AUA Update Series 2021
Lesson 15 Volume 40

Lower Urinary Tract Trauma*

Learning Objective: At the conclusion of this continuing medical education activity, the participant will be able to describe the epidemiology, presentation, diagnostic practices and principles of management for lower urinary tract trauma.

Austin Lee, BA
Disclosures: Nothing to disclose
Department of Urology

Patrick Martin-Tuite, BA
Disclosures: Nothing to disclose
Department of Urology

Nnenaya A. Mmonu, MD
Disclosures: Nothing to disclose
Department of Urology

and

Benjamin N. Breyer MD, MAS
Disclosures: World Journal of Urology, Sexual Medicine Open Access: Health Publishing
Department of Urology
Department of Biostatistics and Epidemiology

University of California San Francisco
San Francisco, California

***This AUA Update addresses the Core Curriculum topic of Trauma and the American Board of Urology Module on Core/General Urology.**

Accreditation: The American Urological Association (AUA) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

Credit Designation: The American Urological Association designates this enduring material for a maximum of 1.0 *AMA PRA Category 1 Credits*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Other Learners: The AUA is not accredited to offer credit to participants who are not MDs or DOs. However, the AUA will issue documentation of participation that states that the activity was certified for *AMA PRA Category 1 Credit*™.

Evidence-Based Content: It is the policy of the AUA to ensure that the content contained in this CME enduring material activity is valid, fair, balanced, scientifically rigorous, and free of commercial bias.

AUA Disclosure Policy: All persons in a position to control the content of an educational activity (ie activity planners, presenters, authors) provided by the AUA are required to disclose to the provider any relevant financial relationships with any commercial interest. The AUA must determine if the individual's relationships may influence the educational content and resolve any conflicts of interest prior to the commencement of the educational activity. The intent of this disclosure is not to prevent individuals with relevant financial relationships from participating, but rather to provide learners information with which they can make their own judgments.

Resolution of Identified Conflict of Interest: All disclosures will be reviewed by the AUA Conflict of Interest (COI) Review Work Group for identification of conflicts of interest. The AUA COI Review Work Group, working with the program directors and/or editors, will document the mechanism(s) for management and resolution of the conflict of interest and final approval of the activity will be documented prior to implementation. Any of the mechanisms below can/will be used to resolve conflict of interest:

- Peer review for valid, evidence-based content of all materials associated with an educational activity by the course/program director, editor and/or AUA COI Review Work Group.
- Limit content to evidence with no recommendations
- Introduction of a debate format with an unbiased moderator (point-counterpoint)
- Inclusion of moderated panel discussion
- Publication of a parallel or rebuttal article for an article that is felt to be biased
- Limit equipment representatives to providing logistics and operation support only in procedural demonstrations
- Divestiture of the relationship by faculty

Off-label or Unapproved Use of Drugs or Devices: The audience is advised that this continuing medical education activity may contain reference(s) to off-label or unapproved uses of drugs or devices. Please consult the prescribing information for full disclosure of approved uses.

Disclaimer: The opinions and recommendations expressed by faculty, authors and other experts whose input is included in this program are their own and do not necessarily represent the viewpoint of the AUA.

Release date: April 2021

Expiration date: April 2024

American Urological Association

Education and Research, Inc.
1000 Corporate Boulevard
Linthicum, MD 21090

Key Words: wounds and injuries, urinary bladder, urethra, penis, testis

INTRODUCTION

Traumatic injuries account for 10% of all-cause mortality in the United States and incur up to $406 billion each year in health care costs and loss of productivity.[1] Genitourinary injuries comprise approximately 10% of all traumatic injuries, with significant mortality and morbidity for patients.

Lower genitourinary tract injuries involving the bladder, urethra, penis and testicles can arise from either penetrating or blunt trauma. Penetrating trauma is most commonly due to gunshot wounds or stab wounds. Gunshot wounds can be particularly damaging because of the high energy transferred to the body and unpredictable path taken by the projectile.[2] Stab wounds due to any number of objects instead typically follow a more predictable path. In contrast, blunt trauma is usually caused by high energy deceleration accidents such as motor vehicle collisions, falls and contact sports.[3] Penetrating trauma compared to blunt trauma often necessitates surgical exploration.[2] In this Update, we discuss the different types of lower genitourinary tract trauma and best practices for diagnosis and management.

BLADDER TRAUMA

Epidemiology. A review of bladder injuries in the National Trauma Data Bank® indicated that 75% of injuries occurred in men, 54% affected individuals under 40 years old, and 51% to 86% were due to blunt trauma, while 49% were due to penetrating trauma.[4] The most common etiologies for bladder perforation in the setting of blunt trauma are motor vehicle collisions and pedestrian vs automobile accidents (80%).[1]

Overall, the incidence of bladder trauma in cases of blunt abdominal trauma range between 0.36% and 1.6%, with mortality as high as 11.1%.[5,6] This high mortality rate in patients with bladder injuries is explained by other concurrent life-threatening injuries that are the ultimate cause of death.[6]

Bladder injury secondary to blunt trauma rarely presents in isolation. Studies demonstrate that 80% to 85% of bladder injuries occur in the setting of pelvic fracture. However, only 5.4% of patients with pelvic fracture have a concurrent bladder injury.[6,7] When bladder injuries occur concurrently with pelvic fractures, they are more frequently extraperitoneal.[6] However, pediatric bladder trauma is more often intraperitoneal due to the abdominal anatomical orientation of the pediatric bladder.

The most common etiology of penetrating bladder injury is abdominal gunshot wound (88%), although only 3.6% of all abdominal gunshot wounds actually involve the bladder.[1] In addition to gunshot wounds, iatrogenic injuries to the bladder during intra-abdominal surgical procedures are common.

Diagnosis. Common clinical signs of bladder trauma can include suprapubic tenderness, diminished voided volume, lower abdominal bruising, swelling and hematoma.[7] The clinical triad of hematuria, suprapubic or abdominal pain, and difficulty voiding should raise suspicion of bladder trauma.[8]

Gross hematuria is common in bladder injuries (67% to 95%) and helpful to identify in initial workup given the high sensitivity.[7,9,10] When there are fewer than 25 red blood cells per high-powered field, incidence of bladder rupture is rare,[8] although no consensus exists regarding a specific threshold for evaluation for bladder trauma. If iatrogenic injury is the cause, bladder rupture may present intraoperatively as clear fluid in the operative field, a visible bladder laceration and gas distention of the urinary drainage bag during laparoscopic cases.[10]

With suspected bladder injury, particularly after verification of gross hematuria and pelvic fracture, bladder cystography is the recommended next step in evaluation.[7,11] Conventional retrograde cystography and CT cystography with retrograde filling are equivalent options in detecting bladder injury.[12,13] Indicative findings include contrast material outside the bladder (fig. 1).[12] Contrast material in intraperitoneal injuries will present in the abdominal space, whereas extraperitoneal injuries can yield contrast material in the prevesical space, anterior peritoneal space and superficial soft tissues of the anterior and medial thighs.[12] Pelvic fracture is a key risk factor for bladder rupture, with diastasis of the pubic symphysis greater than 1 cm and fracture of the obturator ring and subsequent displacement greater than 1 cm significantly increasing the likelihood of bladder injury.[10,14]

Management. Any intraperitoneal injury, penetrating or iatrogenic injury, inability to drain the bladder, bladder neck injury, concurrent rectal or vaginal injury, open pelvic fracture, pelvic fracture requiring open reduction and internal fixation, and bone fragments piercing the bladder should be operated on promptly.[15] **In general, intraperitoneal bladder injury should undergo acute operative repair to limit risk of urinary ascites, abdominal sepsis and healing complications.[5,11]** A few case reports and series have identified conservative management of intraperitoneal rupture with adequate urinary and intraperitoneal drainage as a possibility under certain circumstances.[16,17] There are insufficient data at this point to delineate when conservative measures may be appropriate. **In contrast, extraperitoneal bladder injuries can often be managed nonoperatively unless complicated by the aforementioned issues.[5]** Most operative repairs of the bladder are performed with a 2-layer closure anteriorly and 1-layer posteriorly using a braided, dissolvable suture. Depending on the mechanism of injury, the ureters can be staged by direct visual inspection, passing a feeding tube retrograde or by administering intravenous methylene blue. Following bladder repair, a postoperative cystogram is recommended in 10 to 14 days.[15,18] AUA management guidelines for bladder trauma can be found in part A of the Appendix.

URETHRAL TRAUMA

Epidemiology. Urethral injuries constitute 4% of all urological trauma and may have high morbidity.[19] Men are more commonly affected than women due to increased urethral length and reduced urethral mobility.[20] Similar to bladder injuries, urethral trauma commonly presents along with pelvic fractures (25% of cases in men, 4.6% of cases in women). The most frequent mechanism of injury is motor vehicle collision.[21,22]

ABBREVIATIONS: AUA=American Urological Association, CT=computerized tomogram, MRI=magnetic resonance imaging

Figure 1. Contrast extravasation on CT cystography suggestive of bladder trauma.

Trauma to the urethra is classically divided between posterior and anterior urethral injuries. In posterior urethral injuries, the bulbar urethra immediately proximal to the perineal membrane is less anatomically supported than the prostatic urethra and is thus more easily injured by traumatic forces.[21] In anterior urethral injuries, the bulbar segment is more susceptible to injury because of its fixed anatomical position relative to the penile urethra. Anterior urethral trauma distal to the bulbar segment is rare and typically involves trauma from sexual activity or military warfare.

In developed countries, posterior urethral injuries are approximately 4 times more common than anterior urethral injuries, often in the setting of pelvic fractures.[1] Among urethral injuries, 88% co-occur with pubic symphysis diastasis and displaced inferomedial pubic bone fractures.[22] Vertical sheer fractures (Malgaigne fractures) of the pubic rami and the ipsilateral ilium and sacrum also produce significant sheer forces that can injure the posterior urethra.[9,22]

Diagnosis. The diagnostic triad of blood at the urethral meatus, suprapubic fullness and urinary retention should raise suspicion of urethral injury.[23] When the triad presents in the setting of pelvic fracture, rectal and vaginal examinations should be performed to assess for concomitant injury. **The next step in diagnostic workup after observing blood at the urethral meatus is a retrograde urethrogram (fig. 2).[11]** The urologist's primary objective is to facilitate urinary drainage though either a urethral

Figure 2. Retrograde urethrogram with contrast extravasation suggestive of urethral injury.

catheter or a suprapubic tube. Evidence of severe urethral injury on imaging likely necessitates a suprapubic catheter, but a single attempt at urethral catheterization is reasonable. If there is failure to place a Foley catheter, a suprapubic tube should be placed. For women, urethroscopy with a cystoscope to evaluate the bladder neck is indicated for suspected urethral injury.[24]

Management of posterior urethral trauma. **Delayed Repair: Exploration and anastomotic repair of posterior urethral transection often is not performed at the time of injury due to risk of future incontinence, erectile dysfunction and stricture formation.[25]** Instead, placement of a suprapubic catheter for urinary diversion until sufficient healing of the injury is recommended (3 to 6 months), after which a delayed urethroplasty can be done.[9,26]

Primary realignment/immediate repair: When a patient is clinically stable, advances in surgical instrumentation allow for endoscopic realignment of the urethra.[11] Following urethral realignment, patients must be followed closely as stenosis and obstruction rates are approximately 80%.[27] Whether to perform primary realignment or not remains a great controversy in reconstructive urology. All agree that heroic and lengthy (>45 minutes) attempts to realign the urethra should be avoided as fluid extravasation can lead to worse outcomes in the future, including erectile dysfunction and incontinence.[11]

Management of anterior urethral trauma. Anterior urethral injuries often damage the bulbar urethra in the setting of a saddle injury. When additional injuries prevent immediate surgical repair or there is significant tissue destruction, suprapubic catheterization for urinary diversion followed by interval urethroplasty is indicated.[11,23] Otherwise, penetrating anterior urethral injury should be surgically explored and can be repaired primarily in the absence of other more pressing injuries.[11]

Management of female urethral injuries. **Given that the shorter urethral length in women prevents mobilization after scarring, initial exploration and primary repair is recommended at the time of injury.[23]** Endoscopic techniques have been shown to be successful in the primary repair of female urethral injury.[28] Similar to men, urethral injuries in women often present in the setting of pelvic fracture, so evaluation and primary repair of concomitant vaginal injuries should be encouraged. Surgical

repair of female urethral injury should prioritize preservation of urethral length, minimal periurethral fibrosis, integrity of the urethral neck and vaginal patency.[29] AUA management guidelines for urethral trauma can be found in part B of the Appendix.

PENILE TRAUMA

Penile fracture. Penile trauma is responsible for 10% to 16% of all traumatic genitourinary injuries, with penile fractures constituting 1/175,000 admissions.[1,30] Sexual intercourse is the most common etiology for penile fracture in the United States and Europe.[31]

Penile fracture classically presents as acute penile pain followed by a popping sensation and detumescence, resulting in an "eggplant" deformity if Buck's fascia is not violated (fig. 3).[32] When Buck's fascia tears, blood moves along the Colles fascia to yield a "butterfly" hematoma.[33] Isolated rupture of the deep dorsal vein, superficial dorsal vein, penile vein or penile artery, or tear of the suspensory ligament can mimic penile fracture.[34]

Although primarily a clinical diagnosis, penile fracture can be evaluated with a high detection rate (86%) using ultrasonography.[35] MRI can also be used if there is uncertainty regarding the diagnosis.[36] When concomitant urethral injury is suspected, retrograde urethrography, flexible cystoscopy or direct inspection of the exposed urethra can help in localization.[33] Urethral injuries, if present, will occur most commonly at the site of the tunica albuginea rupture.

When surgically managing a penile fracture, any compromise of the tunica albuginea and concurrent urethral damage requires repair.[11] Surgical incisions employed for fracture repair include a circumcising degloving approach to fully expose the area of fracture, scrotal inguinal incisions and small longitudinal incisions over the fracture site.[35,37] Absorbable sutures are preferred when closing the tunica as nonabsorbable sutures can be a persistent source of pain.[35] Delaying or denying surgery can lead to penile abscess, urine extravasation, penile pain, deformity and erectile dysfunction.[37,38]

Penetrating injuries. A single institution study demonstrated that 33% of penetrating genitourinary trauma injuries affect the penis. These injuries were more commonly due to stab wounds.[39] Assessment of the penetrating injury should be made with physical examination and retrograde urethrography.[40] Any urethral injuries should be surgically repaired using principles of urethroplasty as detailed in the "Urethral Trauma" section.

Amputation. While rare, penile amputation can occur by autoamputation during psychosis, religious extremism, intoxication, gender self-identification conflict or assault.[41] The severed penis can tolerate cold ischemia for 16 hours and warm ischemia for 6 hours. It should be rinsed in saline and then wrapped in saline-soaked gauze and placed on ice in a plastic bag, rather than directly on ice to avoid hypothermic injury.[15]

Reimplantation should be performed within 24 hours of amputation with primary repair of the urethra and corporal bodies. **Microsurgical repair of neurovasculature should occur concomitantly to avoid skin loss.[42]** Higher rates of erectile function are reported with dorsal arterial repair vs cavernosal repair. The dorsal nerve also appears to be less crucial in restoring erectile function.[41] A penile prosthesis may be placed 1 to 2 years following phalloplasty.[43]

Zipper injuries. Over a 9-year period, approximately 81,448 patients with penile and scrotal zipper injuries (95% CI 66,555–96,341) presented to U.S. emergency departments, of which two-thirds were children. Hospital admission is rare (2%).[44] Zipper injury often results in foreskin entrapment, which can be freed with mineral oil.[15] The zipper can also be cut across the teeth or at the apex with a bone cutter. Circumcision and elliptical skin incisions may also be performed, with management depending on each individual case.[45]

Toilet seat injuries. Toilet seat injuries are the leading cause of penile pediatric trauma presenting to the emergency department. Approximately 1,707 toilet seat injuries (95% CI 1,011–2,402) present to emergency departments each year, with the incidence increasing over time. While 97% of these injuries can be managed in the emergency department and do not require admission, MRI can be used to diagnose cavernosal injuries in these patients as needed.[36,46] Preventive measures include keeping the toilet seat up, using a slow-release toilet seat and using a U-shaped seat.

Strangulation injuries. Penile strangulation can occur with hair, rubber bands or any array of different objects.[47] It is important to consider child abuse when presenting in children and sexual practice variations when presenting in adults.[47,48] Different tools can be used to release the strangulating object with or without puncturing the glans to release entrapped blood. Conservative management is recommended for any resultant skin necrosis.

Figure 3. Gross presentation of "eggplant" deformity following penile fracture.

SCROTAL AND TESTICULAR TRAUMA

Epidemiology. Injury to the scrotum or the testes is a rare event, with an incidence under 1% in all male trauma patients in the United States. Recent data demonstrate that blunt trauma (44.6%) no longer accounts for the majority of injuries to the scrotum or testes compared to penetrating trauma (50.5%).[49] Other, less common forms of scrotal injury include degloving and thermal or electrical burns. Traumatic scrotal and testicular injury most often occurs in isolation (74.5% of cases).

The most common etiology of blunt injury to the scrotum and testes is motor vehicle accident.[49] Historically, males between the ages of 10 and 30 years are most likely to be injured by this mechanism, with athletic activity, falls and straddle injuries also contributing to the injury burden within this population.[50] Penetrating injury to the scrotum and testes in the United States most commonly occurs due to firearm assault (75.8% of cases), with self-inflicted injuries, stab wounds and bites being less common.[49]

For any blunt or penetrating traumatic injury to the scrotum, there is concern for testicular injury and rupture. Retrospective reviews of genitourinary trauma have shown that 48% to 63% of penetrating injuries to the scrotum concomitantly result in testicular injury.[51,52] Rates of bilateral testicular injury are smaller and vary with injury mechanism, with up to 31% of penetrating scrotal injury cases involving both gonads compared to 1.5% of blunt scrotal injury cases.[51,53] Testicular rupture, involving the tearing of the tunica albuginea, can occur in up to 48% of patients with blunt scrotal trauma.[52,54]

Diagnosis. There is no universal presentation in scrotal trauma. Blunt trauma may produce a scrotal wall hematoma or hematocele (intratesticular hematoma) along with swelling and tenderness.[55] Regardless of external presentation, all cases of blunt trauma to the scrotum should undergo further evaluation for testicular rupture.[56] Testicular rupture after blunt or penetrating trauma is often associated with pain, ecchymosis, swelling and absence of testicular contours during an examination.[11] Even with testicular rupture, patients may present after blunt trauma with variable presentation, ranging from minimal pain to great distress.[57] Examination of penetrating trauma should note entrance and exit wounds as well as status of nearby vessels and anatomical structures prior to surgical exploration.[56]

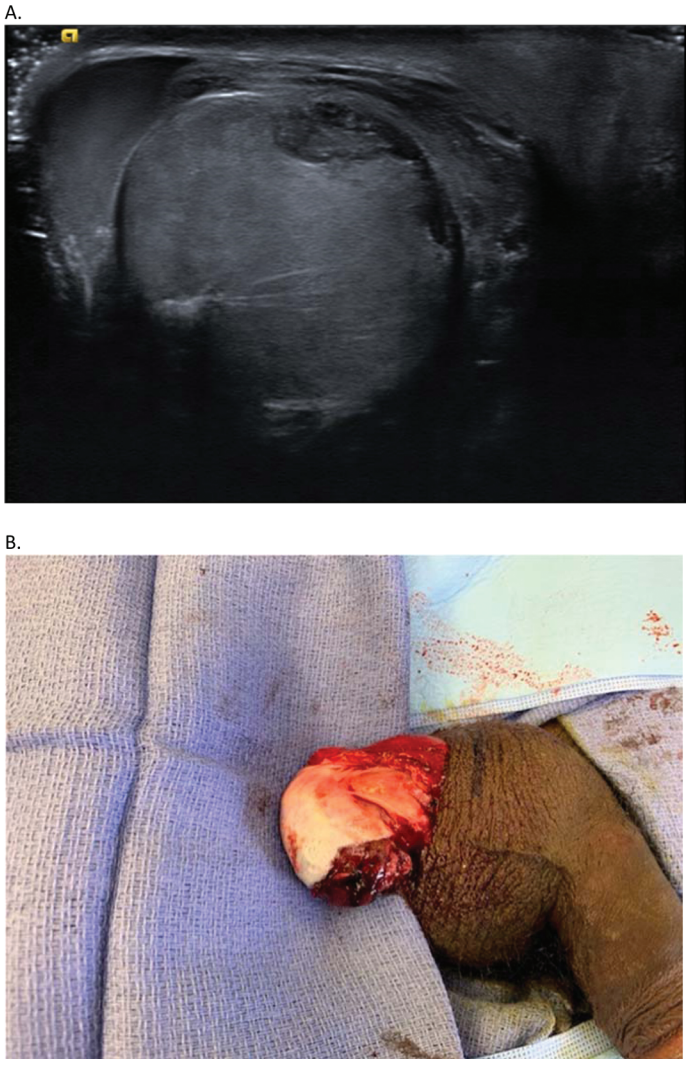

Figure 4. (A) Ultrasound of right testicular rupture demonstrates heterogeneous parenchymal margin. (B) Corresponding gross intraoperative presentation of ruptured testicle.

Current AUA guidelines support ultrasonography in cases of blunt scrotal trauma.[11] Ultrasound assessment should prioritize testicular integrity, perfusion and evidence of injury prior to further management.[56,57] Findings suggestive of testicular rupture include the disruption of the tunica albuginea (seen on ultrasound as an echogenic line surrounding the parenchyma), heterogeneous echotexture of the parenchyma (most common) and inconsistent testicular margins (fig. 4).[57,58] Recent research has shown high sensitivity and specificity with use of ultrasound in diagnosing blunt testicular trauma, but a negative study should not prevent surgical exploration if other clinical findings point toward testicular injury.[57,59] This is particularly applicable in the case of penetrating scrotal trauma, where ultrasound is not needed and may miss injury requiring repair.[51] However, ultrasound may still be done in penetrating scrotal trauma as a diagnostic adjunct when there is low clinical suspicion of rupture.

Management. In all cases of penetrating trauma or in cases of blunt trauma with findings suggestive of testicular rupture, AUA guidelines recommend early surgical exploration and repair.[11] Timely surgical investigation clarifies the amount of tissue damage, allows for removal of nonviable tissue and prevents complications such as ischemic atrophy, infection, excessive bleeding and testicular loss.[56,60] For testicular rupture, testicular salvage rates up to 80% to 90% are possible when intervention occurs within 72 hours of injury.[56,57] A complete surgical approach for rupture involves hematocele evacuation, debridement of the nonviable tissue and closure of the tunica albuginea with absorbable sutures.[11,57] If the tunica albuginea is not available, grafts of tunica vaginalis have been used successfully.[52,61] When testicular salvage is not possible after rupture, orchiectomy is indicated.[11] AUA management guidelines for genital trauma can be found in part C of the Appendix.

GENITAL BURNS

The true incidence of genital burns is difficult to assess but has been reported to be between 2.8% and 13% of burn center admissions.[62] A disproportionate amount of these injuries occur in the pediatric population, with children 0 to 12 years old comprising 37.1% of genital burn presentations to emergency departments.[63]

Proper diagnosis of any genital skin loss relies on a thorough history, physical examination, laboratory studies and imaging when warranted. Across 17,026 cases of genital burns presenting to the emergency department, the most common causative agents associated with genital burns are hot water, hot beverages, chemical cleaners, hot food and fire.[63] The table shows the most common etiologies of genital burn injuries broken down by age. Evaluation of genital burn injury in children should prompt exploration of nonaccidental means of injury.

In cases of widespread genital skin loss, including burns, the AUA recommends surgical exploration, irrigation and debridement of nonviable tissue.[11] Similar to general management of all burns, genital burns should be managed with immediate separation of tissue from contaminated clothing, tissue cooling and wound care.[62] Debridement for genital burns should be restricted to nonviable tissue given the high likelihood of repeat procedures.[11] After removal of burn eschar, the affected

Table. Top 3 causative agents associated with genital burn injuries by age

Rank	0–1 Yrs	2–5 Yrs	6–12 Yrs	13–17 Yrs	18–30 Yrs	31–45 Yrs	46–65 Yrs	66+ Yrs
1	Hot water (86.8%)	Hot water (51.8%)	Hot food (43.8%)	Chemical cleaners (45.3%)	Hot water (35.5%)	Hot water (36.1%)	Hot water (27.3%)	Hot beverages (28.4%)
2	Hot beverages (7.1%)	Chemical cleaners (15.9%)	Hot water (19.2%)	Hot water (17.6%)	Hot beverages (13.3%)	Hot beverages (14.2%)	Fire (22.7%)	Fire (25.1%)
3	Chemical cleaners (6.1%)	Hot beverages (10.4%)	Hot beverages (14.1%)	Fireworks (17.1%)	Hot surfaces (13%)	Fire (10.9%)	Chemical cleaners (13.1%)	Hot surfaces (23.9%)

tissue should be covered with split-thickness skin grafts.[56] Silver sulfadiazine cream is suitable for partial-thickness genital burns. For long-term management, providers should note that patients with genital burns have higher rates of hospital-acquired infections (18.0% vs 2.8%), particularly urinary tract infections, as well as higher rates of mortality (17.0% vs 4.7%) than burn patients without genital burns.[64]

MILITARY TRAUMA

Genitourinary trauma among military service members has increased in prevalence from previous wars, brought on by the introduction of sophisticated blast weapons (eg improvised explosive devices) as well as advances in trauma surgery in the field leading to decreased mortality rates. A study of genitourinary injuries after the completion of Operation Iraqi Freedom and Operation Enduring Freedom revealed that a total of 1,462 service members sustained at least 1 genitourinary injury.[65] More than 20% of affected service members encountered a severe injury to at least 1 testicle, with loss of the penis and/or a testis occurring in 147 male service members.[66] One study of 89 recent service members with genitourinary injuries revealed a 36% rate of sexual dysfunction and a 14% rate of urinary retention or incontinence.[67] Severe testicular injury in this setting merits evaluation for long-term endocrine dysfunction.[68] With the increase in this type of injury, penile transplantation (vascularized composite allotransplantation) has been demonstrated as a potential option for urogenital restoration among this population.[69,70]

ANIMAL AND HUMAN BITES

Animal and human bites of human genitalia remain a rare phenomenon, with very few cases reported. Although animal bites are often minor, immediate care should focus on wound irrigation and debridement of nonviable tissue in combination with antimicrobial prophylaxis. Previous studies have emphasized the prevalence of *Pasteurella* and anaerobic organisms in bite wounds, with caution for both tetanus and rabies prophylaxis.[71] Recommended first line treatment for animal bites includes amoxicillin-clavulanic acid, second generation cephalosporin, or clindamycin with fluoroquinolone.[53] Human bites causing genitourinary damage are extremely rare but also require antimicrobial prophylaxis. The Infectious Diseases Society of America recommends irrigation and proper wound dressing along with first line treatment with amoxicillin-clavulanate, ampicillin or ertapenem. [72] Any concern for testicular injury should incorporate a scrotal ultrasound.

CONCLUSION

Lower urinary tract trauma comprises a notable proportion of traumatic injury-related morbidity and mortality. Accurate clinical assessment and appropriate workup can mitigate poor outcomes in lower urinary tract trauma. An understanding of typical presentations, key next steps in diagnostic evaluation and principles of management will reduce the negative impacts of lower urinary tract trauma.

DID YOU KNOW?

- Trauma resulting in intraperitoneal bladder rupture should undergo operative repair. Most extraperitoneal bladder injuries can be managed with catheter drainage unless there is concurrent heavy hematuria, bone in the bladder, bladder neck injury or rectal/vaginal injury.
- Hematuria in the pelvic fracture patient warrants staging of the bladder for injury.
- The primary objective of managing any lower urinary tract injury is obtaining urinary drainage through either a urethral catheter or a suprapubic tube.
- Penile fractures that are equivocal can be evaluated with ultrasonography or MRI. Hematuria or the inability to void necessitates urethral staging.
- In cases of blunt scrotal trauma, ultrasound assessment should be used to evaluate for testicular rupture. Penetrating injuries should be explored.

Appendix. Selected AUA urotrauma guidelines for bladder trauma, urethral trauma and genital trauma[73]

No.	A. Bladder Trauma Guideline
14a	Clinicians must perform retrograde cystography (plain film or CT) in stable patients with gross hematuria and pelvic fracture. (Standard; Evidence Strength: Grade B)
14b	Clinicians should perform retrograde cystography in stable patients with gross hematuria and a mechanism concerning for bladder injury, or in those with pelvic ring fractures and clinical indicators of bladder rupture. (Recommendation; Evidence Strength: Grade C)
15	Surgeons must perform surgical repair of intraperitoneal bladder rupture in the setting of blunt or penetrating external trauma. (Standard; Evidence Strength: Grade B)
16	Clinicians should perform catheter drainage as treatment for patients with uncomplicated extraperitoneal bladder injuries. (Recommendation; Evidence Strength: Grade C)
17	Surgeons should perform surgical repair in patients with complicated extraperitoneal bladder injury. (Recommendation; Evidence Strength: Grade C)
18	Clinicians should perform urethral catheter drainage without suprapubic cystostomy in patients following surgical repair of bladder injuries. (Standard; Evidence Strength: Grade B)
No.	**B. Urethral Trauma Guideline**
19	Clinicians should perform retrograde urethrography in patients with blood at the urethral meatus after pelvic trauma. (Recommendation; Evidence Strength: Grade C)
20	Clinicians should establish prompt urinary drainage in patients with pelvic fracture associated urethral injury. (Recommendation; Evidence Strength: Grade C)
21	Surgeons may place suprapubic tubes in patients undergoing open reduction internal fixation for pelvic fracture. (Expert Opinion)
22	Clinicians may perform primary realignment in hemodynamically stable patients with pelvic fracture associated urethral injury. (Option; Evidence Strength: Grade C) Clinicians should not perform prolonged attempts at endoscopic realignment in patients with pelvic fracture associated urethral injury. (Clinical Principle)
23	Clinicians should monitor patients for complications (eg stricture formation, erectile dysfunction, incontinence) for at least 1 year following urethral injury. (Recommendation; Evidence Strength: Grade C)
24	Surgeons should perform prompt surgical repair in patients with uncomplicated penetrating trauma of the anterior urethra. (Expert Opinion)
25	Clinicians should establish prompt urinary drainage in patients with straddle injury to the anterior urethra. (Recommendation; Evidence Strength: Grade C)
No.	**C. Genital Trauma Guideline**
26	Clinicians must suspect penile fracture when a patient presents with penile ecchymosis, swelling, pain, cracking or snapping sound during intercourse or manipulation and immediate detumescence. (Standard; Evidence Strength: Grade B)
27	Surgeons should perform prompt surgical exploration and repair in patients with acute signs and symptoms of penile fracture. (Standard; Evidence Strength: Grade B)
28	Clinicians may perform ultrasound in patients with equivocal signs and symptoms of penile fracture. (Expert Opinion)
29	Clinicians must perform evaluation for concomitant urethral injury in patients with penile fracture or penetrating trauma who present with blood at the urethral meatus, gross hematuria or inability to void. (Standard; Evidence Strength: Grade B)
30	Surgeons should perform scrotal exploration and debridement with tunical closure (when possible) or orchiectomy (when nonsalvagable) in patients with suspected testicular rupture. (Standard; Evidence Strength: Grade B)
31	Surgeons should perform exploration and limited debridement of nonviable tissue in patients with extensive genital skin loss or injury from infection, shearing injuries or burns (thermal, chemical, electrical). (Standard; Evidence Strength: Grade B)
32	Surgeons should perform prompt penile reimplantation in patients with traumatic penile amputation, with the amputated appendage wrapped in saline-soaked gauze, in a plastic bag and placed on ice during transport. (Clinical Principle)
33	Clinicians should initiate ancillary psychological, interpersonal and/or reproductive counseling and therapy for patients with genital trauma when loss of sexual, urinary and/or reproductive function is anticipated. (Expert Opinion)

REFERENCES

1. McGeady JB and Breyer BN: Current epidemiology of genitourinary trauma. Urol Clin North Am 2013; **40:** 323.
2. Pereira BMT, Ogilvie MP, Gomez-Rodriguez JC et al: A review of ureteral injuries after external trauma. Scand J Trauma Resusc Emerg Med 2010; **18:** 6.
3. Santucci RA and McAninch JW: Diagnosis and management of renal trauma: past, present, and future. J Am Coll Surg 2000; **191:** 443.
4. Deibert CM and Spencer BA: The association between operative repair of bladder injury and improved survival: results from the National Trauma Data Bank. J Urol 2011; **186:** 151.
5. Gomez RG, Ceballos L, Coburn M et al: Consensus statement on bladder injuries. BJU Int 2004; **94:** 27.
6. Matlock KA, Tyroch AH, Kronfol ZN et al: Blunt traumatic bladder rupture: a 10-year perspective. Am Surg 2013; **79:** 589.
7. Morey AF, Iverson AJ, Swan A et al: Bladder rupture after blunt trauma: guidelines for diagnostic imaging. J Trauma 2001; **51:** 683.
8. Guttmann I and Kerr HA: Blunt bladder injury. Clin Sports Med 2013; **32:** 239.
9. Brandes S and Borrelli J: Pelvic fracture and associated urologic injuries. World J Surg 2001; **25:** 1578.
10. Morgan DE, Nallamala LK, Kenney PJ et al: CT cystography: radiographic and clinical predictors of bladder rupture. AJR Am J Roentgenol 2000; **174:** 89.
11. Morey AF, Brandes S, Dugi DD III et al: Urotrauma: AUA Guideline. J Urol 2014; **192:** 327.
12. Quagliano PV, Delair SM and Malhotra AK: Diagnosis of blunt bladder injury: a prospective comparative study of computed tomography cystography and conventional retrograde cystography. J Trauma 2006; **61:** 410.
13. Peng MY, Parisky YR, Cornwell EE et al: CT cystography versus conventional cystography in evaluation of bladder injury. AJR Am J Roentgenol 1999; **173:** 1269.
14. Avey G, Blackmore CC, Wessells H et al: Radiographic and clinical predictors of bladder rupture in blunt trauma patients with pelvic fracture. Acad Radiol 2006; **13:** 573.
15. Wein AJ, Kavoussi LR, Novick AC et al: Campbell-Walsh Urology, 10th ed. Philadephia: Elsevier 2011.
16. Osman Y, El-Tabey N, Mohsen T et al: Nonoperative treatment of isolated posttraumatic intraperitoneal bladder rupture in children—is it justified? J Urol 2005; **173:** 955.
17. Mahfouz IA, Sayer T and Phillips C: Conservative management of spontaneous rupture of the urinary bladder. Int Urogynecol J 2011; **22:** 629.
18. Kim FJ, Chammas MF, Gewehr EV et al: Laparoscopic management of intraperitoneal bladder rupture secondary to blunt abdominal trauma using intracorporeal single layer suturing technique. J Trauma 2008; **65:** 234.
19. Bariol SV, Stewart GD, Smith RD et al: An analysis of urinary tract trauma in Scotland: impact on management and resource needs. Surgeon 2005; **3:** 27.
20. Carter CT and Schafer N: Incidence of urethral disruption in females with traumatic pelvic fractures. Am J Emerg Med 1993; **11:** 218.
21. Mundy AR and Andrich DE: Urethral trauma. Part I: Introduction, history, anatomy, pathology, assessment and emergency management. BJU Int 2011; **108:** 310.
22. Basta AM, Blackmore CC and Wessells H: Predicting urethral injury from pelvic fracture patterns in male patients with blunt trauma. J Urol 2007; **177:** 571.
23. Kong JPL, Bultitude MF, Royce P et al: Lower urinary tract injuries following blunt trauma: a review of contemporary management. Rev Urol 2011; **13:** 119.
24. Koraitim MM: Pelvic fracture urethral injuries: the unresolved controversy. J Urol 1999; **161:** 1433.
25. Koraitim MM: Pelvic fracture urethral injuries: evaluation of various methods of management. J Urol 1996; **156**: 1288.
26. Mundy AR and Andrich DE: Urethral trauma. Part II: Types of injury and their management. BJU Int 2011; **108:** 630.
27. Leddy LS, Vanni AJ, Wessells H et al: Outcomes of endoscopic realignment of pelvic fracture associated urethral injuries at a level 1 trauma center. J Urol 2012; **188:** 174.
28. Solanki FS, Hussain S, Sharma DB et al: Primary endoscopic realignment in female urethral injuries with pelvic fracture can reduce avoidable morbidity. Indian J Surg 2013; **75:** 31.
29. Dorairajan LN, Gupta H and Kumar S: Pelvic fracture-associated urethral injuries in girls: experience with primary repair. BJU Int 2004; **94:** 134.
30. Cerwinka WH and Block NL: Civilian gunshot injuries of the penis: the Miami experience. Urology 2009; **73:** 877.
31. Fergany AF, Angermeier KW and Montague DK: Review of Cleveland Clinic experience with penile fracture. Urology 1999; **54:** 352.
32. Morey AF, Metro MJ, Carney KJ et al: Consensus on genitourinary trauma: external genitalia. BJU Int 2004; **94:** 507.
33. Garaffa G, Raheem AA and Ralph DJ: Penile fracture and penile reconstruction. Curr Urol Rep 2011; **12:** 427.
34. Feki W, Derouiche A, Belhaj K et al: False penile fracture: report of 16 cases. Int J Impot Res 2007; **19:** 471.
35. Sawh SL, O'Leary MP, Ferreira MD et al: Fractured penis: a review. Int J Impot Res 2008; **20:** 366.
36. Antonini G, Vicini P, Sansalone S et al: Penile fracture: penoscrotal approach with degloving of penis after magnetic resonance imaging (MRI). Arch Ital Urol Androl 2014; **86:** 39.
37. Morris SB, Miller MAW and Anson K: Management of penile fracture. J R Soc Med 1998; **91:** 427.
38. Gamal WM, Osman MM, Hammady A et al: Penile fracture: long-term results of surgical and conservative management. J Trauma 2011; **71:** 491.
39. Phonsombat S, Master VA and McAninch JW: Penetrating external genital trauma: a 30-year single institution experience. J Urol 2008; **180:** 192.
40. Miles BJ, Poffenberger RJ, Farah RN et al: Management of penile gunshot wounds. Urology 1990; **36:** 318.
41. Jezior JR, Brady JD and Schlossberg SM: Management of penile amputation injuries. World J Surg 2001; **25:** 1602.
42. Bhanganada K, Chayavatana T, Pongnumkul C et al: Surgical management of an epidemic of penile amputations in siam. Am J Surg 1983; **146:** 376.
43. Callens N, De Cuypere G, T'Sjoen G et al: Sexual quality of life after total phalloplasty in men with penile deficiency: an exploratory study. World J Urol 2014; **33:** 137.
44. Bagga HS, Tasian GE, McGeady J et al: Zip-related genital injury. BJU Int 2013; **112:** E191.

45. Mellick LB: Wire cutters and penis skin entrapped by zipper sliders. Pediatr Emerg Care 2011; **27:** 451.
46. Glass AS, Bagga HS, Tasian GE et al: No small slam: increasing incidents of genitourinary injury from toilets and toilet seats. BJU Int 2013; **112:** 398.
47. Ivanovski O, Stankov O, Kuzmanoski M et al: Penile strangulation: two case reports and review of the literature. J Sex Med 2007; **4:** 1775.
48. El-Bahnasawy MS and El-Sherbiny MT: Paediatric penile trauma. BJU Int 2002; **90:** 92.
49. Grigorian A, Livingston JK, Schubl SD et al: National analysis of testicular and scrotal trauma in the USA. Res Rep Urol 2018; **10:** 51.
50. Dalton DM, Davis NF, O'Neill DC et al: Aetiology, epidemiology and management strategies for blunt scrotal trauma. Surgeon 2016; **14:** 18.
51. Bjurlin MA, Kim DY, Zhao LC et al: Clinical characteristics and surgical outcomes of penetrating external genital injuries. J Trauma Acute Care Surg 2013; **74:** 839.
52. McCormick CS, Dumais MG, Johnsen NV et al: Male genital trauma at a level 1 trauma center. World J Urol 2020; **38:** 3283.
53. Randhawa H, Blankstein U and Davies T: Scrotal trauma: a case report and review of the literature. Can Urol Assoc J 2019; **113:** S67.
54. Buckley JC and McAninch JW: Use of ultrasonography for the diagnosis of testicular injuries in blunt scrotal trauma. J Urol 2006; **175:** 175.
55. Chandra RV, Dowling RJ, Ulubasoglu M et al: Rational approach to diagnosis and management of blunt scrotal trauma. Urology 2007; **70:** 230.
56. Morey AF and Zhao LC: Genital and lower urinary tract trauma. In: Campbell-Walsh Urology, 11th ed. Edited by AJ Wein, LR Kavoussi, AW Partin et al. Philadelphia: Elsevier 2015; pp 2379–2392.e4.
57. Blok D, Flannigan M and Jones J: Testicular rupture following blunt scrotal trauma. Case Rep Emerg Med 2019; **2019:** 1.
58. Dane B, Baxter AB and Bernstein MP: Imaging genitourinary trauma. Radiol Clin North Am 2017; **55:** 321.
59. Powers R, Hurley S, Park E et al: Usefulness of preoperative ultrasound for the evaluation of testicular rupture in the setting of scrotal gunshot wounds. J Urol 2018; **199:** 1546.
60. Bayne D, Zaid U, Alwaal A et al: Lower genitourinary tract trauma. Trauma 2016; **18:** 12.
61. Simhan J, Rothman J, Canter D et al: Gunshot wounds to the scrotum: a large single-institutional 20-year experience. BJU Int 2012; **109:** 1704.
62. Michielsen DPJ and Lafaire C: Management of genital burns: a review. Int J Urol 2010; **17:** 755.
63. Tresh A, Baradaran N, Gaither TW et al: Genital burns in the United States: disproportionate prevalence in the pediatric population. Burns 2018; **44:** 1366.
64. Harpole BG, Wibbenmeyer LA and Erickson BA: Genital burns in the National Burn Repository: incidence, etiology, and impact on morbidity and mortality. Urology 2014; **83:** 298.
65. Balzano FL and Hudak SJ: Military genitourinary injuries: past, present, and future. Transl Androl Urol 2018; **7:** 646.
66. Janak JC, Orman JA, Soderdahl DW et al: Epidemiology of genitourinary injuries among male U.S. service members deployed to Iraq and Afghanistan: early findings from the Trauma Outcomes and Urogenital Health (TOUGH) Project. J Urol 2017; **197:** 414.
67. Liang SY, Jackson B, Kuhn J et al: Urinary tract infections after combat-related genitourinary trauma. Surg Infect (Larchmt) 2019; **20:** 611.
68. Nnamani NS, Janak JC, Hudak SJ et al: Genitourinary injuries and extremity amputation in Operations Enduring Freedom and Iraqi Freedom: early findings from the Trauma Outcomes and Urogenital Health (TOUGH) Project. J Trauma Acute Care Surg 2016; **81:** S95.
69. Tuffaha SH, Cooney DS, Sopko NA et al: Penile transplantation: an emerging option for genitourinary reconstruction. Transpl Int 2017; **30:** 441.
70. Cetrulo CL, Li K, Salinas HM et al: Penis transplantation. Ann Surg 2018; **267:** 983.
71. Gomes CM, Ribeiro-Filho L, Giron AM et al: Genital trauma due to animal bites. J Urol 2001; **165:** 80.
72. Ng D, Chan T and Pothiawala S: A Human bite on the scrotum: case report and review of management in the emergency department. J Emerg Med 2018; **54:** 537.
73. American Urological Association: Urotrauma Guideline (2020). Available at: https://www.auanet.org/guidelines/urotrauma-guideline#x3277. Accessed May 18, 2020.

Study Questions Volume 40 Lesson 15

1. A 35-year-old man is in the emergency department after involvement in a motor vehicle collision. He has abdominal pain and blood in his urine. There is tenderness to palpation of his flanks bilaterally and over his symphysis. The rest of the examination is normal. Retrograde cystography for evaluation of bladder rupture is indicated due to gross hematuria and
   a. flank tenderness
   b. suprapubic pain
   c. evidence of pelvic fracture
   d. intraperitoneal fluid on focused assessment with sonography for trauma

2. A 27-year-old man on a scooter was run over by a motor vehicle. He is unable to urinate and his examination is significant for blood at the urethral meatus. A retrograde urethrogram reveals complete transection of the posterior urethra at the perineal membrane. He is being resuscitated and further evaluated for multiple orthopedic injuries. The next step in managing his urethra is
   a. voiding cystourethrogram
   b. primary anastomotic repair
   c. endoscopic urethral realignment
   d. placement of suprapubic catheter and delayed urethroplasty

3. A 31-year-old soldier is injured in battle after being ejected from a vehicle. After being hemodynamically stabilized, a pan-CT is taken. The finding on imaging most suggestive of bladder rupture is
   a. fractured obturator ring and displacement greater than 1 cm
   b. diastasis of pubic symphysis 0.5 cm
   c. free fluid in retroperitoneal space
   d. sacral fracture

4. A 28-year-old man is involved in a motorcycle collision. In the trauma bay he is stable, with a physical examination revealing scrotal swelling and tenderness without any evidence of penetrating injury. A scrotal ultrasound is performed. Surgical exploration for testicular rupture is indicated with a finding on physical examination or ultrasound of
   a. pain that precludes completion of a physical examination
   b. ecchymosis on scrotum
   c. irregular tunica albuginea
   d. homogeneous echotexture of testicular parenchyma

5. A 52-year-old man is seen in the emergency department 2 days after dropping hot coffee directly onto his underwear. On examination, there are widespread superficial and full thickness burns across his genitalia. There is a black, firm, circumferential scar on his proximal shaft. He is otherwise stable. The next step is
   a. kidney, ureter and bladder x-ray
   b. non-contrast low dose CT of the abdomen and pelvis
   c. admit and start on broad-spectrum antibiotics
   d. surgical exploration with debridement