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Authors' disclosure of potential conflicts of interest and author/staff contributions appear at the end of the article.

Note to reader:

This document was amended in April 2017 and August 2020 to reflect literature that was released since the original publication of this guideline in April 2014. This document will continue to be periodically updated to reflect the growing body of literature related to this disease.

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UROTRAUMA: AUA GUIDELINE

Allen F. Morey, MD; Steve Brandes, MD; Daniel David Dugi III, MD; John H. Armstrong, MD; Benjamin N. Breyer, MD; Joshua A. Broghammer, MD; Bradley A. Erickson, MD; Jeff Holzbeierlein, MD; Steven J. Hudak, MD; Jeffrey H. Pruitt, MD; James T. Reston, PhD, MPH; Richard A. Santucci, MD; Thomas G. Smith III, MD; Hunter Wessells, MD

Purpose: The authors of this guideline reviewed the urologic trauma literature to guide clinicians in the appropriate methods of evaluation and management of genitourinary injuries.

Methods: A systematic review of the literature using the MEDLINE® and EMBASE databases (search dates 1/1/90-9/19/12) was conducted to identify peer-reviewed publications relevant to urotrauma. The review yielded an evidence base of 372 studies after application of inclusion/exclusion criteria. These publications were used to inform the statements presented in the guideline as Standards, Recommendations or Options. When sufficient evidence existed, the body of evidence for a particular treatment was assigned a strength rating of A (high), B (moderate) or C (low). In the absence of sufficient evidence, additional information is provided as Clinical Principles and Expert Opinions.

In April 2017, the Urotrauma guideline underwent an amendment based on an additional literature search, which retrieved additional studies published between original publication and December 2016. Forty-one studies from this search provided data relevant to the management and treatment of urotrauma.

In April of 2020, the Urotrauma guideline underwent an additional amendment based on a current literature search. This literature search retrieved additional studies published between January 2017 to February 2020. Eighty- three studies were identified from this search to provide data relevant to the management and treatment of urotrauma.

GUIDELINE STATEMENTS

Renal Trauma

1. Clinicians should perform diagnostic imaging with intravenous (IV) contrast enhanced computed tomography (CT) in stable blunt trauma patients with gross hematuria or microscopic hematuria and systolic blood pressure < 90mmHG. (Standard; Evidence Strength: Grade B)

2. Clinicians should perform diagnostic imaging with IV contrast enhanced CT in stable trauma patients with mechanism of injury or physical exam findings concerning for renal injury (e.g., rapid deceleration, significant blow to flank, rib fracture, significant flank ecchymosis, penetrating injury of abdomen, flank, or lower chest). (Recommendation; Evidence Strength: Grade C)

3. Clinicians should perform IV contrast enhanced abdominal/pelvic CT with immediate and delayed images when there is suspicion of renal injury. (Clinical Principle)

4. In hemodynamically stable patients with renal injury, clinicians should use non-invasive management strategies. (Standard; Evidence Strength: Grade B)

5a. In hemodynamically unstable patients with no or transient response to resuscitation, the surgical team must perform immediate intervention (surgery

or angioembolization in selected situations). (Standard; Evidence Strength: Grade B)

5b. For hemodynamically unstable patients with radiographic findings of large perirenal hematoma (> 4 cm) and/or vascular contrast extravasation in the setting of deep or complex renal laceration (AAST Grade 3-5), surgeons should perform immediate intervention (angioembolization or surgery). (Recommendation; Evidence Strength; Grade C)

6. Clinicians may initially observe patients with renal parenchymal injury and urinary extravasation. (Clinical Principle)

7. Clinicians should perform follow-up CT imaging for renal trauma patients having either (a) deep lacerations (AAST Grade IV-V) or (b) clinical signs of complications (e.g., fever, worsening flank pain, ongoing blood loss, abdominal distention). (Recommendation; Evidence Strength: Grade C)

8. Clinicians should perform urinary drainage in the presence of complications such as enlarging urinoma, fever, increasing pain, ileus, fistula or infection. (Recommendation; Evidence Strength: Grade C) Drainage should be achieved via ureteral stent and may be augmented by percutaneous urinoma drain, percutaneous nephrostomy or both. (Expert Opinion)

Ureteral Trauma

9a. Clinicians should perform IV contrast enhanced abdominal/pelvic CT with delayed imaging (urogram) for stable trauma patients with suspected ureteral injuries. (Recommendation; Evidence Strength: Grade C)

9b. Clinicians should directly inspect the ureters during laparotomy in patients with suspected ureteral injury who have not had preoperative imaging. (Clinical Principle)

10a. Surgeons should repair traumatic ureteral lacerations at the time of laparotomy in stable patients. (Recommendation; Evidence Strength: Grade C)

10b. Surgeons may manage ureteral injuries in unstable patients with temporary urinary drainage followed by delayed definitive management. (Clinical Principle)

10c. Surgeons should manage traumatic ureteral contusions at the time of laparotomy with ureteral stenting or resection and primary repair depending on ureteral viability and clinical scenario. (Expert Opinion)

11a. Surgeons should attempt ureteral stent placement in patients with incomplete ureteral injuries diagnosed postoperatively or in a delayed setting. (Recommendation; Evidence Strength: Grade C)

11b. Surgeons should perform percutaneous nephrostomy with delayed repair as needed in patients when stent placement is unsuccessful or not possible. (Recommendation; Evidence Strength: Grade C)

11c. Clinicians should initially manage patients with ureterovaginal fistula using stent placement when possible. In the event of stent failure, clinicians may pursue additional surgical intervention. (Recommendation; Evidence Strength; Grade C)

12a. Surgeons should repair ureteral injuries located proximal to the iliac vessels with primary repair over a ureteral stent, when possible. (Recommendation; Evidence Strength: Grade C)

12b. Surgeons should repair ureteral injuries located distal to the iliac vessels with ureteral reimplantation or primary repair over a ureteral stent, when possible. (Recommendation; Evidence Strength: Grade C)

13a. Surgeons should manage endoscopic ureteral injuries with a ureteral stent and/or percutaneous nephrostomy tube, when possible. (Recommendation; Evidence Strength: Grade C)

13b. Surgeons may manage endoscopic ureteral injuries with open repair when endoscopic or percutaneous procedures are not possible or fail to adequately divert the urine. (Expert Opinion)

Bladder Trauma

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 (SP) cystostomy in patients following surgical repair of bladder injuries. (Standard; Evidence Strength: Grade B)

Urethral Trauma

19. Clinicians should perform retrograde urethrography in patients with blood at the urethral meatus after pelvic trauma. (Recommendation; Evidence Strength: Grade C)

20a. Clinicians should establish prompt urinary drainage in patients with pelvic fracture associated urethral injury. (Recommendation; Evidence Strength: Grade C)

20b. Clinicians should perform percutaneous or open suprapubic tube placement as preferred initial management for most pelvic fracture urethral injury (PFUI) cases. (Recommendation; Evidence Strength: Grade C)

21. Surgeons may place suprapubic tubes (SPTs) in patients undergoing open reduction internal fixation (ORIF) for pelvic fracture. (Expert Opinion)

22. Clinicians may perform primary realignment (PR) 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 (e.g., stricture formation, erectile dysfunction, incontinence) for at least one 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)

Genital Trauma

26. Clinicians must suspect penile fracture when a patient presents with penile ecchymosis, swelling, 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)

30a. For blunt scrotal injuries, clinicians should perform scrotal ultrasonography for most patients having findings suggestive of testicular rupture. (Recommendation; Evidence Strength: Grade C)

30b. For most penetrating scrotal injuries, clinicians should perform prompt surgical exploration with repair or orchiectomy (when non-salvageable) given the high rate of testicular injury and limited sensitivity of ultrasound in this setting. (Recommendation; Evidence Strength: Grade C)

30c. Surgeons should perform scrotal exploration and debridement with tunical closure (when possible) or orchiectomy (when non-salvageable) in patients with suspected testicular rupture. (Standard; Evidence Strength: Grade B)

31. Surgeons should perform exploration and limited debridement of non-viable 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 replantation 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)

INTRODUCTION

Purpose

Urologic injury often occurs in the context of severe multisystem trauma that requires close cooperation with trauma surgeons. The urologist remains an important consultant to the trauma team, helping to ensure that the radiographic evaluation of urogenital structures is performed efficiently and accurately, and that the function of the genitourinary system is preserved whenever possible. Immediate interventions for acute urologic injuries often require flexibility in accordance with damage control principles in critically ill patients. In treating urotrauma patients, urologists must be familiar with both open surgical techniques and minimally invasive techniques for achieving hemostasis and/or urinary drainage. The Panel's purpose is to review the existing literature pertaining to the acute care of urologic injuries in an effort to develop effective guidelines for appropriate diagnosis and intervention strategies in the setting of urotrauma.

Methodology

A comprehensive search of the literature targeted the five main urotrauma topics within the scope of this guideline. The search used an extensive list of keywords related to renal, ureteral, bladder, urethral, and genital trauma. A full list of keywords and the search strategy are available on request. This search covered articles published between January 1990 and September 2012. Study designs consisting of randomized controlled trials (RCTs), controlled clinical trials (CCTs), and observational studies (diagnostic accuracy studies, cohort with and without comparison group, case-control, case series) were included. Systematic reviews were included if they performed a quantitative analysis of data that did not overlap with data from other included studies; otherwise they were retrieved only for hand-searches of their bibliographies.

The following publications and study types were excluded: preclinical studies (e.g., animal models), meeting abstracts, commentary, editorials, non-English language studies, pediatric studies (except for specific key questions associated with renal trauma, ureteropelvic junction [UPJ] trauma and bladder neck/ urethral trauma), and studies of urethral and genital injuries that did not separately analyze data from males and females. Studies with less than 10 patients were excluded from further evaluation and thus data extraction given the unreliability of the statistical estimates and conclusions that could be derived from them. The review yielded an evidence base of 372 studies after application of inclusion/exclusion criteria.

In April 2017, the Urotrauma guideline was updated through the AUA amendment process in which newly published literature is reviewed and integrated into previously published guidelines in an effort to maintain currency. The amendment allowed for the incorporation of additional literature released since the initial publication of this guideline in 2014. Comprehensive searches of several databases from original publication to December 2016 were conducted. The search strategy was designed and conducted by an experienced librarian with input from the study's principle investigator. Controlled vocabulary supplemented with keywords was used to search for studies on treatment and management of urotrauma.

The search yielded 3,976 references, of which 3,657 were excluded after duplicate abstract and title review. A second pass of the abstracts and titles excluded an additional 278 studies. Eventually, 41 studies provided relevant data on the specific treatment for urotrauma.

In April 2020, the Urotrauma guideline was updated through the AUA amendment process in which newly published literature is reviewed and integrated into previously published guidelines in an effort to maintain currency. The amendment allowed for the incorporation of additional literature released since the initial publication of this guideline in 2014 and built on the updated literature review conducted in 2017. Comprehensive searches of several databases from August 2016 to February 2020 were conducted. The search strategy was designed and conducted by an experienced librarian with input from the study's principle investigator. Controlled vocabulary supplemented with keywords was used to search for studies on treatment and management of urotrauma.

The search yielded 6,241 references, of which 5,670 were excluded after a first pass abstract and title review. A second pass of the abstracts and titles excluded an additional 490 studies. Eventually, 81 studies provided relevant data on the specific treatment for urotrauma. Based on these 81 studies plus 41 studies identified by the amendment process in 2017, seven proposed recommendation changes were further investigated. Full text review was conducted on 84 studies that potentially informed on the seven statement changes. Following review, the evidence base consisted of 31 studies, which underwent quality assessment using validated study-type specific risk of bias tools (systematic reviews, AMSTAR[1]; cohort studies, ROBINS-I[2]). The certainty of the evidence base informing each statement alteration was assessed using GRADE[3] and then translated into the AUA 3-tiered strength of evidence grading system.

Quality of Studies and Determination of Evidence Strength. Quality of individual studies was rated

as high, moderate, or low based on instruments tailored to specific study designs. RCTs were assessed using the Cochrane Risk of Bias tool.[4] Conventional diagnostic cohort studies, diagnostic case-control studies, or diagnostic case series that presented data on diagnostic test characteristics were assessed using the QUADAS-2 tool[5] that evaluates the quality of diagnostic accuracy studies. Cohort studies with a comparison of interest were evaluated with the Drug Effectiveness Review Project instrument.[6] There is no widely agreed upon quality assessment tool for case series that do not present data on diagnostic test characteristics, thus the quality of individual case series was not formally assessed with an instrument. Instead, these studies were labeled as low quality due to their study design.

The categorization of evidence strength is conceptually distinct from the quality of individual studies. Evidence strength refers to the body of evidence available for a particular question and includes consideration of study design, individual study quality, consistency of findings across studies, adequacy of sample sizes, and generalizability of samples, settings, and treatments for the purposes of the guideline. The AUA categorizes body of evidence strength as Grade A (well-conducted RCTs or exceptionally strong observational studies), Grade B (RCTs with some weaknesses of procedure or generalizability or generally strong observational studies), or Grade C (observational studies that are inconsistent, have small sample sizes, or have other problems that potentially confound interpretation of data). Because most of the available evidence consisted of low quality case series, the majority of evidence was considered Grade C.

AUA Nomenclature: Linking Statement Type to Evidence Strength. The AUA nomenclature system explicitly links statement type to body of evidence strength and the Panel's judgment regarding the balance between benefits and risks/burdens.[7] ***Standards*** are directive statements that an action should (benefits outweigh risks/burdens) or should not (risks/burdens outweigh benefits) be undertaken based on Grade A or Grade B evidence. ***Recommendations*** are directive statements that an action should (benefits outweigh risks/burdens) or should not (risks/burdens outweigh benefits) be undertaken based on Grade C evidence. ***Options*** are non-directive statements that leave the decision to take an action up to the individual clinician and patient because the balance between benefits and risks/burdens appears relatively equal or appears unclear; the decision is based on full consideration of the patient's prior clinical history, current quality of life, preferences and values. Options may be supported by Grade A, B, or C evidence.

In some instances, the review revealed insufficient publications to address certain questions from an evidence basis; therefore, some statements are provided as Clinical Principles or Expert Opinions with consensus achieved using a modified Delphi technique if differences of opinion emerged.[8] A ***Clinical Principle*** is a statement about a component of clinical care that is widely agreed upon by urologists or other clinicians for which there may or may not be evidence in the medical literature. ***Expert Opinion*** refers to a statement, achieved by consensus of the Panel, that is based on members' clinical training, experience, knowledge, and judgment for which there is no evidence.

Limitations of the Literature. The Panel proceeded with full awareness of the limitations of the urotrauma literature. These limitations include heterogeneous patient groups, small sample sizes, lack of studies with diagnostic accuracy data, lack of RCTs or controlled studies with patient outcome data, and use of a variety of outcome measures. Overall, these difficulties precluded use of meta-analytic procedures or other quantitative analyses. Instead, narrative syntheses were used to summarize the evidence for the questions of interest.

Panel Selection and Peer Review Process. The Panel was created by the American Urological Association Education and Research, Inc. (AUA). The Practice Guidelines Committee (PGC) of the AUA selected the Panel Chair and Vice Chair who in turn appointed the additional panel members, all of whom have specific expertise with regard to the guideline subject. Once nominated, panel members are asked to record their conflict of interest (COI) statements, providing specific details on the AUA interactive web site. These details are first reviewed by the Guidelines Oversight Committee (GOC), a member sub-committee from the PGC consisting of the Vice Chair of the PGC and two other members. The GOC determines whether the individual has potential conflicts related to the guideline. If there are no conflicts, then the nominee's COI is reviewed and approved by the AUA Judicial and Ethics (J&E) committee. A majority of panel members may not have relationships relevant to the guideline topic.

The AUA conducted an extensive peer review process. The initial draft of this Guideline was distributed to 69 peer reviewers of varying backgrounds; 35 responded with comments. The panel reviewed and discussed all submitted comments and revised the draft as needed.

Once finalized, the Guideline was submitted for approval to the PGC. It was then submitted to the AUA Board of Directors for final approval. Funding of the panel was provided by the AUA. Panel members received no remuneration for their work.

Background & Epidemiology

Trauma refers to injury caused by external force from a variety of mechanisms, including traffic- or transportation-related injuries, falls, assault (e.g., blunt weapon, stabbing, gunshot), explosions, etc. Injuries are frequently referred to as being either blunt or penetrating injuries as these different basic mechanisms have implications for management and outcomes. Blast injuries may have features of both penetrating and blunt trauma, and are most common in settings of war or violent conflict.

Traumatic injuries are the leading cause of death in the United States for people ages 1-44 years, and a significant cause of morbidity and loss of productive life across all ages.[9] Worldwide, traumatic injuries are the sixth leading cause of death and the fifth leading cause of moderate and severe disability.[10] Young males ages 15-24 have the greatest burden of injury.[11] Isolated urologic injuries are uncommon in major trauma as the kidneys, ureters, and bladder are well protected within the abdomen and pelvis, and the penis and testes are physically mobile. Urologic injuries are more common in the multiply-injured patient, and urologic organs are involved in approximately 10% of abdominal traumas.[12]

Renal Injuries. The kidneys are the most commonly injured genitourinary organ. Civilian renal injury occurs in up to 5% of trauma victims,[13,14] and accounts for 24% of traumatic abdominal solid organ injuries.[15] The kidney is particularly vulnerable to deceleration injuries (e.g., falls, motor vehicle collisions) because it is fixed in space only by the renal pelvis and the vascular pedicle. Flank ecchymosis and broken ribs are signs suggestive of renal injury. Computed tomography (CT) scan with intravenous (IV) contrast enhancement including delayed imaging remains the most common method of evaluating for extravasation of urine from the collecting system.

Over the past few decades, management of traumatic renal injuries has changed from operative exploration to non-operative management in the vast majority of cases. Much of the impetus for this change comes from the recognition that, in many cases, urgent surgical exploration of renal injuries leads to nephrectomy for the injured kidney.[14] Percutaneous angioembolization is increasingly accepted for treating ongoing bleeding without surgical exploration.[16,17] While non-operative management of the vast majority of blunt renal injuries is now firmly established, non-operative management of penetrating and high-grade renal injuries continues to inspire debate.[18]

Ureteral Injuries. Ureteral injuries are rare, accounting for 1% of urologic injuries. Distinct from other urologic organs, ureteral injuries tend to be iatrogenic, occurring during gynecologic, urologic, or colorectal surgery.[19] The majority of ureteral injuries originating outside of the operating room are a result of penetrating trauma. Injuries may not be recognized early unless they are specifically investigated. Treatment may include placement of a ureteral stent or surgical repair, depending on the severity and location of injury.

Bladder Injuries. Bladder injuries occur in approximately 1.6% of blunt abdominal trauma victims.[20] Because the bladder is well protected within the pelvis, the vast majority of injuries are associated with pelvic fractures. The bladder rupture can occur into the peritoneal cavity (intraperitoneal bladder rupture) or outside the peritoneal cavity (extraperitoneal rupture). Bladder injuries are extraperitoneal in approximately 60%, intraperitoneal in approximately 30%, and the remaining injuries are both intraperitoneal and extraperitoneal ruptures.[21] Gross hematuria is the most common sign, present in 77-100% of injuries.[22] Retrograde cystography (CT or conventional) is critical as it can determine the presence of an injury and whether it is intraperitoneal or extraperitoneal. Since the 1980s, clinicians manage most extraperitoneal bladder ruptures non-operatively with catheter drainage, while intraperitoneal ruptures are surgically repaired.[20]

Urethral Injuries. Injuries to the male urethra are divided into injuries to the posterior urethra (at or above the membranous urethra) or anterior urethra (penile or bulbar urethra). Posterior urethral injuries are almost exclusively associated with pelvic fractures and occur between 1.5 and 10% of pelvic fractures; concomitant bladder injuries are present in 15% of such urethral injuries.[21,23] Urethral injuries may be partial or complete disruption of the urethra. Anterior urethral injures may be blunt (e.g., straddle injuries, where the urethra is crushed between the pubic bones and a fixed object) or penetrating, and the urethra may be lacerated, crushed, or disrupted. Blood at the urethral meatus is the most common finding, although highly variable, present in 37-93%.[24] Other clinical findings include inability to urinate, perineal/genital ecchymosis, and/or a high-riding prostate on physical exam. Diagnosis is made by retrograde urethrography. Immediate surgical closure of urethral injuries is recommended primarily in penetrating injuries of the anterior urethra. Straddle injuries of the anterior urethra are initially treated with suprapubic (SP) or urethral urinary drainage and are at high risk for delayed stricture formation. Attempts at immediate sutured repair of posterior urethral injury are associated with unacceptably high rates of erectile dysfunction and urinary incontinence.[25] Regardless of the type of injury, securing catheter drainage of the bladder is the immediate goal of treatment. In females,

urethral injuries occur almost exclusively as a result of pelvic fracture and should be suspected in patients having labial edema and/or blood in the vaginal vault during pelvic exam.

Immediate management of posterior urethral injuries remains controversial. Traditional management of pelvic fracture urethral injury (PFUI) is placement of a suprapubic tube (SPT) and delayed urethroplasty to reconnect the ruptured urethra. As endoscopic equipment and techniques have improved over the past two decades, primary realignment (PR) of posterior urethral ruptures has become more common. *Primary realignment* refers to advancing a urinary catheter across the ruptured urethra. The goal of PR is to allow a partial urethral injury to heal while diverting the urine via the catheter, or to align both ends of the disrupted urethra so that they heal in the correct position as the pelvic hematoma is reabsorbed. Review of the literature of the incidence of urethral stenosis after primary realignment is variable, ranging from 14 to 100%.[26-28] Concern surrounding primary realignment centers on problems with the definition of success and whether patients in these studies have had appropriate follow-up evaluation, as most eventually require repeated instrumentation and/or formal urethroplasty to maintain patency.[29]

Genital Injuries. Genital injuries are a heterogeneous group of injuries, including blunt injuries, penetrating, amputation, bite, burn, or avulsion injuries to the penis, scrotum, or testicles in males and the vulva in females. There is little epidemiologic data for genital injuries, although one-half to two-thirds of penetrating genitourinary injuries involve the external genitalia.[30] The most commonly encountered injuries are penile fracture, testicular rupture, and penetrating penile injuries.

Penile fracture refers to a rupture of the tunica albuginea of the penis as a result of forceful bending of the erect penis, most commonly during sexual intercourse in the United States. It may be associated with urethral injury in 10-22% of cases.[31] Diagnosis is usually confirmed by clinical history of forceful bending of the erect penis, an audible "pop" or "snap," rapid detumescence, and penile ecchymosis. In equivocal cases, ultrasound or magnetic resonance imaging (MRI) may clarify the diagnosis. Surgical exploration and repair is associated with lower risk of erectile dysfunction and penile curvature.[32]

Blunt scrotal trauma may lead to rupture of the tunica albuginea of the testicle in 50% of cases presenting for evaluation.[33] Ultrasound may confirm or imply testicular rupture, which should prompt exploration and attempt at repair. Early exploration is associated with higher testicular salvage rates.[33] Penetrating injuries to the scrotum should undergo surgical exploration as over 50% will have testicular rupture.[34]

Penetrating penile injuries may be associated with concomitant urethral injuries in 11-29% of cases.[34] All but the most superficial injuries should be evaluated for urethral injury, explored, and repaired. Penile amputation is a rare injury that is usually self-inflicted and associated with extreme mental illness.[35] Replantation can be successful with prompt treatment, especially with microvascular repair.

GUIDELINE STATEMENTS

Renal Trauma

Guideline Statement 1.

Clinicians should perform diagnostic imaging with intravenous (IV) contrast enhanced computed tomography (CT) in stable blunt trauma patients with gross hematuria or microscopic hematuria and systolic blood pressure < 90mmHG. (Standard; Evidence Strength: Grade B)

These criteria should allow early and accurate detection and staging of significant renal injuries. Advantages of CT outweigh the risks, which include contrast related complications, radiation exposure, and the dangers of transporting a patient away from the resuscitation environment into the CT scanner.[36] Generally, children can be imaged using the same criteria as adults. Children, however, often do not exhibit hypotension as adults do.

The AAST organ injury scale for renal trauma is widely used to classify and standardize renal injuries.[37] This injury grading scale has been validated as predictive of morbidity and need for intervention to treat higher grade injuries.[38-40] The system has ambiguity when staging high-grade injuries,[41] however, and several authors have proposed modification of this grading scale to better guide therapy[42] or to address ambiguity in staging injuries.[43] There has been no formal revision of the AAST injury scale.

Guideline Statement 2.

Clinicians should perform diagnostic imaging with IV contrast enhanced CT in stable trauma patients with mechanism of injury or physical exam findings concerning for renal injury (e.g., rapid deceleration, significant blow to flank, rib fracture, significant flank ecchymosis, penetrating injury of abdomen, flank, or lower chest). (Recommendation; Evidence Strength: Grade C)

Up to 34% of multisystem trauma patients may have

renal injury despite absence of hematuria or hemodynamic instability.[44] A lack of these findings should not preclude imaging if clinicians suspect renal injury based on physical findings, associated abdominal injuries, or mechanism of injury.[36]

Guideline Statement 3.

Clinicians should perform IV contrast enhanced abdominal/pelvic CT with immediate and delayed images when there is suspicion of renal injury. (Clinical Principle)

CT scan of the abdomen and pelvis, using IV contrast with immediate and delayed phases is preferred in order to elucidate both the location of renal lacerations and the presence of contrast extravasation from collecting system injuries. Standard intravenous pyelogram (IVP) may be used in rare cases where CT is not available, but is inferior. Ultrasound may be used in children, although CT is preferred.[45] Although it is not a sensitive test for urologic injury,[46] an intraoperative one -shot IVP (2 mL/kg IV bolus of contrast with a single image obtained 10-15 minutes later) may be used to confirm that a contralateral functioning kidney is present in rare cases where the patient is taken to the operating room without preliminary CT scan if surgeons are considering renal exploration or nephrectomy.[47]

Guideline Statement 4.

In hemodynamically stable patients with renal injury, clinicians should use non-invasive management strategies. (Standard; Evidence Strength: Grade B)

Stable patients are defined as those who do not have vital signs consistent with shock and show stable serial hematocrit values over time. Noninvasive management of renal injury, which may consist of close hemodynamic monitoring, bed rest, ICU admission and blood transfusion, avoids unnecessary surgery, decreases unnecessary nephrectomy, and preserves renal function.[48] Patients initially managed noninvasively may still require surgical, endoscopic, or angiographic treatments at a later time, especially those with higher grade injuries. Although devitalized parenchyma has been suggested as a risk factor for development of septic complications, evidence supporting intervention for this radiographic finding is inconclusive.

Guideline Statement 5a.

In hemodynamically unstable patients with no or transient response to resuscitation, the surgical team must perform immediate intervention (surgery or angioembolization in selected situations). (Standard; Evidence Strength: Grade B)

Hemodynamic instability despite resuscitation suggests uncontrolled and ongoing bleeding. Immediate intervention (either open surgery or angioembolization) is warranted for unstable patients to limit the need for future transfusion and prevent life-threatening complications. The goal of operative exploration of an injured kidney is to control bleeding first, repair the kidney (when possible), and establish perirenal drainage. Surgeons may perform one-shot IVP prior to renal exploration to document function of the contralateral, uninjured kidney using 2 mL/kg IV contrast and a single delayed image at 10-15 minutes. The benefit of prior vascular control in the modern series examined in this Guideline are inconclusive,[49,50] although older studies suggest that it is beneficial. Nephrectomy is a frequent result when hemodynamically unstable patients undergo surgical exploration.[51,52]

Selected patients with bleeding from segmental renal vessels may benefit from angioembolization as an effective yet minimally invasive treatment to control bleeding.[53] Angioembolization may be appropriate in centers where experienced interventional radiologists are immediately available. Direct communication between the clinician and angiographer is critical. Patients who are hemodynamically unstable despite active resuscitation should be taken to the operating room rather than angiography, which is usually time-intensive and remote from the intensive care unit and the operating room. Selective angioembolization should be used when possible to preserve renal function. Multiple studies have suggested that additional CT findings, such as IV contrast extravasation and/or large perirenal hematoma, may help predict which patients will eventually need intervention for bleeding complications.[42,54-56] Renal laceration complexity is also an important radiographic predictor for renal injury clinical outcome as confirmed by additional retrospective studies.[42,54-56]

Guideline Statement 5b.

5b. For hemodynamically unstable patients with radiographic findings of large perirenal hematoma (> 4 cm) and/or vascular contrast extravasation in the setting of deep or complex renal laceration (AAST Grade 3-5), surgeons should perform immediate intervention (angioembolization or surgery). (Recommendation; Evidence Strength; Grade C)

Perinephric hematoma size provides a rough radiographic estimate of the magnitude of renal bleeding, and increasing hematoma size has been

incrementally associated with higher intervention rates. For a 4 cm hematoma, the rate of intervention is elevated roughly 10 times (from 1.7 to 16.2%), and for a 6 cm perinephric hematoma, the rate of intervention rises roughly 20 times (to 31.1%). Intravascular contrast extravasation is another common radiographic indicator of active bleeding at various intra--abdominal sites. [57,58]

Guideline Statement 6.

Clinicians may initially observe patients with renal parenchymal injury and urinary extravasation. (Clinical Principle)

Parenchymal collecting system injuries often resolve spontaneously. A period of observation without intervention is advocated in stable patients where renal pelvis or proximal ureteral injury is not suspected, preventing the risk of injury during stent placement, risk of anesthesia, or risk of retained stent through lack of follow-up. When renal pelvis or proximal ureteral avulsion is suspected (e.g., a large medial urinoma or contrast extravasation on delayed images without distal ureteral contrast) prompt intervention, either endoscopic or open depending on the clinical scenario, is warranted. Rare cases of acute renovascular hypertension have been described, and can be treated with antihypertensives, observation, or uncommonly, nephrectomy.

Guideline Statement 7.

Clinicians should perform follow-up CT imaging for renal trauma patients having either (a) deep lacerations (AAST Grade IV-V) or (b) clinical signs of complications (e.g., fever, worsening flank pain, ongoing blood loss, abdominal distention). (Recommendation; Evidence Strength: Grade C)

Follow-up CT imaging (after 48 hours) is prudent in patients with deep renal injuries (AAST Grade IV-V) because these are prone to developing troublesome complications such as urinoma or hemorrhage. AAST Grade I-III injuries have a low risk of complications and rarely require intervention.[42,59] Routine follow-up CT imaging is not advised for uncomplicated AAST Grade I-III injuries because it is not likely to change clinical management in these cases.[60-67] Routine DMSA or other functional nuclear scans are also not advised. Benefits of forgoing routine follow-up imaging in low-grade renal injuries include simplicity in follow-up, decreased radiation exposure and IV contrast complications, patient convenience, and lower cost. Clinicians should not hesitate to perform follow-up imaging studies when a complication of renal injury is suspected. Periodic monitoring of blood pressure up to a year after the injury may uncover the rare instances of post-injury renovascular hypertension.

Guideline Statement 8.

Clinicians should perform urinary drainage in the presence of complications such as enlarging urinoma, fever, increasing pain, ileus, fistula or infection. (Recommendation; Evidence Strength: Grade C) Drainage should be achieved via ureteral stent and may be augmented by percutaneous urinoma drain, percutaneous nephrostomy or both. (Expert Opinion)

An internalized ureteral stent is minimally invasive and alone may provide adequate drainage of the injured kidney.[68] Clinicians must make adequate provision to ensure removal of stent in follow-up. A period of concomitant Foley catheter drainage may minimize pressure within the collecting system and enhance urinoma drainage. If follow-up imaging demonstrates a urinoma increasing in size, purulence, or complexity, a percutaneous drain may also be necessary.

Ureteral Trauma

Guideline Statement 9a.

Clinicians should perform IV contrast enhanced abdominal/pelvic CT with delayed imaging (urogram) for stable trauma patients with suspected ureteral injuries. (Recommendation; Evidence Strength: Grade C)

Ureteral injuries should be suspected in complex, multisystem abdominopelvic trauma patients, such as those with bowel, bladder, or vascular injuries; in those with complex pelvic/vertebral fractures; after rapid deceleration injuries; and when the trajectory of the penetrating injury is near the ureter, especially with high velocity gunshot wounds.[69,70] Absence of hematuria cannot be relied upon to exclude ureteral injury.[71] In stable patients not proceeding directly to exploratory laparotomy, IV contrast enhanced abdominal/pelvic CT with 10 minute delayed images should be obtained to evaluate for ureteral injury. Findings suggestive of ureteral injury include contrast extravasation, ipsilateral delayed pyelogram, ipsilateral hydronephrosis, and lack of contrast in the ureter distal to the suspected injury.[72-74] If the initial delayed images do not adequately opacify the ureters, further delayed imaging may be necessary if ureteral injury is still suspected.

Guideline Statement 9b.

Clinicians should directly inspect the ureters during laparotomy in patients with suspected

ureteral injury who have not had preoperative imaging. (Clinical Principle)

Direct ureteral inspection is necessary in patients suspected to have ureteral injury who proceed directly to laparotomy without adequate radiographic staging. Adjunctive maneuvers to identify ureteral injuries include careful ipsilateral ureteral mobilization and/or IV or intraureteral injectable dyes such as methylene blue or indigo carmine. Retrograde pyelography may be performed in equivocal cases when possible. Intraoperative single-shot IVP cannot reliably exclude ureteral injury and should not be used solely for this purpose.

Guideline Statement 10a.

Surgeons should repair traumatic ureteral lacerations at the time of laparotomy in stable patients. (Recommendation; Evidence Strength: Grade C)

Ureteral repair should be performed at the time of initial laparotomy, when possible, though immediate repair may not be appropriate in unstable, complex polytrauma patients.[75-80]

Guideline Statement 10b.

Surgeons may manage ureteral injuries in unstable patients with temporary urinary drainage followed by delayed definitive management. (Clinical Principle)

In damage control settings when immediate ureteral repair is not possible at time of initial laparotomy, urinary extravasation can be prevented with ureteral ligation followed by percutaneous nephrostomy tube placement or with an externalized ureteral catheter secured to the proximal end of the ureteral defect. Definitive repair of the injury should be performed when the patient's clinical situation has improved/ stabilized.

Guideline Statement 10c.

Surgeons should manage traumatic ureteral contusions at the time of laparotomy with ureteral stenting or resection and primary repair depending on ureteral viability and clinical scenario. (Expert Opinion)

Ureteral contusion is not uncommon in the context of a gunshot wound with blast injury; complications may include delayed ureteral stricture and/or overt ureteral necrosis with urinary extravasation. Thus, when identified during laparotomy, intact but contused ureters should be primarily managed with ureteral stenting; resection with primary repair may be performed in selected instances, particularly after gunshot wounds, depending on the severity of the contusion and the viability of local tissues.

Guideline Statement 11a.

Surgeons should attempt ureteral stent placement in patients with incomplete ureteral injuries diagnosed postoperatively or in a delayed setting. (Recommendation; Evidence Strength: Grade C)

When an incomplete ureteral injury is at first unrecognized or presents in a delayed fashion, retrograde ureteral imaging with ureteral stent placement should be performed initially.[81-87] Immediate repair can be considered in certain clinical situations if the injury is recognized within one week (e.g., injury located near a surgically closed viscus, such as bowel or vagina, or if the patient is being re-explored for other reasons).

Guideline Statement 11b.

Surgeons should perform percutaneous nephrostomy with delayed repair as needed in patients when stent placement is unsuccessful or not possible. (Recommendation; Evidence Strength: Grade C)

When the proximal ureter is completely transected or otherwise cannot be cannulated in a retrograde fashion, or if patient instability precludes attempts at retrograde treatment, a percutaneous nephrostomy tube should be placed. If nephrostomy alone does not adequately control the urine leak, options then include placement of a periureteral drain or immediate open ureteral repair.[81-89]

Guideline Statement 11c.

Clinicians should initially manage patients with ureterovaginal fistula using stent placement when possible. In the event of stent failure, clinicians may pursue additional surgical intervention. (Recommendation; Evidence Strength; Grade C)

In women who undergo vaginal surgery (such as hysterectomy) or sustain penetrating pelvic trauma involving the vagina, an initially unrecognized ureteral injury can present in a delayed manner as a ureterovaginal fistula. Patients with ureterovaginal fistula should be initially managed with ureteral stent insertion, and ureteral reimplantation can be pursued if stent placement fails. Recent studies of patients with ureterovaginal fistula who are initially managed with ureteral stent placement report success rates of 64%-

100% in six series ranging from 11 to 46 patients.[90-95] Patients who failed with ureteral stent insertion went on to undergo ureteral reimplantation with or without Boari flap or psoas hitch, or transureteroureterostomy with success rates approaching 100%.[90-95]

Guideline Statement 12a.

Surgeons should repair ureteral injuries located proximal to the iliac vessels with primary repair over a ureteral stent, when possible. (Recommendation; Evidence Strength: Grade C)

When the ureter is injured above the iliac vessels, a spatulated, tension-free primary ureteral repair over a ureteral stent is advisable after all non-viable ureteral tissue has been judiciously debrided. In situations where the anastomosis cannot be performed without tension, mobilization of the ureter should be performed in a manner that preserves maximal ureteral blood supply. If an anastomosis can still not be performed after mobilization, a ureteral reimplantation can be attempted, incorporating ancillary maneuvers such as a bladder psoas hitch and/or Boari bladder flap. Interposition with bowel and autotransplant are not recommended in the acute setting. If the injury cannot be managed adequately in the acute setting, ureteral ligation with percutaneous nephrostomy tube placement is advised followed by delayed ureteral reconstruction.[69,71,80,96-100]

Guideline Statement 12b.

Surgeons should repair ureteral injuries located distal to the iliac vessels with ureteral reimplantation or primary repair over a ureteral stent, when possible. (Recommendation; Evidence Strength: Grade C)

When the ureter is injured below the iliac vessels, the distal ureter may be healthy enough to perform a simple ureteroureterostomy in select situations, although the surgeon should defer to direct ureteral reimplantation if there is any doubt about the segment's viability. Tension-free reimplantation may require ancillary maneuvers such as a bladder mobilization with psoas hitch or flap. Interposition with bowel is not recommended in the acute setting. If the injury cannot be managed adequately in the acute setting, ureteral ligation with percutaneous nephrostomy tube placement is advised followed by delayed ureteral reconstruction.[69,71,80,96-100]

Guideline Statement 13a.

Surgeons should manage endoscopic ureteral injuries with a ureteral stent and/or percutaneous nephrostomy tube, when possible. (Recommendation; Evidence Strength: Grade C)

When a ureteral injury occurs during ureteral endoscopy, a ureteral stent should be placed. If placement of a ureteral stent is not possible or if stent placement fails to adequately divert the urine, then a percutaneous nephrostomy tube should be placed with or without a periureteral drain. Delayed ureteral reconstruction is often necessary.[82,101-103]

Guideline Statement 13b.

Surgeons may manage endoscopic ureteral injuries with open repair when endoscopic or percutaneous procedures are not possible or fail to adequately divert the urine. (Expert Opinion)

Open or laparoscopic repair of endoscopic ureteral injuries, using techniques and principles mentioned above, is necessary when endoscopic attempts at diverting the urine fail.[81,85,89]

Bladder Trauma

Guideline Statement 14a.

Clinicians must perform retrograde cystography (plain film or CT) in stable patients with gross hematuria and pelvic fracture. (Standard; Evidence Strength: Grade B)

Gross hematuria is the most common indicator of bladder injury.[22,104-114] Pelvic fracture is the most common associated injury with bladder rupture;[22,106,107,111,112,115-117] however, pelvic fracture alone does not warrant radiologic evaluation of the bladder. Bladder injury is present in 29% of the patients presenting with the combination of gross hematuria and pelvic fracture; therefore, gross hematuria occurring with pelvic fracture is considered an absolute indication for retrograde cystography to evaluate for the presence of bladder injury.[22]

Retrograde cystography is the technique of choice to diagnose bladder injury. Plain film and CT cystography have been shown to have a similar specificity and sensitivity.[106,118] Both techniques are highly accurate for the diagnosis of bladder rupture. The choice of imaging modality is largely left to clinician preference, equipment availability, imaging requirements for other associated injuries, patient stability, and ease of testing.

The technique for plain film cystography consists of retrograde, gravity filling of the bladder with contrast. The volume instilled should be a minimum of 300 mL or until the patient reaches tolerance in order to maximally distend the bladder.[106,118] A minimum of two

views is required, the first at maximal fill and the second after bladder drainage. Additional films can be obtained, such as oblique views, which may provide more information but are not required. CT cystogram is performed in a similar fashion using dilute water-soluble contrast to prevent artifacts from obscuring visualization. Simply clamping a Foley catheter to allow excreted IV-administered contrast to accumulate in the bladder is not appropriate. This technique will not provide adequate bladder distention and results in missed bladder injuries.[106,107,118]

Guideline Statement 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)

Although the majority of bladder ruptures (>90%) will present with gross hematuria in the setting of a pelvic ring fracture, a number of other clinical scenarios should warrant retrograde cystography to evaluate for bladder injury.[22,119] A limited number of pelvic fracture patients with bladder injuries will present with microscopic hematuria (0.6-5.0%).[22,119] In general, microscopic hematuria combined with pelvic fracture is not an indication for radiologic evaluation, but may be warranted in select cases.[22,106,115,117,120]Certain fracture patterns including pubic symphysis diastasis and obturator ring fracture displacement of greater than 1 cm have been shown as indicators of potential bladder injury.[115] Other indicators of potential bladder rupture include: the inability to void, low urine output, increased BUN and creatinine secondary to peritoneal absorption of urine, abdominal distention, suprapubic pain, and low density free intraperitoneal fluid on abdominal imaging (urinary ascites).[22,117,120] Gross or microscopic hematuria in the presence of penetrating injuries with pelvic trajectories requires radiological, endoscopic or surgical evaluation of the bladder.

Guideline Statement 15.

Surgeons must perform surgical repair of intraperitoneal bladder rupture in the setting of blunt or penetrating external trauma. (Standard; Evidence Strength: Grade B)

Intraperitoneal bladder ruptures must be repaired.[22,105,108,110,113,118,121-125] Intraperitoneal ruptures caused by blunt external trauma tend to be large "blow-out" injuries located in the dome of the bladder and are unlikely to heal spontaneously with catheter drainage alone. Penetrating injuries with intraperitoneal components generally have smaller injuries but must be repaired as well. Failure to repair intraperitoneal bladder injuries can result in translocation of bacteria from the bladder to the abdominal cavity resulting in peritonitis, sepsis, and other serious complications. During surgical repair of the bladder, the integrity of the bladder neck and ureteral orifices should be confirmed and repair considered if injured. Delays in surgical repair may occur in those patients who are unable to undergo immediate surgical repair, (i.e., the unstable patient). Repair of intraperitoneal bladder injuries should be expedited when medically feasible. While many are repaired by open surgery, laparoscopic repair of isolated intraperitoneal injuries is appropriate in certain instances.[126] Follow-up cystography should be used to confirm bladder healing in complex repairs but may not be necessary in more simple repairs.[122]

Guideline Statement 16.

Clinicians should perform catheter drainage as treatment for patients with uncomplicated extraperitoneal bladder injuries. (Recommendation; Evidence Strength: Grade C)

Uncomplicated extraperitoneal bladder injuries can be managed using urethral Foley catheter drainage with the expectation that the injury will heal with conservative management.[108,110,113,120-122,124,125] Leaving the catheter in place two to three weeks is standard as most uncomplicated bladder injuries will heal within that time frame. Significant concurrent injuries may delay catheter removal due to patient condition. Follow-up cystography should be used to confirm that the extraperitoneal bladder injury has healed after treatment with catheter drainage.[122] Consideration for open repair is appropriate in patients with non-healing bladder injuries persisting after catheter drainage greater than four weeks.

Guideline Statement 17.

Surgeons should perform surgical repair in patients with complicated extraperitoneal bladder injury. (Recommendation; Evidence Strength: Grade C)

Complicated extraperitoneal bladder ruptures should be surgically repaired in the standard fashion to avoid prolonged sequelae from the injury. Extraperitoneal bladder ruptures are considered complex in a number of settings. Pelvic fractures that result in exposed bone spicules in the bladder lumen should be repaired with removal of the exposed bone and closure of the bladder. Concurrent rectal or vaginal lacerations may lead to fistula formation to the ruptured bladder, and in this setting the extraperitoneal bladder rupture should be fixed. Bladder neck injuries may not heal with catheter drainage alone and repair should be

considered. In circumstances where the patient is undergoing open reduction internal fixation or repair of abdominal injuries, the clinician should consider performing bladder repair for extraperitoneal bladder injury given that the typical bladder repair can be performed quickly and with little morbidity.[22,110,121,122,127] Follow-up cystography should be used to confirm that the complex, extraperitoneal bladder injury has healed.[122]

Guideline Statement 18.

Clinicians should perform urethral catheter drainage without suprapubic (SP) cystostomy in patients following surgical repair of bladder injuries. (Standard; Evidence Strength: Grade B)

A number of studies have shown no advantage of combined SP and urethral catheterization over urethral catheterization alone after repair of bladder injuries. Urethral catheters have been shown to adequately drain the repaired bladder and result in shorter hospital stay and lower morbidity.[22,123,128-130]

There are clinical exceptions in which SPTs may be considered; such exceptions include patients requiring long-term catheterization, such as those with severe neurological injuries (i.e., head and spinal cord), those immobilized due to orthopedic injuries, and complex bladder repairs with tenuous closures or significant hematuria.

Urethral Trauma

Guideline Statement 19.

Clinicians should perform retrograde urethrography in patients with blood at the urethral meatus after pelvic trauma. (Recommendation; Evidence Strength: Grade C)

Given concerns for urethral injury, clinicians should perform retrograde urethrography after pelvic or genital trauma when blood is seen at the urethral meatus.[131,132] The retrograde urethrogram may demonstrate partial or complete urethral disruption, providing guidance for how to best manage bladder drainage in the acute setting. Blind catheter passage prior to retrograde urethrogram should be avoided,[133] unless exceptional circumstances indicate an attempt at emergent catheter drainage for monitoring. In the acute setting of a partial urethral disruption, a single attempt with a well-lubricated catheter may be attempted by an experienced team member.

A retrograde urethrogram is performed by positioning the patient obliquely with the bottom leg flexed at the knee and the top leg kept straight. If severe pelvic or spine fractures are present, leaving the patient supine and placing the penis on stretch to acquire the image is appropriate. A 12Fr Foley catheter or catheter tipped syringe is introduced into the fossa navicularis, the penis is placed on gentle traction and 20 mL undiluted water soluble contrast material is injected with the image acquired.

Occasionally a Foley catheter has been placed before evaluating the urethra. Further imaging is not warranted if no meatal blood is present and suspicion of injury is low. If blood is present a pericatheter retrograde urethrogram should be performed to identify potential missed urethral injury. This is done by injecting contrast material through a 3Fr catheter or angiocatheter held in the fossa navicularis to distend the urethra and prevent contrast leak per meatus.

Guideline Statement 20.

Clinicians should establish prompt urinary drainage in patients with pelvic fracture associated urethral injury. (Recommendation; Evidence Strength: Grade C)

Patients with PFUI are often unable to urinate due to their injuries.[132] Trauma resuscitations typically involve aggressive hydration and a critical need to closely monitor patient volume status. Retrograde urethrography is often helpful in delineating the severity of the urethral injury. Clinicians should establish efficient and prompt urinary drainage in the acute setting.

Guideline Statement 20b.

Clinicians should perform percutaneous or open suprapubic tube placement as preferred initial management for most PFUI cases. (Recommendation; Evidence Strength: Grade C)

In the setting of pelvic fracture associated urethral disruption, SPT remains the gold standard for urinary drainage.[134-137] SPT placement in the lower abdominal midline facilitates the treatment of PFUI as the first step for both delayed, definitive urethroplasty and primary endoscopic realignment. SPT may be placed percutaneously or via open technique; a latex Foley catheter 14 Fr or larger is preferred due to ease of exchange at the bedside (usually 6-8 weeks later). Small caliber percutaneous catheters 12 Fr or less are discouraged in this setting since they often require replacement or upsizing in the setting of hematuria, prolonged use, or in preparation for future definitive surgical repair. Bladder localization techniques such as aspiration with an 18 G spinal needle or imaging with ultrasound or fluoroscopy may facilitate percutaneous SPT insertion if the bladder is displaced due to pelvic

hematoma. Most PFUI patients will develop obliterative strictures which are amenable to open posterior urethroplasty which has a high probability of success at most referral centers. Primary endoscopic realignment has been associated with a longer clinical course due to multiple procedures required for recurrent obstruction over an extended timeline.[138]

Guideline Statement 21.

Surgeons may place suprapubic tubes (SPTs) in patients undergoing open reduction internal fixation (ORIF) for pelvic fracture. (Expert Opinion)

The management of PFUI requires close coordination with orthopedic surgeons to optimize timing of interventions. In such cases, concerns regarding the use of SPT in patients undergoing open reduction and internal fixation of the pubic symphysis vary based on individual surgeon and institutional practice patterns. No evidence exists to indicate that SPT insertion increases the risk of orthopedic hardware infection.[128,133] Thus, considerations of the urethral injury and its management should dictate the use of SPT. Particular circumstances, such as gross fecal contamination or open fractures, may suggest exceptions to these general observations.

Guideline Statement 22.

Clinicians may perform primary realignment (PR) 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)

The first priority in management of PFUI is establishment of urinary drainage. SPT and delayed urethral reconstruction remains the accepted treatment for the vast majority of cases. Patients undergoing PR of PFUI may have less severe urethral strictures when compared to patients undergoing SP diversion alone.[26,27]

Although the indications, benefits, and methods of PR remain debatable, attempts at PR should be reserved for hemodynamically stable patients within the first few days after injury.[138,139] The technique may require two urologists to navigate the urethra simultaneously from above and below with multiple flexible or rigid cystoscopes, video monitors, and fluoroscopy. These requirements are best met by a regular urology operating room team once the patient has stabilized in coordination with trauma and orthopedic surgeons, thus the Emergency Department setting is inappropriate for realignment of most PFUI. Prolonged and heroic attempts at endoscopic realignment must be avoided as the process may increase injury severity and long-term sequelae, delay other medical services the patient requires, and has not been shown to improve long-term outcomes. Whether endoscopic realignment is successfully performed or not, patients with pelvic fracture associated urethral injury are at high risk for developing urethral stricture, and thus after PR it may be prudent to maintain SPT drainage while awaiting resolution of PFUI.

Guideline Statement 23.

Clinicians should monitor patients for complications (e.g., stricture formation, erectile dysfunction, incontinence) for at least one year following urethral injury. (Recommendation; Evidence Strength: Grade C)

PFUI is associated with high rates of urethral stricture formation and erectile dysfunction, while only small numbers of men will report urinary incontinence.[132,140] Rates of stricture after PFUI will vary based on injury severity and management with PR or SPT, but in either scenario, stricture in most cases develops within a year of injury and can be treated by urethroplasty or direct vision internal urethrotomy.[25,141] Thus surveillance strategies with uroflowmetry, retrograde urethrogram, cystoscopy, or some combination of methods are recommended for the first year after injury. Impotence and incontinence are generally considered to be caused by the pelvic fracture itself rather than contemporary interventions for PFUI.[142,143]

Guideline Statement 24.

Surgeons should perform prompt surgical repair in patients with uncomplicated penetrating trauma of the anterior urethra. (Expert Opinion)

After a penetrating trauma to the anterior urethra has been appropriately staged, surgical repair should be performed. It is expert opinion that spatulated primary repair of uncomplicated injuries in the acute setting offers excellent outcomes superior to delayed reconstruction. Primary repair should not be undertaken if the patient is unstable, the surgeon lacks expertise in urethral surgery or in the setting of extensive tissue destruction or loss.

Guideline Statement 25.

Clinicians should establish prompt urinary drainage in patients with straddle injury to the anterior urethra. (Recommendation; Evidence Strength: Grade C)

Crush injuries of the bulbar urethra caused by straddle injury require prompt intervention to avoid urinary extravasation.[144] Establishing urinary drainage by SPT, or PR in less severe cases, requires consideration of associated injuries, severity of the disruption, degree of bladder distension, and availability of urological expertise and endoscopic instrumentation. Immediate operative intervention to repair or debride the injured urethra is contraindicated due to the indistinct nature of the injury border. Stricture formation after straddle injury is very high and thus all patients undergoing urinary diversion require follow-up surveillance using uroflowmetry, retrograde urethrogram and/or cystoscopy.[145]

Genital Trauma

Guideline Statement 26.

Clinicians must suspect penile fracture when a patient presents with penile ecchymosis, swelling, cracking or snapping sound during intercourse or manipulation and immediate detumescence. (Standard; Evidence Strength: Grade B)

Penile swelling and ecchymosis are the most common symptoms of penile fracture. Most patients report a cracking or snapping sound followed by immediate detumescence. Other symptoms may include penile pain and penile angulation.[146-148] History and physical examination alone are often diagnostic in patients with these presenting symptoms.[32,149-159]

Guideline Statement 27.

Surgeons should perform prompt surgical exploration and repair in patients with acute signs and symptoms of penile fracture. (Standard; Evidence Strength: Grade B)

In patients with historical and physical signs consistent with penile fracture, surgical repair should be performed. The repair is performed by exposing the injured corpus cavernosum through either a ventral midline or circumcision incision. Tunical repair is performed with absorbable suture and should be performed at the time of presentation to improve long-term patient outcomes.[149,151,156,160-167]

Guideline Statement 28.

Clinicians may perform ultrasound in patients with equivocal signs and symptoms of penile fracture. (Expert Opinion)

Patients with equivocal signs of penile fracture may undergo imaging as an adjunct study to assist with confirmation or exclusion of the diagnosis of penile fracture.[168,169] Ultrasound is the most commonly used imaging modality due to wide availability, low cost, and rapid examination times.[160,161] Routine ultrasound is not necessary in penile fracture cases when the diagnosis is clear. MRI can be considered alternatively in cases when ultrasound proves to be equivocal or unavailable.[150,170] If imaging is equivocal or diagnosis remains in doubt, surgical exploration should be performed.

Guideline Statement 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)

Patients with penile fracture and gross hematuria, blood at the urethral meatus, or inability to void should undergo evaluation for concomitant urethral injury.[157,171-173] An additional risk factor is bilateral corporal body fracture.[149,174,175] Options for evaluation include urethroscopy and retrograde urethrogram.[159.163,165,167,168,176] Neither method is superior for diagnosis. The choice of retrograde urethrogram or cystoscopy is the decision of the urologist based on availability of equipment and timing of the procedure.

Guideline Statement 30a.

For blunt scrotal injuries, clinicians should perform scrotal ultrasonography for most patients having physical findings suggestive of testicular rupture. (Recommendation; Evidence Strength: Grade C)

Clinical examination of the scrotum following trauma can be limited due to significant scrotal swelling and patient discomfort. Scrotal ultrasound can reliably diagnose testicular rupture with a high level of accuracy in the setting of blunt scrotal trauma.[177,178] The most specific findings on ultrasonography are loss of testicular contour and heterogeneous echotexture of parenchyma, which should prompt testicular repair.[177] Prompt surgical exploration is indicated with sonographic findings of testicular rupture, equivocal imaging, large hematoma, or clear physical findings of testicular rupture, which results in testicular salvage rates of 80–90%.[177,179]

Guideline Statement 30b.

For most penetrating scrotal injuries, clinicians should perform prompt surgical exploration with

repair or orchiectomy (when non-salvageable) given the high rate of testicular injury and limited sensitivity of ultrasound in this setting (Recommendation; Evidence Strength: Grade C)

Penetrating injuries to the scrotum require prompt exploration with debridement and primary repair of the tunica albuginea or orchiectomy, as series demonstrate a > 50% rate of testicular injury.[180,181] Clinicians should maintain a high level of clinical suspicion for concomitant injury to the spermatic cord structures, contralateral testicle, penile corporal bodies, and urethra.[182] The utility of scrotal ultrasound for the evaluation of testicular rupture in the setting of penetrating scrotal trauma is limited.[185]

Guideline Statement 30c.

Surgeons should perform scrotal exploration and debridement with tunical closure (when possible) or orchiectomy (when non-salvageable) in patients with suspected testicular rupture. (Standard; Evidence Strength: Grade B)

Testicular rupture after blunt or penetrating scrotal injuries may be suggested by scrotal ecchymosis and swelling or difficulty in identifying the contours of the testicle on physical exam. Early exploration and repair may prevent complications, such as ischemic atrophy of the testis and infection.[183] Repair of the ruptured testis by debriding non-viable tissue and closing the tunica albuginea is preferred when possible.[183,184] Tunica vaginalis flap or graft may be used to provide closure when the tunica albuginea cannot be closed primarily.[185]

Guideline Statement 31.

Surgeons should perform exploration and limited debridement of non-viable tissue in patients with extensive genital skin loss or injury from infection, shearing injuries, or burns (thermal, chemical, electrical). (Standard; Evidence Strength: Grade B)

Initial management in these patients should include operative exploration, irrigation, and limited debridement of clearly non-viable tissue.[186-201] Genital skin is well vascularized and tissues with marginal viability may survive due to collateral blood flow. Typically, these injuries require multiple procedures in the operating room prior to definitive reconstructive procedures. Wound management can include a variety of methods including gauze dressings with frequent changes, silver sulfadiazine or topical antibiotic and occlusive dressing, or negative pressure dressings.[186,188-190,194,198,202-206]Reconstructive techniques for definitive repair include primary closure and advancement flaps, placement of skin grafts, free tissue flaps, and pedicle based skin flaps.[188-190,192,193,197,207-212]

Guideline Statement 32.

Surgeons should perform prompt penile replantation 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)

Urologists should perform re-anastomosis of macroscopic structures, including the corpora cavernosa, spatulated repair of the urethra, and skin, when the amputated penis is available. A microvascular surgeon should be consulted whenever possible to perform microscopic repair of dorsal arteries, veins, and nerves. Microvascular repair may improve outcomes, especially with respect to loss of penile skin. Transfer to a center with these capabilities can be considered for this reason. The amputated appendage should be transported to the hospital in a two-bag system, with the penis wrapped in saline-soaked gauze, placed in a plastic bag, and then placed on ice in a second bag.

Guideline Statement 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)

Genital trauma has the unique capacity to simultaneously alter sexual, urinary, and reproductive function. Such alterations can be temporary or permanent, depending on the severity of the injury(-ies) and degree of soft tissue loss. Sexual activity is limited (or prohibited) during recovery from the initial trauma and any requisite reconstructive surgeries which are commonly performed weeks or months after the initial traumatic event. Additionally, permanent scarring of genital skin and/or overt loss of penile, testicular, or clitoral tissue can challenge the patient's own sense of self and body image. Sexual, urinary, and fertility problems may be amplified in polytrauma patients who sustained comorbid injuries that can also affect genitourinary function, such as traumatic brain injury, spinal cord injury, severe burns, severe orthopedic injuries (including limb amputation), and colorectal injuries.[213-215] The sum-total of these effects can lead to mental health problems for the injured individual and relationship problems between the patient and his/her current or future intimate partner (s). Thus, early consultation with mental health professionals skilled in addressing issues of intimacy

and sexuality may help the patient and his/her sexual partner(s) during the course of recovery and rehabilitation after genital trauma.[216] If permanent loss of reproductive function is anticipated, early salvage of remaining sperm, either aspirated from the seminal vesicles[217] or flushed from the vas deferens after orchiectomy,[218,219] is possible, but presents a myriad of logistical and ethical challenges which limit its feasibility. At a minimum, genital trauma patients at risk for infertility should be referred to appropriate centers for reproductive counseling and treatment, when needed.

FUTURE RESEARCH

As the field of genitourinary reconstruction continues to evolve, clinicians must strive to approach clinical problems in a creative, multi-disciplinary, evidence-based manner to ensure optimal outcomes. Further research is needed to clarify which radiographic indicators of renal injuries can be used to facilitate selection of appropriate candidates for angiographic embolization. Complex ureteral defects are increasingly amenable to robotic repair, and further study is needed to clarify the role of classic reconstructive techniques, such as Boari flap, ileal ureter, and downward nephropexy in the robotic era. Evaluation of the existing literature does not demonstrate conclusively whether or when PR of urethral disruption injuries is advantageous over initial SP urinary diversion alone followed by definitive delayed urethroplasty. Similarly, the role of SPT placement remains controversial in pelvic fracture urethral injury patients who are candidates for internal pubic fixation procedures. Genital injuries are rarely life threatening, but they often become the male trauma patient's chief concern once acute issues are resolved. Plastic surgical principles offer an important guide for optimal genital cosmesis and function. Further study is needed in the areas of tissue engineering, tissue glues, and wound healing biology to optimize outcomes.

LIST OF ABBREVIATIONS

AAST	American Association for the Surgery of Trauma
BUN	blood urea nitrogen
CCT	Controlled clinical trial
COI	Conflict of interest
CT	Computed tomography
DMSA	Dimercaptosuccinic acid
GOC	Guidelines Oversight Committee
ICU	Intensive care unit
IV	Intravenous
IVP	Intravenous pyelogram
J&E	Judicial and ethics
MRI	Magnetic resonance imaging
ORIF	Open reduction internal fixation
PFUI	Pelvic fracture urethral injury
PGC	Practice Guidelines Committee
PR	Primary realignment
RCT	Randomized controlled trial
RUG	retrograde urethrogram
SBP	Systolic blood pressure
SP	Suprapubic
SPT	Suprapubic tube
UPJ	Ureteropelvic junction
VCUG	Voiding cystourethrogram

REFERENCES

1. Shea BJ, Grimshaw JM, Wells GA et al: Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol 2007; **7**: 10.
2. Sterne JA, Hernan MA, Reeves BC et al: ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ 2016; **355:** i4919.
3. Guyatt G, Oxman AD, Akl EA et al: GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. J Clin Epidemiol 2011; **64**: 383.
4. Higgins JDA: Assessing quality of included studies in Cochrane Reviews. The Cochrane Collaboration Methods Groups Newsletter. Vol 112007.
5. Whiting PF, Rutjes AW, Westwood ME et al: QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med 2011; **155**: 529.
6. Norris SL, Lee NJ, Severance S et al: Appendix B. Quality assessment methods for drug class reviews for the drug effectiveness review project. In: Drug Class Review: Newer Drugs for the Treatment of Diabetes Mellitus: Final Report. Portland: Oregon Health & Science University; 2008.
7. Faraday M, Hubbard H, Kosiak B et al: Staying at the cutting edge: a review and analysis of evidence reporting and grading; the recommendations of the American Urological Association. BJU Int 2009; **104**: 294.
8. Hsu C, Sandford BA: The Delphi Technique: Making Sense Of Consensus. Practical Assessment, Research & Evaluation 2007; **12**: 1.
9. Fu Q, Zhang YM, Barbagli G et al: Factors that influence the outcome of open urethroplasty for pelvis fracture urethral defect (PFUD): an observational study from a single high-volume tertiary care center. World J Urol 2015; **33:** 2169.
10. Centers for Disease Control and Prevention: Injury prevention & control: data & statistics. 2010; http://www.cdc.gov/injury/wisqars/LeadingCauses.html. Accessed September 8, 2013.
11. Soreide K: Epidemiology of major trauma. Br J Surg 2009; **96**: 697.
12. McAninch JW: Genitourinary trauma. World J Urol 1999; **17:** 65.
13. Meng MV, Brandes SB, McAninch JW: Renal trauma: indications and techniques for surgical exploration. World J Urol 1999; **17**: 71.
14. Wessells H, Suh D, Porter JR et al: Renal injury and operative management in the United States: results of a population-based study. J Trauma 2003; **54**: 423.
15. Smith J, Caldwell E, D'Amours S et al: Abdominal trauma: a disease in evolution. ANZ J Surg 2005; **75**: 790.
16. Breyer BN, McAninch JW, Elliott SP et al: Minimally invasive endovascular techniques to treat acute renal hemorrhage. J Urol 2008; 179: 2248.
17. Buckley JC, McAninch JW: Selective management of isolated and nonisolated grade IV renal injuries. J Urol 2006; **176**: 2498.
18. Brewer ME, Jr., Strnad BT, Daley BJ, et al: Percutaneous embolization for the management of grade 5 renal trauma in hemodynamically unstable patients: initial experience. J Urol. 2009; **181**: 1737.
19. Al-Awadi K, Kehinde EO, Al-Hunayan A et al: Latrogenic ureteric injuries: incidence, aetiological factors and the effect of early management on subsequent outcome. Int Urol Nephrol 2005; **37**: 235.
20. Gomez RG, Ceballos L, Coburn M et al: Consensus statement on bladder injuries. BJU Int 2004; **94**: 27.
21. Brandes S, Borrelli J, Jr.: Pelvic fracture and associated urologic injuries. World J Surg 2001; **25**: 1578.
22. Morey AF, Iverson AJ, Swan A et al: Bladder rupture after blunt trauma: guidelines for diagnostic imaging. J Trauma 2001; **51**: 683.
23. Bjurlin MA, Fantus RJ, Mellett MM et al: Genitourinary injuries in pelvic fracture morbidity and mortality using the National Trauma Data Bank. J Trauma 2009; **67**: 1033.
24. Martinez-Pineiro L, Djakovic N, Plas E et al: EAU guidelines on urethral trauma. Eur Urol 2010; **57**: 791.
25. Koraitim MM: Pelvic fracture urethral injuries: evaluation of various methods of management. J Urol 1996; **156**: 1288.
26. Koraitim MM: Effect of early realignment on length and delayed repair of postpelvic fracture urethral injury. Urology 2012; **79**: 912.
27. Balkan E, Kilic N, Dogruyol H: The effectiveness of early primary realignment in children with posterior urethral injury. Int J Urol 2005; **12**: 62.
28. Jordan G, Chapple C, Heyns C: eds. Urethral Strictures. Société Internationale d'Urologie; 2010.
29. Leddy L, Voelzke B, Wessells H: Primary realignment of pelvic fracture urethral injuries. Urol Clin North Am 2013; **40**: 393.
30. Brandes SB, Buckman RF, Chelsky MJ et al: External genitalia gunshot wounds: a ten-year experience with fifty-six cases. J Trauma 1995; **39**: 266.
31. Tsang T, Demby AM et al: Penile fracture with urethral injury. J Urol 1992; **147**: 466.
32. Gamal WM, Osman MM, Hammady A et al: Penile fracture: long-term results of surgical and conservative management. J Trauma 2011; **71**: 491.
33. Cass AS, Luxenberg M: Testicular injuries. Urology 1991; **37**: 528.

References

34. Phonsombat S, Master VA, McAninch JW et al: Penetrating external genital trauma: a 30-year single institution experience. J Urol 2008; **180**: 192.
35. Jezior JR, Brady JD, Schlossberg SM: Management of penile amputation injuries. World J Surg 2001; **25**: 1602.
36. Miller KS, McAninch JW: Radiographic assessment of renal trauma: our 15-year experience. J Urol 1995; **154**: 352.
37. Moore EE, Shackford SR, Pachter HL et al: Organ injury scaling: spleen, liver, and kidney. J Trauma 1989; **29**: 1664.
38. Santucci RA, McAninch JW, Safir M et al: Validation of the american association for the surgery of trauma organ injury severity scale for the kidney. J Trauma 2001; **50**: 195.
39. Kuan JK, Wright JL, Nathens AB et al: American association for the surgery of trauma organ injury scale for kidney injuries predicts nephrectomy, dialysis, and death in patients with blunt injury and nephrectomy for penetrating injuries. J Trauma 2006; **60**: 351.
40. Shariat SF, Roehrborn CG, Karakiewicz PI et al: Evidence-based validation of the predictive value of the american association for the surgery of trauma kidney injury scale. J Trauma 2007; **62**: 933.
41. Santucci RA, McAninch JM: Grade IV renal injuries: evaluation, treatment, and outcome. World J Surg 2001; **25:** 1565.
42. Dugi DD, 3rd, Morey AF, Gupta A et al: American Association for the Surgery of Trauma grade 4 renal injury substratification into grades 4a (low risk) and 4b (high risk). J Urol 2010; **183**: 592.
43. Buckley JC, McAninch JW. Revision of current American Association for the Surgery of Trauma Renal Injury grading system. J Trauma 2011; **70**: 35.
44. Brandes SB, McAninch JW: Urban free falls and patterns of renal injury: a 20-year experience with 396 cases. J Trauma 1999; **47**: 643.
45. Tas F, Ceran C, Atalar MH et al: The efficacy of ultrasonography in hemodynamically stable children with blunt abdominal trauma: a prospective comparison with computed tomography. Eur J Radiol 2004; **51**: 91.
46. Patel VG, Walker ML: The role of "one-shot" intravenous pyelogram in evaluation of penetrating abdominal trauma. Am Surg 1997; **63**: 350.
47. Nagy KK, Brenneman FD, Krosner SM et al: Routine preoperative "one-shot" intravenous pyelography is not indicated in all patients with penetrating abdominal trauma. J Am Coll Surg 1997; **185**: 530.
48. Santucci RA, Fisher MB: The literature increasingly supports expectant (conservative) management of renal trauma--a systematic review. J Trauma 2005; **59**: 493.
49. Atala A, Miller FB, Richardson JD et al: Preliminary vascular control for renal trauma. Surg Gynecol Obstet 1991; **172**: 386.
50. Ersay A, Akgun Y: Experience with renal gunshot injuries in a rural setting. Urology 1999; **54**: 972.
51. McGuire J, Bultitude MF, Davis P et al: Predictors of outcome for blunt high grade renal injury treated with conservative intent. J Urol 2011; **185**: 187.
52. Bjurlin MA, Jeng EI, Goble SM et al: Comparison of nonoperative management with renorrhaphy and nephrectomy in penetrating renal injuries. J Trauma 2011; **71**: 554.
53. Sadick M, Rohrl B, Schnulle P et al: Multislice CT-angiography in percutaneous postinterventional hematuria and kidney bleeding: Influence of diagnostic outcome on therapeutic patient management. Preliminary results. Arch Med Res 2007; **38**: 126.
54. Hardee MJ, Lowrance W, Brant WO et al: High grade renal injuries: application of Parkland Hospital predictors of intervention for renal hemorrhage. J Urol 2013; **189**: 1771.
55. Figler BD, Malaeb BS, Voelzke B et al: External validation of a substratification of the American Association for the Surgery of Trauma renal injury scale for grade 4 injuries. J Am Coll Surg 2013; **217**: 924.
56. Lin WC, Lin CH, Chen JH et al: Computed tomographic imaging in determining the need of embolization for high-grade blunt renal injury. J Trauma Acute Care Surg 2013; **74**: 230.
57. Zemp L, Mann U, Rourke KF: Perinephric hemaotoma size is independently associated with the need for urological intervention in multisystem blunt renal trauma. J Urol 2018; **199**: 1283.
58. Keihani S, Putbrese BE, Rogers DM et al: The associations between initial radiographic findings and interventions for renal hemorrhage after high-grade renal trauma: Results from the multi-institutional GU trauma study. J Trauma Acute Care Surg 2019; **86**: 974.
59. Simmons JD, Haraway AN, Schmieg RE et al: Blunt renal trauma and the predictors of failure of non-operative management. J Miss State Med Assoc 2010; **51**: 131.
60. Onen A, Kaya M, Cigdem MK et al: Blunt renal trauma in children with previously undiagnosed pre-existing renal lesions and guidelines for effective initial management of kidney injury. BJU Int 2002; **89**: 936.
61. Abdalati H, Bulas DI, Sivit CJ et al: Blunt renal trauma in children: healing of renal injuries and recommendations for imaging follow-up. Pediatr Radiol 1994; **24**: 573.
62. Bukur M, Inaba K, Barmparas G et al: Routine follow-up imaging of kidney injuries may not be justified. J Trauma 2011; **70**: 1229.

63. Davis P, Bultitude MF, Koukounaras J et al: Assessing the usefulness of delayed imaging in routine followup for renal trauma. J Urol 2010; **184**: 973.
64. Malcolm JB, Derweesh IH, Mehrazin R et al: Nonoperative management of blunt renal trauma: is routine early follow-up imaging necessary? BMC Urol 2008; **8**:11.
65. Blankenship JC, Gavant ML, Cox CE et al: Importance of delayed imaging for blunt renal trauma. World J Surg 2001; **25**: 1561.
66. Moolman C, Navsaria PH, Lazarus J et al: Nonoperative management of penetrating kidney injuries: a prospective audit. J Urol 2012; **188**: 169.
67. El-Atat R, Derouiche A, Slama MR et al: Kidney trauma with underlying renal pathology: is conservative management sufficient? Saudi J Kidney Dis Transpl 2011; **22**: 1175.
68. Fiard G, Rambeaud JJ, Descotes JL et al: Long-term renal function assessment with dimercapto-succinic acid scintigraphy after conservative treatment of major renal trauma. J Urol 2012; **187**: 1306.
69. Siram SM, Gerald SZ, Greene WR et al: Ureteral trauma: patterns and mechanisms of injury of an uncommon condition. Am J Surg 2010; **199**: 566.
70. Elliott SP and McAninch JW: Ureteral injuries: external and iatrogenic. Urol Clin North Am 2006; **33**: 55.
71. Elliott SP and McAninch JW. Ureteral injuries from external violence: the 25-year experience at San Francisco General Hospital. J Urol 2003; **170**: 1213.
72. Carver BS, Bozeman CB and Venable DD: Ureteral injury due to penetrating trauma. South Med J 2004; **97**:462.
73. Gayer G, Zissin R, Apter S et al: Urinomas caused by ureteral injuries: CT appearance. Abdom Imaging 2002; **27**: 88.
74. Ortega SJ, Netto FS, Hamilton P et al: CT scanning for diagnosing blunt ureteral and ureteropelvic junction injuries. BMC Urol 2008; **8**:3.
75. Ghali AM, El Malik EM, Ibrahim AI et al: Ureteric injuries: diagnosis, management, and outcome. J Trauma 1999; **46**: 150.
76. Abid AF and Hashem HL: Ureteral injuries from gunshots and shells of explosive devices. Urol Ann 2010; **2**: 17.
77. Fraga GP, Borges GM, Mantovani M et al: Penetrating ureteral trauma. Int Braz J Urol 2007; **33**: 142.
78. Akay AF, Girgin S, Akay H et al: Gunshot injuries of the ureter: one centre's 15-year experience. Acta Chir Belg 2006; **106**: 572.
79. Best CD, Petrone P, Buscarini M et al: Traumatic ureteral injuries: a single institution experience validating the American Association for the Surgery of Trauma-Organ Injury Scale grading scale. J Urol 2005; **173**:1202.
80. Azimuddin K, Milanesa D, Ivatury R et al: Penetrating ureteric injuries. Injury 1998; **29**: 363.
81. Koukouras D, Petsas T, Liatsikos E et al: Percutaneous minimally invasive management of iatrogenic ureteral injuries. J Endourol 2010; **24**: 1921.
82. Hamano S, Nomura H, Kinsui H et al: Experience with ureteral stone management in 1,082 patients using semirigid ureteroscopes. Urol Int. 2000; **65:** 106.
83. De Cicco C, Schonman R, Craessaerts M et al: Laparoscopic management of ureteral lesions in gynecology. Fertil Steril 2009; **92**: 1424.
84. Giberti C, Germinale F, Lillo M et al: Obstetric and gynaecological ureteric injuries: treatment and results. Br J Urol 1996; **77**: 21.
85. Cormio L: Ureteric injuries. Clinical and experimental studies. Scand J Urol Nephrol Suppl 1995; **171**: 1.
86. Ku JH, Kim ME, Jeon YS et al: Minimally invasive management of ureteral injuries recognized late after obstetric and gynaecologic surgery. Injury 2003; **34**: 480.
87. Lask D, Abarbanel J, Luttwak Z et al: Changing trends in the management of iatrogenic ureteral injuries. J Urol 1995; **154**: 1693.
88. Liatsikos EN, Karnabatidis D, Katsanos K et al: Ureteral injuries during gynecologic surgery: treatment with a minimally invasive approach. J Endourol 2006; **20**: 1062.
89. Ustunsoz B, Ugurel S, Duru NK et al: Percutaneous management of ureteral injuries that are diagnosed late after cesarean section. Korean J Radiol 2008; **9**: 348.
90. Al-Otaibi KM: Ureterovaginal fistulas: The role of endoscopy and a percutaneous approach. Urol Ann 2012; **4**: 102.
91. Rajamaheswari N, Chhikara AB, Seethalakshmi K: Management of ureterovaginal fistulae: an audit. Int Urogynecol J. 2013; **24**: 959.
92. Shaw J, Tunitsky-Bitton E, Barber MD et al: Ureterovaginal fistula: a case series. Int Urogynecol J 2014; **25:** 615.
93. Upadhyay AM, Kunwar A, Shrestha S et al: Managing Ureterovaginal Fistulas following Obstetric and Gynecological Surgeries. J Nepal Health Res Counc 2018; **16**: 233.
94. Li X, Wang, P, Liu Y et al: Minimally invasive surgical treatment on delayed uretero-vaginal fistula. BMC Urol 2018; **18**: 96.
95. Chen YB, Wolff BJ, Kenton KS et al: Approach to ureterovaginal fistula: examining 13 years of experience. Female Pelvic Med Reconstr Surg 2019; **25**: e7.
96. Palmer LS, Rosenbaum RR, Gershbaum MD et al:

Penetrating ureteral trauma at an urban trauma center: 10-year experience. Urology 1999; **54**: 34.
97. Brandes SB, Chelsky MJ, Buckman RF et al: Ureteral injuries from penetrating trauma. J Trauma 1994; **36**: 766.
98. Rober PE, Smith JB and Pierce JM, Jr.: Gunshot injuries of the ureter. J Trauma 1990; **30**: 83.
99. Yuvaraja TB, Wuntakal R, Maheshwari A et al: Management and long-term follow-up of ureteric injuries during radical hysterectomy: Single center experience. Journal of Gynecologic Surgery 2003; **19**: 133.
100. Rencken RK, Jansen AA, Bornman MS et al: Trauma of the ureter. S Afr J Surg 1991; **29**: 154.
101. Al-Ghazo MA, Ghalayini IF, Al-Azab RS et al: Emergency ureteroscopic lithotripsy in acute renal colic caused by ureteral calculi: a retrospective study. Urol Res 2011; **39**: 497.
102. Butler MR, Power RE, Thornhill JA et al: An audit of 2273 ureteroscopies--a focus on intra-operative complications to justify proactive management of ureteric calculi. Surgeon 2004; **2**: 42.
103. Kriegmair M and Schmeller N: Paraureteral calculi caused by ureteroscopic perforation. Urology 1995; **45**: 578.
104. Brewer ME, Wilmoth RJ, Enderson BL et al: Prospective comparison of microscopic and gross hematuria as predictors of bladder injury in blunt trauma. Urology 2007**; 69**:1086.
105. Shlamovitz GZ and McCullough L: Blind urethral catheterization in trauma patients suffering from lower urinary tract injuries. J Trauma 2007; **62**: 330.
106. 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.
107. Chan DP, Abujudeh HH, Cushing GL, Jr. et al: CT cystography with multiplanar reformation for suspected bladder rupture: experience in 234 cases. AJR Am J Roentgenol 2006; **187**: 1296.
108. Margolin DJ and Gonzalez RP: Retrospective analysis of traumatic bladder injury: does suprapubic catheterization alter outcome of healing? Am Surg 2004; **70**: 1057.
109. Peng MY, Parisky YR, Cornwell EE III et al: CT cystography versus conventional cystography in evaluation of bladder injury. AJR Am J Roentgenol 1999; **173:** 1269.
110. Fuhrman GM, Simmons GT, Davidson BS et al: The single indication for cystography in blunt trauma. Am Surg 1993; **59**: 335.
111. Hochberg E and Stone NN: Bladder rupture associated with pelvic fracture due to blunt trauma. Urology 1993; **41**: 531.
112. Albala DM and Richardson JR, Jr.: Diagnosis and treatment of bladder rupture: characteristics of 42 cases. R I Med J 1991; **74**: 133.
113. Rehm CG, Mure AJ, O'Malley KF et al: Blunt traumatic bladder rupture: the role of retrograde cystogram. Ann Emerg Med 1991; **20**: 845.
114. Lis LE and Cohen AJ: CT cystography in the evaluation of bladder trauma. J Comput Assist Tomogr 1990; **14**: 386.
115. 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.
116. Morgan DE, Nallamala LK, Kenney PJ et al: CT cystography: radiographic and clinical predictors of bladder rupture. AJR Am J Roentgenol 2000; **174**: 89.
117. Haas CA, Brown SL and Spirnak JP: Limitations of routine spiral computerized tomography in the evaluation of bladder trauma. J Urol 1999; **162:** 51.
118. Wirth GJ, Peter R, Poletti PA et al: Advances in the management of blunt traumatic bladder rupture: experience with 36 cases. BJU Int 2010; **106**: 1344.
119. Mokoena T and Naidu AG: Diagnostic difficulties in patients with a ruptured bladder. Br J Surg 1995; **82:** 69.
120. Chan L, Nade S, Brooks A et al: Experience with lower urinary tract disruptions associated with pelvic fractures: implications for emergency room management. Aust N Z J Surg 1994; **64:** 395.
121. Pereira BM, de Campos CC, Calderan TR et al: Bladder injuries after external trauma: 20 years experience report in a population-based cross-sectional view. World J Urol 2013; **31**: 913.
122. Inaba K, McKenney M, Munera F et al: Cystogram follow-up in the management of traumatic bladder disruption. J Trauma 2006; **60**: 23.
123. Parry NG, Rozycki GS, Feliciano DV et al: Traumatic rupture of the urinary bladder: is the suprapubic tube necessary? J Trauma 2003; **54**: 431.
124. Hsieh CH, Chen RJ, Fang JF et al: Diagnosis and management of bladder injury by trauma surgeons. Am J Surg 2002; **184:**143.
125. Madiba TE and Haffejee AA: Causes and outcome of bladder injuries in Durban. East Afr Med J 1999; **76**: 676.
126. Nezhat CH, Seidman DS, Nezhat F et al: Laparoscopic management of intentional and unintentional cystotomy. J Urol 1996; **156**: 1400.
127. Deleyiannis FW, Clavijo-Alvarez JA, Pullikkotil B et al: Development of consensus guidelines for venous thromboembolism prophylaxis in patients undergoing microvascular reconstruction of the mandible. Head Neck 2011; **33:** 1034.
128. Alli MO, Singh B, Moodley J et al: Prospective

evaluation of combined suprapubic and urethral catheterization to urethral drainage alone for intraperitoneal bladder injuries. J Trauma 2003; **55:** 1152.
129. Volpe MA, Pachter EM, Scalea TM et al: Is there a difference in outcome when treating traumatic intraperitoneal bladder rupture with or without a suprapubic tube? J Urol 1999; **161**: 1103.
130. Thomae KR, Kilambi NK and Poole GV: Method of urinary diversion in nonurethral traumatic bladder injuries: retrospective analysis of 70 cases. Am Surg 1998; **64**: 77.
131. Elgammal MA: Straddle injuries to the bulbar urethra: management and outcome in 53 patients. Int Braz J Urol 2009; **35**: 450.
132. Mouraviev VB, Coburn M, Santucci RA: The treatment of posterior urethral disruption associated with pelvic fractures: comparative experience of early realignment versus delayed urethroplasty. J Urol 2005; **173:** 873.
133. Jeong SH, Park SJ and Kim YH: Efficacy of urethral catheterisation with a hydrophilic guidewire in patients with urethral trauma for treating acute urinary bladder retention after failed attempt at blind catheterisation. Eur Radiol 2012; **22**: 758.
134. Chung PH, Wessells H, Voelzke BB. Updated outcomes of early endoscopic realignment for pelvic fracture urethral injuries at a level 1 trauma center. Urology 2018; **112**: 191.
135. El Darawany HM: Endoscopic urethral realignment of traumatic urethral disruption: A monocentric experience. Urol Ann 2018; **10**: 47.
136. Light A, Gupta T, Dadabhoy M et al: Outcomes Following Primary Realignment Versus Suprapubic Cystostomy with Delayed Urethroplasty for Pelvic Fracture-Associated Posterior Urethral Injury: A Systematic Review with Meta-Analysis. Curr Urol 2019; **13**: 113.
137. Tausch TJ, Morey AF, Scott JF et al: Unintended negative consequences of primary endoscopic realignment for men with pelvic fracture urethral injuries. J Urol 2014; **192**: 1720.
138. Mayher BE, Guyton JL and Gingrich JR: Impact of urethral injury management on the treatment and outcome of concurrent pelvic fractures. Urology 2001; **57**: 439.
139. Onen A, Ozturk H, Kaya M et al: Long-term outcome of posterior urethral rupture in boys: a comparison of different surgical modalities. Urology 2005; **65**: 1202.
140. Follis HW, Koch MO and McDougal WS: Immediate management of prostatomembranous urethral disruptions. J Urol 1992; **147**: 1259.
141. Guille F, Cippola B, el Khader K et al: Early endoscopic realignment for complete traumatic rupture of the posterior urethra--21 patients. Acta Urol Belg 1998; **66**: 55.
142. Kotkin L and Koch MO: Impotence and incontinence after immediate realignment of posterior urethral trauma: result of injury or management? J Urol 1996; **155**: 1600.
143. Moudouni SM, Patard JJ, Manunta A et al: Early endoscopic realignment of post-traumatic posterior urethral disruption. Urology 2001; **57**: 628.
144. Ku J, Kim ME, Jeon YS et al: Management of bulbous urethral disruption by blunt external trauma: the sooner, the better? Urology 2002; **60**: 579.
145. Gong IH, Oh JJ, Choi DK et al: Comparison of immediate primary repair and delayed urethroplasty in men with bulbous urethral disruption after blunt straddle injury. Korean J Urol 2012; **53**: 569.
146. Ekeke ON, Eke N: Fracture of the penis in the Niger Delta Region of Nigeria. J West Afr Coll Surg 2014; **4**: 1.
147. Khan ZI: Management of penile fracture and its outcome. J Coll Physicians Surg Pak 2013; **23**: 802.
148. Ozorak A, Hoscan MB, Oksay T et al: Management and outcomes of penile fracture: 10 years' experience from a tertiary care center. Int Urol Nephrol 2014; **46**: 519.
149. Gedik A, Kayan D, Yamis S et al: The diagnosis and treatment of penile fracture: our 19-year experience. Ulus Travma Acil Cerrahi Derg 2011;**17**: 57.
150. el-Assmy A, el-Tholoth HS, Mohsen T et al: Does timing of presentation of penile fracture affect outcome of surgical intervention? Urology 2011; **77**: 1388.
151. Athar Z, Chalise PR, Sharma UK et al: Penile fracture at Tribhuvan University Teaching Hospital: a retrospective analysis. Nepal Med Coll J 2010; **12**: 66.
152. Ibrahiem el HI, el-Tholoth HS, Mohsen T et al: Penile fracture: long-term outcome of immediate surgical intervention. Urology 2010; **75**: 108.
153. Nawaz H, Khan M, Tareen FM et al: Penile fracture: presentation and management. J Coll Physicians Surg Pak 2010; **20**: 331.
154. Restrepo JA, Estrada CG, Garcia HA et al: Clinical experience in the management of penile fractures at Hospital Universitario del Valle (Cali--Colombia). Arch Esp Urol 2010; **63**: 291.
155. Agarwal MM, Singh SK, Sharma DK et al: Fracture of the penis: a radiological or clinical diagnosis? A case series and literature review. Can J Urol 2009; **16**: 4568.
156. El Atat R, Sfaxi M, Benslama MR et al: Fracture of the penis: management and long-term results of surgical treatment. Experience in 300 cases. J Trauma 2008; **64**: 121.
157. Lee SH, Bak CW, Choi MH et al: Trauma to male

genital organs: a 10-year review of 156 patients, including 118 treated by surgery. BJU Int 2008; **101**: 211.
158. El-Bahnasawy MS and Gomha MA: Penile fractures: the successful outcome of immediate surgical intervention. Int J Impot Res 2000; **12**: 273.
159. Dincel C, Caskurlu T, Resim S et al: Fracture of the penis. Int Urol Nephrol. 1998; **30**: 761
160. Nasser TA and Mostafa T: Delayed surgical repair of penile fracture under local anesthesia. J Sex Med 2008; **5**: 2464.
161. Hinev A: Fracture of the penis: treatment and complications. Acta Med Okayama 2000; **54**: 211.
162. Pandyan GV, Zaharani AB and Al Rashid M: Fracture penis: an analysis of 26 cases. ScientificWorldJournal. 2006; **6**: 2327.
163. Beysel M, Tekin A, Gurdal M et al: Evaluation and treatment of penile fractures: accuracy of clinical diagnosis and the value of corpus cavernosography. Urology 2002; **60**: 492.
164. Moreno Sierra J, Garde Garcia H, Fernandez Perez C et al: Surgical repair and analysis of penile fracture complications. Urol Int 2011; **86**: 439.
165. Kochakarn W, Viseshsindh V and Muangman V: Penile fracture: long-term outcome of treatment. J Med Assoc Thai 2002; **85**: 179.
166. Shelbaia AM, Fouad T, Ibrahim H et al: Limited experience in the early management of fractured penis. J. Emerg. Med., Trauma Acute Care 2008; **8**: 97.
167. Cavalcanti AG, Krambeck R, Araujo A et al: Management of urethral lesions in penile blunt trauma. Int J Urol 2006; **13**: 1218.
168. Koifman L, Barros R, Junior RA et al: Penile fracture: diagnosis, treatment and outcomes of 150 patients. Urology 2010; **76**: 1488.
169. Dell'Atti L: The role of ultrasonography in the diagnosis and management of penile trauma. J Ultrasound 2016; **19**: 161.
170. Turkay R, Yenice MG, Aksoy S et al: Contribution of MRI to clinically equivocal penile fracture cases. Ulus Travma Acil Cerrahi Derg 2016; **22**: 549.
171. Al-Ghazo MA, Ghalayini IF, Matani YS et al: Immediate surgical repair of penile fracture: Experience in 14 cases. Jordan Med J 2009; **43**: 274.
172. Khan RM, Malik MA, Jamil M et al: Penile fracture: experience at Ayub Teaching Hospital. J Ayub Med Coll Abbottabad 2008; **20**: 49.
173. Wang CN, Huang CH, Chiang CP et al: Recent experience of penile fracture (1989-1993). Gaoxiong Yi Xue Ke Xue Za Zhi 1995; **11**: 654.
174. El-Assmy A, El-Tholoth HS, Mohsen T et al: Long-term outcome of surgical treatment of penile fracture complicated by urethral rupture. J Sex Med 2010; **7**: 3784.
175. Ghilan AM, Al-Asbahi WA, Ghafour MA et al: Management of penile fractures. Saudi Med J 2008; **29**: 1443.
176. Park JS and Lee SJ: Testicular injuries-efficacy of the organ injury scale developed by the American Association for the Surgery of Trauma. Korean J Urol 2007; **48**: 61.
177. Buckley JC, McAninch J: Use of ultrasonography for the diagnosis of testicular injuries in blunt scrotal trauma. J Urol 2006; **175**: 175.
178. Guichard G, El Ammari J, Del Coro C et al: Accuracy of ultrasonography in diagnosis of testicular rupture after blunt scrotal trauma. Urology 2008; **71**: 52.
179. Altarac S: Management of 53 cases of testicular trauma. Eur Urol 1994; **25**: 119.
180. 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.
181. Mohr AM, Pham AM, Lavery RF et al: Management of trauma to the male external genitalia: the usefulness of American Association for the Surgery of Trauma organ injury scales. J Urol 2003; **170**: 2311.
182. 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:** 546.
183. Gomes CM, Ribeiro-Filho L, Giron AM et al: Genital trauma due to animal bites. J Urol 2001; **165**: 80.
184. Jeong JH, Shin HJ, Woo SH et al: A new repair technique for penile paraffinoma: bilateral scrotal flaps. Ann Plast Surg 1996; **37**: 386.
185. Damle, R.N. et al. Tunica vaginalis pedicle flap for repair of ruptured testis: A single-center experience with four patients. Journal of Pediatric Urology 2017; **13**: 519.
186. Abel NJ, Klaassen Z, Mansour EH et al: Clinical outcome analysis of male and female genital burn injuries: a 15-year experience at a level-1 burn center. Int J Urol 2012; **19**: 351.
187. Abdel-Razek SM: Isolated chemical burns to the genitalia. Ann Burns Fire Disasters 30 2006; **19:** 148.
188. Angel C, Shu T, French D et al: Genital and perineal burns in children: 10 years of experience at a major burn center. J Pediatr Surg 2002; **37**: 99.
189. Bangma CH, van der Molen ABM, Boxma H: Burns to the perineum and genitals — management, results and function of the thermally injured perineum in a 5-year-review. European Journal of Plastic Surgery 1995; **18**: 111.
190. Chang AJ and Brandes SB: Advances in diagnosis and management of genital injuries. Urol Clin North Am 2013; **40**: 427.
191. 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.
192.Michielsen DP and Lafaire C: Management of genital burns: a review. Int J Urol 2010; 17: 755.
193.Michielsen D, Van Hee R, Neetens C et al: Burns to the genitalia and the perineum. J Urol 1998; **159**: 418.
194.Peck MD, Boileau MA, Grube BJ et al: The management of burns to the perineum and genitals. J Burn Care Rehabil 1990; **11**: 54.
195.Tiengo C, Castagnetti M, Garolla A et al: High-voltage electrical burn of the genitalia, perineum, and upper extremities: the importance of a multidisciplinary approach. J Burn Care Res 2011; **32**: e168.
196.van der Horst C, Martinez Portillo FJ, Seif C et al: Male genital injury: diagnostics and treatment. BJU Int 2004; **93**: 927.
197.McDougal WS, Peterson HD, Pruitt BA et al: The thermally injured perineum. J Urol 1979; 121: 320.
198.Wessells H and Long L: Penile and genital injuries. Urol Clin North Am 2006; **33**: 117.
199.Chen SY, Fu JP, Wang CH et al: Fournier gangrene: a review of 41 patients and strategies for reconstruction. Ann Plast Surg 2010; **64**: 765.
200.Dryden MS: Complicated skin and soft tissue infection. J Antimicrob Chemother 2010; 65: iii35.
201.Kobayashi S: Fournier's gangrene. Am J Surg 2008; **195**: 257
202.Hudak SJ and Hakim S: Operative management of wartime genitourinary injuries at Balad Air Force Theater Hospital, 2005 to 2008. J Urol 2009; **182**: 180.
203.Iblher N, Fritsche HM, Katzenwadel A et al: Refinements in reconstruction of penile skin loss using intra-operative prostaglandin injections, postoperative tadalafil application and negative pressure dressings. J Plast Reconstr Aesthet Surg 2012; **65**:1377.
204.Zhao JC, Xian CJ, Yu JA et al: Reconstruction of infected and denuded scrotum and penis by combined application of negative pressure wound therapy and split-thickness skin grafting. Int Wound J 2013; **10**: 407.
205.Senchenkov A, Knoetgen J, Chrouser KL et al: Application of vacuum-assisted closure dressing in penile skin graft reconstruction. Urology 2006; **67**: 416.
206.Weinfeld AB, Kelley P, Yuksel E et al: Circumferential negative-pressure dressing (VAC) to bolster skin grafts in the reconstruction of the penile shaft and scrotum. Ann Plast Surg 2005; **54**: 178.
207.Morris MS, Morey AF, Stackhouse DA et al: Fibrin sealant as tissue glue: preliminary experience in complex genital reconstructive surgery. Urology 2006; **67**: 688.
208.Coskunfirat OK, Uslu A, Cinpolat A et al: Superiority of medial circumflex femoral artery perforator flap in scrotal reconstruction. Ann Plast Surg 2011; **67**: 526.
209.Karsidag S, Akcal A, Sirvan SS et al: Perineoscrotal reconstruction using a medial circumflex femoral artery perforator flap. Microsurgery 2011; **31**: 116.
210.Sen C, Ozgenel Y and Ozcan M: A single tensor fasciae latae musculocutaneous and fascia flap for composite reconstruction of urogenital and groin defect. Br J Plast Surg 2005; **58**: 724.
211.Vyas RM and Pomahac B: Use of a bilobed gracilis myocutaneous flap in perineal and genital reconstruction. Ann Plast Surg 2010; **65**: 225.
212.Winterton RI, Lambe GF, Ekwobi C et al: Gluteal fold flaps for perineal reconstruction. J Plast Reconstr Aesthet Surg 2013; **66**: 397.
213.Lucas PA, Page PRJ, Phillip RD et al: The impact of genital trauma on wounded servicemen: Qualitative study. Injury, Int J. Care Injured 2014; **45**: 825.
214.Soresen MD, Wessells H, Rivara FP et al: Prevalence and predictors of sexual dysfunction 12 months after major trauma: A national study. J Trauma 2008; **65**: 1045.
215.Wilcox SL, Redmond S, Hassan AM: Sexual functioning in military personnel: Preliminary estimates and predictors. J Sex Med 2014; **11**: 2537.
216.Frappell-Cooke W, Wink P, Wood A: The psychological challenge of genital injury. J R Army Med Corps 2013; **159**: 52.
217.Healy MW, Yauger BJ, James AN et al: Seminal vesicle sperm aspiration from wounded warriors. Fertil Steril 2016; **106**: 579.
218.Sharma DM: The management of genitourinary war injuries: A multidisciplinary consensus. J R Army Med Corps 2013; **159**: 57.
219.Sharma DM, Bowley DM: Immediate surgical management of combat- related injury to the external genitalia. J R Army Med Corps 2013; **159**: 18.

Urotrauma Panel, Consultants and Staff

Panel
Allen F. Morey, MD (Chair)
UT Southwestern Medical Center
Dallas, TX

Steve Brandes, MD (Vice Chair)
Washington University Medical Center
Saint Louis, MO

John H. Armstrong, MD, FACS
USF Health Simulation Center
Tampa, FL

Benjamin N. Breyer, MD
University of California, San Francisco
San Francisco, CA

Joshua A. Broghammer, MD
University of Kansas Medical Center
Kansas City, KS

Daniel David Dugi III, MD
Oregon Health and Science University
Portland OR

Bradley A. Erickson, MD
University of Iowa Hospitals and Clinics
Iowa City, IA

Jeff Holzbeierlein, MD (PGC Rep)
Kansas University Medical Center
Kansas City, KS

Steven J. Hudak, MD
UT Southwestern Medical Center
Dallas, TX

Jeffrey H. Pruitt, MD
UT Southwestern Medical Center
Dallas, TX

Richard A. Santucci, MD
Detroit Medical Center
Detroit, MI

Thomas G. Smith III, MD
Baylor College of Medicine
Houston, TX

Hunter Wessells, MD
Harborview Medical Center
Seattle, WA

2020 Amendment Panel
Allen F. Morey, MD (Chair)
UT Southwestern Medical Center
Dallas, TX

Joshua A. Broghammer, MD
University of Kansas Medical Center
Kansas City, KS

Courtney MP Hollowell, MD
Cook County Health
Chicago, IL

Maxim J. McKibben, MD
Atrium Health
Charlottee, NC

Consultants
James T. Reston, PhD, MPH
James Robert White, PhD
Lesley Souter,PhD

Staff
Marybeth Farquhar, PhD, MSN, RN
Abid Khan, MHS, MPP
Erin Kirkby, MS
Leila Rahimi, MHS
Brooke Bixler, MPH
Shalini Selvarajah, MD

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All panel members completed COI disclosures. Relationships that have expired (more than one year old) since the panel's initial meeting, are listed. Those marked with (C) indicate that compensation was received; relationships designated by (U) indicate no compensation was received.

Consultant or Advisor: Jeffrey M. Holzbeierlein: Janssen (C); **Allen F. Morey, MD:** American Medical Systems (C)

Meeting Participant or Lecturer: **Steven B. Brandes, MD:** American Medical Systems (C), Astellas (C); **Jeffrey M. Holzbeierlein, MD:** Janssen (C), Amgen (C); **Allen F. Morey, MD**: American Medical Systems (C), Glaxo Smith Kline (C), Coloplast (C), Pfizer (C) (Expired); **Hunter Wessells, MD:** National Institutes of Health

Scientific Study or Trial: Steven Benjamin Brandes, MD: Allergan (U); **Joshua A. Broghammer, MD:** Trauma Urologic Reconstructive Network (U), **Hunter Wessells, MD:** National Institutes of Health (U)

Other: Joshua A. Broghammer, MD: American Medical Systems (C); **Hunter Wessells, MD:** National Institutes of Health (U)

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Consultant or Advisor: Joshua A. Broghammer, MD: Boston Scientific (C)

Scientific Study or Trial: Joshua A. Broghammer, MD: Trauma Urologic Reconstructive Network (U)

Meeting Participant or Lecturer: **Allen F. Morey, MD:** Boston Scientific (C) ; Coloplast (C)

Peer Reviewers 2013

We are grateful to the persons listed below who contributed to the Urotrauma Guideline by providing comments during the peer review process. Their reviews do not necessarily imply endorsement of the Guideline.

Howard L. Adler, MD, FACS
William W. Bohnert, MD
Jill C. Buckley, MD
Daniel J. Culkin, MD
Branden Glenn Duffey, DO
Michael Louis Eisenberg, MD
Christopher Michael Gonzalez, MD
Tomas L. Griebling, MD, MPH
C. D. Anthony Herndon, MD
Courtney M.P. Hollowell, MD, FACS
Jeff Holzbeierlein, MD
Saqib Javed, MBBS
Jerry Jurkovich, MD
Gerald Patrick Kealey, MD
Kirk A. Keegan III, MD
Ron T. Kodama, MD
Granville Lloyd, MD
Kevin R. Loughlin, MD, MBA
Chris McClung, MD
Jay A. Motola, MD
Jeremy B. Myers MD
Stephen Y. Nakada, MD, FACS
Thomas E. Novak, MD
Andrew C. Peterson, MD
Timothy Martin Phillips, MD
Kevin McVary, MD
Maniyur Raghavendran, MD
Hassan Razvi, MD
Pramod C. Sogani, MD
John T. Stoffel, MD
Ryan Terlecki, MD
Christopher Douglas Tessier, MD
Alex Vanni, MD
J. Stuart Wolf, Jr., MD
Lawrence Yeung, MD

Peer Reviewers 2020

AUA (Board of Directors, Science and Quality Council, Practice Guidelines Committee, Journal of Urology)
John Denstedt, MD
Reza Ghavamian, MD
David A. Ginsberg, MD
David F. Green, MD
Frederick Anthony Gulmi, MD
Blake D. Hamilton, MD
Melissa R. Kaufman, MD
Barry A. Kogan, MD
Kurt McCammon, MD
Kevin T. McVary, MD
Thomas Stringer, MD
Scott K. Swanson, MD
Raju Thomas, MD
James Ulchaker, MD

External Reviewers (Non-AUA Affiliates)
Steven J. Hudak, MD
Hunter Wessells, MD FACS

Public Commenters (Via public notice on AUA website
Jay Simhan, MD
Kirill Shiranov, MD
Karthik Tanneru, MD
Jordan Dimitrakoff, MD

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