

## Appropriate Use of Imaging in Patients with Shoulder Pain

BY ROBERT M. LIDDELL, MD

### INTRODUCTION

Imaging of the shoulder should be considered after a focused history and physical examination, and it is typically obtained in the context of a specific clinical scenario. The examiner should determine the severity and urgency of the disorder, its chronicity and the likelihood of a specific diagnosis. Imaging may then be obtained to exclude urgent conditions, to confirm a clinical diagnosis or to guide therapy.

### INDICATIONS FOR RADIOGRAPHS

Conventional radiographs are indicated in the following settings:

- Evaluation for a fracture or dislocation following significant trauma;
- Evaluation of osteoarthritis, calcific tendinitis and crystal deposition disease;
- Suspicion of bony neoplasm, particularly in a patient with a known diagnosis of cancer;
- Suspicion of septic arthritis osteomyelitis (including patients with a history of immunosuppression, chronic steroid use, fever, night sweats or elevated inflammatory markers); or
- Suspicion of humeral head avascular necrosis (AVN).

### INDICATIONS FOR ADVANCED IMAGING (MRI, CT, MR ARTHROGRAPHY AND CT ARTHROGRAPHY)

MRI can be obtained in the **acute setting** for:

- Suspected full-thickness rotator cuff tears in patients who are candidates for early surgical repair;
- Young patients following acute traumatic dislocations;
- Older patients with an acute dislocation and significant rotator cuff tears; or
- Identification of occult fractures not identified on initial radiographs.

MRI is otherwise indicated for patients whose pain and dysfunction persists after four to six weeks of conservative therapy. MRI can be used to detect and direct treatment decisions for rotator cuff tears, labral tears, biceps tendon tears, synovial disorders, arthrosis and chondral loss of the glenohumeral joint, acromioclavicular joint arthrosis, and bursitis.

While not addressed in this document, MRI is also useful to confirm and stage AVN of the humeral head, to identify and characterize bony and soft tissue infection, to evaluate soft tissue masses suspected on clinical exam, and to evaluate bony lesions detected on radiographs.

**3T MRI and MR arthrography** may increase the sensitivity of MRI for partial-thickness rotator cuff tears and labral tears. MR arthrography may also be useful in patients with a history of previous surgery and in patients with indeterminate or nondiagnostic findings on routine MRI.

**CT arthrography** is generally reserved for patients unable to undergo MRI or for patients who have had prior shoulder arthroplasty.

CT without contrast is recommended for characterizing bony Bankart lesions and Hill-Sachs deformities, and to assess glenoid version and posterior glenoid wear in osteoarthritis patients undergoing evaluation for shoulder arthroplasty. CT and PET/CT imaging can be used to characterize bony lesions.

### INSIDE THIS ISSUE



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This material summarizes key elements of Appropriate Use Criteria (AUC) developed by the CDI Quality Institute's Provider Led Entity (PLE). The CDI Quality Institute PLE has been qualified by the Centers for Medicare and Medicaid Services to develop AUC to guide the ordering of advanced imaging studies. The entire AUC library is available at [myCDI.com/PLE](http://myCDI.com/PLE).

Clinical decision support (CDS) is not intended to replace clinician judgment, but rather to provide information to assist care team members in managing the complex and expanding volume of biomedical and person-specific data needed to make timely, informed, and higher-quality decisions based on current clinical science (National Academy of Medicine, 2017).

## INDICATIONS FOR ULTRASOUND

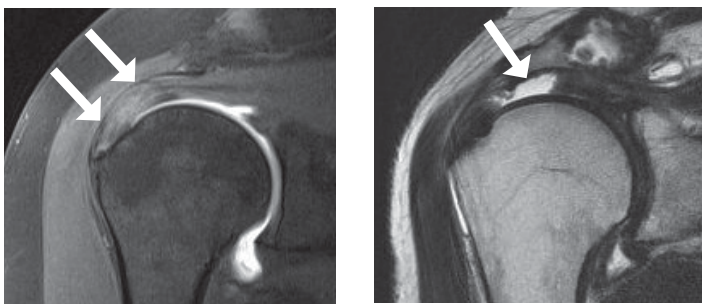
**Ultrasound** is not defined as an “advanced” imaging modality in the federally qualified Provider Led Entity for Appropriate Use Criteria, but we have included several important comments regarding ultrasound’s utility in shoulder imaging. When performed by dedicated and trained experts utilizing high resolution transducers, shoulder ultrasound can be useful to assess suspected complete biceps tendon tears, full-thickness rotator cuff tears and high-grade partial-thickness rotator cuff tears. Ultrasound is also useful to direct therapeutic injections into the biceps tendon sheath or to manipulate and lavage calcifications within rotator cuff tendons.

## CLINICAL SCENARIOS

The strength of recommendations for imaging is indicated as follows:

- Green = indicated
- Yellow = indicated in specific scenarios
- Orange = probably not indicated, with limited exceptions
- Red = not indicated

Shoulder pain with suspected full-thickness rotator cuff tear in patients who are candidates for early surgical repair:	
<span style="color: green;">●</span>	MRI
<span style="color: yellow;">●</span>	CT arthrography in patients unable to undergo MRI
<span style="color: yellow;">●</span>	MR arthrography as the initial study or to evaluate indeterminate findings on previous noncontrast MRI
<span style="color: yellow;">●</span>	CT arthrography in patients with prior shoulder arthroplasty
<span style="color: orange;">●</span>	MRI or MR arthrography in patients with prior shoulder arthroplasty except with MRI systems using advanced metal suppression techniques
<span style="color: red;">●</span>	Bone scan, PET



*(left)* Oblique coronal fat suppressed T1 MR arthrogram demonstrates a thickened and infiltrated supraspinatus tendon (arrows), indicative of tendinosis.

*(right)* Oblique coronal proton density MR image reveals a fluid-filled full thickness supraspinatus tendon tear (*arrow*).

## CLINICAL NOTES

- Patients who are candidates for early surgical repair include those with suspected full-thickness tears following trauma, a palpable defect at the greater tuberosity following trauma, or a new onset of significant weakness on elevation or rotation (drop arm).
- Radiographs are useful to exclude fractures, avulsions and dislocation in patients with shoulder pain following acute trauma.
- Patients with new significant weakness on elevation or rotation or a palpable defect at the greater tuberosity following trauma should have early use of MRI.
- MRI, MR arthrography and ultrasound are highly accurate methods for the diagnosis of full-thickness rotator cuff tears.
- MRI and MR arthrography may be used in patients following shoulder arthroplasty if MRI systems use advanced metal suppression techniques.
- MRI (without intra-articular contrast) may be preferred in patients following acute injury, as it can identify intra-articular effusions, which, if present, would indicate an intra-articular injury. An effusion may be masked by the presence of intra-articular contrast.
- Ultrasound can be useful to evaluate for full-thickness tears in patients with severe pain and in patients who cannot undergo MRI.
- The accuracy of ultrasound for rotator cuff tears is highly operator-dependent, and the performance of ultrasound may vary significantly depending on local expertise.

Shoulder pain with suspected rotator cuff tear in patients who have failed an appropriate course of conservative therapy:	
<span style="color: green;">●</span>	MRI
<span style="color: yellow;">●</span>	CT arthrography in patients unable to undergo MRI
<span style="color: yellow;">●</span>	MR arthrography as the initial study or to evaluate indeterminate findings on previous noncontrast MRI
<span style="color: yellow;">●</span>	CT arthrography in patients with prior shoulder arthroplasty
<span style="color: orange;">●</span>	MRI or MR arthrography in patients with prior shoulder arthroplasty, except with MRI systems using advanced metal suppression techniques
<span style="color: red;">●</span>	Bone scan, PET

## CLINICAL NOTES

- Patients with rotator cuff syndrome and suspected rotator cuff tears commonly respond to a four to six week course of conservative care and may be able to avoid surgery.
- Both full-thickness and partial-thickness rotator cuff tears commonly occur in asymptomatic patients (28-35%), and correlation with clinical findings is important.
- Advanced imaging may not be indicated in patients with clinically suspected rotator cuff tears who do not have pain.
- Patients with marked weakness/drop arm may be candidates for early imaging and early surgery.
- Radiographs may be useful to evaluate for osteoarthritis or calcific tendonitis in patients with rotator cuff syndrome.

- MRI, MR arthrography and ultrasound are highly accurate methods for the diagnosis of full-thickness rotator cuff tears, and they are moderately accurate methods for the detection of partial-thickness rotator cuff tears.
- 3T MRI has been reported to have overall increased accuracy for rotator cuff tears compared to 1.5T, 1.0T or lower field strength MRI systems.
- Despite its invasiveness, MR arthrography can demonstrate more of the small articular-sided partial-thickness tears and demonstrate the extent of the tear more precisely than MR imaging without arthrography.
- MR arthrography does not improve accuracy for partial-thickness bursal surface tears.
- Approximately one-third of patients with rotator cuff disease have concomitant articular cartilage lesions. However, cartilage lesions of the glenohumeral joint are not routinely diagnosed on preoperative MRI, despite their prevalence and clinical significance.

Suspected recurrent rotator cuff tear (following rotator cuff repair) in patients who are candidates for surgical repair:	
●	MRI or MR arthrography
●	CT arthrography in patients unable to undergo MRI
●	MR arthrography in patients with indeterminate findings on MRI
●	CT arthrography in patients with prior shoulder arthroplasty
●	MRI or MR arthrography in patients with prior shoulder arthroplasty except with MRI systems using advanced metal suppression techniques
●	Bone scan, PET



Oblique coronal proton density MR image reveals a fluid-filled partial thickness supraspinatus tendon tear (arrow).

### CLINICAL NOTES

- Areas of attenuation and/or areas of perforation may persist in patients with prior rotator cuff repair.
- Advanced imaging is used primarily to evaluate for moderate or large full-thickness defects and tendon retraction.
- MRI, MR arthrography, CT arthrography and ultrasound are highly accurate methods for the diagnosis of full-thickness rotator cuff tears and tendon retraction.
- MRI and MR arthrography may be used in patients following shoulder arthroplasty if MRI systems use advanced metal suppression techniques.
- MR arthrography can help overcome micrometallic artifact in patients who have undergone previous subacromial decompression and rotator cuff repair.

Suspected labral tear following acute trauma or when symptoms are unresponsive to an appropriate course of conservative therapy:	
●	MRI and MR arthrography
●	CT to assess and characterize bony Bankart lesions and Hill-Sachs deformities for surgical planning
●	CT arthrography in patients unable to undergo MRI
●	MR arthrography in patients with indeterminate or nondiagnostic findings on MRI
●	CT arthrography without prior MRI and without contraindications to MRI
●	Bone scan, PET

### CLINICAL NOTES

- Expert opinion recommends initial conservative care management for superior labrum anterior to posterior (SLAP) tears. Early surgery should be considered only in cases where there is evidence of symptomatic suprascapular nerve compression by an associated paralabral cyst.
- Early surgical repair and early imaging may be considered in young patients active in sports following an acute dislocation, and in older patients with an acute dislocation and significant rotator cuff tear.
- MR arthrography is more accurate than MRI in diagnosing and excluding labral tears, and is more accurate than CT arthrography in the assessment of labroligamentous injuries.
- 3T MRI and modern 1.5T MRI systems with optimized technique may have comparable accuracies to MR arthrography.
- In the acute setting, MRI without arthrography is useful in identifying joint effusions, which, if present, indicate the presence of injuries to the intra-articular structures.
- If a patient is to undergo low-field-strength imaging because of claustrophobia or bariatric issues, MR arthrography should be considered instead of MRI to improve diagnostic accuracy for the detection of labral tears.
- CT arthrography and MR arthrography have comparable diagnostic accuracy in evaluation of SLAP tears, Bankart lesions and Hill-Sachs fractures; however, CT arthrography exposes the patient to ionizing radiation and has decreased accuracy for partial-thickness rotator cuff tears.
- CT without arthrography can be used to detect and grade bony Bankart lesions and Hill-Sachs deformities prior to surgery.

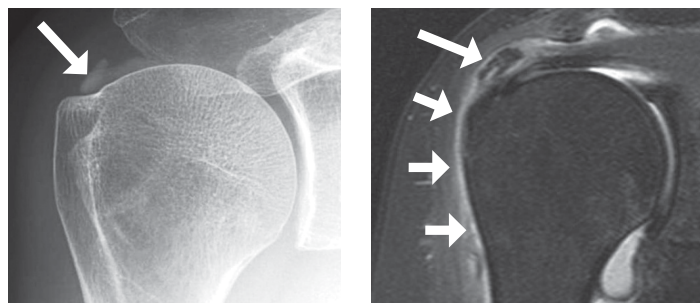


Oblique coronal fat suppressed T1 MR arthrogram image reveals contrast outlining a displaced superior labral tear and displaced biceps tendon origin from the glenoid (arrows).

Suspected long head of the biceps tendon tear/ tendinopathy:	
●	MRI or MR arthrography
●	CT arthrography in patients unable to undergo MRI
●	MR arthrography in patients with discordant MRI findings and symptoms
●	CT
●	Bone scan, PET

## CLINICAL NOTES

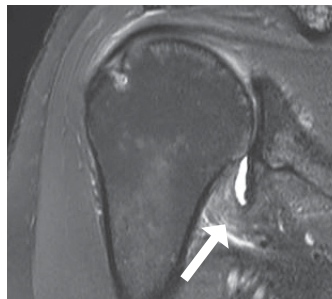
- Patients with bicipital tendon disorders may present with aching, burning and/or stabbing pain in the anterior medial aspect of the shoulder. They may report snapping with a subluxing tendon.
- Immediate sharp pain in the biceps region with tenderness, bruising and a “Popeye” deformity may indicate an acute full-thickness tear of the long head of the biceps following trauma.
- Biceps tears and tendinopathy are often associated with anterior supraspinatus abnormalities, superior subscapularis pathology and subacromial bursitis. These entities may be difficult to distinguish on physical exam.
- Ultrasound is accurate in the evaluation of full-thickness biceps tendon tears, and it is useful to direct therapeutic injections into the biceps tendon sheath.
- MRI, MR arthrography, and ultrasound have limited diagnostic accuracy for the evaluation of biceps tendinosis and partial-thickness tearing.
- There is no difference in the diagnostic accuracy for MRI or MR arthrography for biceps tears or tendinosis. However, MR arthrography is invasive and is associated with patient discomfort as well as a small risk of infection and allergic reaction.
- MR arthrography is the optimal test for the evaluation of biceps pulley lesions and evaluation for the rotator cuff interval widening, which can be associated with instability.
- CT arthrography and MR arthrography have comparable diagnostic accuracies; however, CT arthrography exposes the patient to ionizing radiation.



(left) AP radiograph reveals dense calcification within the supraspinatus tendon, indicating calcific tendonitis.

(right) Oblique coronal fat suppressed T2 MR image corroborates calcification within a partially torn supraspinatus tendon (long arrow) and also shows subdeltoid subacromial bursitis (small arrows).

Suspected adhesive capsulitis:	
●	MRI
●	MR arthrography as the initial study or to evaluate associated labral abnormalities
●	CT arthrography in patients unable to undergo MRI
●	CT arthrography as the initial study in patients without contraindications to MRI
●	CT, Bone scan, PET



Oblique coronal fat suppressed T2 image demonstrates edema infiltrating a markedly thickened axillary capsule (arrow) of the glenohumeral joint; findings indicative of capsulitis.

## CLINICAL NOTES

- Adhesive capsulitis is characterized by gradual and insidious onset of pain and restriction of glenohumeral joint mobility in multiple planes, particularly with external rotation.
- The key clinical difference between adhesive capsulitis and rotator cuff impingement or tear is stiffness (limitation of passive range). In the early stages, the clinical diagnosis can be difficult.
- Adhesive capsulitis may follow trauma, myocardial infarction, neck or cardiac surgery, radiation therapy, and prolonged immobilization.
- Risk factors for adhesive capsulitis include diabetes and thyroid disease.
- Radiographs (including a transaxillary view) are useful at the time of initial evaluation to exclude the presence of calcific tendinitis, osteoarthritis, and chronic posterior dislocation, each of which can result in pain and limitations of mobility.
- Thickening of the axillary capsule with T2 hyperintensity are useful criteria for the diagnosis of adhesive capsulitis. PD and STIR imaging are more sensitive than T2 images for hyperintensity.
- Patients with adhesive capsulitis show effacement of fat within the anterior rotator cuff interval, secondary to capsular and ligamentous thickening.
- Rotator interval enhancement may increase the specificity of adhesive capsulitis on contrast-enhanced MRI.
- Patients with adhesive capsulitis may also show a disproportionate amount of fluid within the biceps tendon sheath and subcoracoid recess relative to fluid in the joint space.

(continued on page 5)

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Shoulder pain in patients with osteoarthritis undergoing surgical planning for arthroplasty:	
●	CT to quantitate glenoid version, subchondral cystic changes and posterior glenoid wear
●	MRI to evaluate the integrity of the rotator cuff
●	CT arthrography to evaluate the integrity of the rotator cuff in patients unable to undergo MRI
●	Bone scan, PET

## CLINICAL NOTES

- Radiographs are the initial study of choice for the detection and evaluation of osteoarthritis.
- Radiographs with axillary views are useful for the detection of, and to follow, posterior glenoid wear.
- Quantifying glenoid version and the presence or severity of subchondral cystic change is useful for surgical planning for shoulder arthroplasty. Correction of glenoid retroversion before glenoid component implantation is important to the restoration of normal joint biomechanics.
- 3D CT may be more accurate than 2D CT in the assessment of glenoid version and may change surgical planning in a significant number of cases.
- Glenoid retroversion can also be assessed on MRI if additional T1 axial images are obtained with the field of view increased to include the medial border of the scapula. CT may be avoided in these patients.

Nonspecific shoulder pain with indeterminate history, physical exam, radiographs and failure of an appropriate course of conservative therapy:	
●	MRI
●	CT arthrography in patients unable to undergo MRI
●	MR arthrography except in patients with a history of previous rotator cuff, labral, or biceps tendon surgery
●	CT arthrography without a contraindication to MRI, Bone scan, PET

## CLINICAL NOTES

- Radiographs are useful to evaluate for osteoarthritis, periarticular calcium deposition disease, fractures, dislocations and bone lesions in patients with nonspecific pain and an indeterminate history and physical exam.
- MRI is accurate for the evaluation of rotator cuff pathology, full-thickness biceps tendon tears and labral tears. MRI is also useful to identify bone marrow associated with radiographically occult fractures or avulsions.
- Ultrasound is useful and accurate for the evaluation of full-thickness rotator cuff tears, and for the evaluation of biceps tendon pathology.
- MRI has a low sensitivity but high specificity for the diagnosis of chondral lesions.
- MRI is useful for the diagnosis of early radiographically occult osteoarthritis.
- Bone scan demonstrates increased activity with many pathologic entities; however, it has relatively poor resolution for pathology.

## REFERENCES

Complete references as well as evidence tables can be found on the CDI Quality Institute website, at [myCDI.com/PLE](http://myCDI.com/PLE).

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Shoulder pain with suspected full-thickness rotator cuff tear in patients who are candidates for early surgical repair:	
●	MRI
●	CT arthrography in patients unable to undergo MRI
●	MR arthrography as the initial study or to evaluate indeterminate findings on previous noncontrast MRI
●	CT arthrography in patients with prior shoulder arthroplasty
●	MRI or MR arthrography in patients with prior shoulder arthroplasty except with MRI systems using advanced metal suppression techniques
●	Bone scan, PET

Shoulder pain with suspected rotator cuff tear in patients who have failed an appropriate course of conservative therapy:	
●	MRI
●	CT arthrography in patients unable to undergo MRI
●	MR arthrography as the initial study or to evaluate indeterminate findings on previous noncontrast MRI
●	CT arthrography in patients with prior shoulder arthroplasty
●	MRI or MR arthrography in patients with prior shoulder arthroplasty, except with MRI systems using advanced metal suppression techniques
●	Bone scan, PET

Suspected recurrent rotator cuff tear (following rotator cuff repair) in patients who are candidates for surgical repair:	
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●	CT arthrography in patients unable to undergo MRI
●	MR arthrography in patients with indeterminate findings on MRI
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●	MRI or MR arthrography in patients with prior shoulder arthroplasty except with MRI systems using advanced metal suppression techniques
●	Bone scan, PET

Suspected labral tear following acute trauma or when symptoms are unresponsive to an appropriate course of conservative therapy:	
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●	CT arthrography without prior MRI and without contraindications to MRI
●	Bone scan, PET

Suspected long head of the biceps tendon tear/tendinopathy:	
●	MRI or MR arthrography
●	CT arthrography in patients unable to undergo MRI
●	MR arthrography in patients with discordant MRI findings and symptoms
●	CT
●	Bone scan, PET

Suspected adhesive capsulitis:	
●	MRI
●	MR arthrography as the initial study or to evaluate associated labral abnormalities
●	CT arthrography in patients unable to undergo MRI
●	CT arthrography as the initial study in patients without contraindications to MRI
●	CT, Bone scan, PET

Shoulder pain in patients with osteoarthritis undergoing surgical planning for arthroplasty:	
●	CT to quantitate glenoid version, subchondral cystic changes, and posterior glenoid wear
●	MRI to evaluate the integrity of the rotator cuff
●	CT arthrography to evaluate the integrity of the rotator cuff in patients unable to undergo MRI
●	Bone scan, PET

Nonspecific shoulder pain with indeterminate history, physical exam, radiographs and failure of an appropriate course of conservative therapy:	
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