

### **Musculoskeletal Ultrasound**

Pocket Guide

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## Musculoskeletal

#### Objective of this guide

The Musculoskeletal Ultrasound Pocket Guide is a portable and easy-to-use reference for students, residents and physicians. It is a beginner's guide for the most common diagnostic musculoskeletal ultrasound studies. The images provided are those most frequently obtained during the sonographic evaluation of each respective joint.

Each chapter covers the examination of a joint. The examinations covered for the upper extremity are the shoulder, elbow, hand and wrist. The examinations covered for the lower extremity are the hip, knee, foot and ankle. In addition each chapter concludes with some of the more common ultrasound-guided injection techniques.



Each section is organised using the following system:





Mistakes to avoid during the study



MRI images and corresponding sonograms with identifying landmarks





#### Musculoskeletal ultrasound today

Musculoskeletal ultrasound is being utilised in a variety of specialties such as physical medicine & rehabilitation, sports medicine, rheumatology, and orthopaedics. Its modern day uses are vast as there are many advantages to using ultrasound for imaging.

- It is comparatively a lower cost, real-time, dynamic imaging modality that can be utilised in the clinic or in the field.
- Ultrasound can provide immediate verification of findings suspected on physical exam.
- Easy comparison with the unaffected side can serve as a control in assessing for pathology.



- Dynamic studies allow for the evaluation of pathology during movement.
- Ultrasound can be utilised for needle placement in treatment of the patient.

As a diagnostic tool, ultrasound is often used to assess for:

- Joint effusions
- Bony irregularities (osteophytes, loose bodies, fractures, erosions, degenerative changes, lytic changes)
- Tendon pathology (tears, ruptures, dislocations, tendinitis, tendinosis, tenosynovitis)
- Muscle pathology (tears, atrophy, impingement, herniations)
- Bursal pathology (thickening, enlargement)
- Nerve pathology (entrapments, subluxations)

#### Tips for using this guide

When utilising this guide, remember that the patient's right side is used by convention. All images, MRI, ultrasound, anatomic drawings and patient positioning correlate with the patient's right side. Remember to flip or rotate the images in your mind to better understand the relationships between each of them. From this guide, you will better understand the spatial relationships between structures.

# Sonographic Evaluation of the Shoulder

#### **The Shoulder**

In the hands of a skilled operator, ultrasound is more sensitive than even MRI for the diagnosis of rotator cuff tears.

Rotator Cuff Tears	Ultrasound	MRI		
Full-thickness tear				
Sensitivity	94.3%	91.2%		
Specificity	95.3%	94.2%		
Partial-thickness tear				
Sensitivity	79.1%	63.1%		
Specificity	94.6%	93.7%		
Overall				
Sensitivity	91.0%	79.6%		
Specificity	87.0%	90.6%		

Data from Diagnostic Imaging of Rotator Cuff Tears: A Meta-Analysis of the Accuracy of US and MR. Department of Radiology, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania.

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#### **Overview of Shoulder Evaluation**

- Anterior Shoulder
  - Tendon of the long head of the biceps brachii
    - Dynamic Manoeuvre: Medial subluxation of the tendon of the long head of the biceps brachii
  - Subscapularis tendon



#### **Posterior Shoulder**

- Glenohumeral joint and glenoid labrum
- Infraspinatus tendon and teres minor

Al

Suprascapular nerve

**Superior Shoulder** 

Acromioclavicular joint

Anterolateral Shoulder

- Supraspinatus tendon
- Dynamic Manoeuvre: Subacromial impingement

#### An Anterior Shoulder Tendon of the long head of the biceps brachii



#### Anatomy: Biceps Brachii

#### **Origin (Proximal Attachment)**

- Short head: Coracoid process of scapula
- Long head: Supraglenoid tubercle of scapula

#### **Insertion (Distal Attachment)**

Radial tuberosity

#### Action

- Flexion and supination of the forearm at the elbow
- Flexion of the arm at the shoulder

#### Innervation

- Nerve root: C5-C6 (C6)
- Peripheral nerve: Musculocutaneous

Seat your patient with the shoulder adducted and elbow flexed to approximately 90°. Supinate the forearm and rest



#### **Transducer Tips**

#### On short axis, angle the transducer superiorly to eliminate echogenicity of the tendon. The degree of external rotation of the forearm will directly influence the position of the long head of the biceps brachii tendon relative to the head of the humerus. Adjust the patient's forearm such that the long head appears centered over the humerus.

Patient Position

it on the thigh.

Transducer Position

The long head of the biceps brachii is located lateral to that of the short head. On initial placement of the transducer, start lateral to the region where the short head can be palpated.



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#### ✓ Assess the following

- · Integrity of the cortical surface and depth of the bicipital groove
- Thickness and echogenicity of the tendon
- Assess for fluid within the tendon sheath
- Assess for neovascularisation
- Dynamic Manoeuvre: Medial dislocation of the tendon upon external rotation of the shoulder

#### X Mistakes to avoid

- Do not confuse anisotropy in the proximal tendon with pathologic changes
- Do not confuse tenosynovitis with fluid that originates from within the joint
- Do not assume that fluid in the tendon sheath is limited to biceps tendon pathology (rotator cuff estimate)
- Do not confuse flow within the anterior circumflex artery with neovascularisation

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#### Pathology

- Biceps tendon joint effusion
- Biceps tenosynovitis
- Biceps ganglion cyst
- Biceps brachii tenodesis
- Biceps brachii subluxation

#### Notes

#### Tendon of the Long Head of the Biceps Brachii | Axial Plane



- D Deltoid muscle
- H Humerus
- B Bicipital groove
- Tendon of the long head of the biceps brachii (short axis)
- T Greater tuberosity
- t Lesser tuberosity



#### Tendon of the Long Head of the Biceps Brachii | Short Axis



- D Deltoid muscle
- B Bicipital groove
- Transverse humeral ligament

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- Tendon of the long head of the biceps brachii (short axis)
- T Greater tuberosity
- t Lesser tuberosity



#### Tendon of the Long Head of the Biceps Brachii | Axial Plane



- D Deltoid muscle
- H Humeral head
- Tendon of the long head of the biceps brachii
- T Greater tuberosity
- t Lesser tuberosity



#### Tendon of the Long Head of the Biceps Brachii | Long Axis



- D Deltoid muscle
- Tendon of the long head of the biceps brachii (long axis)
- H Humerus



#### An Anterior Shoulder

Dynamic Manoeuvre: Medial subluxation of the tendon of the long head of the biceps brachii



#### Patient Position

Seat your patient with the shoulder adducted and elbow flexed to approximately 90°. Supinate the forearm and rest it on the thigh. Ask the patient to externally rotate the arm at the shoulder.

#### Transducer Position

During the dynamic manoeuvre, the transducer should remain in the short axis position.

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#### **Transducer Tips**

The arm should stay adducted at the patients side with the forearm supinated while the patient is passively and then actively externally rotating the shoulder.

#### Notes



#### An Anterior Shoulder Subscapularis Tendon



#### Anatomy: Subscapularis

#### Origin

• Subscapular fossa of the scapula

#### Insertion

• Lesser tuberosity and crest of the humerus

#### Action

• Internal rotation of the arm at the shoulder

#### Innervation

- Nerve Root: C5-C6 (C6)
- Peripheral Nerve: Upper and lower subscapular nerves



#### **Patient Positioning**

Seat your patient with the shoulder adducted and elbow flexed to approximately 90°. Supinate the forearm and rest it on the thigh. Rotate the shoulder externally while the forearm remains supinated.

#### Transducer Positioning

The transducer position for identification of the subscapularis will be located just medial to that of the long head of the biceps brachii.

#### **Transducer Tips**

The fibers of the subscapularis muscle course perpendicular to that of the long head of the biceps brachii muscle. For this reason the terms short-axis and long-axis appear opposite that of the biceps.



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#### ✓ Assess the following

- Cortex of the lesser tuberosity
- Insertion of the subscapularis tendon
  - Note: The insertion of the tendon is large, requiring movement of the probe from proximal to distal. Also, notice the multipennate architecture of the muscle.
- Thickness and echogenicity of the tendon in short and long-axis
- Assess for a tear:
  - If complete, note the distance that the tendon has retracted
  - · If partial, note whether it is a bursal vs. articular-sided tear
  - · Assess for fluid in the subacromial-subdeltoid bursa

#### X Mistakes to avoid

• When evaluating the subscapularis tendon in short-axis, do not confuse the fascicles of the tendon a tear. Recognize that the mulipennate structure is normal.

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#### Pathology

- Subscapularis Tear
- Subscapularis Tendinosis
- Subscapularis Tendon Avulsion

#### Notes



#### Subscapularis Tendon | Axial Plane



- D Deltoid muscle
- Subscapularis tendon
- t Lesser tuberosity of humerus
- G Glenoid
- I Infraspinatus muscle



#### Subscapularis Tendon | Long Axis



- D Deltoid muscle
- Subscapularis tendon

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- t Lesser tuberosity of humerus
- h Humeral head



#### Subscapularis Tendon | Coronal Plane



- S Subscapularis tendon
- A Acromion
- H Humeral head
- D Deltoid muscle



#### Subscapularis Tendon | Short Axis



#### Su Superior Shoulder Acromioclavicular Joint



#### Anatomy: Acromioclavicular Joint

#### Description

- Attaches the acromion of the scapula to the clavicle
- Consists of the superior and inferior acromioclavicular ligaments

#### Function

- Is a synovial gliding joint
- Provides mobility and support during
  - Protraction/retraction (punching)
  - Rotation (raising arm above shoulder)
  - Elevation/depression



#### **Patient Positioning**

Seat your patient with the shoulder adducted and elbow flexed to approximately 90°. Supinate the forearm and rest it on the thigh.

**Transducer Positioning** Place the transducer directly on top of the apex (highest point) of the shoulder.



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#### **Transducer Tips**

If you have difficulty locating the acromioclavicular joint, then first locate the clavicle's bony acoustic shadow and follow it laterally until you reach its articulation with the acomion.

#### 32 Sonographic Evaluation of the Shoulder

#### ✓ Assess the following

- The bony cortices of both the proximal acromion and the distal clavicle
- Evaluate for capsular dilatation
- Look for the "geyser sign" (pathognomonic for complete rupture of the supraspinatus)

#### **X** Mistakes to avoid

- Do not confuse "Os Acromiale" with calcification of the joint
- Do not confuse the visualisation of a meniscus with fibrocartilage pathology in young people

#### Pathology

- Os Acromiale
- AC Joint Osteoarthritis and cysts
- AC Joint infection

#### Notes



#### Acromioclavicular Joint | Coronal Plane



- A Acromion
- C Clavicle
- H Humeral head
- S Supraspinatus muscle



#### Acromioclavicular Joint | Long Axis



- C Edge of the clavicle
- A Edge of the acromion
  - Acromioclavicular capsule



#### Al Anterolateral Shoulder Supraspinatus Tendon



#### Anatomy: Supraspinatus

#### Origin

• Supraspinatus fossa of scapula

#### Insertion

Greater tubercle of humerus

#### Action

Abduction of the arm

#### Innervation

- Nerve Root: C5, C6
- Peripheral Nerve: Suprascapular nerve

#### **Patient Positioning**

Seat your patient and ask him or her to perform the Crass Manoeuvre or the Modified Crass Manoeuvre. Either position can be used depending on the patient's comfort. These positions move the supraspinatus anteriorly and out from underneath the acromion. This allows for better visualisation of the supraspinatus fibers.

#### Crass Manoeuvre

The shoulder is adducted, in extension, and internally rotated (reaching towards the contralateral scapula).

#### Modified Crass Manoeuvre

The shoulder is extended with hand in supination and placed on ipsilateral buttock (as if in the patient's back pocket). This manoeuvre tends to be more comfortable in the painful shoulder. Proper positioning requires the elbow to remain in the posterior position.



#### Transducer Positioning

Start in the long axis with the transducer placed in a vertical position just medial to the humeral head. To obtain a short axis view, turn the transducer 90°.

#### **Transducer Tips**

Transducer position may seem counterintuitive at first. Remember that the plane in which the supraspinatus sits changes upon asking the patient to perform the above manoeuvres. Be mindful of the position of the humeral head (internal rotation in the Crass position vs. external rotation in the Modified Crass position.





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#### ✓ Assess the following

- Cortex of the greater tuberosity
- Thickness and echogenicity of the tendon in long and short-axis
- Assess for a tear:
  - If complete, note the distance the tendon has retracted
  - · If partial, note whether there is a bursal vs. articular tear
- Dynamic Manoeuvre: Abduction of the shoulder to 90° to assess for bursal ± tendinous impingement beneath the acromion.

#### **X** Mistakes to avoid

Do not confuse anisotropy of the tendinous insertion with a partial tear/rupture

#### Pathology:

- Supraspinatus Tear (partial vs. full-thickness)
- Supraspinatus Tendinosis

#### Supraspinatus Muscle | Coronal Plane



- A Acromion
- S Supraspinatus muscle
- G Glenoid fossa
- D Deltoid muscle
- H Humeral head



#### Supraspinatus Muscle | Long Axis



- D Deltoid
- Bursa
- S Supraspinatus
- Hyaline articular cartilage

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- T Greater tuberosity
- H Humerus



#### Supraspinatus Tendon | Saggital View



- D Deltoid muscle
- S Supraspinatus muscle
- H Humeral head



#### Supraspinatus Tendon | Short Axis



- S Supraspinatus tendon
- Hyaline articular cartilage
- Subacromial-subdeltoid bursa





#### Anterolateral Shoulder

**Dynamic Manoeuvre: Subacromial Impingement** 



#### **Patient Position**

Seat your patient with the arm fully adducted to the side. Ask the patient to abduct the arm to approximately 90°.

Transducer Position The transducer should traverse both the acromion and the supraspinatus in the long axis.

#### $\checkmark$ Assess the following

- Look for impingement of the superior fibers of the supraspinatus beneath the acromion
- Bursal thickening

#### Notes

#### Dynamic Manoeuvre: Subacromial Impingement | Coronal Plane



- A Acromion
- S Supraspinatus muscle
- H Humeral head



#### Dynamic Manoeuvre: Subacromial Impingement | Long Axis



- A Acromion
- S Supraspinatus muscle

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 Subacromialsubdeltoid bursa



#### Po Posterior Shoulder Glenohumeral joint and superior posterior glenoid labrum





#### Anatomy: Glenohumeral Joint

#### **Glenohumeral Joint**

The glenohumeral joint is a multiaxial synovial ball and socket joint and involves articulation between the glenoid fossa of the scapula and the head of the humerus.

#### **Glenoid Labrum**

The glenoid labrum is a fibrocartilaginous rim attached around the margin of the glenoid cavity in the scapula. In bony terms the the glenoid fossa of the scapula is quite shallow and small, covering at most only a third of the head of the humerus. The socket is deepened by the glenoid labrum. It deepens the articular cavity, and protects the edges of the bone.



#### **Patient Positioning**

Seat your patient with the shoulder adducted and elbow flexed to approximately 90°. Supinate the forearm and rest it on the thigh. You will be seated behind your patient facing the posterior shoulder.

#### Transducer Positioning

Imagine a line drawn from the apex of the shoulder to the superior aspect of the axilary fold. Place the transducer at the point 1/3 of the distance from the apex.



#### 50 Sonographic Evaluation of the Shoulder

#### ✓ Assess the following

- Cortex of the greater tuberosity
- · Integrity of the posterior superior glenoid labrum
- The existence of posterior glenohumeral joint fluid

#### Pathology

Posterior glenohumeral recess joint effusion

#### Notes

#### Notes

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#### **Glenohumeral Joint | Coronal View**



- A Acromion
- G Glenoid fossa
- H Humeral head
- D Deltoid muscle
- Posterior labrum and glenohumeral joint



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#### Glenohumeral Joint | Long Axis



- D Deltoid
- I Infraspinatus muscle
- G Glenoid
- N Spinoglenoid notch
- H Humeral head
- Posterior labrum and posterior Glenohumeral joint



#### Po Posterior Shoulder Infrspinatus Tendon and Teres Minor



#### Anatomy: Infraspinatus Origin

Infraspinatus fossa of scapula

#### Insertion

• Greater tubercle of humerus below supraspinatus

#### Action

• Lateral rotation of the arm

#### Innervation

- Nerve Root: C5, C6
- Peripheral Nerve: Suprascapular nerve

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#### **Patient Positioning**

Seat your patient with the shoulder adducted and elbow flexed to approximately 90°. Supinate the forearm and rest it on the thigh. You will be seated behind your patient facing the posterior shoulder.

#### **Transducer Positioning**

Place the transducer just inferior to the scapular spine at an angle parallel to it. Rotate the transducer to visualise the central tendon of the infraspinatus. This can be followed laterally to the insertion of the tendon onto the middle facet of the greater tuberosity.





#### ✓ Assess the following

- · Thickness and echogenicity of both tendons in long-axis
- Assess for a tear:
  - If complete, note the distance the tendon has retracted
  - If partial, note whether there is a bursal vs. articular tear

#### X Mistakes to avoid

• Do not confuse the insertion of the infraspinatus with that of the teres minor

#### Pathology

- Infraspinatus tear
- Infraspinatus tendinosis
- Infraspinatus atrophy

#### Notes

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#### Infraspinatus Tendon | Coronal View



- I Infraspinatus muscle
- G Glenoid
- H Humeral head



#### Infraspinatus Tendon | Long Axis



- D Deltoid
- I Infraspinatus tendon (long axis)

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T Greater tuberosity (middle facet)



#### Po Posterior Shoulder Suprascapular Nerve

#### Anatomy: Suprascapular Nerve

#### Course

• C5, C6  $\rightarrow$  upper trunk of the brachial plexus  $\rightarrow$  deep to the omohyoid & trapezius muscle  $\rightarrow$  traverses the suprascapular notch beneath the transverse scapular ligament  $\rightarrow$  enters the supraspinatus fossa:



- Motor branches supply the supraspinatus
- ✓ Sensory branches receive information from the glenohumeral and acromioclavicular joints, rotator cuff, and posterior 2/3 of the capsule

→ nerve then courses laterally around the scapular spine → through the spinoglenoid notch → enters the infraspinatus fossa:

✓ Pure motor nerve to the infraspinatus



#### **Patient Positioning**

Seat your patient with the shoulder adducted and elbow flexed to approximately 90°. Supinate the forearm and rest it on the thigh. You will be seated behind your patient facing the posterior shoulder.

#### Transducer Positioning

Move the transducer just medial to the position where it was placed for locating the glenohumeral joint and the posterior labrum. There, you will find the suprascapular nerve in the spinoglenoid notch along with its associated vessels.



#### Pathology

- Suprascapular Nerve Compression
- Suprascapular Nerve Hypertrophy
- Paralabral Cyst

#### Notes



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#### Suprascapular Nerve | Long Axis



- G Glenoid
- H Humeral head
- I Infraspinatus tendon
- Posterior labrum
- Suprascapular nerve (in the spinoglenoid notch)

