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Emergency Management of Renal and Genitourinary Trauma: Best Practices Update

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Abstract

In up to 10% of patients who experience abdominal trauma, renal and urogenital systems will be involved. In polytrauma patients with other potentially life-threatening injuries, renal and genitourinary trauma may be overlooked initially, but a delayed or missed diagnosis of these injuries may result in preventable complications. This review provides a best-practice approach to the diagnosis and management of renal and genitourinary injuries, with an emphasis on the systematic approach needed to identify subtle injuries and avoid long-term urinary sequelae such as hypertension, incontinence, erectile dysfunction, chronic kidney disease, and nephrectomy.

Case Presentations

You've just arrived for a long Saturday overnight when the EMS notification pager goes off. Your first patient is a 23-year-old man who was in an altercation outside a bar. He is intoxicated, has bruises and red marks that look like shoe prints all over his abdomen, flanks, and chest, and tells you it hurts "everywhere." On his right flank, he has a 1- by 2-centimeter wound that he thinks was made by a screwdriver. You put out a trauma page, and in the interim, you wonder: will a urinalysis really help in working up this patient? What kind of special imaging is he going to need? Should I order pre-op labs?"

Into the next trauma bay arrives a 46-year-old woman, also intoxicated, who was the unrestrained and ejected passenger in a high-speed, rollover motor vehicle crash. She is hypotensive and tachycardic. She has a pelvic binder on, with a tense, swollen belly extending above it. During the resuscitation, you notice she is bleeding briskly from her vagina. Your nursing colleague asks if you want a Foley catheter. Should you place one? Do you need to page urology as well as trauma? Is it necessary to alert interventional radiology of this patient's arrival?

Since bad news comes in threes, you are immediately called to a third trauma patient. This one is a 54-year-old man who was in a high-speed motorcycle collision. He is screaming in pain and has an obvious chest wall deformity with crepitus. What he's screaming about, however, is his genitals, making a number of medical students and residents blush. He has a massive hematoma to his perineum and scrotum, a testicle that appears dislocated and free from the scrotal sack, and a deformity to his penile shaft. There is gross blood at the urethral meatus. Where do you begin in assessing this patient's genitourinary trauma? Should you place a suprapubic catheter? Is an ultrasound, CT, or MRI best for fully assessing the extent of his injury and helping your urology colleagues plan for treatment?

Introduction

Worldwide, approximately 250,000 traumatic renal injuries occur annually.[1] The urological organ most commonly injured is the kidney, followed by the testicles and the bladder.[2] Depending on the data set used, renal and genitourinary (GU) trauma is present in 5% to 10% of all abdominal trauma patients.[3-5] Over the last 20 to 30 years, the care of renal and GU injuries has evolved, becoming more conservative and expectant. Advances in military medicine, where 5% of all combat injuries are GU-related, have accelerated the pace of this change and advances in care.[6]

The principles of effective trauma care are to prioritize life- and limb-threatening injuries.[7] Blunt and penetrating trauma that affects the kidneys or other GU organs is rarely isolated, and nearly all patients with penetrating or high-grade blunt abdominal trauma have multiple injured organs.[8,9] As a result, renal, bladder, and other GU injuries can be missed in the rush to contend with emergent interventions.[7,10,11] Indeed, in one case series performed at a specialized trauma center, 20% to 25% of all bladder and urethral injuries associated with pelvic fracture were missed initially.[12]

Patients with GU injuries tend to be sicker than their cohorts without such injuries.[13-15] Missed renal and GU injuries are associated with increased morbidity and mortality.[14,16] Coordinated trauma care, particularly care that takes place in a designated trauma center, reduces the risk of nephrectomy and inpatient mortality in renal trauma.[17] **Table 1** lists potential sequelae of renal and GU injuries.[16,18-20]

Long-term consequences of renal and GU injuries include hypertension, chronic kidney disease, erectile dysfunction, incontinence and voiding issues, hydronephrosis, fistula, recurrent pyelonephritis, and nephrolithiasis.[4,16,21,22] Although hypertension is relatively rare as a late consequence (approximately 5%), it is emblematic of the need to accurately and quickly diagnose these types of injuries to avoid unnecessary morbidity.[23] Recognizing and initiating treatment of these non–life-threatening GU injuries is vital in reducing the incidence of future strictures, impotence and other sexual dysfunction, and incontinence.[24-26] This issue of *Emergency Medicine Practice* will review common and uncommon traumatic GU emergencies and provide a best-practice framework for diagnosis and management.

Critical Appraisal of the Literature

A literature search was performed using PubMed and the services of a medical research librarian using the search terms *kidney trauma, renal trauma, ureteral trauma, bladder trauma, urethral trauma, genital trauma, penile trauma, urological trauma,* and *genitourinary trauma.* A total of 383 articles from 1968 to the present were reviewed. There are no reviews in the Cochrane Database on this topic. We searched the National Guideline Clearinghouse created by the United States Agency for Healthcare Research and

Table 1. Potential Sequelae of Renal and Genitourinary Injuries

- Renal parenchymal scarring
- Stricture
- Thrombosis and ischemia
- Delayed nephrectomy due to bleeding, fistula, or pseudoaneurysm formation
- Urinary leaks and urinomas
- Abscess
- Peritonitis
- Sepsis

Quality (www.guideline.gov). This, in addition to our literature search, yielded 5 core, evidence-based and consensus guidelines, listed in **Table 2**. We also reviewed guidelines by the American Association for the Surgery of Trauma (AAST) organ injury severity system.

The majority of recommendations on this topic are based on retrospective reviews, case studies, and consensus. Well-designed prospective trials are rare in GU trauma.[27] Most articles are case reports, expert opinion pieces, or single-institution retrospective case series. One sizable study randomized penetrating renal trauma patients to direct exploration of the kidney versus early vascular control. This study, and a limited number of large retrospective reviews, are the exception; the rest of the literature is weak.[1,28] One expert, lamenting this dearth of quality literature on GU trauma noted, "Most studies repeat the same old messages/prejudices. One could argue that there has been no major advance in the (early) treatment of urethral trauma since 1757."[29] Although we disagree with that grim assessment of the recent advances in this field, expert consensus is the norm in the literature presented here.

Epidemiology

The incidence of GU trauma is heavily skewed toward young (80% aged < 45 years) and male patients (75% of all patients).[3,35] The kidneys are injured in approximately 5% of all patients admitted with trauma, making them the most frequently injured GU organs, followed by the ureter and bladder.[32] The external genitalia are the most frequently involved GU organs in patients presenting with sports-related injuries.[36]

Non-iatrogenic blunt trauma mechanisms (most commonly from motor vehicle crashes) cause approximately 90% of injuries to the GU tract.[3] The rates of penetrating injury are substantially higher in underdeveloped and urban areas.[32] Only 1% to 3% of penetrating trauma involves the kidneys or GU system, although this number appears to be rising.[5,9] Most penetrating trauma in the United States is the result of gunshot wounds (70%-80%), followed by stabbings.[10] Because the ureter is well-protected from blunt trauma by surrounding structures, it is the only GU organ that is injured more frequently by penetrating mechanisms.[3] Injuries due to sexual encounters comprise a minority of injuries to the GU tract,[37] but these are important to identify in order to screen patients further regarding sexual abuse.

Etiology and Pathophysiology

For a summary of the types of injuries GU organs may sustain, see **Table 3, page 4.**

Kidney and Ureter

The kidneys and ureter are protected by adjacent anatomic structures, but they are suspended from the renal pedicle, without other firm attachments. As a result, blunt trauma to these organs is usually secondary to a rapid deceleration injury as opposed to being from direct trauma. The forces of deceleration can cause a spectrum of injuries to the parenchyma, from contusions to a shattering of the kidney. Additionally, the vascular supply to and from the kidney can be injured, which can lead to necrosis if left untreated.[38]

In contrast to the other GU organs, the main cause of ureteral injury (other than iatrogenic injury) is penetrating trauma. Although it is the least frequently injured GU organ, the ureter is injured

Table 2. Expert Guidelines in Renal and Genitourinary Trauma

Guideline, Year of Last Review	Type of Guideline	Main Recommendations That Impact Emergency Care	Strength of Evidence
American College of Radiology Appropriateness Criteria®: Renal Trauma, 2012[30]	Evidence-based; graded based on literature review	• CT with IV contrast is the gold standard test in blunt and penetrating renal trauma	Strong
American College of Radiology Appropriateness Criteria®: Suspected Lower Urinary Tract Trauma, 2013[31]	Evidence-based; graded based on literature review	• Indications and uses of CT cystogram and retrograde urethrogram in bladder and lower tract trauma	Moderate/strong
Urotrauma: American Urological Association Guideline, 2014[32]	Evidence-based; graded based on literature review	• Imaging indications and selection in GU trauma • Operative intervention versus observation	Moderate/weak
Genitourinary Trauma, Diagnostic Evaluation of, Eastern Association for the Surgery of Trauma, 2003[33]	Evidence-based; graded based on literature review	• Imaging after blunt trauma • Use of CT over IV pyelogram • Use of urinalysis after penetrating trauma	Moderate/weak
European Association of Urology Guidelines on Urological Trauma, 2016[34]	Evidence-based; graded based on literature review	• Initial evaluation and subsequent management of GU trauma	Moderate

Abbreviations: CT, computed tomography; GU, genitourinary; IV, intravenous.

in approximately 5% of penetrating wounds to the abdomen.[3] Penetrating trauma involving the ureter often involves simultaneous hollow viscus and vascular injuries. Ureteral injuries due to blunt trauma are usually seen in conjunction with lumbosacral spine injuries and pelvic fractures, reflecting the extreme force needed to stretch or rupture the walls of the tubular ureter.[39]

Bladder

The spectrum of bladder injuries from blunt trauma ranges from mural contusions to complete rupture, typically resulting from extreme compressive forces on the bladder wall.[40] Ruptures are classified as intraperitoneal and extraperitoneal, with intraperitoneal ruptures occurring at the superior dome of the bladder and extraperitoneal ruptures occurring along the inferior aspect of the bladder. The majority of rupture injuries are intraperitoneal.[32] Pelvic fractures are often found in patients with bladder injuries, and while they typically reflect the extreme force of the trauma causing such an injury, they can also be the direct cause when the bony spicules penetrate the bladder.[40] Intraperitoneal bladder rupture results in urinary extravasation into the peritoneal cavity. Extraperitoneal bladder rupture similarly causes urinary extravasation, but the urine drains into the pelvic cavity.[41]

Table 3. Renal and Genitourinary Organ Injuries

Kidney (See Table 4, page 5)
- Contusion
- Hematoma
- Laceration
- Vascular (renal artery/vein)

Bladder
- Hematoma
- Laceration
- Rupture (Intraperitoneal/ extraperitoneal)

External Genitalia
- Scrotum
  - Contusion
  - Laceration
  - Avulsion
- Penis
  - Laceration (including fracture)
  - Penectomy
- Female genitalia
  - Contusion/hematoma
  - Laceration

Ureter
- Contusion
- Laceration
- Transection
- Avulsion

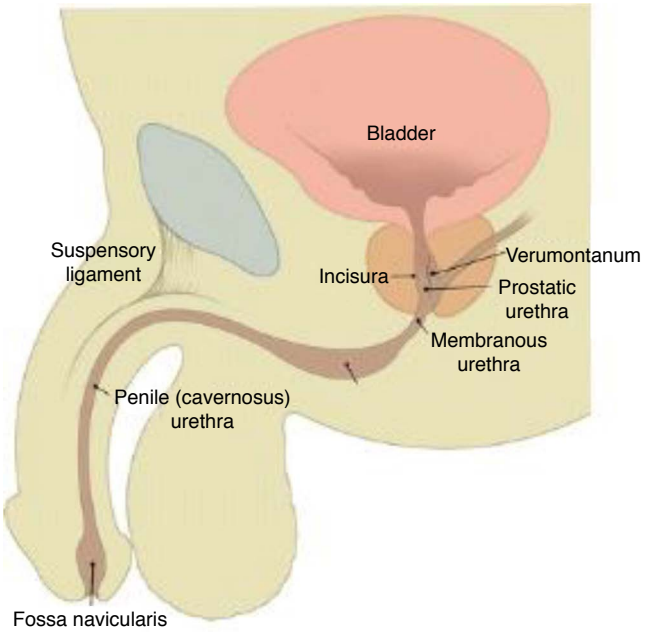
Urethra
- Contusion
- Stretch injury
- Partial disruption
- Complete disruption/ transection

Male Genitalia

The male urethra is divided into the posterior segment (consisting of the prostatic urethra and membranous urethra) and anterior segment (consisting of the bulbous, penile, and glandular urethra). **(See Figure 1.)** It is significantly longer than the female urethra, and thus more likely to be injured.[21] Because of the posterior urethra's proximity to the bladder, injuries to this segment are commonly associated with pelvic fractures and concomitant bladder injuries. Due to its external location in males, the anterior urethra is injured more commonly as a result of penetrating injuries.[3]

Penetrating and blunt mechanisms cause similar numbers of genital injuries in men, but the injuries that require admission most frequently—penile fractures and testicular rupture—are typically due to blunt trauma.[3] Penile fractures occur most often during sexual intercourse as a result of blunt force on an erect penis, causing a rupture of the tunica albuginea, which covers the corpora cavernosa. Urethral injury accompanies penile fracture in approximately 20% of cases.[42] Testicular rupture occurs when extreme blunt forces cause a rupture of the tunica albuginea that covers the individual testicles, causing an extrusion of the seminiferous tubules. Penetrating injuries can cause lacerations, contusions, avulsions, and even amputation of the scrotum or penis. Zipper injuries and burns are other possible causes of trauma.

Figure 1. Anatomy of the Normal Male Urethra



Female Genitalia

Female genital injury may be caused by blunt trauma, and can result in lacerations, hematomas, or significant swelling and disfigurement. In women with genital injury, associated injuries of the urethra can occur and must always be considered.[32]

Differential Diagnosis

A range of injuries can occur for each organ of the GU tract. **Table 3 (page 4)** delineates the types of injuries, by organ, according to the American Association for the Surgery of Trauma.[43,44] The grading of renal injury is especially important with regard to management.[45] The complete grading system can be found in **Table 4** and **Figure 2**.

Prehospital Care

Exsanguination from a severe kidney injury or genital injury can lead to shock. Concomitant injuries are very common and should be managed simultaneously. Pelvic fractures are seen frequently in patients with bladder or urethral trauma, and the use of a pelvic binder can decrease bleeding and aid in clot formation. Placement of a pelvic binder should be strongly considered when performing the patient's primary survey, as there is very little disadvantage to its use.[46]

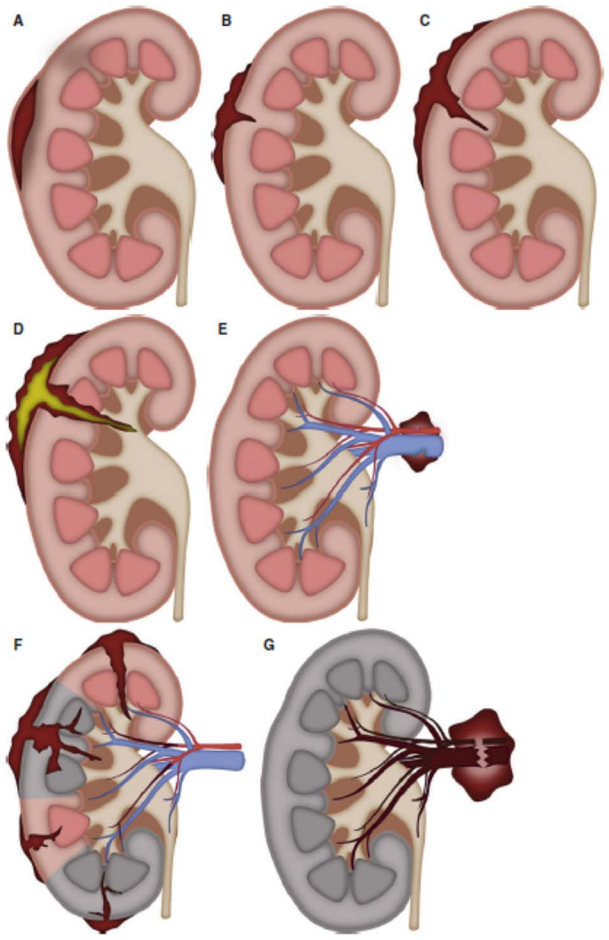
Obtaining history regarding the nature of the trauma can be very helpful in diagnosing and managing these patients, if this is possible to do without causing delays in transport; however, the unstable patient should be transferred expeditiously to a care facility with trauma capabilities. Isolated injuries to the GU tract do not require immediate transport to a trauma center unless the patient is hemodynamically unstable.

Table 4. American Association for the Surgery of Trauma Kidney Injury Scoring Scale

Grade	Type	Description
I	Contusion	Microscopic or gross hematuria. Negative imaging studies.
	Hematoma	Subcapsular and nonexpanding. No parenchymal laceration.
II	Hematoma	Perirenal and nonexpanding. Confined to retroperitoneum.
	Laceration	< 1-cm depth into parenchyma. Spares collecting system.
III	Laceration	> 1-cm depth into parenchyma. Spares collecting system.
IV	Laceration	> 1 cm and involves collecting system with urinary extravasation.
	Vascular	Main renal artery or vein injury with contained hemorrhage.
V	Laceration	Completely shattered kidney.
	Vascular	Avulsion of renal hilum; devascularized kidney.

Ernest E. Moore, Frederick A. Moore. American Association for the Surgery of Trauma Organ Injury Scaling: 50th Anniversary Review Article of *the Journal of Trauma. The Journal of Trauma-Injury Infection & Critical Care. 2010.* Volume 69, Issue 6. Pages 1600-1601. Reprinted with permission of Wolters Kluwer.
DOI: http://dx.doi.org/10.1097/TA.0b013e318201124e

Figure 2. Diagram of The American Association for the Surgery of Trauma Grading System for Renal Injury



A: Grade I, contusion and subcapsular hematoma.
B: Grade II, superficial laceration and perirenal hematoma.
C: Grade III, deep laceration without urinary extravasation.
D: Grade IV, laceration with urinary extravasation.
E: Grade IV, main renal artery or vein injury with contained hemorrhage.
F: Grade V, shattered kidney.
G: Grade V, avulsion of renal hilum that devascularizes the kidney.
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Emergency Department Evaluation

History

The value of a history from conscious patients, witnesses, and EMS personnel cannot be overstated. In blunt trauma, a blow to the flank or rapid deceleration mechanism (eg, high-speed motor vehicle crash or fall from significant height) is suggestive of trauma to the upper GU tract. Rapid deceleration is associated with vascular injury to the kidney, such as avulsion of the vascular pedicle and renal artery thrombosis.[24] Some salient historical features in renal and GU trauma are common to all abdominal trauma: in motor vehicle and motorcycle crashes as well as pedestrians struck, the speed of the vehicle(s) involved and whether the patient was restrained, ejected, or airborne are important considerations. The presence of seatbelt use and airbag deployment is correlated to a decreased rate of nephrectomy in renal trauma patients.[47]

In penetrating injuries, the size of the weapons used in stabbings and the type of gun in gunshot wounds can sometimes help prognosticate the nature and severity of the injury. Penetrating trauma to the lower chest and/or upper abdomen are potential clues to underlying renal or ureteral trauma.[32] The patient's past medical and surgical history is also crucial in assessing for and evaluating renal and GU trauma. Pre-existing structural urologic pathology such as hydronephrosis, tumors, cysts, strictures, or solitary kidneys are highly associated with renal injury after even minor trauma and necessitate a more intensive workup.[34,48,49] Pre-existing renal dysfunction is important to note, given the risk of trauma-associated acute kidney injury from insults such as hypotension, rhabdomyolysis, and contrast-induced nephropathy.[4,32] Pre-existing urologic pathology that would make bladder sensation unreliable, such as a neurogenic bladder disorder, places patients at greater risk for missed injury.[50] Key historical features are summarized in **Table 5**.

Ability to Void, Dysuria, and Hematuria

In the controlled chaos that characterizes the initial evaluation of trauma patients, some historical features and concerning symptoms are easily missed. One example is the inability to void, which is sometimes attributed to pain from other injuries or anxiety. Difficulty voiding and gross hematuria are hallmarks of bladder injury, with the latter seen in nearly all (95%) of the injuries reviewed in a recent case series and consensus statement on the topic.[10,51] A high level of suspicion should be doubled in the presence of a patient with a straddle injury, trauma to the perineum, or pelvic fracture.[24] "Reflex retention" is a real phenomenon seen in lower GU tract trauma, and it can be easily assessed with a bedside ultrasound or bladder scanning machine in patients with or without a urinary catheter in place.[29,51] For patients with delayed presentation, eliciting any instances of dysuria or hematuria is essential in risk stratifying their likelihood of GU injury.[24] Delayed onset of gross hematuria after injury raises the possibility of the rare but potentially life-threatening complication of renal artery pseudoaneurysm.[52]

Physical Examination

Examination findings for patients with GU trauma can be obvious, subtle, or even absent. The patient should be undressed fully in order to identify the location of any penetrating injuries and identify subtle findings, such as perineal ecchymosis, that might indicate a deeper injury. Though it sounds obvious, this is often skipped, and it is the only way to accurately identify genital injuries that occur very commonly with urologic injuries.[53]

The most lethal GU injury—kidney trauma—can exist with minimal to no physical examination findings, especially when it occurs in isolation,[48] highlighting the importance of considering renal trauma in patients with mechanisms that may put them at risk, such as rapid deceleration and direct flank trauma. Physical examination findings that may be seen in patients with blunt renal trauma include left upper quadrant or flank tenderness and ecchymosis, loss of flank contour, and fractured ribs.[38]

Ureteral injuries rarely occur in isolation and, by themselves, do not usually produce any physical examination findings. Injuries to the lumbosacral spine and pelvis following blunt trauma should raise suspicion for ureteral injury.[39] Intraperitoneal bladder rupture can cause abdominal distension and pain due to urinary extravasation, while extraperitoneal bladder rupture is highly associated with pelvic fractures and resultant pain and bruising in the pelvic area.[54]

Blood at the urethral meatus is the most common finding seen with urethral trauma, although genital hematomas, bruising, or swelling can also be seen in these patients.[32] Urethral trauma can also result in the inability to urinate, resulting in bladder distension on physical examination.[55] Pelvic fractures on physical examination should also raise the suspicion for urethral injury. Classically, digital rectal examination has been taught as a method to diagnose urethral transection via a "high-riding"

Table 5. Key Historical Questions in Renal and Genitourinary Trauma

- Blunt trauma: mechanism of injury, restraints (eg, seatbelts), nature of deceleration (height or speed)
- Penetrating trauma: specific type of gun (caliber), dimension of stabbing weapon
- Prior urologic history (eg, hydronephrosis, cysts, etc)
- Prior renal function
- Suprapubic discomfort, hematuria, or dysuria
- Difficulty voiding

prostate, but in a retrospective review by Docimo et al, none of the 7 patients they studied with urethral injuries had the finding on physical examination.[56] Moreover, Ball et al found in a retrospective review that only 1 (2%) of the 41 patients with urethral disruptions had a high-riding prostate on examination.[57] As evidenced, digital rectal examination is not a sensitive enough test to rule out urethral injury, though it is still recommended by the American College of Surgeons in Advanced Trauma Life Support.

Both penile and scrotal injuries can result in tenderness, swelling, ecchymosis, and lacerations. Significant swelling in the scrotum can limit the testicular examination.[58] Penile fractures typically present with significant bruising and swelling and can cause an "eggplant deformity," due to the ecchymotic swelling as well as disruption of the tunica albuginea.[59] **(See Figure 3.)**

Given the high incidence of urologic injury with genital trauma in women, examination under anesthesia should be considered for patients who are not able to tolerate a thorough pelvic examination, but who have concerning findings for genital injury such as labial bruising, bleeding, swelling, or tenderness.[60]

Diagnostic Studies

Urinalysis

Understanding the limitations of the urinalysis in renal and GU trauma is central to clinical decision-making. Urinalysis should be performed on all abdominal trauma patients. If renal or GU injury is suspected, the first spontaneously voided sample of urine is essential to identify hematuria, as this has the highest sensitivity, before fluid administration or diuresis can obscure its presence.[38,61] Offering a urinal or bedpan after initial stabilization can help facilitate this. Hematuria is defined as more than 5 red blood cells seen per high-power field. This is generally ascertainable by urine dipstick, although differing brands may have variable specificity and sensitivity, with a false-negative rate up to 10% reported.[4,62] Differentiating between gross and microscopic hematuria is important, with most experts putting the break point between the two at 30 to 50 red cells per high-power field.[62]

Based exclusively on retrospective data in blunt trauma, gross hematuria is the single best indicator of injury, and can be found in up to 90% of renal injuries.[33] There is a correlation (in blunt trauma only) between the degree of hematuria and the likelihood of intra-abdominal injury not related to the GU system.[33] There is a current expert consensus in blunt abdominal trauma that gross hematuria or microscopic hematuria with hypotension (systolic blood pressure < 90 mm Hg) is an indication for imaging to investigate renal or GU injury.[30,32-34] This was derived from and validated by a number of large prospective and retrospective studies looking at renal trauma patients and their need for imaging.[63-66] Nonetheless, the absence of hematuria is not enough to ensure that no renal or GU injuries are missed. One series of 396 patients with renal injury after a fall found that 21% of patients with Grade II to IV renal injury had no hematuria.[67] The absence of hematuria does not rule out a renovascular injury, with numerous case reports describing a negative urinalysis in patients with complete renal pedicle avulsion, ureteropelvic junction disruption, and other severe injuries.[24,33,68,69] A 25-year case series from San Francisco General Hospital also found that the absence of hematuria was not enough to rule out ureteral injury.[70]

In penetrating trauma, there is no correlation between the amount or even presence of hematuria and the degree of injury.[33,34,71] The American College of Radiology has published guidelines, summarized in **Table 6, page 8,** that aim to strike a balance between the overuse of imaging with any degree of hematuria and missing injuries in patients without hematuria but with a mechanism likely to produce significant renal or GU trauma.[61] This expert consensus recommends CT in patients with 5 to 30 red blood cells per high-power field when there is hypotension or other signs of shock, or other injuries that would require it (eg, a positive FAST [focused assessment with sonography in trauma] examination), which is to say that the hematuria alone does not mandate a CT. It recommends serious consideration of CT imaging without any red blood cells in a urinalysis for a rapid deceleration mechanism (such as a high-speed motor vehicle crash or a fall from a height), direct trauma to the flank (such as a punch or kick) with significant pain and/or ecchymosis to

Figure 3. Eggplant Deformity

Case courtesy of Dr. Praveen Jha, Radiopaedia.org, rID: 25999
Source: https://radiopaedia.org/cases/penile-fracture-2
Used with permission.

the flank area, or adjacent fractures of the ribs or spine. There is little evidence to formally guide clinicians on how to quantify the amount of force to the flank that, even without hematuria or hemodynamic instability, would necessitate a CT.

Baseline Renal Function

Although baseline renal function is assessed almost axiomatically in nearly all trauma patients, this initial creatinine measurement reflects pre-existing renal insufficiency and does not reflect the impact of any renal or GU injury.[34]

Computed Tomographic Imaging

CT imaging is the gold standard in assessing renal and GU trauma. It is more sensitive and specific than intravenous pyelogram (IVP), ultrasound, or angiography. It better detects, localizes, and characterizes the nature of injuries, and concomitant trauma and is particularly useful in evaluating injuries in patients with pre-existing urological structural abnormalities.[34] Because renal and GU injury can be present without hematuria or hemodynamic signs, clinician gestalt based on mechanism of injury and physical examination is essential.[32]

For patients stable enough to go to CT, all expert guidelines recommend an immediate IV-contrasted study. Findings on CT that suggest major renal injury include (but are not limited to) hematoma, urinary extravasation, and lack of contrast enhancement of the renal parenchyma.[72] Because modern helical CT scanners generally obtain images before contrast is excreted in the urine, scans can miss significant injuries to the renal pelvis, collecting system, and ureter.[73,74] In one study of patients with ureteral injury from blunt trauma, conventional CT missed 80% of injuries, and they were only discovered on delayed imaging after complications ensued.[74] In a prospective study by Hardee et al, 33% of patients with high-grade renal injuries had a collecting system injury missed due to the absence of delayed excretory CT images.[75] When there is a high-grade renal injury (grade IV or V), ureteropelvic junction injury, or any concern for ureteral injury based on gestalt or first CT, the addition of approximately 10-minute-delayed CT images of the pelvis should be obtained to look for telltale abnormalities such as extravasation, periureteral urinoma, or a lack of contrast distal to the suspected ureteral injury (Level III/C evidence).[24,32,33,75,76]

The only exception to using IVP over CT is the so-called "single shot" IVP performed perioperatively in unstable patients requiring immediate operation for other injuries, making CT imaging impossible.

Computed Tomographic Cystography

Routine CT of the abdomen is often not enough to detect bladder injury.[14,33] Even clamping the Foley catheter and letting the bladder distend is not sufficient.[77] Morey et al found that, in 53 patients with bladder injury, 100% had hematuria and 85% had pelvic fractures.[50] Numerous other studies found similarly high correlations to hematuria and pelvic fractures.[24] CT cystography is performed when there is gross hematuria or pelvic free fluid without another explanation other than bladder injury and when there are pelvic fractures (other than acetabular fractures) on the initial CT.[14,33,78] **Table 7** lists recommendations for identifying which patients need CT cystography. **Figure 4 (page 9,** ⧉**)** is an example of a positive CT cystogram.

CT cystography and cystography performed in the cystography suite are interchangeable and equally sensitive and specific.[79] The sensitivity of CT cystography in detecting bladder injuries is 78% to 100%.[41,78,80] CT cystography is performed by draining the bladder via Foley catheter, instilling 350 mL of diluted, sterile CT contrast (made with 30 mL of contrast in a 500 mL bag of warmed normal saline) into the bladder by gravity, clamping the Foley or suprapubic tube, and obtaining CT images of the pelvis.[40] There is no need for a subsequent postvoid film.[79]

Table 6. American College of Radiology Guidelines Appropriateness Criteria® for Computed Tomographic Imaging in Renal and Genitourinary Trauma

- Blunt abdominal trauma and gross hematuria (Grade B, clinical studies without randomized controlled trials).
- Blunt abdominal trauma, shock (systolic pressure < 90 mm Hg in the field or during resuscitation), and microscopic hematuria (Grade B).
- Blunt trauma with injuries known to be associated with renal injury such as rapid deceleration, direct contusion to the flank, flank ecchymoses, or fractures of the lower ribs or thoracolumbar spine, regardless of the presence or absence of hematuria (Grade C, expert consensus).
- Penetrating trauma to the upper abdomen or lower thorax regardless of the presence or absence of hematuria (Grade B).

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Table 7. Recommendations for Use of Computed Tomographic Cystography[40,50]

- Gross hematuria or pelvic fluid with pelvic fracture
- Gross hematuria without other injury to explain it
- Microscopic hematuria with pelvic fracture
- Isolated microhematuria with physician concern
- Difficulty voiding or suprapubic pain and any hematuria
- Penetrating injuries of the buttock, pelvis, or lower abdomen with any hematuria

Computed Tomographic Angiography

CT angiography is sometimes performed, generally preoperatively, to localize acute arterial hemorrhage in preparation for surgical repair and/or embolization.[81] CT with or without angiography has been used in some institutions to determine the need for embolization.[82]

Retrograde Urethrogram

A retrograde urethrogram (RUG) should be performed prior to blind insertion of a urinary catheter if there is concern for urethral injury (as suggested by blood at the urethral meatus), pelvic fracture, the inability to urinate, or significant pelvic swelling or ecchymosis. It is performed by gently stretching the penis over the thigh at an oblique angle to radiographically visualize the entire urethra, and performing an x-ray as a scout for comparison. Next, contrast is instilled into the urethral meatus. An abdominal radiograph is then performed to evaluate for contrast extravasation along the course of the urethra, which indicates urethral disruption. If there is complete disruption, the bladder will not fill with contrast. The sensitivity and specificity of RUG are extremely high, and because it can be performed at the bedside, it is superior to CT.[83] **Figure 5** is an example of a positive RUG.

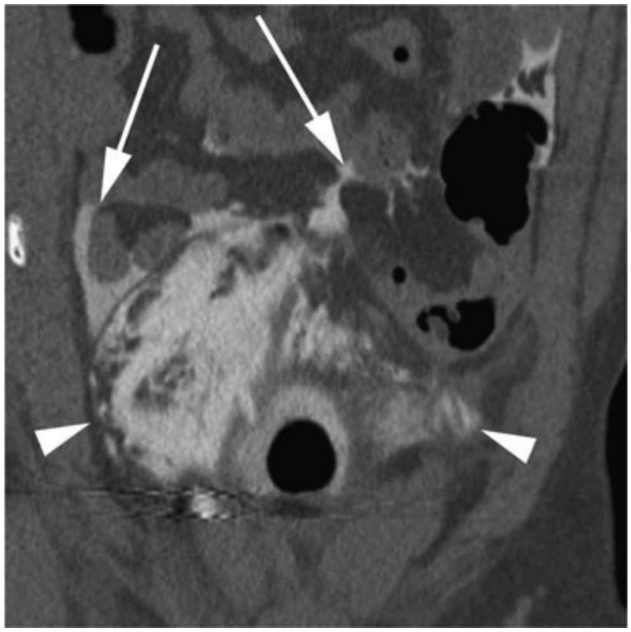
Because urethral injuries are not life-threatening and because the injected contrast can potentially interfere with the interpretation of contrast-enhanced CT scans, RUGs are typically performed in a delayed fashion, but they still can occur in the ED. An abnormal RUG should prompt immediate urology consultation. In the interim, blind passage of a urinary catheter should not be attempted, to limit any further damage to the urethra. If RUG reveals disruption of the urethra and the bladder is markedly distended, suprapubic catheterization can be considered for bladder decompression.[32] If a urinary catheter has already been placed but urethral injury is suspected, a pericatheter RUG can still be performed by introducing a pediatric (4-6 French) catheter beside the urinary catheter into the distal urethra, and then injecting contrast.[84]

Ultrasound

FAST examination via bedside ultrasound can be very helpful in identifying intraperitoneal free fluid, as would occur from intraperitoneal bladder rupture, and it has also been used to identify the site of bladder rupture.[83] However, due to poor sensitivity, it has minimal utility in diagnosing renal parenchymal trauma or retroperitoneal bleeding. CT scanning with IV contrast is typically the imaging modality of choice for traumatic injuries to the upper GU tract.[38]

Formal ultrasound can be obtained to confirm

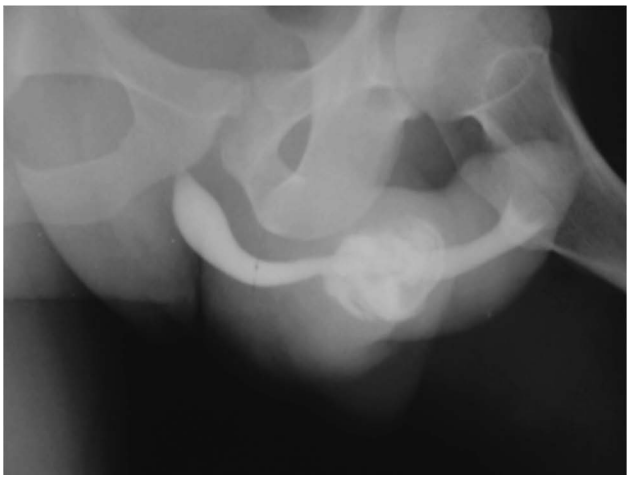
Figure 4. Positive Computed Tomographic Cystogram in a Patient With Penetrating Trauma and Bladder Rupture



Computed tomographic cystogram after penetrating trauma shows extensive contrast around the bladder (white arrowheads) as well as bowel loops and mesenteric folds in the peritoneum (white arrows).

Emergency Radiology. Lower Male Genitourinary Trauma: A Pictorial Review. Volume 21; 2013. Bruce E. Lehnert, Claudia Sadro, Eric Monroe, Mariam Moshiri. © 2013 American Society of Emergency Radiology. With permission of Springer.

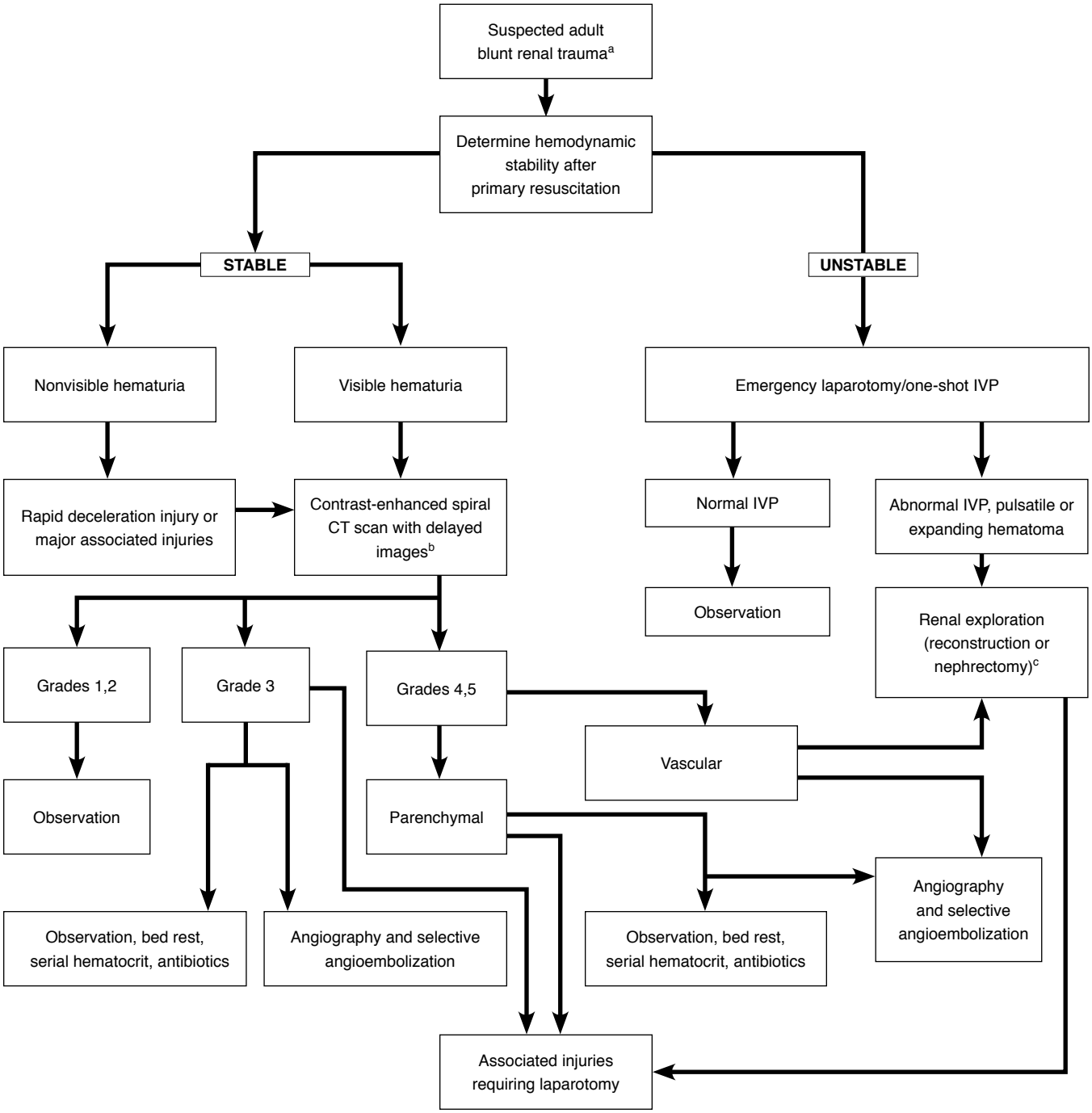
Figure 5. Retrograde Urethrogram Performed in a Patient With a Penile Fracture



Note the contrast extravasation within the penile shaft, indicating a concomitant anterior urethral injury.

Andre Cavalcanti, Renato Krambeck, Alexandre AraÚJo, et al. Management of Urethral Lesions in Penile Blunt Trauma. *International Journal of Urology,* 2006; Volume 13, issue 9. With permission of John Wiley and Sons.

Clinical Pathway for Evaluation of Blunt Renal Trauma in Adults



[a]Suspected renal trauma results from reported mechanism of injury and physical examination.
[b]Renal imaging: CT scans are the gold standard for evaluating blunt and penetrating renal injuries in stable patients. In settings where CT is not available, the urologist should rely on other imaging modalities (IVP, angiography, radiographic scintigraphy, magnetic resonance imaging).
[c]Renal exploration: Although renal salvage is a primary goal for the urologist, decisions concerning the viability of the organ and the type of reconstruction are made during the operation.

Abbreviations: CT, computed tomography; IVP, intravenous pyelogram.

Reprinted with permission of the European Association of Urology. Figure 4.1.1. Available at: http://uroweb.org/guideline/urological-trauma#4

penile fracture (though the diagnosis is typically made clinically) or to evaluate for testicular injury, as it can help distinguish between testicular contusion and rupture. Doppler examination for blood flow within the scrotum can help determine the viability and vulnerability of the tissue.[86]

Treatment

Catheters and Urinary Diversion

Placement of a urinary catheter is often indicated in the care of a trauma patient for monitoring resuscitation and fluid status, as well as logistical reasons in a critically ill, bed-bound patient. It is recommended by the American Urological Association guidelines in many renal and GU injuries such as bladder rupture or straddle injury to the urethra (Grade C evidence, considered "low" quality).[32] In patients with diagnosed or suspected renal and GU trauma, however, this is slightly more complicated.

A common question in the ED is whether to attempt placement of a Foley catheter in patients when there is even the remote possibility of a urethral injury. The question is particularly pertinent in the initial evaluation and resuscitation: Will catheterization make a patient worse, potentially turning a partial tear into a complete perforation? A retrospective study of 46 patients with urethral and bladder trauma seen at the University of California Los Angeles Medical Center found that blind Foley placement was attempted in 91% of patients. They could find no evidence that this attempt worsened the initial injury, including patients with blood at the meatus.[87] In a sweeping review article on the history of urethral trauma, Mundy and Andrich argued that, in the modern era of urinary catheters and antibiotics, a blind attempt at Foley catheterization (with the caveat that adequate confirmation of bladder placement is vital) is unlikely to cause additional harm and is a reasonable approach in a trauma patient that requires one.[29] Despite these studies, blind catheter placement is best avoided, if possible. If it is attempted, it should be noted that successful passage of a Foley catheter does not exclude the possibility of a small or incomplete perforation of the urethra.[33] In a trauma patient, the inability to easily pass a Foley catheter mandates stopping for urethral imaging and either passing a Foley over a guidewire or a suprapubic catheter.[22,29]

Suprapubic Catheterization

Suprapubic catheter insertion is rarely necessary, but may be a consideration in select cases (eg, prolonged immobilization), and some cases of severe bladder, urethral, or genital injury.[51] For patients with a pelvic fracture-associated urethral injury who are going to the operating room or interventional radiology, the recommendation is to place a suprapubic catheter at that time. Likewise, patients with a straddle injury of the anterior urethra are at high risk for a delayed stricture; if a Foley is not possible or advisable, a suprapubic catheter is recommended.[16,32] In bladder trauma, recent studies have found fewer complications and shorter hospital stays with Foley catheters,[14,88] leading consensus guidelines to recommend them preferentially in bladder trauma.[32,89] In anterior or posterior urethral injury, primary surgical repair versus suprapubic catheter with delayed repair is an ongoing area of controversy and is left to the discretion of the urologist.[5,51,78,90] Delayed repair with primary placement of a suprapubic catheter (or sometimes a Foley catheter) is increasingly used as part of a damage-control approach to GU trauma in the polytrauma patient.[91]

Alternative Methods of Urinary Diversion

In some cases of complex trauma, particularly to the upper urinary tract, alternative methods of urinary diversion, such as ureteral stents and/or percutaneous nephrostomy are called for. This is the current expert consensus (evidence grade C) for patients with complications of renal or GU trauma (eg, expanding urinoma, increasing pain, infection), and in those requiring delayed surgical repair.[32] The possible need for such urologic procedures and collaborative planning of care makes involving urology colleagues early in the process highly beneficial. Early, rapid, temporizing urologic intervention to divert urine reduces future complications such as infection, ileus, and chemical peritonitis.[91]

Surgery

Most grade I, II, or III renal injuries due to blunt trauma can be managed nonsurgically, whereas grade IV and V injuries frequently require intervention.[92] It has been shown that performing an explorative laparotomy, however, independently increases the rate of nephrectomy. Therefore, a trend toward more conservative management has led to fewer nephrectomies in patients with significant renal trauma.[93] Ureteral injuries are also commonly treated primarily with stenting, although debridement and primary anastomosis may be required for severe injuries such as complete transection.[39] Intraperitoneal bladder ruptures do not usually heal spontaneously and typically require operative exploration and repair. Extraperitoneal ruptures, on the other hand, can usually be managed by placing a urinary catheter, which promotes bladder rest and healing.[94] Immediate surgical repair of urethral trauma is rarely indicated, but these injuries must eventually be definitively managed surgically to minimize the likelihood of erectile dysfunction, incontinence, and stricture formation.[95]

The 2 most common indications for surgical intervention with genital trauma are penile fracture and testicular rupture, and immediate repair should

always be considered.[3] The goals for surgery in penile fracture are to restore function and cosmesis, but also to evaluate for and treat urethral injuries, which are common.[96] Early intervention for testicular rupture leads to lower rates of testicular necrosis and orchiectomy.[97] Other indications for surgical intervention include large scrotal hematomas, hematoceles, testicular dislocation, scrotal or penile amputation, and female genital injuries such as large hematomas and lacerations.[37,58,98]

Interventional Radiology

As conservative management with resultant lower rates of nephrectomy becomes more popular, interventional radiology has been used with increased frequency in patients suffering from GU trauma, both for diagnostic and therapeutic indications. Diagnostically, angiography can be used to evaluate for continued bleeding. Embolization can then be performed in an attempt to minimize hemorrhage in patients who are hemodynamically stable. Additionally, renal artery and ureteral injuries can be stented to achieve repair.[99]

Admission

Although the management of renal injuries has moved increasingly toward nonoperative and expectant, the consensus on whom to admit has not changed very much. Although institutional practice will vary, expert consensus still supports admitting all renal injuries, even grade I and II.[65,80] Some have suggested that patients with grade I injury without visible hematuria can be discharged home with close follow-up.[100] Trauma patients with higher-grade injuries with anticipated nonoperative management are admitted for bed rest, frequent check of vital signs, serial hematocrit testing, assessment of urine output and degree of hematuria, and potentially repeat CT.[34,72]

To the consternation of practitioners, however, there is wide variation in practice from all fields when it comes to repeat imaging, inpatient monitoring, IV fluids, antibiotics, activity restriction, and need/timeline for follow-up.[100] In terms of fluids, there is no specific recommendation other than that required to maintain adequate urine output.[101] Prophylaxis with antibiotics is often recommended for the renal and GU trauma patient, although there is minimal evidence to support this, most of it grade C (expert consensus).[100,102] The idea is to decrease the incidence of urinary tract infection and perinephric abscess; **Table 8** presents the guidelines recommended in Australia and New Zealand.

It is traditional, and still widely practiced, to prescribe bed rest for patients with renal trauma.[100] The original paper recommending this dates back to 1968 and recommended 3 weeks, with the first week taking place in the hospital.[103] Current guidelines, however, are less conservative, and advocate early return to mobilization.[100] No expert guidelines or literature addresses return to sports or activities after conservatively managed renal or GU injury. Given that 25% of all renal injuries grade III or greater experience a secondary hemorrhage,[102] and that the most common time period in which to experience this is the first 2 weeks, that seems like a minimum reasonable recommendation for patients going home.[100] A standard pediatric recommendation, which could be applied in adults, is 2 to 3 weeks off school and 2 to 3 months off sports.[104]

Special Populations

The Pediatric Patient

Due to anatomic factors, children are at higher risk of sustaining blunt renal injury than adults.[89] In one study, while renal trauma accounted for only 3.5% of pediatric GU injuries, 25.7% of trauma admissions were due to renal trauma.[105] History and physical examination are less reliable in this patient population, as children can have significant renal trauma without gross hematuria or hypotension.[106] The rate of nephrectomies in this population is significantly lower than that in adults, and this is likely due to a lower incidence of major trauma, as well as increased efforts to minimize long-term morbidity by avoiding surgical intervention.[107] The management of ureteral, bladder, and urethral injuries in children is similar to adults, although most authors agree that minimizing unnecessary radiation is important.[89]

Sexual abuse must be considered in any child presenting with a genital injury.[37] If there is a suggestion of genital injury, a complete examination is recommended, often requiring an examination with sedation (or even under anesthesia) in young girls.[60]

Table 8. Antibiotic Prophylaxis and Renal Injury[100]

Consider:

- Patient age, comorbidities, and immunocompromise.
- Fever or risk factors (ischemic segments, significant soft-tissue loss, bowel or pancreatic injury, immunosuppression).
- In the absence of fever or risk factors, grades I, II, and III do not require antibiotics.

In the presence of fever or risk factors:

- Grade IV and V injuries should receive intravenous antibiotics for 48-72 hours and then orally for 5 days.
- Recommended regimens include first-generation cephalosporins, ciprofloxacin, or ampicillin with gentamicin (local resistance taken into consideration).
- Concomitant bowel injury requires additional coverage for gastrointestinal microbes.

The Elderly

The epidemiology of renal and GU trauma in patients aged 65 and older is similar to that of adults under age 65. The kidney, bladder, and urethra are the most frequently injured GU organs. However, given similar mechanisms and injury severity scores, elderly patients tend to have more intensive care unit admissions, longer hospital stays, and a significant increase in mortality when compared to younger adults. These differences are likely secondary to decreased physiologic reserve as well as pre-existing comorbidities.[108]

Controversies and Cutting Edge

Magnetic Resonance Imaging

Although magnetic resonance imaging (MRI) can provide more accurate images when compared to CT, because of cost, time to acquire images, and limited access, MRI is not routinely used to determine the extent of renal and GU injuries. However, MRI may have some utility in patients who have iodinated contrast-dye allergies.[109] MRI has also been used to evaluate penile fractures and scrotal injury. Given that ultrasound can also be used for diagnosis of such injuries, is typically more readily available, and can be performed at the bedside, it is preferred in both instances.[79] MRI is never an appropriate imaging study for an unstable patient, and its utility in patients presenting with renal and GU trauma in the ED is limited.

Nonoperative Management

To reduce the rates of nephrectomy, as well as the morbidity associated with surgical complications, there has been a trend toward more conservative management in blunt renal trauma. Strategies include close observation, the use of interventional radiology for selective embolization, and percutaneous treatments. Despite the use of more conservative therapy, the incidence of complications and death from these injuries has not changed. Surgery remains indicated in renal trauma patients with hypotension, renal pedicle injury, renal artery thrombosis, or urinary extravasation.[1]

Contrast-Enhanced Ultrasound

As previously mentioned, ultrasound carries fairly low sensitivity when diagnosing renal trauma. Contrast-enhanced ultrasound (CEUS) is a newer imaging technique that carries higher accuracy, but it is still inferior to CT scanning. It involves injecting echogenic microbubbles into the circulation, and visualizing the organ in question with ultrasound as the microbubbles enter the parenchyma, causing increased echogenicity. By brightening the parenchyma, discontinuity of the tissue is highlighted. CEUS can be used to diagnose lacerations, hematomas, and even renal hilar avulsion if there is absence of parenchymal enhancement with contrast. The number of microbubbles in the ureter, bladder, and urethra are negligible, making CEUS unhelpful in diagnosing injuries to these organs.[110]

Disposition

Consultation

Any injury to the kidneys, ureter, bladder, or urethra should, at the very least, be discussed with and possibly evaluated by a trauma surgeon and/or urologist while the patient is in the ED. If urology or trauma surgery is not available within the hospital, transfer to a trauma center is appropriate. Most injuries to the upper GU tract do require admission, although a minority of the cases can be safely discharged from the ED provided that they have close follow-up after discussion with a urologist, are hemodynamically stable, and their pain is well controlled. The majority of injuries to the genitals, including superficial lacerations and zipper injuries, do not generally require emergent urologic evaluation. However, crush injuries to the scrotum or penis should be radiologically evaluated via an ultrasound or RUG, respectively, to ensure that the testicles and urethra are not injured. Testicular dislocation, rupture, traumatic torsion, and penile fracture require operative intervention. When in doubt, a specialist should be consulted regarding any injury to the GU tract to ensure proper follow-up.

Urinary Catheter Care

Some patients with anterior urethral injuries can be managed with an indwelling urinary catheter. If a patient has a positive RUG for anterior urethral injury, urology should be consulted to avoid blind catheter placement. Assuming there are no other injuries, these patients can be sent home with an indwelling catheter provided they are able to follow up closely with a urologist and that they understand strict return precautions. The catheter will remain in place until definitive management can occur. Delayed management can lead to strictures, erectile dysfunction, and infection, highlighting the importance of ensuring the patient understands that he or she must follow up promptly with a urologist.

Time- and Cost-Effective Strategies

- **Consider the diagnosis**. Because urologic injuries are rarely life-threatening, diagnoses are frequently delayed, or even missed. If GU trauma is not considered in the patient with abdominal trauma, patients may suffer from significant unnecessary morbidity. Therefore, a high index of suspicion is required. A urinalysis is a very helpful screening tool to send early in any

patient presenting with trauma to the abdomen, lower thorax, or flank, but it is not sufficient to rule out injury. A thorough physical examination as part of the initial secondary survey, including the perineum and genitals, will help to minimize missed diagnoses.

- **Use IV contrast when possible, and delayed images when indicated.** Assuming no contraindications to its use, IV contrast should be used on initial CT scans for trauma to the abdomen, as it not only allows for better visualization of injuries, but can also identify the need for emergent intervention. Extravasation of contrast immediately, or on delayed images, can indicate ongoing hemorrhage or urinary leak, respectively. If CT scans are performed without contrast, repeat imaging with contrast may be needed, which can lead to significant delays, as well as increased cost and radiation to the patient.
- **Involve urology early**. Emergent urology evaluation may be necessary in patients with urethral injury who present with urinary retention and abdominal distention, particularly if the emergency clinician is not experienced and credentialed in placing a suprapubic catheter. Even if the patient presents with a nonemergent condition, however, after an injury to the renal or GU tract has been identified, a urologist can help facilitate appropriate management, disposition, and follow-up. This is particularly true for trauma to the genitalia, where ordering testing and imaging may be unnecessary, and can lead to significant delays when operative intervention is required for exploration and potential repair.

Risk Management Pitfalls for Renal and Genitourinary Trauma

(Continued on page 15)

1. **"I ruled out kidney damage with a normal urinalysis and sent her home. She came back with renal necrosis."**
   While a urinalysis can help risk stratify and identify the severity of some types of renal trauma, a normal urinalysis is not sufficient to rule out the diagnosis. There are many case reports of patients with severe injuries and normal urinalyses, especially in vascular injury and penetrating trauma.

2. **"He only had a little blood at the meatus on examination, so I went ahead and tried to place a Foley."**
   In any patient for whom you have a concern for possible urethral injury, based on history, physical examination, presence of significant pelvic fractures on x-ray, or suspicious findings on initial CT scan, you should perform a RUG prior to attempting placement of a Foley catheter. Without this test, you risk turning a minor urethral injury into a major one.

3. **"Radiology hedged their read on our CT because we did the RUG before he went to CT."**
   The contrast from a RUG can make accurately reading a subsequent CT of the abdomen with IV contrast or a CT cystogram very difficult. Since the placement of a Foley catheter is not emergent, the CT imaging should be performed first before performing a urethrogram to rule out urethral injury.

4. **"I diagnosed her posterior rib fractures with an x-ray after she was hit on the flank. Her belly examination and blood pressure were normal, so I sent her home. She came back with a grade IV renal laceration."**
   Patients presenting with blunt or penetrating trauma to the lower thorax, upper abdomen, or flank should raise your suspicion for underlying renal trauma. Depending on history, mechanism of injury, adjacent injuries (such as vertebral fractures) and presence and degree of hematuria, such presentations may require additional imaging for possible renal injury.

5. **"When we found his pelvic fracture, I called orthopedics and trauma, but I didn't think about a urethral injury."**
   Pelvic fractures (apart from acetabular fractures), are highly correlated to urethral injury. In patients who have difficulty or pain with voiding, or hematuria with a pelvic fracture or trauma to the genitals or pelvis, a urethral injury must be on your differential, even if the patient is admitted and cannot have the definitive test before going upstairs. Depending on the institution, this can mean a RUG performed downstairs, a discussion with trauma surgery/admitting service, or a urology consult.

Summary

Renal and GU trauma occur in 10% of abdominal trauma patients. Injuries to this organ system can be subtle and challenging to diagnose, particularly in polytrauma patients with other life-threatening injuries. Early detection and appropriate treatment can help avoid lifelong morbidity and increased long-term mortality. Given the subtle nature of these injuries, the history and physical examination are important in determining the timing and nature of investigation. Normal urinalysis without hematuria, though sometimes used to reassure practitioners, is not sufficient to rule out renal or GU trauma. Although most adult patients with blunt abdominal trauma will have gross hematuria or hypotension with microscopic hematuria (with notable exceptions), children may not show hemodynamic instability in spite of significant injury. There is growing consensus on the diagnosis and management of these injuries, including a tremendous shift in the last 20 years towards nonoperative and minimally invasive management. Advances in CT and ultrasound imaging have allowed improved detection, prognostication, and long-term management of these patients. CT scan with IV contrast is the gold standard in evaluating for most renal and GU trauma, with the exception of isolated testicular trauma. Nevertheless, some patients will require delayed excretory phase imaging and/or a CT cystogram to adequately diagnose their injury. Most patients with renal or GU trauma will be admitted for further observation, even if stable. Early consultation with a urologist in cases of renal and GU injury is vital in devising an appropriate plan and disposition.

Risk Management Pitfalls for Renal and Genitourinary Trauma

(Continued from page 14)

6. **"I just assumed he couldn't urinate because he was anxious after his car crash and because we gave him fentanyl."**
   Inability to void is common in the setting or lower urinary tract injury. In a setting of abdominal or pelvic trauma, this complaint must be investigated with bladder ultrasound to look for retention and appropriate additional imaging (CT cystogram, RUG, etc) to ensure the inability to void is not masking serious injury. Missed bladder and urethral injury can cause significant lifelong morbidity.

7. **"His scrotum was so swollen and he had so many other injuries from his motorcycle crash, I couldn't have possibly caught his traumatic testicular torsion."**
   Renal and GU trauma is rarely the "main event" in the sick polytrauma patient. ATLS guidelines, with good reason, mandate dealing with the life-threatening injuries first. However, genital trauma with marked physical examination abnormalities can and should be addressed on secondary or tertiary examination, with a plan in place for additional imaging, such as ultrasound, and appropriate subspecialty consultation. The time-sensitive nature of some genital trauma makes this especially important.

8. **"I assumed he had a penile fracture, but he was able to void, so I sent him home with pain medicine and a plan to see urology in the clinic in 1 to 2 days."**
   Penile fracture, most commonly caused by trauma sustained during sexual intercourse, is a surgical emergency no matter how severe it appears on physical examination or the patient's ability to void. Although urethral injury is a concern, repairing the underlying defect in the tunica albuginea is also essential for future sexual function and cosmesis.

9. **"We got a stat CT of the abdomen and pelvis when we saw the flank bullet exit wound, but we missed the ureteral injury because of how we ordered it."**
   Ureteral injuries are uncommon in general, but they are most commonly seen in penetrating trauma. A regular CT of the abdomen with IV contrast is not timed to catch most ureteral injuries. When the path of the projectile or stabbing implement, based on history or physical examination, is near a ureter or the kidney, delayed excretory images performed roughly 10 minutes after contrast administration are required.

10. **"We called trauma when we saw the shattered kidney. When her FAST was positive and her pressure dropped, she went straight upstairs. Urology complained the next day."**
    Although in most institutions the management of critically ill trauma patients is primarily dictated by the ED and their trauma surgery consultants, any high-grade renal or GU injury benefits from early involvement of a urologist. Ideally, they are involved in the initial operative intervention to help with urinary diversion and lend their expertise in renal salvage.

Case Conclusions

The young man who was shanked with a screwdriver was rapidly resuscitated after he was found on primary survey to have a blood pressure of 85/49 mm Hg. He had a negative extended FAST exam. His urinalysis, surprisingly, was normal. After a rapid infusion of blood products, you and your trauma colleagues agreed he was stable enough for CT of the abdomen and pelvis with IV contrast. While he was transported, you called a stat urology consult. His initial scan showed a grade IV renal injury on the side of his penetrating trauma and possible stranding adjacent to that ureter. With close monitoring, you obtained 10-minute-delayed images that confirmed a ureteral injury with extravasation. He was taken to the OR with trauma and urology for continued hemorrhage from concomitant injuries, where he underwent primary repair of his ureteral injury as well.

For the woman in the motor vehicle crash, you paged trauma stat while beginning to resuscitate and evaluate her. You asked your nurse to defer attempting to place a Foley at this time due to concern for possible urethral injury caused by a presumed pelvic fracture. You knew a catheter would have to be inserted eventually, whether Foley or suprapubic catheter, but that her hemodynamic status came first. You carefully performed a vaginal examination, with full visualization before palpation to avoid lacerating your finger on any bony fragments. You appreciated a vaginal laceration adjacent to her urethra. While her extended FAST was in progress, you put out pages to interventional radiology for possible embolization of pelvic vessels and to urology, given your concern for lower urinary tract injury. Her positive extended FAST and continued hypotension sent her to the OR with trauma emergently. Because of the nature of her pelvic fractures, urology performed both a RUG and one-shot IVP before placing a suprapubic catheter.

After providing some pain-dose ketamine for your motorcycle crash patient, you continued with his primary survey. He was intubated for continuing respiratory distress and a chest tube was inserted on his left. His dislocated testicle was covered in moist, sterile gauze. This alone was a surgical urological emergency, so you placed a page to the urologist. The patient's penile shaft deformity was concerning for a penile fracture, which you knew was also a surgical emergency. You deferred performing a RUG out of concern for exacerbating his penile injury, and held off on attempting to pass a Foley. You discussed placing an ultrasound-guided suprapubic catheter with the urology consultant, but as she was 5 minutes away, you agreed to wait. In lieu of testicle ultrasound, the urologist planned to take him to the OR once he was cleared by trauma surgery.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study is included in bold type following the reference, where available. In addition, the most informative references cited in this paper, as determined by the authors, are noted by an asterisk (*) next to the number of the reference.

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1. The most frequently injured genitourinary (GU) organ from blunt trauma is the:
a. Kidney
b. Bladder
c. Urethra
d. Scrotum

2. Injury to what part of the GU tract is more commonly due to penetrating trauma, as opposed to blunt trauma?
a. Bladder
b. Ureter
c. Posterior urethra
d. Kidney

3. Which of the following historical elements is most sensitive in detecting bladder rupture?
a. Suprapubic discomfort
b. Decreased urine output
c. Inability to void
d. Gross hematuria

4. Gross hematuria is defined at a baseline of how many red blood cells per high-power field?
a. 5
b. 10
c. 30
d. 100

5. Which of the following findings on initial CT scan of the abdomen in a blunt trauma patient requires delayed excretory images 10 minutes after the administration of contrast?
a. Acetabular fracture
b. Grade III renal injury
c. Ureteropelvic junction hematoma
d. Anterior urethral disruption

6. A patient suffering blunt abdominal trauma complains of suprapubic pain and has gross hematuria. Initial CT of the abdomen and pelvis with IV contrast is normal. What is the best way to determine whether she has a bladder injury?
a. Instill dilute contrast in the bladder and perform a CT.
b. Clamp a Foley catheter, let her bladder distend, and perform a CT.
c. Wait 10 minutes after her initial IV contrast bolus and perform a CT.
d. Send her back for arterial phase contrast and perform a CT.

7. **A 37-year-old man presents with penile pain that occurred during sexual intercourse, and is found to have significant ecchymosis and swelling of the penis. He is unable to urinate, and physical examination reveals blood at the urethral meatus. Which of the following is inappropriate?**
   a. Blind insertion of a urinary catheter to decompress the bladder
   b. Contacting urology immediately
   c. Providing analgesia
   d. Placing a suprapubic catheter

8. **Regarding retrograde urethrography (RUG), which statement is FALSE?**
   a. It cannot be performed if a urinary catheter is already in place.
   b. It can be performed by an emergency physician.
   c. A scout image is typically obtained first.
   d. A lack of contrast entering the bladder suggests urethral transection.

9. **Which of the following diagnoses requires immediate operative intervention?**
   a. Grade III renal laceration
   b. Bladder injury with gross hematuria
   c. Testicular rupture
   d. Ureteral injury with gross hematuria

10. **A 45-year-old man with no other past medical or surgical history sustains an isolated grade II renal injury after a fall from standing. He has no fever. What antibiotic regimen is recommended?**
   a. No antibiotics are indicated
   b. Cephalexin for 5 days
   c. Ciprofloxacin for 5 days
   d. Ceftriaxone IV for 2 days and then cephalexin for 5 days

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