American College of Radiology
ACR Appropriateness Criteria®
Penetrating Trauma-Abdomen and Pelvis

Variant: 1 Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CTU without and with IV contrast	Usually Appropriate	☢☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
US kidneys and bladder retroperitoneal	Usually Not Appropriate	O
Radiography intravenous urography	Usually Not Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
MRU without IV contrast	Usually Not Appropriate	O

Variant: 2 Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Fluoroscopy retrograde urethrography	Usually Appropriate	☢☢☢
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT pelvis with bladder contrast (CT cystography)	Usually Appropriate	☢☢☢☢
Fluoroscopy voiding cystourethrography	May Be Appropriate (Disagreement)	☢☢
Fluoroscopy retrograde cystography	May Be Appropriate (Disagreement)	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT pelvis with IV contrast	May Be Appropriate	☢☢☢
CT pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	☢☢☢☢
CT pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
CTU without and with IV contrast	May Be Appropriate (Disagreement)	☢☢☢☢
US pelvis (bladder and urethra)	Usually Not Appropriate	O
Radiography intravenous urography	Usually Not Appropriate	☢☢☢
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
MRI pelvis without and with IV contrast	Usually Not Appropriate	O
MRI pelvis without IV contrast	Usually Not Appropriate	O
MRU without and with IV contrast	Usually Not Appropriate	O
MRU without IV contrast	Usually Not Appropriate	O

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Summary of Literature Review

Introduction/Background

Upper and lower urinary tract injuries are most commonly the result of blunt trauma, but can also result from penetrating or iatrogenic trauma [1]. Urinary tract injury that is due to blunt trauma is discussed in the separate ACR Appropriateness Criteria topic on "Major Blunt Trauma" [2]. Clinical findings in a patient with penetrating trauma to the upper urinary tract include wounds to the flanks, lower back, upper abdomen or pelvis, or gross hematuria [1].

Renal injuries: Renal injuries are the most common genitourinary injury, occurring in up to 5% of trauma victims (though most of these mechanisms are blunt). Penetrating renal injury may result in renal lacerations, hematomas, active bleeding, and/or extravasation of urine. Management of traumatic renal injuries has shifted from operative to nonoperative management due to the recognition that operative management frequently results in nephrectomy [3].

Ureteral injuries: Penetrating ureteral injuries are rare due to the small size of the ureters and their proximity to osseous and muscular structures, which protect them from injury. Although a majority of ureteral injuries are iatrogenic in nature, ureteral injuries do account for 1% to 2.5% of urinary tract traumatic injuries, with gunshot wounds being the leading cause of penetrating trauma. Ureteral injuries are associated with complex multisystem trauma and are often diagnosed by exploratory laparotomy [1, 4].

Bladder injuries: Bladder injuries have been reported to occur in 1.6% of patients sustaining blunt trauma [5]; however, a bladder injury that is due to penetrating trauma occurs less commonly, although its prevalence is not well known. Penetrating bladder injury may result in extraperitoneal extravasation, intraperitoneal extravasation, or combined extravasation of urine. Penetrating bladder injuries that are apparent clinically are typically treated with emergent exploration and repair [6]. The Consensus Panel of the Société Internationale D'Urologie and the American Association for the Surgery of Trauma (AAST) have separate organ injury severity scales for bladder trauma [7].

Urethral injuries: Most of the contemporary literature concerning urethral injury deals with posterior urethral injuries associated with pelvic fractures, which are most commonly due to motor vehicle accidents [8]. In male patients with suspected penetrating trauma of the urethra, the anterior urethra is most often affected. Penetrating injury to the anterior urethra is typically surgically repaired in the acute setting [5, 6]. Evaluating the degree of disruption of the anterior urethra is an important factor in operative planning. Penetrating posterior urethral injury is treated with immediate exploration via a retropubic approach and primary repair; if coexisting severe injuries preclude direct urethral repair initially, suprapubic diversion with delayed urethroplasty can be performed [6].
Injuries to the male urethra have been traditionally classified into two main categories according to

their mechanism of injury: 1) those associated with a fracture of the anterior pelvic arch (usually involving the membranous urethra) and 2) those occurring as the result of a straddle injury (usually involving the bulbous urethra); both of these types of male urethral injury are more commonly found after blunt trauma, but can also result from penetrating trauma. An alternative classification has been set forth by AAST in which urethral injuries are classified by the treatment required and the degree of urethral disruption, regardless of location. The penile urethra is injured less frequently than the bulbar and membranous segments of the urethra overall; however, the penile urethra is more commonly injured with penetrating trauma because of its entirely external location.

Female urethral injuries are rare and are usually associated with pelvic fracture or vaginal laceration [5, 9, 10]. The rarity of female urethral injury is due to the relatively shorter length, internal location posterior to the osseous pubic arch, relatively increased mobility, and lack of significant attachment to the pubic bone [9, 10]. The European Association of Urology recommends urethroscopy for diagnosis of suspected injury of the female urethra [6, 7].

Special Imaging Considerations

CT urography (CTU) is an imaging study that is tailored to improve visualization of both the upper and lower urinary tracts. Although specific parameters and timing of image acquisition may vary, CTU with and without contrast should include, at the very least, unenhanced images followed by intravenous (IV) contrast-enhanced images in the nephrographic and excretory phases acquired at least 5 minutes after contrast injection. Reconstruction methods commonly include maximum intensity projection or 3-D volume rendering. For the purposes of this document, we make a distinction between CTU and CT abdomen and pelvis without and with IV contrast. CT abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts and without both the precontrast and excretory phases.

MR urography (MRU) is tailored to improve imaging of the urinary system. Although specific parameters and timing of image acquisition may vary, MRU without and with IV contrast should include T2-weighted images as well as precontrast and postcontrast-enhanced T1-weighted series with images acquired during the corticomedullary, nephrographic, and excretory phase. MRU without IV contrast relies upon heavily weighted T2-weighted imaging of the intrinsic high signal intensity from urine for evaluation of the urinary tract. For the purposes of this document, we make a distinction between MRU and MRI abdomen and pelvis without and with IV contrast. MRI abdomen and pelvis without and with IV contrast is defined as any protocol not specifically tailored for evaluation of the upper and lower urinary tracts, without both the precontrast and excretory phases, and without heavily weighted T2-weighted images of the urinary tract.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.

The goal of imaging in patients with suspected penetrating upper urinary tract trauma is to accurately diagnose the extent and location of injuries. This includes identifying renal and ureteral injuries. Patients with suspected penetrating urinary tract trauma benefit from the accurate diagnosis of the extent and location of urinary tract injuries, which is crucial for guiding appropriate clinical management.

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
A. CT abdomen and pelvis with IV contrast

Dane et al [4] states that CT abdomen and pelvis with IV contrast is the reference standard for detecting intraabdominal injuries in patients with penetrating trauma, which is in line with guidelines from the American Urological Association [3], World Society of Emergency Surgery, and AAST [11]. Arterial phase imaging can be used for the detection of vascular injury such as pseudoaneurysm or active extravasation. Portal venous phase imaging can allow for better assessment of the renal parenchyma and extent of injury [12]. Delayed imaging can also contribute to identification of small areas of bleeding.

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

CT abdomen and pelvis without and with IV contrast, separate from a CTU, has limited use in the initial workup of suspected upper urinary tract trauma. The noncontrast phase provides limited evaluation for suspected penetrating injury to the upper urinary tract because of nonopacification of the upper collecting system and lack of enhancement of the pelvic viscera [14]. In patients with hyperdense foreign bodies (eg, bullet fragments), precontrast images may help distinguish those from areas of extravasation or pseudoaneurysms.

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
C. CT abdomen and pelvis without IV contrast

CT abdomen and pelvis without IV contrast provides limited evaluation for suspected penetrating injury to the upper urinary tract because of nonopacification of the upper collecting system and lack of enhancement of the pelvic viscera [14]. However, it may be useful in detecting fluid or hematoma adjacent to the kidneys, prompting a follow-up evaluation with CT with IV contrast. CT abdomen and pelvis without IV contrast may occasionally be used for detection and localization of a foreign body.

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
D. CTU without and with IV contrast

CTU without and with IV contrast is typically a 3-phase examination extending through the entire renal collecting system and including a noncontrast, a nephrogenic phase, and an excretory phase. Collecting system injuries are often not apparent on arterial and portal venous phase imaging. Therefore, excretory phase imaging should be obtained in patients with suspected collecting system injury; excretory phase imaging allows for visualization of contrast outside of the renal pelvis or ureter, confirming the presence and clarifying the extent of injury [12]. Although protocol varies among institutions, recent work from the Multi-institutional Genito-Urinary Trauma Study renal trauma collaborative proposes 9 minutes as the optimal timing of excretory phase images to identify collecting system/ureteral injuries in traumatic injuries [13].

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
E. MRI abdomen and pelvis without and with IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the upper urinary tract. Its use is generally reserved as a secondary problem-solving tool or for specific scenarios [11].

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
F. MRI abdomen and pelvis without IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the upper urinary tract. Its use is generally reserved as a secondary problem-solving tool or for specific scenarios [11].

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
G. MRI abdomen without and with IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the upper urinary tract. Its use is generally reserved as a secondary problem-solving tool or for specific scenarios [11].

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
H. MRI abdomen without IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the upper urinary tract. Its use is generally reserved as a secondary problem-solving tool or for specific scenarios [11].

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
I. MRU without and with IV contrast

There is no relevant literature regarding the use of MRU in the initial evaluation of penetrating trauma to the upper urinary tract. Its use is generally reserved as a secondary problem-solving tool or for specific scenarios [11].

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
J. MRU without IV contrast

There is no relevant literature regarding the use of MRU in the initial evaluation of penetrating

trauma to the upper urinary tract. Its use is generally reserved as a secondary problem-solving tool or for specific scenarios [11].

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
K. Radiography intravenous urography

IV pyelography is substandard compared to CT and should not routinely be performed. There is no recent relevant literature regarding the use of an IV urography in the evaluation of penetrating trauma to the lower urinary tract. A limited role for a modified IV pyelography using delayed abdominal radiography following bedside administration of iodinated contrast, which can give some information about genitourinary system injury, may be pertinent in selected cases and instead is being triaged directly to the operating room.

Variant 1:Adult. Penetrating trauma, abdomen and pelvis. Suspected upper urinary tract trauma. Initial imaging.
L. US kidneys and bladder retroperitoneal

Ultrasound (US) has not been routinely used for evaluating penetrating trauma of the upper urinary tract. It can be used for follow-up of injuries such as hematomas, but is not accurate for assessment of renal lacerations, therefore its use does not preclude the necessity for CT in a hemodynamically stable patient.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.

The goal of imaging in patients with suspected penetrating lower urinary tract trauma is to accurately identify, localize, and characterize injuries to the bladder and urethra to guide appropriate management.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
A. CT abdomen and pelvis with IV contrast

CT abdomen and pelvis with IV contrast is frequently ordered for evaluation of hemodynamically stable patients with penetrating trauma of the abdomen. Without an excretory phase; however, it has a limited role in the detection of urinary extravasation or bladder injuries [4, 11].

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
B. CT abdomen and pelvis without and with IV contrast

CT abdomen and pelvis without and with IV contrast, separate from a CTU, has limited use in the initial workup of suspected lower urinary tract trauma. The noncontrast phase provides limited evaluation for suspected penetrating injury to the lower urinary tract, although in patients with hyperdense foreign bodies (eg, bullet fragments), precontrast images may help distinguish those from areas of extravasation or pseudoaneurysms.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
C. CT abdomen and pelvis without IV contrast

CT abdomen and pelvis without IV contrast provides limited evaluation for suspected penetrating injury to the lower urinary tract because of nonopacification of excretory system [14]. However, it may be useful in detecting fluid or hematoma adjacent to the urinary tract, prompting a follow-up

evaluation with CT with IV contrast, CTU, radiography, or CT cystography. CT abdomen and pelvis without IV contrast may occasionally be used for detection and localization of a foreign body.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
D. CT pelvis with bladder contrast (CT cystography)

The World Society of Emergency Surgery and the AAST recommend either retrograde cystography or CT cystography as the diagnostic procedure of choice for a suspected bladder injury, with Horstman et al [18] finding that both types of imaging examinations equally detected all types of bladder injury in blunt trauma patients. Since urinary contrast leak in the setting of an extraperitoneal bladder injury could obscure active pelvic bleeding, CT cystography should be performed after the initial abdominopelvic contrast-enhanced CT.

Although the data support equal diagnostic performance of both conventional radiographic cystography and CT cystography for bladder assessment, with physician preference and diagnostic protocols generally defining the method used [3, 14], advantages of CT cystography include the ability to diagnose injuries to other pelvic viscera, osseous structures, and vasculature [19], and improved visualization of the specific location of the injury.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
E. CT pelvis with IV contrast

Pelvic CT with IV contrast allows improved assessment of the pelvic viscera and vessels compared with CT without IV contrast. However, evaluation for bladder injury remains limited because of suboptimal distension and nonopacification of the urinary bladder lumen. The use of antegrade cystography, during which the urinary bladder is gradually opacified by excretion of IV contrast, provides inadequate evaluation of bladder injury that is due to suboptimal distension of the bladder lumen, dilution of excreted contrast material by urine, and the time delay required for excretion of IV contrast [3].

This procedure may be useful as an initial triage examination and to evaluate for bladder wall hematoma or indirect evidence of lower urinary tract injury.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
F. CT pelvis without and with IV contrast

Pelvic CT without and with IV contrast is suboptimal compared with CT cystography because of the reasons previously described. Specifically, pelvic CT without and with IV contrast does not provide adequate distension of the bladder, thereby limiting sensitivity for detection of leaks. Additionally, pelvic CT without IV contrast is further limited by lack of enhancement of the pelvic viscera.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
G. CT pelvis without IV contrast

Pelvic CT without IV contrast provides limited evaluation for suspected penetrating injury to the lower urinary tract because of nonopacification of the urinary bladder lumen and lack of enhancement of the pelvic viscera [21]. However, it may be useful in detecting fluid or hematoma adjacent to the urinary bladder, prompting a follow-up evaluation with radiographic or CT

cystography. Pelvic CT without IV contrast may be occasionally considered for evaluation of urethral or periurethral foreign body.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
H. CTU without and with IV contrast

CTU is not a reliable means to diagnose bladder rupture [3]. Although intraperitoneal and extraperitoneal fluid can be detected during excretory phase, and ureteral injuries can be detected with this examination, the etiology of the fluid cannot be determined in bladder injury cases because the bladder is usually inadequately distended to cause extravasation through a laceration or perforation. Although the absence of pelvic fluid is strong evidence against a bladder rupture, a negative study does not exclude bladder injury [22, 23].

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
I. Fluoroscopy retrograde cystography

The diagnosis of bladder rupture is typically straightforward with cystography, whether performed with CT or fluoroscopy. Fluoroscopic cystography has an accuracy rate of 85% to 100% for detecting bladder injury [20]. However, bladder injury can only be excluded when the cystogram is properly performed [15]. Compared with fluoroscopic cystography, CT cystography offers several advantages: evaluation of associated injuries to pelvic viscera, bones, and vasculature, as well as better delineation of the injury site and reduced operator dependence. These features have made CT cystography the preferred approach in most settings.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
J. Fluoroscopy retrograde urethrography

Patients with penetrating trauma to the penis should undergo retrograde urethrography (RUG) as the primary diagnostic procedure because of concern for injury of the anterior urethra [15]. Because posterior urethral injuries can also result from penetrating trauma to the pelvis and perineum, and are associated with pelvic fractures, a RUG should be performed before inserting a catheter [14, 16, 17]. In the past, a diagnosis of acute urethral injury often was based loosely on the clinical triad of 1) blood at the urethral meatus, 2) inability of the patient to void, and 3) a palpable urinary bladder. An inability to pass the catheter into the bladder was also considered diagnostic of a posterior urethral injury. It is now well established; however, that diagnostic catheterization is to be avoided, as it may convert a partial injury into a complete disruption [3, 15]. Penetrating trauma of the female urethra is uncommon because of its anatomy and is typically diagnosed with urethroscopy.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
K. Fluoroscopy voiding cystourethrography

Fluoroscopy voiding cystourethrography can be obtained for evaluation of hemodynamically stable patients with possible urethral injuries, although direct urethroscopy may be considered. In male patients with clinical concern for posterior urethral injury, a RUG should be performed prior to a voiding cystourethrography. Voiding cystourethrography is usually obtained in conjunction with the fluoroscopy retrograde cystography as there is overlap between the clinical presentation of bladder and urethral injuries.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
L. MRI abdomen and pelvis without and with IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the lower urinary tract.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
M. MRI abdomen and pelvis without IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the lower urinary tract.

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
N. MRI pelvis without and with IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the lower urinary tract. MRI has been described for follow-up evaluation of urethral injury as an adjunctive tool for subsequently assessing complex urethral anatomic derangements [25, 26].

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
O. MRI pelvis without IV contrast

There is no relevant literature regarding the use of MRI in the initial evaluation of penetrating trauma to the lower urinary tract. MRI has been described for follow-up evaluation of urethral injury as an adjunctive tool for subsequently assessing complex urethral anatomic derangements [25, 26].

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
P. MRU without and with IV contrast

There is no recent relevant literature regarding the use of an MRU in the initial evaluation of penetrating trauma to the lower urinary tract. Its use is generally reserved for specific scenarios [11].

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
Q. MRU without IV contrast

There is no recent relevant literature regarding the use of an MRU in the initial evaluation of penetrating trauma to the lower urinary tract. Its use is generally reserved for specific scenarios [11].

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
R. Radiography intravenous urography

There is no recent relevant literature regarding the use of an IV urography in the evaluation of penetrating trauma to the lower urinary tract. An IV urography is typically inadequate for evaluating the bladder and urethra after penetrating trauma because the contrast material within the bladder is diluted and the resting intravesical pressure is too low to demonstrate a small

tear [24].

Variant 2:Adult. Penetrating trauma, lower abdomen and pelvis. Suspected lower urinary tract trauma. Initial imaging.
S. US pelvis (bladder and urethra)

US has not been routinely used for evaluating penetrating trauma of the lower urinary tract. It can be used for follow-up of injuries such as active hemorrhage and hematomas but is not accurate for assessment of ureteral or bladder injuries, therefore its use does not preclude the necessity for CT in a hemodynamically stable patient.

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- Variant 1: CT abdomen and pelvis with IV contrast and CTU without and with IV contrast are usually appropriate for the initial evaluation of suspected penetrating upper urinary tract trauma, with CTU providing dedicated excretory phase imaging when collecting system or ureteral injury is suspected.
- Variant 2: Fluoroscopic RUG, CT abdomen and pelvis with IV contrast, and CT pelvis with bladder contrast (CT cystography) are usually appropriate for the initial evaluation of suspected penetrating lower urinary tract trauma. These examinations are complementary, as they assess different components of the lower urinary tract, including the urethra, bladder, and associated pelvic structures, and are frequently used together to fully characterize injury. Fluoroscopic voiding cystourethrography and fluoroscopic retrograde cystography may be appropriate in selected clinical scenarios, particularly in hemodynamically stable patients with suspected urethral or bladder injury. These procedures demonstrated panel disagreement, reflecting variability in clinical practice and institutional preference. When used, they are often performed in conjunction with RUG because of overlap in the clinical presentation of urethral and bladder injuries.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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