

ACR Appropriateness Criteria[®]

Penetrating Trauma-Abdomen and Pelvis: Update 2026

Expert Panel on Urologic Imaging: *Daniel N. Costa, MD^a, Michael Bass, MD^b, Brian C. Allen, MD^c, Baris Turkbey, MD^d, Sarah Ahmad, MD^e, Marielia Gerena, MD^f, Carla Harmath, MD^g, Niels V. Johnsen, MD, MPH^h, Tasneem Lalani, MDⁱ, Susan B. Promes, MD, MBA^j, Lilja B. Solnes, MD, MBA^k, Scott D. Steenburg, MD^l, Ryan D. Ward, MD^m, Pat Whitworth III, MDⁿ, Gaurav Khatri, MD^o*

Abstract

Penetrating urinary tract trauma requires timely imaging to correctly identify the location and extent of injury and guide management. In patients with suspected penetrating upper tract trauma, CT of the abdomen and pelvis with intravenous contrast and CT urography without and with contrast are usually appropriate for initial imaging, with CT urography providing superior evaluation of the collecting system and ureters. CT protocols without dedicated urographic phases may be appropriate in selected circumstances but provide

^aUniversity of Texas MD Anderson Cancer Center, Houston, Texas.

^bResearch Author, University of Texas Southwestern Medical Center, Dallas, Texas.

^cPanel Chair, Duke University Medical Center, Durham, North Carolina.

^dPanel Vice-Chair, National Cancer Institute, National Institutes of Health, Bethesda, Maryland.

^eUniversity of Toronto, Toronto, Ontario, Canada; American College of Physicians.

^fNew York Medical College, Valhalla, New York.

^gUniversity of Chicago, Chicago, Illinois.

^hVanderbilt University Medical Center, Nashville, Tennessee; American Urological Association.

ⁱNew York University Langone Medical Center, New York, New York.

^jPennsylvania State University College of Medicine, Hershey, Pennsylvania; American College of Emergency Physicians.

^kUniversity of Texas Southwestern Medical Center, Dallas, Texas; Commission on Nuclear Medicine and Molecular Imaging.

^lIndiana University School of Medicine and Indiana University Health, Indianapolis, Indiana; Committee on Emergency Radiology, Commission on General, Small, Emergency and/or Rural Practices.

^mCleveland Clinic, Cleveland, Ohio.

ⁿThomas F. Frist, Jr. College of Medicine, Belmont University, Nashville, Tennessee.

^oSpecialty Chair, University of Texas Southwestern Medical Center, Dallas, Texas.

Corresponding author: Daniel N. Costa, MD, University of Texas MD Anderson Cancer Center, Abdominal Imaging Department, 1400 Pressler Street, Unit 1473, Houston, TX 77030; e-mail: dncosta@mdanderson.org.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document. Reprint requests to: publications@acr.org.

Baris Turkbey, MD, reports cooperative research and development agreements with Nvidia and Philips. Niels V. Johnsen, MD, MPH, reports a relationship with Boston Scientific that includes: consulting or advisory. Susan B. Promes, MD, MBA, reports a relationship with the American Board of Emergency Medicine that includes: travel reimbursement; reports a relationship with McGraw-Hill Professional Division that includes: funding grants; reports a relationship with the Society of Academic Emergency Medicine (SAEM) (editor-in-chief for journal, board membership for SAEM Foundation, and Association of Academic Chairs of Emergency Medicine) that includes: board membership, funding grants, and travel reimbursement; reports the funding noted above for McGraw-Hill is royalties and the funding for SAEM is for my role as editor-in-chief for one of SAEM's journals; reports member of the American College of Emergency Physicians Clinical Policies Committee. All other authors state that they have no conflict of interest related to the material discussed in this article.

All authors are non-partner/non-partnership track/employees.

The ACR Appropriateness Criteria documents are updated regularly. Please go to the ACR website at <https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria> to confirm that you are accessing the most current content.

Disclaimer: The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

limited assessment and should not replace CT urography when urinary tract injury is suspected. In patients with suspected penetrating lower tract trauma, fluoroscopic retrograde urethrography, contrast-enhanced CT of the abdomen and pelvis, and CT cystography are usually appropriate and may be complementary, allowing evaluation of the urethra, bladder, and other pelvic structures. Other CT or fluoroscopic examinations may be appropriate in select cases, whereas ultrasound and MRI-based techniques are usually not appropriate for initial evaluation.

The American College of Radiology Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed annually by a multidisciplinary expert panel. The guideline development and revision process support the systematic analysis of the medical literature from peer reviewed journals. Established methodology principles such as Grading of Recommendations Assessment, Development, and Evaluation or GRADE are adapted to evaluate the evidence. The RAND/UCLA Appropriateness Method User Manual provides the methodology to determine the appropriateness of imaging and treatment procedures for specific clinical scenarios. In those instances where peer reviewed literature is lacking or equivocal, experts may be the primary evidentiary source available to formulate a recommendation.

Key Words: Appropriateness Criteria, appropriate use criteria, AUC, clinical decision support, emergency imaging, lower urinary tract injury, penetrating trauma, upper urinary tract injury

J Am Coll Radiol 2026;■:■-■. © 2026 American College of Radiology. Published by Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

ACR Appropriateness Criteria[®] Penetrating Trauma-Abdomen and Pelvis: Update 2026. [Variants 1 to 2](#) and [Tables 1 and 2](#).

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	○
Radiography intravenous urography	Usually Not Appropriate	⊕⊕⊕
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	○
MRI abdomen without and with IV contrast	Usually Not Appropriate	○
MRI abdomen without IV contrast	Usually Not Appropriate	○
MRU without and with IV contrast	Usually Not Appropriate	○
MRU without IV contrast	Usually Not Appropriate	○

Variation 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	○
Radiography intravenous urography	Usually Not Appropriate	⦿⦿⦿
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	○
MRI pelvis without and with IV contrast	Usually Not Appropriate	○
MRI pelvis without IV contrast	Usually Not Appropriate	○
MRU without and with IV contrast	Usually Not Appropriate	○
MRU without IV contrast	Usually Not Appropriate	○

Table 1. 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.

Table 2. Relative radiation level designations

RRL	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
○	0	0
⊕	<0.1	<0.03
⊕⊕	0.1-1	0.03-0.3
⊕⊕⊕	1-10	0.3-3
⊕⊕⊕⊕	10-30	3-10
⊕⊕⊕⊕⊕	30-100	10-30

Note: Relative radiation level (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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “varies.”

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 pre-contrast 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.

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.

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].

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.

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 non-contrast 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.

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.

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.

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].

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].

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].

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].

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].

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 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.

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.

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].

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.

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.

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.

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.

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.

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.

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.

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.

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].

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.

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].

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.

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.

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].

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].

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].

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].

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 [27].

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 2). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [28].

ACKNOWLEDGEMENTS

The ACR is the sole funding source for the ACR AC.

REFERENCES

1. Serafetinides E, Kitrey ND, Djakovic N, et al. Review of the current management of upper urinary tract injuries by the EAU Trauma Guidelines Panel. *Eur Urol* 2015;67:930-6.
2. Shyu JY, Khurana B, Soto JA, et al. ACR Appropriateness Criteria® major blunt trauma. *J Am Coll Radiol* 2020;17:S160-74.
3. Morey AF, Broghammer JA, Hollowell CMP, McKibben MJ, Souter L. Urotrauma guideline 2020: AUA guideline. *J Urol* 2021;205:30-5.
4. Dane B, Baxter AB, Bernstein MP. Imaging genitourinary trauma. *Radiol Clin North Am* 2017;55:321-35.
5. Morey AF, Brandes S, Dugi DD III, et al. Urotrauma: AUA guideline. *J Urol* 2014;192:327-35.
6. Lumen N, Kuehhas FE, Djakovic N, et al. Review of the current management of lower urinary tract injuries by the EAU Trauma Guidelines Panel. *Eur Urol* 2015;67:925-9.
7. Bryk DJ, Zhao LC. Guideline of guidelines: a review of urological trauma guidelines. *BJU Int* 2016;117:226-34.
8. Shenfeld OZ, Gnessin E. Management of urogenital trauma: state of the art. *Curr Opin Urol* 2011;21:449-54.
9. Ingram MD, Watson SG, Skippage PL, Patel U. Urethral injuries after pelvic trauma: evaluation with urethrography. *Radiographics* 2008;28:1631-43.
10. Chapple CR. Urethral injury. *BJU Int* 2000;86:318-26.
11. Cocolini F, Moore EE, Kluger Y, et al. Kidney and uro-trauma: WSES-AAST guidelines. *World J Emerg Surg* 2019;14:54.
12. Schneider RE. Genitourinary trauma. *Emerg Med Clin North Am* 1993;11:137-45.
13. Bock SA, Sampson HA, Atkins FM, et al. Double-blind, placebo-controlled food challenge (DBPCFC) as an office procedure: a manual. *J Allergy Clin Immunol* 1988;82:986-97.
14. Corriere JN Jr, Sandler CM. Diagnosis and management of bladder injuries. *Urol Clin North Am* 2006;33:67-71, vi.
15. Jankowski JT, Spirnak JP. Current recommendations for imaging in the management of urologic traumas. *Urol Clin North Am* 2006;33:365-76.
16. Sandler CM, Hall JT, Rodriguez MB, Corriere JN Jr. Bladder injury in blunt pelvic trauma. *Radiology* 1986;158:633-8.
17. Sandler CM, Goldman SM, Kawashima A. Lower urinary tract trauma. *World J Urol* 1998;16:69-75.
18. Horstman WG, McClennan BL, Heiken JP. Comparison of computed tomography and conventional cystography for detection of traumatic bladder rupture. *Urol Radiol* 1991;12:188-93.
19. Yeung LL, McDonald AA, Como JJ, et al. Management of blunt force bladder injuries: A practice management guideline from the Eastern Association for the Surgery of Trauma. *J Trauma Acute Care Surg* 2019;86:326-36.
20. Carroll PR, McAninch JW. Major bladder trauma: the accuracy of cystography. *J Urol* 1983;130:887-8.
21. Chou CP, Huang JS, Wu MT, et al. CT voiding urethrography and virtual urethroscopy: preliminary study with 16-MDCT. *AJR Am J Roentgenol* 2005;184:1882-8.
22. Hsieh CH, Chen RJ, Fang JF, et al. Diagnosis and management of bladder injury by trauma surgeons. *Am J Surg* 2002;184:143-7.
23. Chan DP, Abujudeh HH, Cushing GL Jr, Novelline RA. CT cystography with multiplanar reformation for suspected bladder rupture: experience in 234 cases. *AJR Am J Roentgenol* 2006;187:1296-302.
24. Bigongiari LR, Zarnow H. Traumatic, inflammatory, neoplastic, and miscellaneous lesions of the bladder. In: Lang EK, ed. *Radiology of the lower urinary tract*. Berlin: Springer; 1994:69-147.
25. Kim B, Kawashima A, LeRoy AJ. Imaging of the male urethra. *Semin Ultrasound CT MR* 2007;28:258-73.
26. Koraitim MM, Reda IS. Role of magnetic resonance imaging in assessment of posterior urethral distraction defects. *Urology* 2007;70:403-6.
27. National Academies of Sciences, Engineering, and Medicine; Division of Behavioral and Social Sciences and Education; Committee on National Statistics; Committee on Measuring Sex, Gender Identity, and Sexual Orientation. Measuring sex, gender identity, and sexual orientation. In: Becker T, Chin M, Bates N, eds. *Measuring sex, gender identity, and sexual orientation*. Washington, DC: National Academies Press; 2022.
28. American College of Radiology. ACR Appropriateness Criteria® radiation dose assessment introduction. Available at: <https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiation-Dose-Assessment-Introduction.pdf>.