American College of Radiology
ACR Appropriateness Criteria®
Minor Blunt Trauma

Variant: 1 Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☢
Radiography rib views	Usually Appropriate	☢☢☢
CT chest with IV contrast	Usually Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
US chest	Usually Not Appropriate	O
MRI chest with IV contrast	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
Bone scan chest	Usually Not Appropriate	☢☢☢
Bone scan ribs	Usually Not Appropriate	☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢
V/Q scan lung	Usually Not Appropriate	☢☢☢

Variant: 2 Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. 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	☢☢☢☢
US abdomen	Usually Not Appropriate	O
Radiography abdomen and pelvis	Usually Not Appropriate	☢☢☢
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CTA abdomen with IV contrast	Usually Not Appropriate	☢☢☢
DMSA renal scan	Usually Not Appropriate	☢☢☢
DTPA renal scan	Usually Not Appropriate	☢☢☢
Liver spleen scan	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis with bladder contrast (CT cystography)	Usually Not Appropriate	☢☢☢☢
CTA abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 3 Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
US abdomen	Usually Not Appropriate	O

Radiography abdomen	Usually Not Appropriate	☢☢
MRI abdomen without and with IV contrast	Usually Not Appropriate	O
MRI abdomen without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CTA abdomen and pelvis with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 4 Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
US abdomen	Usually Not Appropriate	O
Radiography abdomen	Usually Not Appropriate	☢☢
MRI abdomen and pelvis with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT enterography	Usually Not Appropriate	☢☢☢☢

Variant: 5 Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT pelvis with bladder contrast (CT cystography)	Usually Appropriate	☢☢☢☢
Fluoroscopy cystography	May Be Appropriate	☢☢☢
US abdomen	Usually Not Appropriate	O
Radiography abdomen and pelvis	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
Nuclear medicine cystography	Usually Not Appropriate	☢☢
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
DMSA renal scan	Usually Not Appropriate	☢☢☢
DTPA renal scan	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 6 Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
US abdomen	Usually Not Appropriate	O
Fluoroscopy small bowel follow-through	Usually Not Appropriate	☢☢☢

Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢
Radiography abdomen and pelvis	Usually Not Appropriate	☢☢☢
MR enterography	Usually Not Appropriate	O
MRI abdomen and pelvis with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	O
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

Trauma is a common indication for seeking medical treatment including falls, motor vehicle collision (MVC), and assault. Minor blunt trauma can be defined as minor nonfatal injury to a single body part or minor injury with a low-risk mechanism including limited assault, ground-level falls, low-speed MVC, fall from bicycle, and blunt sports injuries. Patients are assumed to be ambulatory without distracting injuries to limit physical examination with normal mental status.

This review covers minor blunt trauma resulting in focal injuries. Penetrating injuries and pediatric and pregnant patients are excluded. Scenarios related to major blunt trauma or polytrauma involving multiple injuries are covered in the ACR Appropriateness Criteria® topic on "Major Blunt Trauma" [1]. Scenarios related to suspected cervical, thoracic, or lumbar spine injury and recommendations for initial imaging are covered in the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [2].

Special Imaging Considerations

The ACR defines practice parameters and technical standards for ultrasound (US) examinations. These US examinations are ordered by clinicians and performed in radiology departments with interpretation by radiologists. For the purposes of this document, the examination, listed on the variant tables and described in the variants below, is the US procedure as defined by the ACR practice parameters and technical standards.

Deviations from these examinations include but are not limited to targeted Point-of-Care US, Focused Assessment with Sonography (FAST), and extended-FAST (E-FAST). These examinations are often performed at bedside as part of a clinical examination, are fundamentally different from comprehensive diagnostic US examinations, and are not performed in the radiology department or interpreted by radiologists.

FAST is often performed in a triage setting by trained personnel at the bedside and consists of scanning of the 4 abdominal quadrants and midline looking for free fluid and the chest for hemopericardium. E-FAST includes assessment of the chest for pneumothorax, pleural effusions/hemothorax, and rib step-off deformities. There is some evidence to suggest FAST can be performed in the prehospital setting and direct management and transport [3,4]. Radiographs are also often performed as a triage tool at many urgent care and primary care settings in addition to the emergency department.

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA) [5]:

"*CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial and/or venous enhancement, depending on the vascular structures to be analyzed. The resultant volumetric data set is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings*."

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs with contrast also include timing issues and reconstructions/reformats. Only in CTA; however, is 3-D rendering a required element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

Modern CT scanner speeds and multiplanar reformations and 3-D reconstruction capability have enabled protocols for both total body scanning for major trauma and focused selective imaging for more specific mechanisms and patient-directed complaints in the setting of minor trauma. These scans are typically performed with a single contrast bolus and can be performed in a single phase or multiphasic and with or without oral contrast material. Given increasing use, concerns have been raised about the usefulness of total body CT scanning in the setting of trauma.

A retrospective study of 1,236 blunt trauma patients demonstrated a low yield of total body scanning given low yield for clinically significant injuries in more than 1 anatomic region and suggests selective imaging in low-risk populations [6]. A more recent study in Australia also demonstrated a low rate of serious injury in low-risk patients on total body scanning, and all injuries would been identified by selective imaging based on clinical findings supporting a selective imaging strategy [7]. Conversely, a 2015 meta-analysis suggests whole body CT over all conventional imaging has a mortality benefit and can improve survival in stable and unstable blunt trauma patients [8]. Nomograms have been proposed to determine which patients need CT scans; these in part use findings on FAST and radiography in addition to clinical parameters [9].

There are many commercially available artificial intelligence products that can assist in identification of traumatic abnormalities such as rib fractures; an in-depth discussion of these is beyond the scope of this discussion.

Geriatric trauma (in those >65 years of age) may require different imaging pathways due to high risk of injury. Initial imaging pathways remain similar. A study by Leede et al [10] noted that geriatric trauma patients (83% were due to fall) with positive chest radiography (CXR) or pelvis radiography (PXR) were 8 times more likely to have abdominal injuries and 6.6 times more likely to

undergo laparotomy. CXR and PXR combined had a 78% specificity for abdominal injury and 79% specificity for laparotomy; for ground-level falls this was 85%. Therefore, CXR and PXR are useful in the screening of geriatric patients for blunt injury and should prompt additional imaging but negative initial radiographic imaging should be combined with FAST and examination findings to determine need for CT scanning.

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. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.

This variant recommends initial imaging in the setting of minor blunt trauma from assault or ground-level fall with local chest tenderness only. The expected injuries would include fractures of the bony structures of the thorax, pneumothorax, and/or hemothorax. Depending on size, hemothorax or pneumothorax might require intervention and follow-up imaging.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
A. Bone Scan Chest

There is no relevant literature to support the use of bone scan in the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall. Bone scan is not performed because of the time required in the emergency setting.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
B. Bone Scan Ribs

There is no relevant literature to support the use of bone scan in the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall. Bone scan is not performed because of the time required in the emergency setting.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
C. CT Chest With IV Contrast

Contrast-enhanced chest CT is considered the reference standard for assessment of thoracic injury and is more sensitive for minor and major injury detection, many of which (ie, nondisplaced rib

fractures) have low clinical significance.

In a large study of 8,661 patients, 67% of pneumothorax and 80% of hemothorax were seen on CT only [11], and in the same cohort, 73% of pulmonary contusions were only seen on CT [12]. In a large NEXUS cohort, 94% of sternal fractures were only seen on CT, but that majority were clinically insignificant [13].

Although some authors advocate eliminating the CXR and starting with CT with all blunt thoracic trauma patients undergoing CT, others caution against its overuse.

Similarly, in low-risk populations, it is recommended to selectively use CT scans to detect injuries in more than 1 body region, rather than automatically performing a total body CT scan [6].

Clinical decision tools exist to select which blunt chest trauma patients would benefit from chest CT [13]; those without or with 1 criterion are unlikely to benefit from CT chest [14]. Of note, a study looking at low-dose CT found that it had a higher sensitivity than CXR but with a similar dose [15]. In a study of 1,654 patients who sustained falls from standing, 121 patients had a total of 179 chest injuries, whereas 379 patients with a Glasgow Coma Scale score of 15 underwent thoracic CT, yet only 3% required intervention. The negative predictive value (NPV) for physical examination of chest injuries was 100%, indicating that selective use of CT scanning in this cohort is sufficient [16]. A smaller retrospective study in ground-level fall patients also showed normal history and physical examination to have an NPV and sensitivity of 100%. Furthermore, patients with rib fractures all had pain on palpation or complained of chest pain; patients with pneumothorax were identified on E-FAST, and the authors recommended against complete CT torso imaging in this population [17].

A more recent study of 1,214 ground-level fall patients who underwent CT showed that abnormal chest physical examination had a positive predicative value (PPV) of 60.2%, and in patients with normal chest physical examination, NPV was 95.8%, sensitivity was 83.5%, and specificity was 87.2% for chest injury, confirming that physical examination may help reduce the number of CTs [18]. In a study by Singleton et al [19] among elderly fall patients, although CT identified more rib fractures and the CT-identified rib fractures were associated with increased hospital admissions, there was no difference in procedural interventions, intensive care unit admission, hospital/intensive care unit length of stay, or mortality for patients with and without radiographically occult fractures; a higher threshold may be warranted in this patient group.

In a specific group of ground-level fall patients with altered mental status, a normal physical examination, CXR, and PXR had an NPV of 96%, and those who underwent CT had a significantly lower rate of injury than alert patients; the authors recommend strong consideration to forgo CT scanning in these patients [20].

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.

D. CT Chest Without and With IV Contrast

No specific literature addressed preliminary unenhanced CT followed by the administration of intravenous (IV) contrast for the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall. Expert consensus was that use of unenhanced images does not add diagnostic information, and contrast-enhanced images are preferred.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
E. CT Chest Without IV Contrast

No specific literature addressed unenhanced CT specifically in the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall, but several articles did not specifically discuss scan protocol. Expert consensus was that use of this examination might be useful in the clinical setting in which the main concern is rib fracture not seen radiographically and for assessment of associated pneumothorax.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
F. MRI Chest With IV Contrast

There is limited literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall. Contrast is not necessary for fracture detection.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
G. MRI Chest Without and With IV Contrast

There is limited literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall. Contrast is not necessary for fracture detection.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
H. MRI Chest Without IV Contrast

There is limited literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall. One article demonstrated a return-to-work benefit for early (not initial) noncontrast chest MRI in minor closed chest trauma in the occupational setting with identification of radiographically occult rib fractures [21]. In an additional study comparing MRI and CT in minor chest trauma, noncontrast MRI was highly sensitive for acute rib fractures, particularly nondisplaced CT-occult fractures, and could be considered [22]. A study in chest trauma in rugby players recommended MRI after radiography when vascular injury is not suspected, due to sensitivity and lack of radiation in this young population [23]. Musculoskeletal chest MRI is performed with T2-weighted and short tau inversion recovery with T1-weighted spin echo for assessment of hemorrhage.

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
I. Radiography Chest

There is extensive literature supporting CXR as the initial imaging modality of choice in blunt thoracic trauma, including the ACR Appropriateness Criteria® topic on "Rib Fractures" [24]. This can be performed concurrently with chest US (E-FAST) [25-28].

In a large cohort study of 8,661 patients, the sensitivity and specificity for CXR for pulmonary contusion were 27.0% and 98.8%, with a PPV of 75.4% and NPV of 91.1% [12]. Of the large NEXUS cohort, only 2% had sternal fracture and 94% were radiographically occult seen only on CT [13]. A study of 192 patients demonstrated that an absence of or 2 or 3 mediastinal signs correlated with

lack of mediastinal hematoma or major aortic injury on CT, suggesting this would preclude need for additional imaging [25]. Among patients with ground-level fall and altered mental status, a normal physical examination, CXR, and PXR had an NPV of 96% for identification of additional injury on CT [20]. Conversely, some authors have suggested that due to low sensitivity and specificity, CXR should not be used as the sole imaging for pneumothorax, hemothorax, and contusion [29].

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
J. Radiography Rib Views

In a study, single-view CXR provided sufficient information for the clinical management of ambulatory patients with rib pain over rib series [30]. An earlier study in outpatients both with and without history of trauma showed a sensitivity of only 38% for frontal CXR when using the rib series as a reference standard [31].

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.
K. US Chest

For the purposes of ACR Appropriateness Criteria, an US chest is a formal examination performed in the radiology department and not the same as an e-FAST US. Please see the Special Imaging Considerations section more details.

There is extensive literature to support the use of US of E-FAST and trauma US as the initial imaging modality or concurrently with CXR in the setting of minor blunt chest trauma but not formal radiology US as the first-line modality.

A meta-analysis by Battle et al [32] suggests US may be better than CXR for rib fractures, but variability and poor quality of the studies precluded a definitive recommendation. A meta-analysis by Tian et al [33] showed an overall sensitivity of US for pneumothorax diagnosis of 89% (95% confidence interval [CI], 86%-91%), a specificity of 96% (95% CI, 95%-97%), and a diagnostic odds ratio of 193.94 (59.009-637.40) at 95% CI. In a study by Celik et al [34] comparing US with CT, diagnostic accuracy of US was 80%, with a sensitivity of 91.2% and specificity of 72.7% for the detection of any rib fracture. Although sensitive, a positive US lacked specificity in determining the site and number of fractures. Zanobetti et al [35] also looked at the ability to identify lung contusion and found a sensitivity of 59%, specificity of 98%, PPV of 92%, NPV of 86%, and accuracy of 87%, as well as a high sensitivity and specificity for pneumothorax (84%, 98%) and hemothorax (82%, 97%). A large meta-analysis of 24,350 patients found a pooled sensitivity of 69% and specificity of 99% for pneumothorax [36]. A review by Gilbertson et al [37] found a pooled sensitivity of 89.3% and a specificity of 98.4% of US compared with CT for diagnosis of any rib fracture. A review article by Alrajab et al [38] found a pooled sensitivity of 78.6% and a specificity of 98.4% for pneumothorax versus 39.8% and 99.3% for CXR. A meta-analysis by Chan et al [39] found a sensitivity and specificity of US of 91% and 99% versus 47% and 100% for supine CXR in detecting pneumothorax. Conversely, a retrospective review showed trauma US having a lower sensitivity for pneumothorax than CXR (35% versus 43%), including clinically significant pneumothorax, and cautioned against its use as primary imaging evaluation [40].

A recent retrospective review demonstrated greater sensitivity and specificity of E-FAST (68.4% and 87.5%) over CXR (23.5% and 86.3%) for moderate to large pneumothorax seen on CT [41]. Another

review study demonstrated higher sensitivity of US in detection of rib fracture compared with CXR (97% vs 77%) [42]. In ambulatory minor trauma patients, E-FAST was concordant with CXR and picked up rib fractures in 5 patients' status after a fall with negative CXR [43]. In a small prospective study, US had a sensitivity of 86.4%, specificity of 100%, PPV of 100%, and NPV of 95.6% for pneumothorax versus CXR, which had a sensitivity of 48.6%, specificity of 100%, PPV of 100%, and NPV of 85.1%, and was faster (2 min versus 12 min) [44]. A large retrospective study of both blunt and penetrating injuries identified 13 of 15 patients with significant pneumothorax with a sensitivity of 87% and specificity of 100% [45]. However, another study showed twice as many false-positives using US for pneumothorax [46]. In an underresourced setting, E-FAST had greater sensitivity (96.1%) than CXR (45.1%) for hemothorax [47]. In a small study of elderly hemodialysis patients' status after a fall, US demonstrated a 100% sensitivity for the detection of rib and clavicle fractures in 5 patients reporting fall and pain when arriving for hemodialysis [48]. Of note, a secondary analysis of blunt chest trauma E-FAST that replaced clinical decision instrument demonstrated decreased sensitivity for injury and cannot replace the CXR criterion [49, 50].

Variant 1: Adult. Minor blunt trauma from assault or ground-level fall with local chest tenderness. Initial imaging.

L. V/Q Scan Lung

There is no relevant literature to support the use of ventilation-perfusion (V/Q) lung scanning in the initial evaluation of the minor blunt trauma patient's status after assault or ground-level fall.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.

This variant recommends initial imaging in the setting of minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low-speed MVC with right upper quadrant pain. The expected injuries would include liver/hepatobiliary injury or renal injury. Some injuries might require treatment depending on severity. It is worth mentioning that clinical suspicion in the setting of minor blunt abdominal trauma is the key leading factor to the appropriate imaging, because advanced imaging may not be necessary because of high NPV of negative physical examination along with negative radiography [51,52].

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.

A. CT Abdomen and Pelvis With IV Contrast

One group advocates for initial late corticomedullary/standard portal venous phase images with arterial phase images deemed not necessary in the majority of cases, then delayed 5 to 10 min images if an abnormality is seen on initial scan [53]. Additionally, up to a 96.5% accuracy in detecting liver injury has been reported, although the energy level was not specifically discussed for liver injury cases [54].

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.

B. CT Abdomen and Pelvis Without and With IV Contrast

A small retrospective study of multiple trauma patients with abdominopelvic injuries on CT scans showed no improvement in renal injury detection with initial noncontract images and resulted in

dose increase [55]. Expect consensus was that use of unenhanced images does not add diagnostic information, and contrast-enhanced images are preferred.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
C. CT Abdomen and Pelvis Without IV Contrast

There is no relevant literature to support the use of unenhanced CT in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
D. CT Pelvis With Bladder Contrast (CT Cystography)

In the setting of flank pain and hematuria, appropriate initial imaging should assess the entire urinary tract for injury, and CT urography (CTU) supersedes CT cystography in this setting; CT cystogram alone cannot assess for the presence of ureteral or renal injury and was deemed usually not appropriate by expert consensus.

The preferred examination when a patient is undergoing CT for assessment of bladder injury is a CT cystogram after or in conjunction with a trauma CT scan [56]. This is further discussed in Variant 5.

CT cystogram has a similar sensitivity and specificity to a retrograde cystogram [56-59]. There is consensus among several professional organizations (American Urological Association [AUA], European Association of Urology [EAU], World Society of Emergency Surgery and the American Association for the Surgery of Trauma [WSES-AAST]) that retrograde cystography (by radiography or CT) be performed in the setting of gross hematuria and/or pelvic fracture in the hemodynamically stable patient, whereas the Eastern Association for the Surgery of Trauma (EAST) recommends CT cystogram; delayed/excretory CT is inferior to CT cystogram for bladder injury (WSES-AAST) [60]. This is in line with previous consensus imaging recommendation as either conventional or CT cystogram for bladder injury from the AUA, EAU, and Societe Internationale d'Urologie (SIU) [61]. With sensitivity and specificity up to 95% and 100% for both conventional and CT cystography, CT can detect subtle injuries obscured by other structures further increasing sensitivity and classification [62].

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
E. CTA Abdomen and Pelvis With IV Contrast

Some institutions perform CT scans for trauma using late arterial phase images followed by assessment of the kidneys and then perform delayed 4 to 5 min excretory images if needed [63]. Note that many trauma patients are scanned to look for injury to multiple organs, not just the kidney, and are scanned with arterial phase CT followed by portal venous phase CT with delayed excretory phase based on hematuria or CT findings [64]. Revised 2018 AAST renal injury scale advocates use of dual-phase contrast-enhanced CT with arterial and portal venous phase imaging of renal injuries and excretory phase imaging as needed and is the modality of choice for renovascular trauma [65]. Note that this typically refers to major rather than minor blunt trauma,

and given that vascular injuries are less likely in minor trauma, arterial phase imaging is usually not necessary and was deemed usually not appropriate by expert consensus.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
F. CTA Abdomen With IV Contrast

There is no relevant literature to support the use of CTA of the abdomen in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria. Pelvic scans are needed to assess the entire collection system.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
G. CTU Without and With IV Contrast

Multiphasic CT of the abdomen and pelvis (CTU) is the reference standard for complete imaging in the assessment of renal trauma [66], and although no single best technique for ureteral injury has been established, the AUA recommends 10-min delayed images (CTU) for ureteral assessment [59]. Abdominopelvic CT with IV contrast with immediate and delayed images has been recommended as the imaging technique of choice for defining the location and severity of renal injury (grade C, AUA and SIU; grade A, EAU) and is also recommended for suspected vascular injury. Similarly, both the EAU and AUA guidelines recommend abdominopelvic CT with IV contrast with immediate and delayed images for the diagnosis of ureteric injury (grade C, AUA) [61]. Chouhan et al [67] also recommend CT with IV contrast and delayed images. Patel and Popat [68] also note that CT imaging should include an unenhanced scan, a corticomedullary (nephrographic) phase, and a delayed phase to detect urinary leakage from the collecting system or ureter. CTU is also given as the examination of choice for suspected traumatic or iatrogenic ureteral injuries by Alabousi et al [69]. CTU is most used when traumatic ureteral injury is suspected due to opacification of the collecting system and generally consists of 3 phases, including a nonenhanced, nephrogenic, and excretory phase [70]. In a study of patients with grade 3 to 5 renal injuries, only 73% had delayed images, and 33% had a delay in care because of the lack of excretory imaging on initial scan; the sensitivity and specificity of CT with excretory images was 93% and 100% for collecting system injury [71]. One study suggests that 9 min is the optimal timing for detection of urinary extravasation [72]. In a 15-year retrospective review in a small group of 18 patients with blunt ureteral injury, all patients underwent CTU at time of initial evaluation, and all ureteral injuries were correctly graded as partial or complete [73].

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
H. DMSA Renal Scan

There is no relevant literature to support the use of dimercaptosuccinic acid (DMSA) renal scan in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
I. DTPA Renal Scan

There is no relevant literature to support the use of diethylenetriamine pentaacetic acid (DTPA) renal scan in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
J. Liver Spleen Scan

There is no relevant literature to support the use of liver spleen scan in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
K. MRI Abdomen Without and With IV Contrast

There is no relevant literature to support the use of MRI of the abdomen without and with IV contrast in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
L. MRI Abdomen Without IV Contrast

There is no relevant literature to support the use of MRI of the abdomen without IV contrast in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria.

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
M. Radiography Abdomen and Pelvis

There is no relevant literature to support the use of abdominal radiography in the initial evaluation of the minor blunt trauma patient's status after assault with right upper flank pain and hematuria. PXR may still be performed per trauma center protocols particularly considering association of bladder injury with pelvic fractures. Of note, in patients with pelvic fractures, time to intervention/arterial embolization was longer in patients without initial PXR before CT scanning [74].

Variant 2: Adult. Minor blunt trauma from assault with right upper flank pain with hematuria or assault or fall or low speed motor vehicle collision with right upper quadrant pain. Initial imaging.
N. US Abdomen

For this purpose, US abdomen is considered a routine abdominal US examination performed by the radiology department and not an E-FAST.

A retrospective study of 5,536 blunt trauma patients demonstrated that traditional non-FAST abdominal US in hemodynamically stable patients with normal neurological, chest, and abdominopelvic examinations and without distracting injuries only had intraabdominal injuries in 0.1%, and in those with normal abdominal US, none had injuries. In those with Abbreviated Injury

Scale (AIS) >1, US identified 71 of 75 injuries [75]. A large meta-analysis of 24,350 patients found a pooled sensitivity of 74% and a specificity of 98% for free fluid; in normotensive patients these were 76% and 98%, respectively, supporting E-FAST for ruling-in free fluid but not supporting its use as a tool to rule out injury [36]. This supports an earlier retrospective study showing a low sensitivity (22%) for FAST in hemodynamically stable patients with injury confirmed by CT or laparotomy [76]. A Cochrane review from 2015 noted that current evidence on patient-centered outcomes provided insufficient evidence to determine the use of US in the initial diagnostic pathway in blunt abdominal trauma considering low sensitivity but may impact clinical decision making [77]. Of note, US cannot reliably diagnose renal lacerations [78]. Use of US for assessment of ureteral injuries is precluded by anatomic location of the ureters.

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.

This variant recommends initial imaging in the setting of minor blunt trauma from a fall from a bicycle with handlebar injury. The expected injuries would include central abdominal wall contusion, duodenal/small bowel injury, mesenteric, diaphragmatic injury, or pancreatic injury.

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
A. CT Abdomen and Pelvis With IV Contrast

Abdominal CT scanning has become the reference standard in assessing hemodynamically stable blunt trauma patients for intraabdominal injury, but concerns exist regarding overutilization. Validated clinical prediction rules (includes CXR) exist to determine patients at low risk for intraabdominal injury who can forgo CT scanning [79], but they are underused in the evaluation of blunt abdominal trauma [80]. A retrospective study of pancreatic trauma patients (both blunt and penetrating) demonstrated an overall sensitivity and specificity of 36.4% and 68.2%, with CT missing pancreatic injuries 78.8% of the time [81]. CT is 80% to 90% sensitive for blunt and penetrating diaphragmatic injuries; however, diaphragmatic injuries mostly occur with more severe trauma in the presence of additional injuries [82]. A recent meta-analysis confirmed that CT is the reference standard for diagnosing blunt traumatic diaphragmatic injury, and modern CT scanners have increased diagnostic accuracy [83]. CT scanning is preferred over US for the evaluation of rectus sheath hematoma [84]. Evidence does not specify phase of imaging.

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
B. CT Abdomen and Pelvis Without and With IV Contrast

A small retrospective study of multiple trauma patients with abdominopelvic injuries on CT scans showed no advantage to performing preliminary noncontract images and resulted in dose increase [55].

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
C. CT Abdomen and Pelvis without IV Contrast

There is no relevant literature to support the use of unenhanced CT in the initial evaluation of the minor blunt trauma patient's status after a fall from bicycle with handlebar injury.

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
D. CTA Abdomen and Pelvis With IV Contrast

Vascular injury is not typically associated with minor blunt trauma from a fall from a bicycle with a handlebar injury; therefore, the use of CTA with IV contrast is generally not useful in such cases.

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
E. MRI Abdomen Without and With IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status after a bicycle handlebar injury. In a large multicenter retrospective review, the sensitivity of MR cholangiopancreatography (MRCP) for pancreatic ductal injury was 37%, with a specificity of 94%, PPV of 77%, and NPV 73%, with 64% discordance with endoscopic retrograde cholangiopancreatography (ERCP). Overall, the accuracy of MRCP for main pancreatic duct injury was not superior to CT in this study [85]. MRI is not a first-line diagnostic tool but can assess the function of the diaphragm in the subacute setting if needed [82].

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
F. MRI Abdomen Without IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status after a bicycle handlebar injury. In a large multicenter retrospective review, the sensitivity of MRCP for pancreatic ductal injury was 37%, with a specificity of 94%, PPV of 77%, and NPV of 73%, with 64% discordance with ERCP. Overall, the accuracy of MRCP for main pancreatic duct injury was not superior to CT in this study [85]. MRI is not a first-line diagnostic tool but can assess the function of the diaphragm in the subacute setting if needed [82].

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
G. Radiography Abdomen

There is no relevant literature to support the use of abdominal radiography in the initial evaluation of the minor blunt trauma patient's status after a bicycle handlebar injury. Note that this is referring to dedicated abdomen radiographs and not a pelvic radiograph as part of initial trauma scan.

Variant 3: Adult. Minor blunt trauma as a result of fall from bicycle with handlebar injury. Initial imaging.
H. US Abdomen

For this purpose, US abdomen is considered a routine abdominal US examination performed by the radiology department and not an E-FAST.

A retrospective study of 5,536 blunt trauma patients demonstrated that traditional non-FAST abdominal US in hemodynamically stable patients with normal neurological, chest, and abdominopelvic examinations and without distracting injuries only had intraabdominal injuries in 0.1%, and in those with normal abdominal US, none had injuries. In those with AIS >1, US identified 71 of 75 injuries [75]. A large meta-analysis of 24,350 patients found pooled sensitivity of 74% and specificity of 98% for free fluid; in normotensive patients this was 76% and 98%, respectively, supporting E-FAST for ruling-in free fluid but not supporting its use as a tool to rule out injury [36]. This supports an earlier retrospective study showing a low sensitivity (22%) for FAST in hemodynamically stable patients with injury confirmed by CT or laparotomy [76]. Pancreatic injuries are difficult to diagnose on US, which is best used as follow-up tool for complications [86].

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.

This variant recommends initial imaging in the setting of minor blunt trauma from MVC with abdominal and pelvic seatbelt sign. The expected injuries would include solid organ, mesenteric, or bowel injury and may require additional treatment depending on severity. This includes low-speed collisions (<10 mph) with little vehicular damage. Seatbelt sign is the presence of contusion in the anterior abdominal wall under the vehicle restraint device.

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
A. CT Abdomen and Pelvis With IV Contrast

In a large retrospective study of 425 patients with abdominal seatbelt sign, 36.1% had intraabdominal injury on CT, but only 13.6% required laparotomy, and the initial CT demonstrated a 100% sensitivity [87]. A recent meta-analysis confirmed CT is the reference standard for diagnosing blunt traumatic diaphragmatic injury, and modern CT scanners have increased diagnostic accuracy [83]. In a large series of patients with abdominal seatbelt sign, biphasic (arterial and portal venous) CT scan demonstrated a sensitivity and NPV of 100% [88]. CT has replaced immediate laparotomy in stable patients with seatbelt sign, and a recent prospective study of 220 patients with seatbelt sign also showed that no patients with a negative CT scan had or required surgery for a hollow viscous injury [89]. A review study by Redmond et al on abdominal seatbelt sign concluded that a clinical seatbelt sign was sensitive but nonspecific for injury and should prompt an abdominal CT [90].

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
B. CT Abdomen and Pelvis Without and With IV Contrast

A small retrospective study of multiple trauma patients with abdominopelvic injuries on CT scans showed no advantage to performing preliminary noncontract images and resulted in dose increase [55].

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
C. CT Abdomen and Pelvis Without IV Contrast

There is no relevant literature to support the use of unenhanced CT in the initial evaluation of the minor blunt trauma patient's status post-MVC with seatbelt sign.

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
D. CT Enterography

There is no relevant literature to support the use of CT enterography in the initial evaluation of the minor blunt trauma patient's status post-MVC with seatbelt sign.

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
E. MRI Abdomen and Pelvis With IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status post-MVC with seatbelt sign. In a large multicenter retrospective review, the sensitivity of MRCP for pancreatic ductal injury was 37%, with a specificity of 94%, PPV of 77%, and NPV of 73%, with 64% discordance with ERCP. Overall, the accuracy of MRCP for main

pancreatic duct injury was not superior to CT in this study [85]. MRI is not a first-line diagnostic tool but can assess the function of the diaphragm in the subacute setting if needed [82].

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
F. MRI Abdomen and Pelvis Without and With IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status post-MVC with seatbelt sign. In a large multicenter retrospective review, the sensitivity of MRCP for pancreatic ductal injury was 37%, with a specificity of 94%, PPV of 77%, and NPV of 73%, with 64% discordance with ERCP. Overall, the accuracy of MRCP for main pancreatic duct injury was not superior to CT in this study [85]. MRI is not a first-line diagnostic tool but can assess the function of the diaphragm in the subacute setting if needed [82].

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
G. MRI Abdomen and Pelvis Without IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status post-MVC with seatbelt sign. In a large multicenter retrospective review the sensitivity of MRCP for pancreatic ductal injury was 37%, with a specificity of 94%, PPV of 77%, and NPV of 73%, with 64% discordance with ERCP. Overall, the accuracy of MRCP for main pancreatic duct injury was not superior to CT in this study [85]. MRI is not a first-line diagnostic tool but can assess the function of the diaphragm in the subacute setting if needed [82].

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
H. Radiography Abdomen

There is no relevant literature to support the use of abdominal radiography in the initial evaluation of the minor blunt trauma patient's status post-MVC with seatbelt sign.

Variant 4: Adult. Minor blunt trauma from motor vehicle collision with seatbelt sign. Initial imaging.
I. US Abdomen

For this purpose, US abdomen is considered a routine abdominal US examination performed by the radiology department and not an E-FAST.

A retrospective study of 5,536 blunt trauma patients demonstrated that traditional non-FAST abdominal US in hemodynamically stable patients with normal neurological, chest, and abdominopelvic examinations and without distracting injuries only had intraabdominal injuries in 0.1%, and in those with normal abdominal US, none had injuries. In those with AIS >1, US identified 71 of 75 injuries [75]. A large meta-analysis of 24,350 patients found a pooled sensitivity of 74% and a specificity of 98% for free fluid; in normotensive patients these were 76% and 98%, respectively, supporting E-FAST for ruling-in free fluid but not supporting its use as a tool to rule out injury [36]. This supports an earlier retrospective study showing a low sensitivity (22%) for FAST in hemodynamically stable patients with injury confirmed by CT or laparotomy [76]. A Cochrane review from 2015 noted that current evidence on patient-centered outcomes provided insufficient evidence to determine the use of US in the initial diagnostic pathway in blunt abdominal trauma considering low sensitivity but may impact clinical decision making [77]. Pancreatic injuries are difficult to diagnose on US, which is best used as a follow-up tool for complications [86].

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.

This variant recommends initial imaging in the setting of minor blunt trauma from MVC with gross hematuria. The expected injuries would include renal, ureteral, urinary bladder, and urethral injuries. Note that renal or ureteral injury is more likely to present with microscopic hematuria. Depending on injury type, further treatment may be required.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
A. CT Abdomen and Pelvis With IV Contrast

Although CT scanning may be performed for the assessment of traumatic injuries in general, it is not sensitive enough for bladder injury detection. Similarly, delayed/excretory CT is inferior to CT cystogram for bladder injury (WSES-AAST) [60]. Other authors note that antegrade passive distention of the urinary bladder is unreliable [53,63,70]. Standard CT is not reliable in the diagnosis of bladder rupture in part because it cannot differentiate urine from ascites [91].

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
B. CT Abdomen and Pelvis Without and With IV Contrast

A small retrospective study of multiple trauma patients with abdominopelvic injuries on CT scans showed no advantage to performing preliminary noncontract images and resulted in dose increase [55].

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
C. CT Abdomen and Pelvis Without IV Contrast

There is no relevant literature to support the use of unenhanced CT in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
D. CT Pelvis With Bladder Contrast (CT Cystography)

The preferred examination when a patient is undergoing CT for the assessment of bladder injury is a CT cystogram after or in conjunction with a CT scan with contrast [56]. This examination consists of the instillation of water-soluble contrast into the urinary bladder via Foley catheter and scanning without additional oral or IV contrast [92]. CT cystogram has a similar sensitivity and specificity to a fluoroscopic cystogram [56-59]. There is consensus among several professional organizations (AUA, EAU, WSES-AAST) that retrograde cystography (by fluoroscopy or CT) be performed in the setting of gross hematuria and/or pelvic fracture in the hemodynamically stable patient, whereas the EAST recommends CT cystogram; delayed/excretory CT is inferior to CT cystogram for bladder injury (WSES-AAST) [60]. This is in line with previous consensus imaging recommendation as either conventional or CT cystogram for bladder injury from the AUA, EAU, and SIU [61]. With a sensitivity and specificity up to 95% and 100% for both conventional and CT cystography, CT can detect subtle injuries obscured by other structures, further increasing sensitivity and classification [62]. Additionally, other studies reported similar sensitivity and specificity for CT cystography but recommended it only in cases of gross hematuria with moderate risk of bladder rupture. In contrast, in the case of microscopic hematuria only, no imaging is recommended for diagnosis [93].

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
E. DMSA Renal Scan

There is no relevant literature to support the use of DMSA renal scan in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
F. DTPA Renal Scan

There is no relevant literature to support the use of DTPA renal scan in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
G. Fluoroscopy Cystography

CT cystogram has a similar sensitivity and specificity to a retrograde cystogram [56-59]. There is consensus among several professional organizations (AUA, EAU, WSES-AAST) that retrograde cystography (by radiography or CT) be performed in the setting of gross hematuria and/or pelvic fracture in the hemodynamically stable patient, whereas the EAST recommends CT cystogram; delayed/excretory CT is inferior to CT cystogram for bladder injury (WSES-AAST) [60]. This is in line with previous consensus imaging recommendation as either conventional or CT cystogram for bladder injury from the AUA, EAU, and SIU [61]. Some authors advocate CT over x-ray cystography only when patient is already undergoing CT [91]. Note that a retrograde urethrogram remains the reference standard for an assessment of urethral injury and should be performed after initial CT scan and before placement of a Foley catheter [63,94].

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
H. MRI Abdomen and Pelvis Without and With IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
I. MRI Abdomen and Pelvis Without IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
J. MRI Abdomen Without and With IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
K. MRI Abdomen Without IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
L. Nuclear Medicine Cystography

There is no relevant literature to support the use of nuclear medicine cystography in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria.

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
M. Radiography Abdomen and Pelvis

There is no relevant literature to support the use of abdominal radiography in the initial evaluation of the minor blunt trauma patient's status post-MVC with gross hematuria. PXR may still be performed per trauma center protocols particularly considering association of bladder injury with pelvic fractures. Of note, in patients with pelvic fractures, time to intervention/arterial embolization was longer in patients without initial PXR before CT scanning [74].

Variant 5: Adult. Minor blunt trauma from motor vehicle collision with gross hematuria. Initial imaging.
N. US Abdomen

For this purpose, US abdomen is considered a routine abdominal US examination performed by the radiology department and not an E-FAST.

A retrospective study of 5,536 blunt trauma patients demonstrated that traditional non-FAST abdominal US in hemodynamically stable patients with normal neurological, chest, and abdominopelvic examinations and without distracting injuries only had intraabdominal injuries in 0.1%, and in those with normal abdominal US, none had injuries. In those with AIS >1, US identified 71 of 75 injuries [75]. A large meta-analysis of 24,350 patients found a pooled sensitivity of 74% and a specificity of 98% for free fluid; in normotensive patients these were 76% and 98%, respectively, supporting E-FAST for ruling-in free fluid but not supporting its use as a tool to rule out injury [36]. Furthermore, the sensitivity and specificity of E-FAST for renal injury detection has been estimated to be 22% to 67% and 96% to 100%, respectively [95]. This supports an earlier retrospective study showing a low sensitivity (22%) for FAST in hemodynamically stable patients with injury confirmed by CT or laparotomy [76]. A Cochrane review from 2015 noted that current evidence on patient-centered outcomes provided insufficient evidence to determine the use of US in the initial diagnostic pathway in blunt abdominal trauma considering its low sensitivity but may impact clinical decision making [77].

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.

This variant recommends initial imaging in the setting of minor blunt trauma with left upper quadrant pain only. The expected injuries would include soft tissue contusions, bowel, left kidney, or splenic injury. Depending on injury severity, intervention might be required. This does not include overuse injuries or non-impact-related muscle or tendon injuries.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.
A. CT Abdomen and Pelvis With IV Contrast

MDCT is the modality of choice for the evaluation of genitourinary trauma in the stable athlete with suspected genitourinary trauma and is typically performed with IV contrast in the setting of

multiorgan trauma; multiphasic imaging is recommended when there is a high suspicion of renal trauma [58]. Additionally, a CT scan with IV contrast is currently the reference standard for assessing splenic rupture following a traumatic event [96]. However, some cases of delayed splenic rupture have been reported, highlighting the need for active and ongoing clinical evaluation even after a negative CT scan at the time of admission [97]. Furthermore, a study of 349 patients who fell from a standing position showed that the NPV of a physical examination combined with normal vital signs was up to 100% for abdominal injuries [16].

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.
B. CT Abdomen and Pelvis Without and With IV Contrast

A small retrospective study of multiple trauma patients with thoracoabdominal injuries on CT scans showed no advantage to performing preliminary noncontract images and resulted in dose increase [55].

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.
C. CT Abdomen and Pelvis Without IV Contrast

There is no relevant literature to support the use of unenhanced CT in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.
D. Fluoroscopy Small Bowel Follow-Through

There is no relevant literature to support the use of fluoroscopy small bowel follow-through in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.
E. Fluoroscopy Upper GI Series With Small Bowel Follow-Through

There is no relevant literature to support the use of fluoroscopy upper gastrointestinal (GI) series with small bowel follow-through in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.
F. MR Enterography

There is no relevant literature to support the use of MR enterography in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.
G. MRI Abdomen and Pelvis With IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial

imaging.

H. MRI Abdomen and Pelvis Without and With IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.

I. MRI Abdomen and Pelvis Without IV Contrast

There is no relevant literature to support the use of MRI in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.

J. Radiography Abdomen and Pelvis

There is no relevant literature to support the use of abdominopelvic radiography in the initial evaluation of the minor blunt trauma patient from sports injury, assault, fall, or low-speed MVC with left upper quadrant pain.

Variant 6: Adult. Minor blunt trauma from sports injury with left upper quadrant pain. Initial imaging.

K. US Abdomen

For this purpose, US abdomen is considered a routine abdominal US examination performed by the radiology department and not an E-FAST.

US may play a role in the prehospital evaluation of athletes, skiers, and snowboarders with thoracoabdominal trauma to improve the triage process by identifying splenic and other injuries [98]. A prior study has shown that FAST had a 31% false negative rate on patients with positive physical examination. Therefore, although it is helpful in detecting free fluid in the abdominal cavity, its use in definite diagnosis of splenic rupture is limited [16].

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**: For initial imaging of the adult minor blunt trauma patient resulting from limited assault or ground-level fall with local chest tenderness, radiography of the chest or ribs and/or concurrent CT chest with IV contrast are recommended studies. CT of the chest without IV contrast may be appropriate if the only concern is rib fracture and pneumothorax not seen radiographically.

- **Variants 2,3, and 4**: For initial imaging of the adult minor blunt trauma patient from 1) limited assault, fall, or a low-speed MVC with right upper quadrant pain or right upper flank pain with hematuria; 2) fall from bicycle; or 3) MVC with seatbelt sign, CT of the abdomen and pelvis with IV contrast is recommended. CTU is appropriate in the setting of right upper flank pain with hematuria to assess renal collecting system injury. US of the abdomen (note this is not a physician performed trauma FAST scan) has low sensitivity for solid organ injury visualization.

- **Variant 5**: For initial imaging of the adult minor blunt trauma patient from MVC with gross

hematuria, CT of the abdomen and pelvis with IV contrast and CT of the pelvis with bladder contrast (CT cystogram) are recommended. Traditional fluoroscopic cystogram may be appropriate and is institutionally dependent.

- **Variant 6**: For initial imaging of the adult minor blunt trauma patient with left upper quadrant pain from sports injury, CT the abdomen and pelvis with IV contrast is recommended. US of the abdomen (not trauma FAST scan) has low sensitivity for solid organ injury visualization.

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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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.

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