# American College of Radiology
# ACR Appropriateness Criteria®

**Clinical Condition:** **Acute Shoulder Pain**

**Variant 1:** **Any etiology; best initial study.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| X-ray shoulder | 9 | | ☢ |
| CT shoulder without contrast | 1 | | ☢ ☢ ☢ |
| CT arthrography shoulder | 1 | | ☢ ☢ |
| MRI shoulder without contrast | 1 | | O |
| MR arthrography shoulder | 1 | | O |
| US shoulder | 1 | | O |
| X-ray arthrography shoulder | 1 | | ☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Variant 2:** **Radiographs noncontributory. Persistent significant pain. Physical examination and history nonspecific. Next study.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI shoulder without contrast | 9 | | O |
| CT arthrography shoulder | 5 | If MRI contraindicated. | ☢ ☢ |
| US shoulder | 5 | If MRI contraindicated. | O |
| MR arthrography shoulder | 1 | | O |
| CT shoulder without contrast | 1 | | ☢ ☢ ☢ |
| X-ray arthrography shoulder | 1 | | ☢ |
| X-ray arthrography shoulder with anesthetic and/or corticosteroid | 1 | | ☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Variant 3:** **Radiographs noncontributory. Age less than 35 years, suspect labral tear with or without instability on physical examination.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MR arthrography shoulder | 9 | See statement regarding contrast in text under "Anticipated Exceptions." | O |
| MRI shoulder without contrast | 7 | With optimized imaging equipment. | O |
| CT arthrography shoulder | 5 | If MRI contraindicated. | ☢ ☢ |
| CT shoulder without contrast | 1 | | ☢ ☢ ☢ |
| US shoulder | 1 | | O |
| X-ray arthrography shoulder | 1 | | ☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Clinical Condition:** **Acute Shoulder Pain**

**Variant 4:** **Radiographs noncontributory. Questionable bursitis or long head of biceps tenosynovitis based on clinical findings including physical examination.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI shoulder without contrast | 9 | MRI and US are equivalent in this evaluation. | O |
| US shoulder | 9 | MRI and US are equivalent in this evaluation. If local expertise available. Study may include injection of anesthetic and/or corticosteroid if clinically warranted. | O |
| CT shoulder without contrast | 1 | | ☢☢☢ |
| CT arthrography shoulder | 1 | | ☢☢ |
| MR arthrography shoulder | 1 | | O |
| X-ray arthrography shoulder | 1 | | ☢ |
| X-ray shoulder bursography/tenography with anesthetic and/or corticosteroid | 1 | | ☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Variant 5:** **Normal radiographs or radiographs that demonstrate coracoacromial arch osteophytes/syndesmophytes. Suspect rotator cuff tear/impingement, over age 35 years.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI shoulder without contrast | 9 | | O |
| US shoulder | 8 | | O |
| MR arthrography shoulder | 7 | See statement regarding contrast in text under "Anticipated Exceptions." | O |
| CT arthrography shoulder | 5 | If MR or US cannot be performed. | ☢☢ |
| X-ray arthrography shoulder | 1 | | ☢ |
| CT shoulder without contrast | 1 | | ☢☢☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Variant 6:** **Radiographs noncontributory. Previous total shoulder arthroplasty. Suspect rotator cuff tear.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| US shoulder | 9 | | O |
| X-ray arthrography shoulder | 8 | If US expertise not available. | ☢ |
| CT arthrography shoulder | 7 | With optimized imaging equipment. | ☢☢ |
| MR arthrography shoulder | 6 | See statement regarding contrast in text under "Anticipated Exceptions." | O |
| MRI shoulder without contrast | 5 | With dedicated metal suppression protocol. | O |
| CT shoulder without contrast | 1 | | ☢☢☢ |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Clinical Condition:** **Acute Shoulder Pain**

**Variant 7:** **Radiographs noncontributory. Status post prior rotator cuff repair. Suspect re-tear.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI shoulder without contrast | 9 | MRI, MR arthrography, and US are equivalent in this evaluation, depending on local expertise. | O |
| MR arthrography shoulder | 9 | MRI, MR arthrography, and US are equivalent in this evaluation, depending on local expertise. See statement regarding contrast in text under "Anticipated Exceptions." | O |
| US shoulder | 9 | MRI, MR arthrography, and US are equivalent in this evaluation, depending on local expertise. | O |
| X-ray arthrography shoulder | 5 | If MRI or US cannot be performed. | ☢ |
| CT arthrography shoulder | 5 | If MRI or US cannot be performed. | ☢ ☢ |
| CT shoulder without contrast | 1 | | ☢ ☢ ☢ |
| **Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

**Variant 8:** **Radiographs noncontributory. Suspect septic arthritis.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| US arthrocentesis shoulder | 9 | US and x-ray guidance are equivalent. | O |
| X-ray arthrocentesis shoulder | 9 | US and x-ray guidance are equivalent. | ☢ |
| MRI shoulder without and with contrast | 7 | Aspiration is the procedure of choice. May be appropriate if clinical concern warrants. See statement regarding contrast in text under "Anticipated Exceptions." | O |
| MRI shoulder without contrast | 6 | Aspiration is the procedure of choice. May be appropriate if clinical concern warrants. | O |
| CT shoulder without and with contrast | 5 | Aspiration is the procedure of choice. May be appropriate if clinical concern warrants. | ☢ ☢ ☢ |
| CT arthrography shoulder | 1 | | ☢ ☢ |
| MR arthrography shoulder | 1 | | O |
| US shoulder | 1 | | O |
| CT shoulder without contrast | 1 | | ☢ ☢ ☢ |
| **Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

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## Summary of Literature Review

### Introduction

The shoulder has the greatest freedom of motion of any joint in the body. The shoulder joint is a complex array of muscles, tendons, and capsuloligamentous structures that demonstrates a wide variety of pathology. Acute (<2 weeks) shoulder pain can be attributable to structures related to the glenohumeral articulation and joint capsule, the rotator cuff, acromioclavicular joint, and scapula. Radiography is a safe, fast, low-cost imaging modality that effectively demonstrates many forms of shoulder pathology. However, a multimodal approach may be required to accurately assess shoulder pathology.

### Radiography

Radiography is a useful initial screening modality for acute shoulder pain of all causes. Radiography is useful in the evaluation of fractures of the shoulder girdle. All radiographic shoulder studies should include frontal examinations. The frontal views can be straight anteroposterior projection (AP) with the humerus in neutral position or with the humerus in internal and/or without external rotation. Local protocols for radiographic evaluation of the shoulder for trauma vary widely. However, the shoulder trauma protocol should have at least three views, of which two views are orthogonal. For trauma, a Grashey projection is recommended to profile the glenohumeral joint, which is AP to the scapula, by turning the patient into a 30-degree posterior oblique profile [1]. For trauma, this examination should have an axillary lateral view, a scapular Y view, or both [1-4]. The axillary lateral view or scapular Y view is advisable if there is a question of instability or dislocation [1,5]. However, the position required for the axillary lateral view may be painful for the patient who has just dislocated his/her shoulder. Care should be taken if the shoulder has just been reduced, as this positioning may lead to re-dislocation. The transthoracic view has little to offer but is not infrequent when outside radiographs become available for review. There have been several reports assessing special views for the evaluation of shoulder impingement and the anterior acromion [3-4,6]. An upright 30-degree angled caudad radiograph (Rockwood view) or a suprascapular outlet view will suffice in most cases [6-7]. A radiograph taken with the patient prone with the shoulder resting on a cushion and arm abducted 90 degrees, with the forearm and hand in pronation, hanging downwards off the edge of the table (Westpoint view), can improve detection of a bony Bankart lesion [1]. A radiograph taken with patient in the supine position, the arm externally rotated and abducted and the x-ray beam angled 10 degrees cephalad and centered on the coracoid process (Stryker notch view) used with an AP internal rotation view, is a sensitive technique for evaluation of a Hill-Sachs deformity [1].

Fluoroscopic arthrography was the mainstay of evaluation for rotator cuff tear until the advent of shoulder magnetic resonance imaging (MRI). Fluoroscopic arthrography is currently used only as a potential study in patients with suspected rotator cuff disease who have a contraindication to MRI and when shoulder ultrasound (US) expertise is not available. Fluoroscopic radiography is a useful modality for directing shoulder injections and aspirations. Aspirations are useful in differentiating between inflammatory and septic arthropathy. Fluoroscopic arthrography can be a useful tool in experienced hands.

### Magnetic Resonance Imaging

MRI can aid in detecting osseous and soft-tissue abnormalities that may predispose to or be the result of shoulder impingement [8-9]. The soft-tissue abnormalities in the supraspinatus tendon, subacromial bursa, and biceps tendon are well seen [10]. The osseous lesions include morphologic abnormalities of the acromion and acromioclavicular joint. When a tendon has a signal intensity abnormality without focal disruption or associated findings to suggest a partial-thickness tear, the terms “tendinosis” or “tendinopathy” have been used to signify an underlying tendon degeneration or inflammation. These terms suggest that there is a chronic degenerative process. The presence of tendinous enlargement and a heterogeneous signal pattern that demonstrates diffuse increased signal intensity on T1-weighting, often with a slight increase in signal intensity

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on T2-weighting, is seen in patients with tendinosis. Partial-thickness tears of the rotator-cuff can be seen inferiorly at the articular surface, superiorly at the bursal surface, or within the tendon substance. Tears at the articular surface are the most common type of partial-thickness tears. These are the only types of partial-thickness tears demonstrated by conventional shoulder arthrography [11]. Full-thickness tears of the rotator-cuff tendon can be accurately identified using conventional nonarthrographic MRI with high sensitivity and specificity. Increased signal intensity extending from the inferior to the superior surface of the tendon on all imaging sequences is an accurate sign of a full-thickness rotator-cuff tear [8]. Ten percent of rotator-cuff tears are asymptomatic and present only with morphologic changes. Tendon retraction, muscle atrophy, and fatty infiltration are important findings that can be useful for decisions regarding conservative versus operative repair, type of operative repair (open, mini-open, or arthroscopic cuff repair; substitute, or muscle transfer) and to provide a postoperative prognosis. If there is any question concerning the distinction between a full-thickness and partial-thickness tear, MR arthrography (MRA) is recommended. It is particularly helpful if the abnormal signal intensity extends from the undersurface of the tendon.

The shoulder joint is the most unstable joint in the body. Instability can be difficult to diagnose, and the pain produced by the unstable shoulder could be mistaken for that of shoulder impingement, cervical disc disease, acromioclavicular joint disease, and other processes. During the last decade, MRI has allowed for direct visualization of many of the lesions related to instability, aiding in diagnosis as well as therapeutic planning and follow-up. Although high resolution nonenhanced MRI has been shown to have high accuracy rates for demonstrating labral tears, direct MRA with intra-articular injection of a dilute gadolinium solution has gained popularity during the last decade because of its ability to distend the joint and outline labral and capsular structures as well as the undersurface of the rotator-cuff [9,11-20]. Currently MRA is generally recommended in cases where the patient is under age 35 years, as instability has been shown to be predominately related to rotator-cuff disease in older patients [21-22]. MRI can also play an important role in imaging the postoperative shoulder and in the evaluation of shoulder hardware [23-24].

**Computed Tomography**

Computed tomography (CT) is useful for characterizing fractures, if more information is needed preoperatively. It can demonstrate fracture complexity, displacement, and angulation, especially with the use of reconstructed images [25-26]. Multidetector CT can produce high-quality isotropic imaging. This can be helpful in evaluating a shoulder with metallic hardware. The evaluation of a metallic prosthesis can be optimized by using a higher voltage (140 kVp), higher exposure (200–400 mAs), and reduced pitch with slice overlap (less than 1). This will improve image quality, but also result in increased radiation dose [27]. This panel's consensus opinion is that CT shoulder arthrography is superior to MRI or MRA in the evaluation of the rotator-cuff in the setting of a previous shoulder arthroplasty. CT arthrography is useful for evaluation of the postoperative labrum, rotator-cuff, and loosening around implants. CT arthrography is a second-line procedure for shoulders with suspected instability or labral disorders, when MRA and MRI are unavailable or contraindicated [28].

**Ultrasound**

US can be used to evaluate the acromioclavicular joint, tendons of the rotator-cuff, and the long head of biceps tendon. It is operator dependent and limited in evaluation of the other important deep shoulder structures and marrow. US-guided injections and aspirations are helpful in treating and diagnosing shoulder pain with appropriate local expertise.

US can be used to determine if a partial-thickness or full-thickness rotator-cuff tear is present [29]. US is equivalent to MRI, with appropriate local expertise, in the evaluation of rotator-cuff tears [7]. US can also play an important role in the evaluation of the postoperative shoulder and in rotator-cuff integrity after shoulder replacement [30].

**Neoplasm**

Neoplasm is another cause of shoulder pain, and (diagnostically) these lesions can be approached like other neoplasms in the musculoskeletal system. (See ACR Appropriateness Criteria® on "Soft Tissue Masses" and ACR Appropriateness Criteria® on "Primary Bone Tumors.")

**Osteomyelitis**

Osteomyelitis can be a cause of shoulder pain (Although there are no current recommendations by this committee other than osteomyelitis of the foot. (See ACR Appropriateness Criteria® on "Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus.")

**Summary**

- The mainstay in initial imaging of shoulder trauma is the radiograph. Radiography provides a quick, inexpensive evaluation for fracture and dislocation.
- A good shoulder trauma radiography protocol includes: AP, Grashey, axillary, and/or scapular Y projections. Special projections include the Rockwood view for evaluation of shoulder impingement, the Westpoint view for Bankart fractures, and the Stryker notch view for Hill-Sachs fractures.
- MRI is currently the procedure of choice for evaluation of occult fractures and the shoulder soft tissues, including the tendons, ligaments, muscles, and labrocapsular structures. The shoulder MRI protocol may or may not include Gadolinium, depending on the clinical question. MRI and MRA are the modalities of choice in evaluation of patients

<35 years with shoulder pain and in patients with instability/questionable labral pathology.

- US with appropriate local expertise is excellent in the depiction of rotator-cuff and long head of biceps pathology in the preoperative and postoperative shoulder. It is an excellent modality to guide injections and aspirations.
- Fluoroscopic arthrography was the mainstay of evaluation for rotator-cuff tear until the advent of shoulder MRI. It is an excellent modality to guide injections and aspirations. Fluoroscopic arthrography is currently used only as a potential study in patients with suspected rotator-cuff disease who have a contraindication to MRI, and when shoulder US expertise is not available.
- CT without contrast is useful for characterizing fractures, if more information is needed preoperatively. It can demonstrate fracture complexity, displacement, and angulation, especially with the use of reconstructed images. This panel's consensus opinion is that CT shoulder arthrography is superior to MRI or MRA in the evaluation of the rotator-cuff in the setting of a previous shoulder arthroplasty. CT arthrography is useful for evaluation of the cuff, and loosening around implants. CT arthrography is a good alternative in patients who have a contraindication to MRI/MRA.

**Anticipated Exceptions**

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m$^2$), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m$^2$. For more information, please see the ACR *Manual on Contrast Media* [31].

**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, both because of 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 to 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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

**Supporting Document(s)**

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

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