Learning objectives

- To demonstrate the normal anatomy of the rotator interval and related capsuloligamentous structures on magnetic resonance (MR) arthrography
- To recognise lesions of the rotator interval that may be visualised by MR arthrography

Background

The rotator interval represents a triangular discontinuity in the musculotendinous rotator cuff at the anterosuperior aspect of the shoulder. It is defined by the anterior border of the supraspinatus tendon (SST) superiorly and the superior border of the subscapularis tendon (SCT) inferiorly. The base of the triangle is formed medially by the coracoid process with the apex at the intertubercular sulcus. The rotator interval is traversed by the long head of the biceps tendon (LHBT). In this region the LHBT is stabilised by the reflection pulley, a capsuloligamentous sling formed by the coraco-humeral (CHL) and superior glenohumeral (SGHL) ligaments.

The structures of the rotator interval are thought to play an important role in glenohumeral motion and stability. Injury to this region may result in functional impairment and anterior shoulder pain. Direct MR arthrography is the imaging modality of choice to investigate patients with a suspected rotator interval lesion and guide further management.

Findings and procedure details

MR arthrography was performed using a 3T system (Discovery MR750w 3.0T GE Healthcare) following the injection of 12-15mls of dilute Gadolinium into the glenohumeral joint.

We describe the normal appearances of the rotator interval and summarise the signs suggestive of a rotator interval lesion at MR arthrography.
Anatomy

Rotator interval

Triangular discontinuity in the musculotendinous rotator cuff at the anterosuperior aspect of the shoulder (1).

Borders:

- Superior: Anterior fibres of the SST
- Inferior: Superior fibres of the SCT
- Medial (base of triangle): Base of the coracoid process
- Lateral (apex of triangle): Intertubercular sulcus
- Floor: Humeral head articular cartilage
- Roof: Glenohumeral joint capsule reinforced by the CHL (bursal surface) and SGHL (articular surface)

The rotator interval comprises a group of closely related structures which can be considered as a single functional complex.

Components:

- LHBT
- Biceps anchor
- CHL
- SGHL
- Anterior portion of the SST
- Superior portion of the SCT
- Glenohumeral joint capsule

Structures of the rotator interval

Long Head of Biceps Tendon

- Origin: Within the joint capsule from the supraglenoid tubercle of the scapula, superior glenoid labrum or both (2)
- Course: Passes laterally through the rotator interval where it is stabilised by the biceps pulley as it turns 30-45° to enter the extracapsular bicipital groove (Fig. 1)
MR appearance: Low signal on all sequences, with smooth contours and no significant changes in diameter (Fig. 1)

**Biceps pulley**
- Comprises the medial band of the coracohumeral and the superior glenohumeral ligaments which together form a sling at the apex of the rotator interval (Fig. 2) with contributions from the superior fibres of the distal subscapularis tendon (3,4)
- Stabilises the intra-articular long head of biceps tendon and limits medial subluxation of the biceps tendon when the arm is abducted and externally rotated

**Coracohumeral ligament**
- Origin: Lateral aspect of the base of the coracoid process
- Course: Posterolateral course through the rotator interval, fusing with the rotator interval capsule. Laterally divides into 2 bands: a) Lateral band: larger, surrounds the superolateral biceps tendon b) Medial band: smaller, crosses over the biceps tendon and merges with fibres of superior glenohumeral ligament forming the SGHL-MGHL complex which surrounds the inferomedial LHBT
- Insertion: a) Lateral band: Greater tuberosity, merging with fibres of the anterior supraspinatus tendon b) Medial band: Lesser tuberosity, blends with superior fibres of the subscapularis tendon
- MR appearance: Single or double hypointense band on all sequences (5), travels obliquely traversing fat above the shoulder joint, merging with the capsule laterally (3) (Fig. 3 & 4)
- Infrequently absent or hypoplastic (6%) (6)

**Superior Glenohumeral Ligament**
- Origin: Superior glenoid tubercle anterior to the origin of the LHBT, can be variable
- Course: Crosses the rotator interval deep to the coracohumeral ligament, initially anterior to the LHBT, then passes beneath the LHBT laterally forming part of the biceps sling (Fig. 2)
- Insertion: Superior aspect of the lesser tuberosity, blending with the fibres of the superior subscapularis tendon and medial fibres of the CHL
- MR appearance: Hypointense on all sequences, usually smaller than the adjacent coracohumeral ligament (Fig. 5)
- Absent at arthroscopy in 3% (7)

**Rotator Interval Capsule**
• Bridges between anterior SST and superior SCT
• Reinforced by the CHL (bursal surface) and SGHL (articular surface)
• MR appearance: uniform low signal intensity, smooth contour, thin approximately 2mm on oblique sagittal images just lateral to coracoid process
• May be difficult to appreciate (1)

Clinical Importance

• Structures of the rotator interval thought to play an important role in glenohumeral motion and stability
• Capsuloligamentous structures help prevent inferior and posterior translation at the glenohumeral joint (8-10)
• Stability is also maintained by the negative intra-articular pressure generated within an intact joint capsule (9,10)
• Tears of the rotator cuff interval are associated with instability and pain
• Closure of rotator interval defects and operative imbrication of the rotator interval have been shown to improve symptoms and stability (8,11-13)

Lesions of the rotator interval

Classification

Initially described by Nobuhara and Ikeda in patients without previous trauma. They classified lesions as:

• Type 1: Contracted state with inflammatory changes in the superficial bursa without associated instability
• Type 2: Instability with extensive inflammation of deeper tissues of the rotator interval

Abnormalities of the rotator interval lesions can also be classified according to aetiology

• Traumatic: Acute traumatic injury, Chronic repetitive microtrauma
• Degenerative
• Congenital
• Infective
• Inflammatory: Adhesive capsulitis, Inflammatory arthritides
MR Arthrography of the Rotator Interval

Direct MR arthrography is the imaging modality of choice for delineating the capsuloligamentous structures of the rotator interval (1). Distension of the glenohumeral joint allows separation and better visualisation of the intimately related components of the rotator interval which contribute to the biceps pulley. Therefore the one of the primary roles of MR arthrography in the evaluation of the rotator interval is to assess the biceps pulley (3,14-19), which will also be the focus of this poster.

Biceps pulley Lesions

Causes

- Trauma: Fall on outstretched arm with full internal or external rotation, falling backwards on to the hand or elbow and direct anterior impact (20)
- Repetitive, chronic microtrauma: repetitive overhead movements related to throwing sports or occupation (21)
- Adjacent rotator cuff tears: Extension of tears from adjacent anterior SST and superior SCT fibres which border the rotator interval (19)
- Anatomical variants: congenital defects of the rotator interval

Signs at MR Arthrography

1. Non visibility or discontinuity of the SGHL
   - Prevalence of isolated tears of SGHL reported to be 29% - 74% (4,16,22)
   - Previous cadaveric study visualised the SGHL in all cases with direct MR arthrography (1)
   - Absence or discontinuity of the SGHL has demonstrated a high a sensitivity (79-100%) and specificity (75-94%) for the diagnosis of a pulley lesion (16,23) (Fig. 6)

2. Thickening of the SGHL and CHL
   - Thickening, scarring or attenuation may be present in chronic rotator interval injuries (15,18) (Fig. 7)
   - The normal SGHL is usually smaller than the adjacent coracohumeral ligament
3. Displacement sign (16)

- Refers to caudal/anterior displacement of the LHBT to lie on the SCT in the presence of a SGHL tear
- Appearance: LHBT seen resting on SCT without the SGHL or contrast material seen between the two structures (Fig. 8)
- Assessed on oblique sagittal images at the midpoint of the lesser tuberosity
- Demonstrated high sensitivity and specificity for the presence of a pulley lesion (16)

4. Subluxation/Dislocation

- Injury to the capsuloligamentous sling which stabilises the LHBT in the rotator interval may lead to subluxation or dislocation of the LHBT (4,14,16,20,24).
- Appearance: medial subluxation = displacement over the inner rim of the tubercular groove, dislocation = complete loss of contact between the LHBT and bicipital groove
- Best appreciated on axial images
- Although highly specific for an associated pulley tear (75-100%) reported sensitivity is variable (14,16)
- The direction of LHBT displacement is related to the site at which the sling is torn (Fig. 9)
- Patterns of subluxation and dislocation related to pulley tears have previously been classified by Walch (20), Bennet (24) and Habermeyer (4)

5. Biceps tendinopathy

- Loss of integrity of the pulley sling results in chronic instability and subsequent tendinopathy of the LHBT
- Appearance: The tendon may demonstrate increased signal (Fig. 8), change in diameter or irregular margins
- Best appreciated: Axial and oblique sagittal T1 & T2 weighted images.
- LHBT tendinopathy on oblique sagittal T1 images at the midpoint of the lesser tuberosity (Fig. 8) has a high sensitivity and specificity for an associated pulley lesion (16)
- Presence of tendinopathy on axial images also demonstrates high specificity however is insensitive (16)

6. Abnormality of the adjacent Supraspinatus and Subscapularis or both

- Insertional fibres of the anterior SST and superior SCT are intimately related to the CHL - SGHL complex
- Therefore anterosuperior rotator cuff tears adjacent to the rotator interval risk extension to involve the biceps pulley (2,6,8).
• Appearance: a) Discontinuity of tendon fibres on MR arthrography with extension of contrast into the defect b) Thickening of the superior border of the SCT on axial gradient echo and parasagittal T1 has shown high sensitivity and specificity for the presence of a pulley lesion (14)
• Although tears of the SST and SCT are not sensitive in the diagnosis of an associated pulley lesion, tears of the SCT have demonstrated high specificity (16)

7. SLAP Tears

• Given the close proximity, SLAP (Superior Labral tear from Anterior to Posterior) tears may be associated with tears of the pulley complex (17)
• Type X lesions describe extension into the SHGL
• Appearance: High signal extending into the substance of the labrum (Fig. 10)

8. Contrast communication

• Extension of contrast out of the glenohumeral joint in the absence of a full thickness cuff tear suggests disruption of the rotator interval capsule
• Gadolinium extending to the undersurface of the coracoid process in place of normal subcoracoid fat has been reported in a small series of patients with pulley tears
• Best appreciated: Fat saturated T1 weighted sagittal oblique images

Images for this section:
**Fig. 1:** a,b Coronal T1-weighted MR Arthrographic image demonstrates the intra and extra-articular course of the LHBT (B) related to the humerus (H)
Fig. 2: a,b Sagittal T1-weighted MR Arthrographic images demonstrate the sling formed by the CHL and SGHL (S) which provides support to the LHBT (B).
**Fig. 3:** a,b Sagittal T1-weighted MR Arthrographic images demonstrate the normal appearance of the CHL as a hypointense band coursing posteriorly, superior to the glenohumeral joint. C = Coracoid process, DC = Distal Clavicle, A = Acromion, SC = Subscapularis muscle belly and tendons, SS = Supraspinatus muscle belly and tendon, IS = Infraspinatus muscle belly and tendon, TM = Teres minor muscle belly and tendon.

**Fig. 4:** a,b Coronal T1-weighted MR Arthrographic images demonstrate the normal appearance of the CHL as a hypointense band coursing laterally where it is met by the SGHL (S). C = Coracoid process, A = Acromion.

**Fig. 5:** a,b Axial T1-weighted MR Arthrographic images demonstrate the origin of the SGHL anterior to the LHBT (B). Note is made of irregularity of the superolateral humeral head in keeping with a Hill Sachs defect. H = Humeral head, G = Superior Glenoid, SL = Superior Labrum, C = Coracoid process.
**Fig. 6:** Fig. 6 Sagittal T1-weighted MR Arthrographic images at the level of the lesser tuberosity. (a) demonstrates the expected normal appearance of the SGHL (S) as a well-defined structure between the LHBT (B) and SCT. (b,c) demonstrate an irregular discontinuous SGHL in keeping with a tear.

**Fig. 7:** Axial T1-weighted MR Arthrographic images at the level of the coracoid process (C). (a) demonstrates the expected normal appearance of the SGHL (S) as a well-defined structure, smaller than the adjacent CHL. (b,c) The SGHL is hyperintense, thickened and larger than the CHL suggestive of a chronic injury. G = Glenoid, B = LHBT, H = Humeral head.
Fig. 8: Sagittal T1-weighted MR Arthrographic images at the midpoint of the lesser tuberosity. (a) demonstrates the expected normal position of the SGHL (S), separating the LHBT (B) from the SCT. (b,c) the SGHL is not visualised and there is caudal displacement of the LHBT to lie on the SCT. The biceps tendon is also tendinopathic, demonstrating increased signal.

Fig. 9: Axial T1-weighted MR Arthrographic images. (a) demonstrates the expected normal position of the LHBT (B) in the bicipital groove with the overlying CHL. (b,c) demonstrate discontinuity of the CHL with fibrotic material in the lateral aspect of the bicipital groove. There is subsequent medial subluxation of the LHBT to lie on the intact SCT (Type IV lesion according to the Bennett Classification (24)). There are also tears of the anterior (AL) and posterior (PL) labra with an associated defect of the glenoid articular cartilage (C) anteriorly. G = Glenoid, MGHL = Middle glenohumeral ligament.

Fig. 10: Sagittal Fat saturated PD-weighted MR Arthrographic images. (a) demonstrates the expected normal appearance of the superior labrum (SL) as a well-defined, triangular low signal structure. (b,c) demonstrate a defect which extends into the superior labrum
which does not follow the contour of the articular cartilage in keeping with a SLAP tear. H = Humerus, G = Glenoid.
Conclusion

Knowledge of the normal appearances of the rotator interval at MR arthrography is important to help identify associated pathology and guide further management.

Personal information

References


