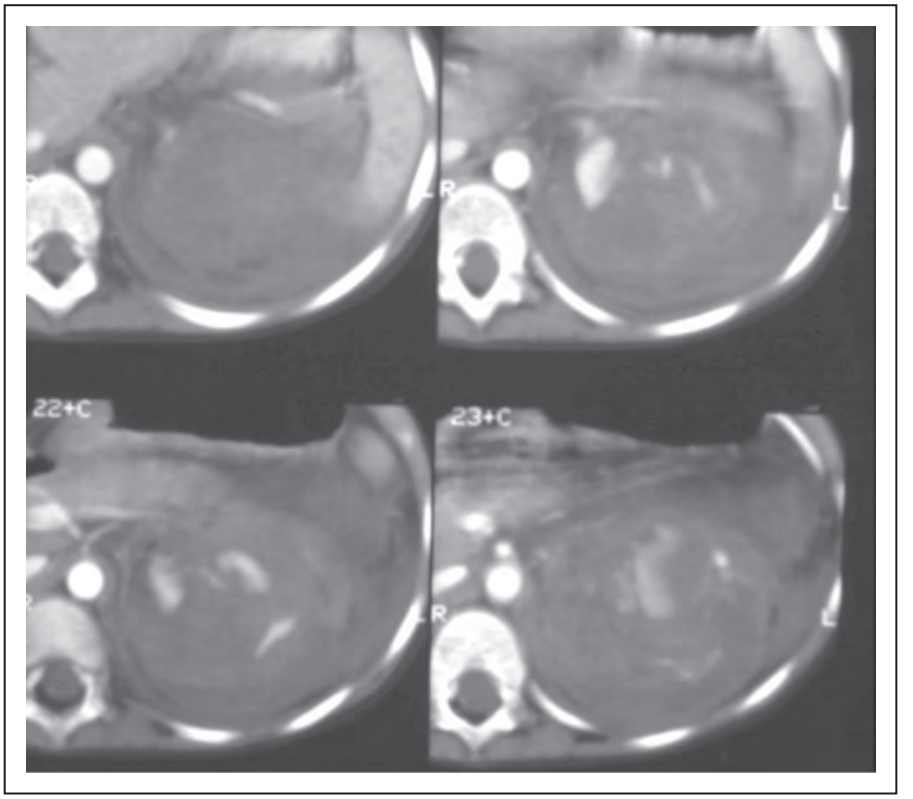

FIGURE 2. Grade V renal injury.

nephrectomy or angioembolization (with expected renal loss) whenever clinically appropriate is most prudent.

URETERAL

Evaluation

In patients with gross hematuria after trauma, or after an injury mechanism with a high chance of causing ureteral injuries (penetrating abdominal injury, high-speed acceleration/deceleration injury such as a fall from a height or high-speed auto accident) should be evaluated for ureteral injury, usually with a CT scan with contrast. If a patient with suspected ureteral injury requires immediate trauma laparotomy, surgeons should inspect the ureters directly [1▪]. Adjunct tools, such as intraoperative one-shot intravenous pyelogram, may be used. This is most helpful when the study is normal as significant ureteral injuries are unlikely. This is also helpful when it localizes an area of extravasation, allowing thorough inspection of that area. Hematuria has a poor sensitivity for identification of ureteral injury such that a lack of hematuria does not reassure that there is not a ureteral injury [2▪].

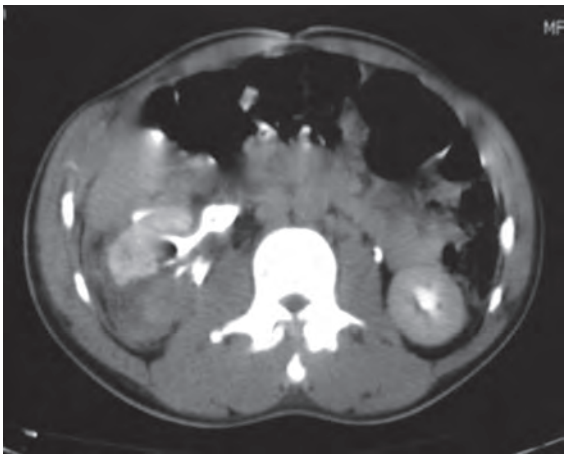

FIGURE 3. Renal gunshot wound.

Management

In general, ureteral injuries discovered intraoperatively can be repaired immediately. If the patient is hemodynamically unstable, cold or coagulopathic, then delayed repair can be done. The surgeon can ligate the distal end of the ureter over a stent, with the distal portion of the stent brought out through the skin. Alternatively, the ureter is ligated and a percutaneous nephrostomy tube is placed.

Complete ureteral injuries in the stable patient should be repaired. Injuries above the level of the

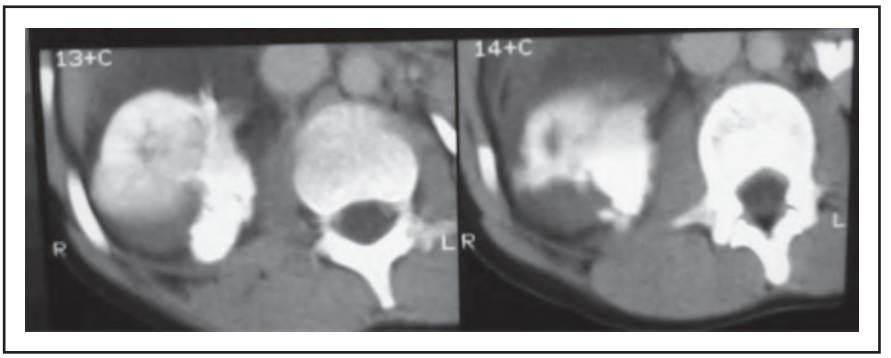

FIGURE 4. Medial urine extravasation after renal injury.

iliac vessels should be repaired with primary ureteroureterostomy whenever possible. Certain surgical principles of ureteral repair can improve long-term outcomes. The longitudinal branches of the vessels supplying blood to the ureters are described as being contained within an 'adipose fibrous sheet' that is not tightly connected to the ureter [10]. One anatomic study of 100 ureters described approximately 10% of ureters that maintained a primary blood supply from a single arterial source to a longer segment of the distal ureter, such that when the ureter was transected, the primary blood supply to that segment then relied only on local small branches largely arising from peritoneal attachments [11]. In light of the above described anatomy, minimal ureteral dissection, especially within the vascular planes described above, as well as maintaining the peritoneal small vasculature to the more distal ureter wherever possible, may reduce the chance of ureteral devascularization. The repair should be spatulated, a stent should be placed, retroperitonealized when possible and a drain should be placed in the area. If the injury is below the level of the iliac vessels, one should attempt ureteral reimplantation into the bladder whenever possible, with or without the use of psoas hitch [1▪,2▪]. Boari flaps are technically challenging, time-consuming and are usually not appropriate in the acute trauma setting.

Iatrogenic ureteral injuries often present differently. Inadvertent ureteral injuries identified intraoperatively should generally be repaired at the time of discovery. Most ureteral injuries, however, are not found during the original causative surgery. In these cases, there are three goals to treatment. The first is to fully identify the injury. The second is to allow urinary drainage. The third, when possible, is to place ureteral stents which may or may not (usually not) actually be curative for the injury. In ureteral transection, stent placement is only sometimes possible, and it serves mainly for urinary drainage and to possibly avoid long-term nephrostomy tube placement. Long-term stricture formation and the need for definitive repair are not improved by stenting a complete ureteral injury [12,13]. In other words, the injury itself, rather than when and if a stent is placed, will dictate whether or not definitive repair is eventually needed.

Incomplete ureteral injuries found at the time of surgery can be repaired primarily or less commonly stented, depending on ureteral viability. If diagnosed in a delayed manner, a stent should be placed when possible [1▪,2▪]. If a stent cannot be placed, then a nephrostomy tube should be placed; with planned delayed repair if necessary. In the setting of incomplete ureteral injuries, stent placement may decrease the risk of stricture formation [2▪]; however, extensive supporting data are lacking. Endoscopic ureteral injury should be managed with ureteral stenting. If a stent cannot be placed, then attempt percutaneous drainage with antegrade stenting or delayed open repair. If stenting or nephrostomy tube is not possible, then open repair may be necessary.

BLADDER

Evaluation

Patients should be evaluated with gross hematuria, and a pelvic fracture or mechanism of injury concerning for bladder injury requires cystogram [1▪,2▪]. There is no difference in sensitivity between correctly performed plain film cystogram or CT cystography [1▪].

Management

Intraperitoneal bladder ruptures require repair and are likely to be large (Fig. 5). The average intraperitoneal bladder rupture is about 6 cm in size. Extraperitoneal bladder rupture may be treated with catheter drainage if uncomplicated; however, if complicated, it should be primarily repaired. Complicated extraperitoneal bladder injuries include

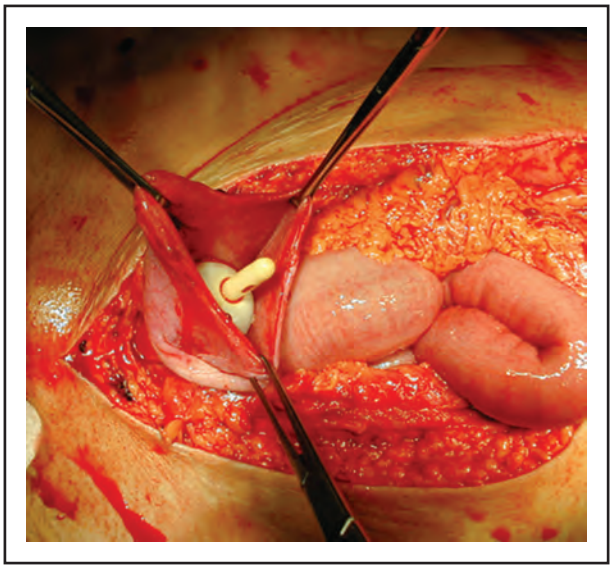

FIGURE 5. Intraperitoneal bladder rupture with large defect.

a number of scenarios. Bone fragments in the bladder prevent bladder healing with only catheter drainage. Concurrent vaginal or rectal lacerations can cause subsequent fistula formation if not repaired primarily. Bladder neck injuries tend to not heal well with catheter drainage, and persistent leakage can lead to surrounding tissue infection. (It used to be said that continence was improved if bladder neck injuries occurring with pelvic fracture urethral injury were surgically repaired.) Pediatric series have shown that repairing bladder neck injuries does not improve continence, but does avoid the sequelae of pelvic infection [14]. If the patient is undergoing pelvic fixation with hardware, the bladder may be repaired primarily to avoid persistent bathing of hardware with urine and subsequent infection risk. When the patient is undergoing laparotomy for unrelated injuries, one may consider concurrent extraperitoneal bladder injury repair to avoid a need for prolonged catheter drainage and potential fistula to laparotomy wound. Penetrating bladder injuries should be explored and repaired primarily [3▪]. It should be stressed that if a urinary drainage catheter is placed for the treatment of extraperitoneal bladder rupture, but does not drain well because of clot retention or other reasons, then improved drainage by placement of a suprapubic tube or even primary repair should be performed.

After repair, the bladder should be managed with Foley catheter urinary drainage alone (without placement of suprapubic tube) in most settings [1▪,3▪]. If there is a very complex bladder injury (Fig. 6) or excessive hematuria, the surgeon should consider leaving a suprapubic catheter for additional improved drainage.

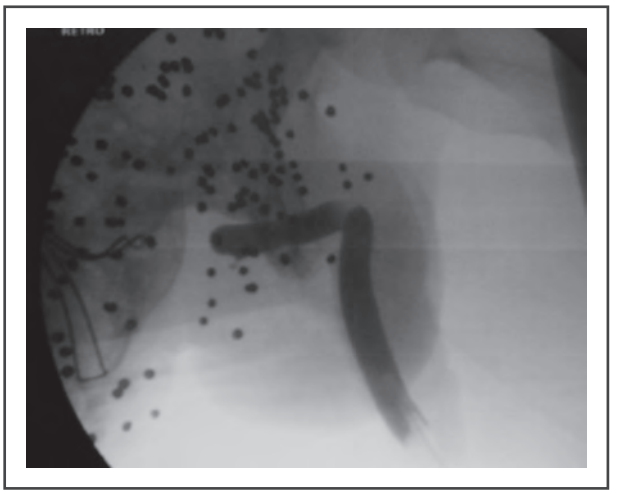

FIGURE 6. Complex bladder injury secondary to shotgun injury.

URETHRA: PELVIC FRACTURE URETHRAL INJURY

Pelvic fracture urethral injury (PFUI) is the contemporary accepted term for urethral injuries (usually causing complete urethral separation) caused by high impact usually blunt trauma. The term 'posterior urethral' injury should be abandoned as they are more often not posteriorally located and 'posterior urethral stricture' never used as they generally do not result in true stricture of the urethra.

Evaluation

Any concern for urethral injury should prompt evaluation of the urethra. Concerning clinical findings include, blood at the urethral meatus, inability to void, penile and perineal hematoma, or mechanism concerned for straddle injury. Evaluation of the urethra should be performed with retrograde urethrogram. Alternatively, a single passage of a urethral catheter can be attempted by an expert practitioner to allow immediate urinary drainage in the acute trauma setting. Later, when the patient is stable, a pericatheter urethrogram can be performed to rule out significant urethral injury.

Management

The guidelines recommend establishing prompt urinary drainage in cases of pelvic fracture urethral injury [1▪,3▪]. The AUA guidelines state that a clinician may perform realignment but should not make very prolonged attempts [1▪]. Although we agree that prolonged attempts should not be made, a patient with pelvic fracture urethral injuries may yet benefit from early endoscopic realignment.

Many series of primary endoscopic realignment demonstrate successful avoidance of stenosis in approximately one-third of patients [3▪,15]. Furthermore, stenosis after primary realignment may result in a less severe stenosis that allows for a technically easier urethroplasty and management [16]. If realignment is not easily feasible or not deemed appropriate, then a suprapubic tube should be placed. Patients should never undergo open surgery with the sole goal of open urethral realignment, except perhaps in some future clinical trial in expert hands. Suprapubic tubes may be placed even in the setting of pelvic fixation with hardware [1▪]. Orthopedists are often concerned that suprapubic catheters may infect their hardware, but any clinical data to support this concern are lacking. One might place the suprapubic tube as high as possible on the abdomen, even placed above the umbilicus and tunneling down to the bladder, to allay their fears.

URETHRA: NON-PELVIC FRACTURE URETHRAL INJURY

Treatment of non-PFUI injuries to the urethra is highly dependent on location and in some cases, mechanism. Most injuries to the prostatic urethra should have a Foley catheter placed. If there is associated rectal injury, this should be repaired (with or without presacral drains) or a diverting colostomy placed or both, as determined by the general surgery team. Most injuries to the bulbar urethral should probably also have a Foley catheter placed, but selected primary repair of, say, urethral stab injury may be contemplated. In urethral crush/straddle injuries in the absence of actual urethral separation, at least two articles suggest that urethral rest after suprapubic urinary drainage is the best approach. The EUA guidelines strongly favor this approach [3▪,17,18].

Penile urethral injuries may be treated by primary repair, catheter drainage or suprapubic drainage. Primary repair of uncomplicated penetrating trauma to the anterior urethra in a stable patient may be done [1▪,3▪]. Consider temporizing measures such as catheter drainage with delayed repair in patients with severe, complex or large urethral injuries such as by close range shotgun blast. Do not attempt to place grafts or flaps in the acute setting because of expected poor take. Pendulous urethral injuries may be repaired primarily, or marsupialized to the skin and repaired in a delayed staged closure [3▪].

Follow-up

Urethral injury frequently results in stenosis. Close monitoring of patients for at least 1 year is essential to identify and appropriately treat the urethral sequelae of traumatic injury [1▪,3▪]. Recent data show that patients developing urethral obstruction after urethral injury or PFUI who have established urinary drainage may suffer delay in definitive repair if they are not ultimately referred to a center of expertise in a timely manner [19]. Referral for definitive repair should be a priority in patients with postinjury urethral stenosis, and multiple attempts at dilation/urethrotomy/cut to the light procedures avoided.

GENITAL TRAUMA

Penile fracture

Suspect penile fracture in the setting of appropriate history and physical examination (that is ecchymosis and swelling in the setting of a popping/cracking sound during sexual activity with rapid detumescence). History and physical examination are often sufficient to diagnose penile fracture and are

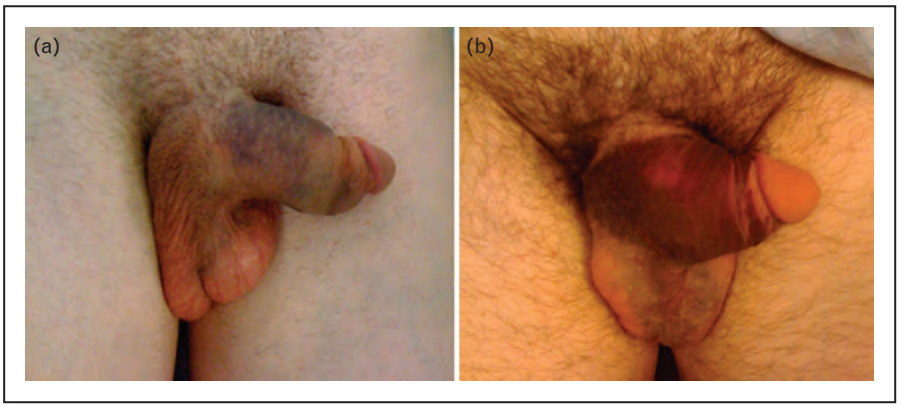

FIGURE 7. (a) Patient with penile fracture reporting a 'pop' with immediate detumescence; (b) patient with superficial vein avulsion reporting a 'tearing' sensation without detumescence. Ecchymosis and swelling approximately 15 mins after sex.

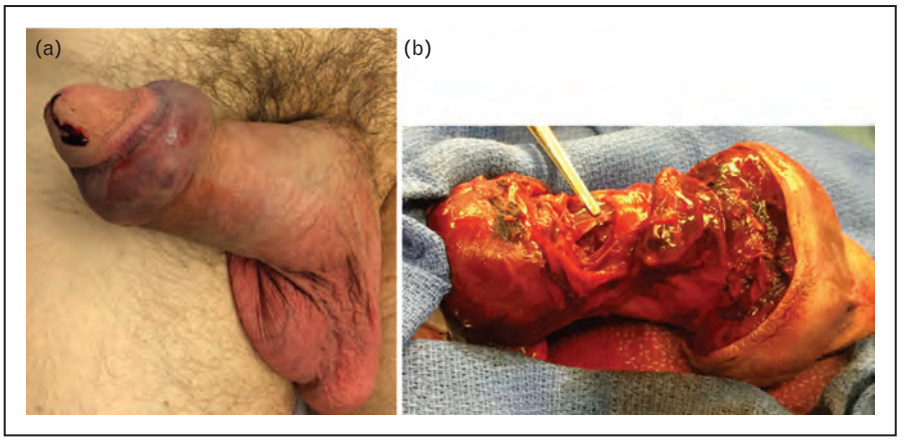

FIGURE 8. (a) Suspected penile fracture with blood at the meatus. (b) Subsequent exploration demonstrating bilateral corporal rupture with complete urethral disruption with catheter seen in urethra.

essential for distinguishing and diagnosing patients (Fig. 7). Nonetheless, ultrasound may rarely be required in equivocal cases, but we favor immediate exploration and repair [1▪]. Evaluation of urethral injury with cystoscopy, retrograde urethrogram or careful inspection is necessary in the setting of blood at the meatus, gross hematuria or inability to void (Fig. 8). Often, careful surgical exploration aided by a Foley catheter in the urethra is all one needs to find and fix urethral injuries (Fig. 8). Following clinical diagnosis, prompt surgical exploration with primary tunical repair is required. Concurrent urethral repair should be performed.

Testicular rupture

Scrotal exploration should be performed for any suspected testicular rupture. Surgical repair should include debridement and tunica albuginea closure when possible or orchiectomy if not salvageable [1▪]. Tunica albuginea closure may be aided by the creation of a tunica vaginalis flap and using this to cover the testicle, in cases of loss of tunica albuginea. We favor testicular repair over orchiectomy in cases where at least (arbitrarily) 25% or so of the testicles can be preserved.

Extensive genital skin loss or burn

Management should include debridement and closure or coverage. Of note, the guidelines suggest minimal debridement because of the well-vascularized nature of genital skin [1▪].

Penile amputation

The appendage should be managed by wrapping in physiological saline gauze, then placing in plastic and only then placed on ice. Microvascular reimplantation should be undertaken when possible, with the assistance of experts in microsurgery for the nerve/artery/vein anastomosis if possible (Fig. 9) [1▪]. If unable to reattach (usually because the severed penis has been discarded), the surgeon should formalize the partial penectomy to allow for voiding and any residual erectile ability (Fig. 10). A wide open spatulated urethral neomeatus should be made to avoid subsequent stenosis.

CONCLUSION

Over the past year, the AUA and EAU have published updates on the guidelines of management of urotrauma. Although these updates have been well reviewed and are authoritative, there still remain some areas of ambiguity that can be better clarified and point expounded upon. Throughout this review, we have highlighted the features of the guidelines as well as included sections of update from our own experiences in which the guidelines remain vague or are absent.

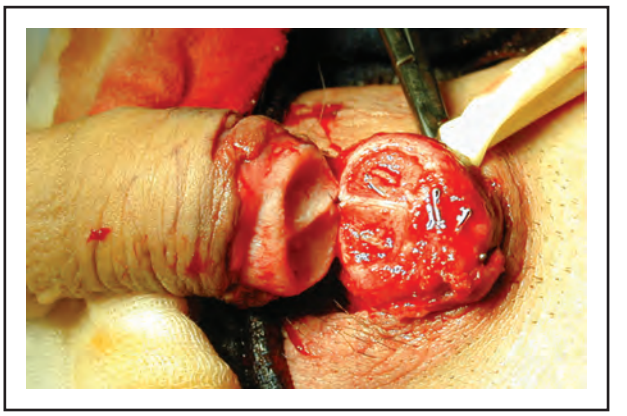

FIGURE 9. Penile amputation.

FIGURE 10. Partial penectomy following penile amputation.

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Conflicts of interest

There are no conflicts of interest.

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Papers of particular interest, published within the annual period of review, have been highlighted as:

- ■ of special interest
- ■■ of outstanding interest

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