American College of Radiology
ACR Appropriateness Criteria®
Acute Shoulder Pain

<u>Variant 1:</u> **Adult. Acute shoulder pain. Any etiology. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography shoulder	Usually Appropriate	☢
US shoulder	Usually Not Appropriate	O
MR arthrography shoulder	Usually Not Appropriate	O
MRI shoulder without and with IV contrast	Usually Not Appropriate	O
MRI shoulder without IV contrast	Usually Not Appropriate	O
Bone scan shoulder	Usually Not Appropriate	☢☢☢
CT shoulder with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without IV contrast	Usually Not Appropriate	☢☢☢
CT arthrography shoulder	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

<u>Variant 2:</u> **Adult. Acute shoulder pain. Suspect occult fracture. Radiographs negative or indeterminate. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI shoulder without IV contrast	Usually Appropriate	O
CT shoulder without IV contrast	Usually Appropriate	☢☢☢
US shoulder	Usually Not Appropriate	O
MR arthrography shoulder	Usually Not Appropriate	O
MRI shoulder without and with IV contrast	Usually Not Appropriate	O
Bone scan shoulder	Usually Not Appropriate	☢☢☢
CT shoulder with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually Not Appropriate	☢☢☢
CT arthrography shoulder	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Variant 3: **Adult. Acute shoulder pain. Radiographs positive for proximal humerus, scapular, or clavicle fracture. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
CT shoulder without IV contrast	Usually Appropriate	☢☢☢
MRI shoulder without IV contrast	May Be Appropriate	O
US shoulder	Usually Not Appropriate	O
MR arthrography shoulder	Usually Not Appropriate	O
MRI shoulder without and with IV contrast	Usually Not Appropriate	O
Bone scan shoulder	Usually Not Appropriate	☢☢☢
CT shoulder with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually Not Appropriate	☢☢☢
CT arthrography shoulder	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Variant 4: **Adult. Acute shoulder pain. History or physical examination consistent with dislocation or instability. Radiographs positive, negative, or indeterminate. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI shoulder without IV contrast	Usually Appropriate	O
MR arthrography shoulder	May Be Appropriate (Disagreement)	O
CT shoulder without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
US shoulder	Usually Not Appropriate	O
MRI shoulder without and with IV contrast	Usually Not Appropriate	O
Bone scan shoulder	Usually Not Appropriate	☢☢☢
CT shoulder with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually Not Appropriate	☢☢☢
CT arthrography shoulder	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

<u>Variant 5:</u> **Adult. Acute shoulder pain. Physical examination consistent with labral tear. Radiographs negative or indeterminate. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
MR arthrography shoulder	Usually Appropriate	O
MRI shoulder without IV contrast	Usually Appropriate	O
CT arthrography shoulder	Usually Appropriate	☢☢☢☢
US shoulder	Usually Not Appropriate	O
MRI shoulder without and with IV contrast	Usually Not Appropriate	O
Bone scan shoulder	Usually Not Appropriate	☢☢☢
CT shoulder with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without IV contrast	Usually Not Appropriate	☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

<u>Variant 6:</u> **Adult. Acute shoulder pain. Physical examination consistent with rotator cuff tear. Radiographs negative or indeterminate. Next imaging study.**

Procedure	Appropriateness Category	Relative Radiation Level
US shoulder	Usually Appropriate	O
MRI shoulder without IV contrast	Usually Appropriate	O
MR arthrography shoulder	Usually Not Appropriate	O
MRI shoulder without and with IV contrast	Usually Not Appropriate	O
Bone scan shoulder	Usually Not Appropriate	☢☢☢
CT shoulder with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without and with IV contrast	Usually Not Appropriate	☢☢☢
CT shoulder without IV contrast	Usually Not Appropriate	☢☢☢
CT arthrography shoulder	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

ACUTE SHOULDER PAIN

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<u>Summary of Literature Review</u>

Introduction/Background

Trauma is a predominant cause of acute shoulder pain, commonly secondary to fractures (clavicle, scapula, or proximal humerus) or soft tissue injuries (typically involving the rotator cuff, acromioclavicular ligaments, or labroligamentous complex). The incidence of traumatic shoulder pain varies depending on age, activity level, and sport participation and tends to disproportionately involve young adults and male patients [1,2].

The etiology of acute shoulder pain is often discerned through clinical examination and comprehensive clinical history that includes the mechanism of injury. Traumatic shoulder injuries can generally be separated into injuries requiring acute surgical management and those for which conservative management is initially considered before contemplating surgery. Unstable or significantly displaced fractures and joint instability are injuries most likely requiring acute surgical treatment, noting that factors such as patient's age, comorbidities, and current and expected activity level all help in determining the appropriate management strategy. Soft tissue injuries, including labral tears and rotator cuff tears, may undergo a period of conservative management. However, it's important to note that the repair of traumatic massive rotator cuff tears may require an expedited timeline to achieve optimal postoperative functional outcomes [3].

Imaging of chronic shoulder pain is beyond the scope of this topic and is covered in the ACR Appropriateness Criteria® topic on "<u>Chronic Shoulder Pain</u>" [4]. Calcific tendinitis and bursitis are also covered in the ACR Appropriateness Criteria® topic on "<u>Chronic Shoulder Pain</u>" [4]. Imaging of suspected inflammatory or crystalline arthritis is covered in the ACR Appropriateness Criteria® topic on "<u>Chronic Extremity Joint Pain-Suspected Inflammatory Arthritis, Crystalline Arthritis, or Erosive Osteoarthritis</u>" [5]. Pathologic fractures as the cause of the acute shoulder pain are also outside the scope of this document.

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 where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Adult. Acute shoulder pain. Any etiology. Initial imaging.

The goal of imaging is to diagnose or exclude conditions as the source of acute shoulder pain. This imaging information improves patient outcome by characterizing the injury pattern and thereby guiding timely management.

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This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Bone Scan Shoulder
There is no relevant literature to support the use of bone scan in the initial evaluation of acute shoulder pain.

CT Arthrography Shoulder
There is no relevant literature to support the use of CT arthrography shoulder in the initial evaluation of acute shoulder pain.

CT Shoulder With IV Contrast
There is no relevant literature to support the use of CT shoulder with intravenous (IV) contrast in the initial evaluation of acute shoulder pain.

CT Shoulder Without and With IV Contrast
There is no relevant literature to support the use of CT shoulder with and without IV contrast in the initial evaluation of acute shoulder pain.

CT Shoulder Without IV Contrast
CT without IV contrast surpasses radiographs in its ability to characterize fracture patterns [6-8]. However, radiographs are preferred over CT for initial evaluation because of their efficacy in diagnosing displaced fractures and shoulder malalignment, which are the primary concerns in the initial assessment of acute shoulder pain [7,9].

FDG-PET/CT Skull Base to Mid-Thigh
There is no relevant literature to support the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT in the initial evaluation of acute shoulder pain.

MR Arthrography Shoulder
There is no relevant literature to support the use of MR arthrography in the initial evaluation of acute shoulder pain.

MRI Shoulder Without and With IV Contrast
There is no relevant literature to support the use of MRI shoulder with and without IV contrast in the initial evaluation of acute shoulder pain.

MRI Shoulder Without IV Contrast
There is no relevant literature to support the use of MRI shoulder without IV contrast in the initial evaluation of acute shoulder pain.

Radiography Shoulder
Radiographs are the preferred initial diagnostic modality in cases of acute shoulder pain because they can delineate shoulder malalignment and most shoulder fractures [7,9]. A standard set of shoulder radiographs for trauma should include at minimum the following 3 views: anterior-posterior (AP) views in internal and external rotation and an axillary or scapula-Y view. Axillary or scapula-Y views are vital in evaluating traumatic shoulder injuries as acromioclavicular and glenohumeral joint dislocations can be misclassified on AP views [10,11]. The Stryker notch view can be used to evaluate Hill-Sachs lesions. Radiographs provide good delineation of bony anatomy to assess for fracture and appropriate shoulder alignment, which are the 2 primary concerns in management of acute traumatic shoulder pain. Furthermore, radiographs aid in fracture classification and assist with determining the appropriate management approach, such as surgical or nonsurgical, for conditions like proximal humeral fractures [12]. They can also confirm successful glenohumeral joint reduction following an acute dislocation event.

US Shoulder
Ultrasound (US) has limited usefulness in patients with acute shoulder pain that cannot be localized to the rotator cuff or biceps tendon. Diagnosis of proximal humerus fractures by US has been described [13], but US is generally limited in evaluating bone due to acoustic shadowing.

Variant 2: Adult. Acute shoulder pain. Suspect occult fracture. Radiographs negative or indeterminate. Next imaging study.

The goal of imaging is to detect radiographically occult fracture. This imaging information can improve patient outcome by detecting occult fracture and guiding appropriate management. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Bone Scan Shoulder
There is no relevant literature to support the use of bone scan as the next study in the evaluation of acute shoulder pain with normal or indeterminate radiographs.

CT Arthrography Shoulder
There is no relevant literature to support the use of CT arthrography as the next study in the evaluation of acute shoulder pain with normal or indeterminate radiographs.

CT Shoulder With IV Contrast
There is no relevant literature to support the use of CT shoulder with IV contrast in the evaluation of acute shoulder pain with normal or indeterminate radiographs.

CT Shoulder Without and With IV Contrast
There is no relevant literature to support the use of CT shoulder without and with IV contrast in the evaluation of acute shoulder pain with normal or indeterminate radiographs.

CT Shoulder Without IV Contrast
CT is advantageous over radiography in identifying subtle nondisplaced fractures and characterizing fracture morphology, especially in cases of complex comminuted fractures in which radiographs are indeterminate for comprehensive fracture characterization. For example, a study by Stoddard et al [14] demonstrated that CT imaging obtained after radiographs can affect clinical management in up to 41% of patients with proximal humeral fractures. CT is also the most useful modality in detection of scapular fractures that are frequently missed on radiographs, especially when they are nondisplaced [15,16].

FDG-PET/CT Skull Base to Mid-Thigh
There is no relevant literature to support the use FDG-PET/CT in the evaluation of acute shoulder pain with normal or indeterminate radiographs.

MR Arthrography Shoulder
There is no relevant literature to support the use of MR arthrography shoulder in the evaluation of acute shoulder pain with normal or indeterminate radiographs.

MRI Shoulder Without and With IV Contrast
There is no relevant literature to support the use of MR shoulder without and with IV contrast in the evaluation of acute shoulder pain with normal or indeterminate radiographs.

MRI Shoulder Without IV Contrast
Noncontrast MRI may be a useful imaging study in the setting of acute shoulder pain and noncontributory radiographs. MRI can frequently establish underlying pathology leading to pain, such as rotator cuff tears, osseous contusions, acromioclavicular sprains, bony and osseous abnormalities following glenohumeral joint dislocation [17]. In the acute posttraumatic setting, MRI without IV contrast is preferred to MR arthrography because acute intraarticular pathology will typically result in a significant joint effusion, facilitating the assessment of intraarticular soft tissue structures. MRI is the preferred imaging modality in assessing extraarticular soft tissue traumatic pathology such as capsular and ligament tears [18,19]. MRI is also sensitive for diagnosing bone marrow contusion and has been shown to be beneficial in assessing shoulder physeal injuries in pediatric patients [20,21].

US Shoulder
US exhibits limited usefulness in cases of acute shoulder pain when the source cannot be localized to the rotator cuff or biceps tendon. A 2020 study by Saragaglia et al [17] highlighted that shoulder US offers minimal value, except in cases where an isolated rotator cuff tear is suspected, and it tends to overlook osseous and soft tissue injuries associated with shoulder instability or bony contusion.

Variant 3: Adult. Acute shoulder pain. Radiographs positive for proximal humerus, scapular, or clavicle fracture. Next imaging study.

The goal of imaging is to further characterize the fracture or associated soft tissue injuries 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 fracture reduction and/or operative management. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Bone Scan Shoulder
There is no relevant literature to support the use of bone scan as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

CT Arthrography Shoulder
There is no relevant literature to support the use of CT arthrography as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

CT Shoulder With IV Contrast
There is no relevant literature to support the use of CT shoulder with IV contrast as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

CT Shoulder Without and With IV Contrast
There is no relevant literature to support the use of CT shoulder without and with IV contrast as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

CT Shoulder Without IV Contrast
Nondisplaced fracture planes and complex bony anatomy can result in underappreciation of the extent of proximal humeral fractures on radiographs. Consequently, poor agreement between observers has been shown on grading of humeral head fractures on radiographs [7]. CT is the optimal imaging modality for delineating proximal humeral fracture patterns [12]. Obtaining 3-D volume-rendered CT images can further enhance the characterization of fracture patterns and assess humeral neck angulation, which may impact functional outcomes [22]. CT is also advantageous in detection of fractures of the medial end of the clavicle, which can be missed on radiography [23].

Because of the scapula's complex osteology and overlying ribs, scapular fractures can be easily missed or underappreciated on conventional radiographs. CT is the best imaging modality for identifying and characterizing scapular fracture patterns [16]. Intraarticular extension, angulation, and lateral border offset can all be better assessed on CT compared with conventional radiographs [16,24,25]. Three-dimensional reformatted CT images can better visualize scapula fracture displacement and angulation [24].

FDG-PET/CT Skull Base to Mid-Thigh
There is no relevant literature to support the use of FDG PET/CT as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

MR Arthrography Shoulder
There is no relevant literature to support the use of MR arthrography shoulder as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

MRI Shoulder Without and With IV Contrast
There is no relevant literature to support the use of MRI shoulder without and with IV contrast as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

MRI Shoulder Without IV Contrast
MRI without IV contrast is inferior to CT in evaluating fracture planes in complex fracture patterns and, generally, in characterizing proximal humerus fractures. Although MRI can detect rotator cuff tears associated with proximal humeral fracture, significant rotator cuff tears are typically identified and addressed during open reduction and internal fixation of the fracture [26]. An MRI of the shoulder without IV contrast may be useful in assessing rotator cuff integrity in patients with proximal humeral fractures not undergoing surgical fixation [26].

In evaluating scapular fractures, MRI has limited usefulness. The thin cortex and sparse medullary cavity of the scapula body can pose challenges for diagnosing scapula body fractures on MRI [15]. Additionally, the shoulder-specific coils commonly used for MRI shoulder may not cover the entire scapula, necessitating the use of body coils with a larger field-of-view. This would compromise resolution of the study, resulting in suboptimal evaluation of scapular fracture displacement and angulation.

MRI may be useful in assessment of acromioclavicular joint separation injuries, providing a detailed assessment of the coracoclavicular ligaments that can influence clinical management [19].

US Shoulder
There is no relevant literature to support the use of US as the next study in the evaluation of acute shoulder pain with radiographs positive for proximal humerus, scapular, or clavicle fractures.

Variant 4: Adult. Acute shoulder pain. History or physical examination consistent with dislocation or instability. Radiographs positive, negative, or indeterminate. Next imaging study.

The goal of imaging is to detect sequelae of recent or prior glenohumeral dislocation that may predispose to recurrent glenohumeral joint instability. This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by guiding nonsurgical therapy and/or surgical management. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Bone Scan Shoulder
There is no relevant literature to support the use of bone scan as the next study in the evaluation of acute shoulder pain in assessment of shoulder instability.

CT Arthrography Shoulder
There is no relevant literature to support the use of CT arthrography as the next study in the evaluation of acute shoulder pain in assessment of shoulder instability.

CT Shoulder With IV Contrast
There is no relevant literature to support the use of CT shoulder with IV contrast as the next study in the evaluation of acute shoulder pain in assessment of shoulder instability.

CT Shoulder Without and With IV Contrast
There is no relevant literature to support the use of CT shoulder without and with IV contrast as the next study in the evaluation of acute shoulder pain in assessment of shoulder instability.

CT Shoulder Without IV Contrast
Noncontrast CT has historically been used to assess Hill-Sachs and bony Bankart lesions, which are frequently underestimated or missed on radiographic examination [27]. However, MRI has been shown to be equivalent to CT for assessing both glenoid and humeral head bone loss, and CT is limited in the assessment of cartilaginous Hill-Sachs lesions [8,28-30]. Noncontrast CT is also unable to assess rotator cuff and labroligamentous pathology commonly seen in shoulder dislocations and instability. In general, CT should be reserved for patients in whom MRI assessment of bone loss is limited.

FDG-PET/CT Skull Base to Mid-Thigh
There is no relevant literature to support the use of FDG-PET/CT as the next study in the evaluation of acute shoulder pain in assessment of shoulder instability.

MR Arthrography Shoulder
There is limited literature describing the use of MR arthrography for the evaluation of glenohumeral joint instability in patients with acute shoulder pain, including for the diagnosis of labroligamentous injuries [31,32]. However, in the setting of acute glenohumeral joint dislocation or instability, a posttraumatic joint effusion or hemarthrosis is typically present and can provide sufficient visualization of soft tissue structures on MR arthrography.

MRI Shoulder Without and With IV Contrast
There is no relevant literature to support the use of MRI shoulder without and with IV contrast as the next study in the evaluation of acute shoulder pain in assessment of shoulder instability.

MRI Shoulder Without IV Contrast
MRI without IV contrast may be preferred to MR arthrography in the setting of acute shoulder dislocation when a posttraumatic joint effusion is present to provide sufficient visualization of soft tissue structures. In the subacute or chronic setting, the glenohumeral joint effusion is usually too small to provide adequate joint distention for optimal assessment of soft tissue structures, and noncontrast MRI has been shown to be inferior to MR arthrography in diagnosing labroligamentous and rotator cuff injuries [31,33]. Noncontrast MRI performs comparably to CT in evaluating glenoid and humeral head bone loss [29,33], which may obviate the need for noncontrast CT.

US Shoulder
There is no relevant literature to support the use of US shoulder as the next study in the evaluation of acute shoulder pain in assessment of shoulder instability.

Variant 5: Adult. Acute shoulder pain. Physical examination consistent with labral tear. Radiographs negative or indeterminate. Next imaging study.

The goal of imaging is to detect labral tear. This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by guiding nonsurgical therapy and/or surgical management. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Bone Scan Shoulder

There is no relevant literature to support the use of bone scan as the next study in assessment of suspected labral tear.

CT Arthrography Shoulder

CT arthrography provides comparable sensitivity and possibly improved specificity in detection of labral lesions compared to MR arthrography and can provide improved visualization of the osseous abnormality such as glenoid rim fractures [29,34,35]. However, interobserver variability in reporting of labral lesions is low [36]. CT arthrography has also been shown to be inferior to MR arthrography in assessing partial-thickness rotator cuff tears [29], which makes CT arthrography less desirable in patients where rotator cuff tears may be suspected.

CT Shoulder With IV Contrast

There is no relevant literature to support the use of CT shoulder with IV contrast as the next study in assessment of suspected labral tear.

CT Shoulder Without and With IV Contrast

There is no relevant literature to support the use of CT shoulder without and with IV contrast as the next study in assessment of suspected labral tear.

CT Shoulder Without IV Contrast

There is no relevant literature to support the use of CT shoulder without IV contrast as the next study in assessment of suspected labral tear.

FDG-PET/CT Skull Base to Mid-Thigh

There is no relevant literature to support the use of FDG-PET/CT as the next study in assessment of suspected labral tear.

MR Arthrography Shoulder

MR arthrography is considered the reference standard for labral imaging given its high sensitivity for detection of labral injury, ranging from 86% to 100% secondary to optimal glenohumeral joint distention and improved soft tissue contrast [32,37-41]. However, MRI without IV contrast may be preferred modality in acute posttraumatic setting with acute shoulder pain when a posttraumatic joint effusion is present to provide sufficient visualization of soft tissue structures. Additionally, the issue of selection bias is inherent in the design of many of retrospective MR arthrography studies [42]. For example, these studies often identified patient groups at the time of arthroscopy, resulting in the inclusion of patients with proven labral lesions, rather than evaluating all patients with clinically unstable shoulders.

Compared to noncontrast MRI, MR arthrography has been shown to have superior diagnostic sensitivity for detection of anterior labral and superior labrum anterior to posterior (SLAP) tears [33,43]. Another meta-analysis showed that MR arthrography is slightly more sensitive than noncontrast MRI for anterior labral tears but not statistically significant (87% versus 83%, $P = .083$) [44]. For SLAP lesions, 3T 2-D neutral MR arthrography was of similar sensitivity to 3T MRI (84% versus 83%, $P = .575$) but less specific (99% versus 92% $P < .0001$) [44]. Particularly in the context of small and nondisplaced labral tears, addition of abduction and external rotation sequence to conventional MR arthrography further increased diagnostic accuracy for labral tear detection [45].

MRI Shoulder Without and With IV Contrast

There is no relevant literature to support the use of MRI shoulder without and with IV contrast as the next study in assessment of suspected labral tear.

MRI Shoulder Without IV Contrast

MRI without IV contrast may be preferred to MR arthrography in the setting of acute trauma when a posttraumatic joint effusion is typically present to provide sufficient visualization of soft tissue structures. In the subacute or chronic setting, the glenohumeral joint effusion is usually too small to provide sufficient joint distention to adequately assess soft tissue structures, and MR arthrography has been considered a reference standard in those cases, even when compared to 3T conventional MRI [31,33,44]. Note that 3T MRI appears to improve diagnostic accuracy compared to 1.5 T MRI [46]. In addition, MRI of the shoulder may be more suitable for middle aged to older patient group who often have asymptomatic age-related labral tears not necessitating detailed characterization or surgical intervention [47].

US Shoulder
There is no relevant literature to support the use of US as the next study in assessment of suspected labral tear.

Variant 6: Adult. Acute shoulder pain. Physical examination consistent with rotator cuff tear. Radiographs negative or indeterminate. Next imaging study.

The goal of imaging is to detect rotator cuff tear. This imaging information helps to initiate the appropriate treatment plan sooner, which can improve patient outcome by guiding nonsurgical therapy and/or surgical management. This imaging information benefits the patient by reducing potential delay in appropriate treatment and by hastening patient recovery.

Bone Scan Shoulder
There is no relevant literature to support the use of bone scan as the next study in assessment of suspected rotator cuff tear.

CT Arthrography Shoulder
There is no relevant literature to support the use of CT arthrography as the next study in assessment of suspected rotator cuff tear.

CT Shoulder With IV Contrast
There is no relevant literature to support the use of CT shoulder with IV contrast as the next study in assessment of suspected rotator cuff tear.

CT Shoulder Without and With IV Contrast
There is no relevant literature to support the use of CT shoulder without and with IV contrast as the next study in assessment of suspected rotator cuff tear.

CT Shoulder Without IV Contrast
There is no relevant literature to support the use of CT shoulder without IV contrast as the next study in assessment of suspected rotator cuff tear.

FDG-PET/CT Skull Base to Mid-Thigh
There is no relevant literature to support the use of FDG-PET/CT as the next study in assessment of suspected rotator cuff tear.

MR Arthrography Shoulder
There is limited literature describing the use of MR arthrography for the evaluation of rotator cuff tears in patients with acute shoulder pain. MRI without IV contrast may be preferred to MR arthrography in the setting of acute shoulder trauma when a posttraumatic joint effusion is present to provide sufficient visualization of soft tissue structures. However, in general, MR arthrography has shown increased sensitivity for detection of partial-thickness articular surface supraspinatus tears compared with conventional MRI [31,48,49].

MRI Shoulder Without and With IV Contrast
There is no relevant literature to support the use of MRI shoulder without and with IV contrast as the next study in assessment of suspected rotator cuff tear.

MRI Shoulder Without IV Contrast
MRI shoulder without IV contrast is generally considered the best modality for adequately assessing most soft tissue injuries, including labroligamentous, cartilage, and rotator cuff pathology, particularly in the setting of recent trauma [29,31], It has high sensitivity and specificity in detection of full-thickness rotator cuff tears, but lower sensitivity compared to MR arthrography for detection of partial-thickness tears [49].

US Shoulder
US shoulder has high sensitivity and specificity for the detection of specifically full-thickness rotator cuff tears, showing performance levels similar to MRI and MR arthrography imaging [49-52]. A comprehensive meta-analysis by Roy et al [49] estimated sensitivities ranging from 90% to 91% and specificities from 93% to 95% for these

modalities. There is conflicting evidence on the ability of US to diagnose partial-thickness rotator cuff tears [31,52-55]. Similarly, although interobserver agreement in detection of full-thickness rotator cuff tears can be high, it is much more variable for detection of partial-thickness tears [56,57].

In specific scenarios, such as cases involving previously placed proximal humeral hardware with limited MRI examination due to susceptibility artifacts, US may be preferred over MRI. Conversely, MRI might be the preferred imaging modality in cases with large body habitus, restricted range of motion due to acute pain, or when there is suspicion of other intraarticular pathologies, such as labral tears.

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**: Radiography of the shoulder is usually appropriate as the initial imaging study in the setting of acute shoulder pain of any etiology.
- **Variant 2**: In the setting of acute shoulder pain with normal or nonspecific radiographs and suspicion for occult fracture, CT shoulder without IV contrast or MRI shoulder without IV contrast is usually appropriate as the next imaging study. CT shoulder without IV contrast provides detailed evaluation of osseous anatomy with high spatial resolution facilitating identification of subtle nondisplaced fractures. MRI shoulder can demonstrate evidence of bone marrow edema in the setting of trauma and identify capsuloligamentous soft tissue pathology such as rotator cuff or labral tear.
- **Variant 3**: In the setting of acute shoulder pain and radiographs positive for proximal humerus, scapular, or clavicle fracture, CT shoulder without IV contrast is usually appropriate as the next imaging study. MRI without IV contrast is inferior to CT in evaluating fracture planes in complex fracture patterns and, generally, in characterizing proximal humerus fractures. However, MRI shoulder without IV contrast may be appropriate as the next imaging study in assessment of possible rotator cuff injury in patients who are not planned to undergo surgical fixation of the fracture, as well as in evaluation of the acromioclavicular joint separation injuries, providing a detailed assessment of the coracoclavicular ligament pathology that can influence clinical management.
- **Variant 4**: In the setting of acute shoulder pain and history of physical examination consistent with dislocation or instability, MRI shoulder without IV contrast is usually appropriate as the next imaging study. CT shoulder without IV contrast may be appropriate for patients in whom MRI assessment of bone loss is limited. MRI arthrography shoulder may be appropriate for detailed evaluation of the labral pathology. However, in the setting of acute glenohumeral joint dislocation or instability, a posttraumatic joint effusion or hemarthrosis is typically present and can provide sufficient visualization of soft tissue structures on MRI without IV contrast.
- **Variant 5**: In the setting of acute shoulder pain and physical examination consistent with labral tear with negative or indeterminate radiographs, MRI shoulder without IV contrast or MR arthrography or CT arthrography is usually appropriate as the next imaging study. MRI without IV contrast may be preferred to MR arthrography in the setting of acute trauma when a posttraumatic joint effusion is typically present to provide sufficient visualization of soft tissue structures. In the subacute or chronic setting, the glenohumeral joint effusion is usually too small to provide sufficient joint distention to adequately assess soft tissue structures, and MR arthrography has been considered a reference standard in those cases. CT arthrography is usually an appropriate next imaging study in patients with contraindications to obtaining MRI.
- **Variant 6**: In the setting of acute shoulder pain and physical examination consistent with rotator cuff tear with negative or indeterminate radiographs, MRI shoulder without IV contrast or ultrasound of the shoulder is usually appropriate as the next imaging study. These procedures are equivalent alternatives and only one study needs to be ordered for advancement of patient care. MRI shoulder without IV contrast might be the preferred imaging modality in cases with large body habitus, restricted range of motion due to acute pain, or when there is suspicion of other intraarticular pathologies, such as labral tears.

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 go to www.acr.org/ac.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that pre-dates 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 [58].

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 [59].

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 (eg, 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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