American College of Radiology
ACR Appropriateness Criteria®

Acute Hip Pain

Variant: 1 Adult. Acute hip pain, traumatic. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography hip	Usually Appropriate	☢☢☢
US hip	Usually Not Appropriate	O
MRI hip without and with IV contrast	Usually Not Appropriate	O
MRI hip without IV contrast	Usually Not Appropriate	O
Bone scan hip	Usually Not Appropriate	☢☢☢
CT hip with IV contrast	Usually Not Appropriate	☢☢☢
CT hip without and with IV contrast	Usually Not Appropriate	☢☢☢
CT hip without IV contrast	Usually Not Appropriate	☢☢☢

Variant: 2 Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
MRI hip without IV contrast	Usually Appropriate	O
CT hip without IV contrast	Usually Appropriate	☢☢☢
US hip	Usually Not Appropriate	O
MRI hip without and with IV contrast	Usually Not Appropriate	O
Bone scan hip	Usually Not Appropriate	☢☢☢
CT hip with IV contrast	Usually Not Appropriate	☢☢☢
CT hip without and with IV contrast	Usually Not Appropriate	☢☢☢

Variant: 3 Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
CT hip without IV contrast	Usually Appropriate	☢☢☢
MRI hip without IV contrast	May Be Appropriate	O
US hip	Usually Not Appropriate	O
MRI hip without and with IV contrast	Usually Not Appropriate	O
Bone scan hip	Usually Not Appropriate	☢☢☢
CT hip with IV contrast	Usually Not Appropriate	☢☢☢
CT hip without and with IV contrast	Usually Not Appropriate	☢☢☢

Variant: 4 Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.

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

MRI hip without IV contrast	Usually Not Appropriate	O
Bone scan hip	Usually Not Appropriate	☢☢☢
CT hip with IV contrast	Usually Not Appropriate	☢☢☢
CT hip without and with IV contrast	Usually Not Appropriate	☢☢☢

<u>Variant: 5</u> Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
MRI hip without IV contrast	Usually Appropriate	O
US hip	Usually Not Appropriate	O
MRI hip without and with IV contrast	Usually Not Appropriate	O
Bone scan hip	Usually Not Appropriate	☢☢☢
CT hip with IV contrast	Usually Not Appropriate	☢☢☢
CT hip without and with IV contrast	Usually Not Appropriate	☢☢☢
CT hip without IV contrast	Usually Not Appropriate	☢☢☢

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Summary of Literature Review

Introduction/Background

Proximal femoral fractures (commonly known and henceforth referred to as hip fractures) occur in patients of all ages but are a particularly important source of morbidity and mortality in elderly patients with osteoporosis [1,2]. Over 300,000 people per year are hospitalized for hip fractures in the United States [2]. Delays in diagnosis and treatment of hip fractures are associated with increased costs, complication rates, hospital length-of-stay, and mortality [3-6]. In a retrospective study of 3,517 surgeries performed for hip fractures in patients >50 years of age, Nyholm et al [6] reported that a surgical delay of >12 hours significantly increased the adjusted risk of 30-day mortality (prior studies had used 48 hours as the significant timepoint for surgical delay in this clinical scenario). Imaging is essential in the timely and accurate diagnosis of hip fractures, particularly because hip fractures cannot be diagnosed or excluded definitively via physical examination alone.

Hip fractures can be intracapsular (involving the femoral head and/or neck) or extracapsular (involving the basicervical, intertrochanteric, or subtrochanteric regions). Nondisplaced subcapital femoral neck fractures are typically treated with closed reduction percutaneous pinning, whereas displaced subcapital femoral neck fractures are typically treated with arthroplasty. True isolated greater trochanteric fractures are predominantly managed conservatively, but intertrochanteric fractures (including a subset of incomplete intertrochanteric fractures) are typically treated with internal fixation. Consequently, the imaging evaluation of fracture extent/alignment is integral in the appropriate management of hip fractures [7].

Hip dislocation and muscle/tendon injury are additional important etiologic considerations for the patient presenting with acute traumatic hip pain. Native hip dislocation in the nonosteoporotic patient most commonly results from high-energy injury, such as motor vehicle collision [8,9]. Please note that this narrative focuses on acute traumatic pain in the native hip. For postarthroplasty patients, please refer to the ACR Appropriateness Criteria® topic on "Imaging After Total Hip Arthroplasty" [10]. Labral tears are more likely to present clinically in the setting of chronic hip pain and are discussed in the ACR Appropriateness Criteria® topic on "Chronic Hip Pain" [11]. Stress (fatigue/insufficiency) fractures are fully detailed in the ACR Appropriateness Criteria® topic on "Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae" [12]. Suspected osteomyelitis/septic arthritis is covered in the ACR Appropriateness Criteria® topic on "Suspected Osteomyelitis, Septic Arthritis, or Soft Tissue Infection (Excluding Spine and Diabetic Foot)" [13].

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. Acute hip pain, traumatic. Initial imaging.

The goal of imaging is to detect hip fracture and/or dislocation. This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by reducing length of immobility and possible risk of osteonecrosis. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
A. Bone scan hip

There is no evidence to support the use of bone scan as the initial imaging study for the evaluation of acute traumatic hip pain.

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
B. CT hip with IV contrast

There is no evidence to support the use of CT with intravenous (IV) contrast as the initial imaging study for the evaluation of acute traumatic hip pain.

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
C. CT hip without and with IV contrast

There is no evidence to support the use of CT without and with IV contrast as the initial imaging study for the evaluation of acute traumatic hip pain.

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
D. CT hip without IV contrast

There is no evidence to support the use of CT without IV contrast as the initial imaging study for the evaluation of acute traumatic hip pain.

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
E. MRI hip without and with IV contrast

There is no evidence to support the use of MRI without and with IV contrast as the initial imaging study for the evaluation of acute traumatic hip pain.

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
F. MRI hip without IV contrast

There is no evidence to support the use of MRI without IV contrast as the initial imaging study for the evaluation of acute traumatic hip pain.

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
G. Radiography hip

Radiography is the initial imaging modality of choice in the evaluation of acute traumatic hip pain [2]. Standard posttraumatic hip radiographs should include an anteroposterior (AP) view with 15 degrees of internal hip rotation and a cross-table lateral view of the affected hip. Many institutions include an AP view of the pelvis for assessment of hip symmetry, either as part of the standard trauma evaluation or in conjunction with the dedicated hip series. The cross-table lateral view is favored over the frog-leg lateral view due to the potential risk for fracture displacement with frog-leg technique [14]. Radiographs are fast to obtain and can be performed portably in the trauma bay—this rapid method of diagnosis reduces the morbidity associated with acute hip fracture and/or dislocation without moving the patient [14].

Several publications describe possible additional radiographic views that can aid in fracture detection and classification [15-17], though none of these views has supplanted the standard AP and cross-table lateral views. For example, in a retrospective study of 78 consecutive hip fracture patients, Khurana et al [16] report that the addition of an internal rotation traction view can improve reader confidence and accuracy in the classification of intracapsular femoral neck fractures (displaced versus nondisplaced) and intertrochanteric fractures (stable versus unstable).

Variant 1: Adult. Acute hip pain, traumatic. Initial imaging.
H. US hip

There is no evidence to support the use of ultrasound (US) as the initial imaging study for the evaluation of acute traumatic hip pain.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.

The goal of imaging is to detect radiographically occult fracture. This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by reducing length of immobility and possible risk of osteonecrosis. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.
A. Bone scan hip

There is insufficient evidence to support the use of bone scan as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.
B. CT hip with IV contrast

There is no evidence to support the use of CT with IV contrast as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.
C. CT hip without and with IV contrast

There is no evidence to support the use of CT without and with IV contrast as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.
D. CT hip without IV contrast

Multiple studies over the past 2 decades have demonstrated the importance of cross-sectional imaging (CT and/or MRI) in revealing radiographically occult hip fractures in patients with acute traumatic hip pain [18-22]. Given the importance of rapid diagnosis in decreasing fracture-related morbidity, the relative speed in obtaining CT (versus MRI or bone scan) supports CT as the next imaging examination after negative radiographs when there is persistent clinical concern for hip fracture [18,19,21-24]. Patients with persistent clinical concern for hip fracture after a negative or equivocal CT will still need an MRI [18,19,21,23].

In a recent meta-analysis of 2,992 patients (35 studies) with clinically suspected hip fracture and using MRI as the reference standard, Haj-Mizraian et al [20] reported a frequency of surgical hip fracture in 39% of patients (1,110 of 2,835) with negative radiographs (moderate strength of evidence). The authors reported similar sensitivity for CT (79%) and bone scan (87%) in detecting radiographically occult hip fracture in this patient population (P = .67, noting low strength of evidence for this latter analysis). In a meta-analysis of 1,248 patients (13 studies) with clinically suspected hip fracture and negative radiographs, Kellock et al [21] reported a CT sensitivity of 94% and a specificity of 100% with 50 false-negative CT examinations in their study cohort. The studies in this latter meta-analysis used MRI or clinical follow-up as the reference standard (496 patients with hip fracture, 752 patients without hip fracture). A recent meta-analysis by Gatt et al [25] demonstrated that CT after negative radiographs found occult hip fractures in 24.1% and led to a change in management in 20% of cases. These authors also found that increasing the number of radiographic projections did not decrease the need for CT.

Dual-energy CT (with virtual noncalcium maps) can be helpful in evaluating fractures that predominantly involve cancellous/trabecular bone, such as nondisplaced intertrochanteric fractures. This technique enables CT detection of bone marrow edema, which previously required

MRI to visualize [26]. For example, Kellock et al [27] reported that the addition of virtual noncalcium maps increased sensitivity for detection of nondisplaced hip fracture by 4% to 5% in their study population.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.
E. MRI hip without and with IV contrast

There is no evidence to support the use of MRI without and with IV contrast as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.
F. MRI hip without IV contrast

Several meta-analyses recommend MRI after negative CT in patients with persistent clinical concern for CT-occult fracture given the morbidity and mortality associated with hip fractures [18,20-23]. In a recent retrospective study of 103 patients with clinically suspected but radiographically occult hip fracture, all patients underwent CT, and if the CT was negative, the patients then had MRI to exclude CT-occult fracture [19]. Although 49% of patients in this study were diagnosed with fracture by CT alone, 23% of the negative CT patients were found to have a fracture on MRI that necessitated surgery. The mean time from admission to diagnosis was 3 hours for the CT-only group and 40 hours for the CT plus MRI group.

Though the association of ipsilateral femoral neck fracture with high-energy femoral shaft fracture is well documented in surgical literature, the femoral neck fracture may be occult on radiographs/CT and is prone to delay in diagnosis with reports that up to 57% of these fractures are not diagnosed until or after surgery for the femoral shaft fracture [28]. Inadequate fixation of the femoral neck fracture can result in unplanned reoperation, femoral head osteonecrosis, and/or nonunion. Rogers et al [28] reported the usefulness of an abbreviated MRI protocol (coronal T1 and coronal short tau inversion-recovery [STIR]) for patients with high-energy femoral shaft fracture-MRI identified ipsilateral femoral neck fractures that were not visualized on CT in 12% of the patients in their study population.

Several other studies report the usefulness of an abbreviated MRI protocol in the emergency department setting with the primary goal of ruling in or ruling out hip fracture [29-31]. In a recent meta-analysis, Wilson et al [31] reported that a protocol consisting only of coronal T1-weighted and coronal STIR sequences is 100% sensitive for detecting radiographically occult hip fracture.

Variant 2: Adult. Acute hip pain, traumatic. Suspect fracture. Radiographs negative or indeterminate. Next imaging study.
G. US hip

There is insufficient evidence to support the use of US as the next imaging study for the evaluation of acute traumatic hip pain. There are 2 recent studies on the topic of point-of-care US performed by expert emergency sonographers that suggest potential usefulness for US in this setting [32,33], but more research on this topic would be necessary to validate more widespread use.

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.

The goal of imaging is to further characterize the fracture in order to guide appropriate treatment planning. This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by indicating the need for operative management. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.
A. Bone scan hip

There is no evidence to support the use of bone scan as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.
B. CT hip with IV contrast

There is no evidence to support the use of CT with IV contrast as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.
C. CT hip without and with IV contrast

There is no evidence to support the use of CT without and with IV contrast as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.
D. CT hip without IV contrast

CT can be helpful in surgical decision-making for known femoral neck or trochanteric fractures. In a study of patients with nondisplaced femoral neck fractures, Zamora et al [34] reported that the addition of CT resulted in greater interobserver agreement with regard to surgical decision-making (arthroplasty versus closed reduction percutaneous pinning) and altered this decision in 21% of cases, with an odds ratio of 1.4 (95% confidence interval 0.62-3.2) for choosing arthroplasty if CT was performed. However, the authors report that CT did not affect interobserver agreement for Garden classification or posterior tilt evaluation. Hardy et al [35] evaluated the potential for 2 angles measured on CT (impaction angle in the coronal plane and posterior tilt angle in the axial plane) to predict secondary displacement of nondisplaced femoral neck fractures if treated nonsurgically. Their results support the femoral neck impaction angle on CT as a reproducible metric that can predict secondary displacement (odds ratio of 11.73 for impaction angles ≤135 degrees). Several studies also report the improved interobserver reliability of trochanteric fracture classification by CT as compared to radiographs [36-38]. These studies primarily use a 3-D CT adaptation of the 2018-revised AO Foundation/Orthopaedic Trauma Association classification.

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.
E. MRI hip without and with IV contrast

There is no evidence to support the use of MRI without and with IV contrast as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.
F. MRI hip without IV contrast

When seemingly isolated fracture of the greater trochanter is visualized on radiographs or CT, it is important to consider the possibility that the fracture might reflect incomplete intertrochanteric fracture with occult fracture propagation into the intertrochanteric region (rather than true isolated greater trochanteric fracture) [20,39,40]. Although true isolated greater trochanteric fractures are often treated conservatively, a subset of incomplete intertrochanteric fractures warrant internal fixation due to their risk for progression to complete intertrochanteric fracture.

In a meta-analysis of 2,992 patients (35 studies) with clinically suspected hip fracture and using MRI as the reference standard, Haj-Mirzaian et al [20] reported a frequency of surgically managed hip fracture in 92% of patients with seemingly isolated greater trochanteric fractures on radiographs (134 of 157 patients). In a retrospective study of 146 patients who underwent MRI after identification of seemingly isolated greater trochanteric fracture on radiographs or CT, Walsh et al [40] examined if the orientation/degree of intertrochanteric fracture extension on MRI correlated with the decision to undergo conservative versus surgical management. The authors stratified patients into 1 of 5 categories based on fracture morphology on MRI: horizontal isolated greater trochanteric fracture, vertical fracture along the lateral femoral cortex, intertrochanteric fracture extending <50% in the mid coronal plane, intertrochanteric fracture extending >50% in the mid coronal plane but not contacting medial cortex, and intertrochanteric fracture contacting medial cortex. They reported that intertrochanteric fracture extension >50% in the mid coronal plane (ie, the latter 2 categories above) was a highly statistically significant predictor of surgical management in their study cohort ($P < .0001$), but they acknowledge that 31.9% of the surgical fractures in their study traversed <50% of the mid coronal plane [40]. In a retrospective review of 15 incomplete intertrochanteric fractures that traversed less than or close to 50% of the mid coronal plane on initial MRI (one of these fractures traversed 60% whereas the others traversed <50%), all 15 fractures healed on follow-up radiographs without fracture displacement or need for surgical intervention [41].

Variant 3: Adult. Acute hip pain, traumatic. Radiographs positive for hip fracture. Next imaging study.
G. US hip

There is no evidence to support the use of US as the next imaging study for the evaluation of acute traumatic hip pain.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.

The goals of imaging are to confirm successful reduction of native hip dislocation and to detect possible associated fracture(s). This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by reducing length of immobility and potential risk of recurrent dislocation. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.
A. Bone scan hip

There is no evidence to support the use of bone scan as follow-up imaging after reduction of hip dislocation.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.

B. CT hip with IV contrast

There is no evidence to support the use of CT with IV contrast as follow-up imaging after reduction of hip dislocation.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.
C. CT hip without and with IV contrast

There is no evidence to support the use of CT without and with IV contrast as follow-up imaging after reduction of hip dislocation.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.
D. CT hip without IV contrast

Postreduction CT may be considered to evaluate for joint congruence, intraarticular fragments, and to characterize associated acetabular fracture, noting that CT has better detection/evaluation of these findings than radiographs [8]. Postreduction hip CT is particularly indicated for radiographically visible (larger) fractures of the posterior acetabular wall to further characterize the fracture and determine if surgical management will be necessary to prevent repeat hip dislocation. Additionally, any patient who fails closed reduction should undergo CT to evaluate for entrapped fracture fragment(s) within the hip joint as the source of failed reduction.

In a study correlating CT, MRI, and arthroscopy after traumatic hip dislocation, Mandell et al [42] reported that although CT had a sensitivity of 87.3% for detecting intraarticular fracture fragments, 43.3% of patients with negative preoperative CT had intraarticular fracture fragments at arthroscopy. Mullis and Dahners [43] evaluated the arthroscopic detection of small intraarticular fracture fragments or small (nonsurgical) acetabular wall fracture that were not identified on radiographs or CT—they reported that intraarticular fragments were found in 78% of patients who had negative radiographs and CT.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.
E. MRI hip without and with IV contrast

There is no evidence to support the use of MRI without and with IV contrast as follow-up imaging after reduction of hip dislocation.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.
F. MRI hip without IV contrast

There is insufficient evidence to support the use of MRI in the acute postreduction setting.

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.
G. Radiography hip

Hip radiographs (AP and cross-table lateral views) are the mainstay of postreduction imaging after hip dislocation and should be obtained in all patients who do not undergo immediate postreduction CT. Prompt concentric reduction of hip dislocation and timely confirmation of successful reduction via imaging are essential to prevent femoral head osteonecrosis and other potential complications [44].

Variant 4: Adult. Acute hip pain, traumatic. Post reduction of hip dislocation. Follow-up imaging.
H. US hip

There is no evidence to support the use of US as follow-up imaging after reduction of hip dislocation.

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.

The goal of imaging is to detect acute myotendinous injury as the source of acute hip pain. This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by reducing length of immobility. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.
A. Bone scan hip

There is no evidence to support the use of bone scan as the next imaging study for the evaluation of suspected tendon, muscle, or ligament injury.

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.
B. CT hip with IV contrast

There is no evidence to support the use of CT with IV contrast as the next imaging study for the evaluation of suspected tendon, muscle, or ligament injury.

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.
C. CT hip without and with IV contrast

There is no evidence to support the use of CT without and with IV contrast as the next imaging study for the evaluation of suspected tendon, muscle, or ligament injury.

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.
D. CT hip without IV contrast

There is no evidence to support the use of CT without IV contrast as the next imaging study for the evaluation of suspected tendon, muscle, or ligament injury.

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.
E. MRI hip without and with IV contrast

There is no evidence to support the use of MRI without and with IV contrast as the next imaging study for the evaluation of suspected tendon, muscle, or ligament injury.

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.
F. MRI hip without IV contrast

MRI is the next useful imaging examination to evaluate for tendon, muscle, or ligament injury about the hip. The usefulness of MRI in diagnosing gluteus medius tendon avulsion/tear was first reported in radiology literature in the late 1990s around the same time that orthopedic literature began to focus on the gluteus minimus/medius tendons as the functional "rotator cuff of the hip" [45]. A 2004 retrospective analysis reported that MRI had sensitivity of 93%, specificity of 92%, and accuracy of 91% in the detection of gluteus minimus/medius tendon tear [46]. More recent retrospective reviews and meta-analyses have reported more modest MRI accuracy, though still acknowledging that MRI remains the mainstay of evaluating gluteus minimus/medius tendiopathy [47-50]. Of note, most of these studies included patients with chronic greater trochanteric pain syndrome and were not limited to patients with acute tendon injury. For example, a meta-analysis of 5 MRI studies with intraoperative correlation reported sensitivity range of 33% to 100% and specificity range of 92% to 100% for MRI in detecting gluteus minimus/medius tendon tears [51].

Hamstring injuries are common in athletes and are among the most common reason that athletes miss time from sports [52]. Though most muscle belly hamstring injuries do not require MRI in the acute setting, MRI evaluation is particularly useful in acute proximal hamstring tendon avulsions with successful outcomes reported for repairs of both partial and complete tendon avulsions [53]. In a retrospective study comparing US and MRI for proximal hamstring avulsion injuries, Koulouris and Connell [54] reported that MRI detected 100% of these injuries, whereas US detected only 58.3%. Several more recent publications on the topic of hamstring injuries describe the usefulness of MRI in classifying the location, extent, degree (partial versus complete), and chronicity [52,55,56].

Two recent review articles describe the usefulness of MRI in the evaluation of iliofemoral ligament and ligamentum teres injury, respectively [57,58].

Variant 5: Adult. Acute hip pain, traumatic. Suspect tendon, muscle, or ligament injury. Radiographs negative or indeterminate. Next imaging study.
G. US hip

There is insufficient evidence to support the use of US as the next imaging study for the evaluation of suspected tendon, muscle, or ligament injury. There is a paucity of studies that specifically evaluate the usefulness of US for the detection of acute gluteus tendon tear—most sonographic studies to date include patients with chronic greater trochanteric pain syndrome. For example, a study of patients with chronic greater trochanteric pain syndrome reported a sensitivity of 79% for US in the detection of gluteus minimus/medius tendon tear [59].

A review article by Lungu et al [56] describes US of myotendinous injuries about the hip but the authors report that it has limited use in return-to-play decisions with MRI playing a more important role. In a retrospective study comparing US and MRI for proximal hamstring avulsion injuries, Koulouris and Connell [54] reported that MRI detected 100% of these injuries, whereas US detected only 58.3%.

There are no publications on the topic of iliofemoral ligament evaluation via US and the ligamentum teres cannot be evaluated sonographically because of its depth within the hip joint.

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**: Hip radiographs (AP and lateral views) are usually appropriate for the initial imaging of acute hip pain.

- **Variant 2**: If there is persistent concern for hip fracture after negative or indeterminate radiographs, then noncontrast CT is usually appropriate as the first-line examination in this scenario, but patients with persistent clinical concern for hip fracture after negative or equivocal CT will still need noncontrast MRI.
- **Variant 3**: After a positive radiograph for hip fracture, noncontrast CT is usually appropriate when further characterization of fracture alignment is needed for surgical decision-making. Noncontrast MRI may be appropriate to identify incomplete intertrochanteric fracture extension, which cannot be reliably distinguished from isolated greater trochanteric fracture on radiographs and CT.
- **Variant 4**: After reduction of hip dislocation, repeat radiographs (AP and lateral views) should be obtained to confirm successful hip relocation. In patients with associated large posterior acetabular wall fracture on radiographs or difficulty in obtaining successful reduction, noncontrast CT is usually appropriate to evaluate if surgical fixation of the posterior acetabular wall fracture is warranted or if there are intra-articular fracture fragments that impede complete/anatomic relocation.
- **Variant 5**: MRI of the hip without contrast is usually appropriate when evaluating for clinically suspected tendon, muscle, or ligament injury as the source of acute hip pain after negative or indeterminate radiographs.

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

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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