Essentials of Musculoskeletal Imaging

Written by Maria Vinall

Laura W. Bancroft, MD, University of Central Florida College of Medicine, Tallahassee, and Florida State University College of Medicine, Orlando, Florida, USA, reviewed the conventional magnetic resonance imaging (MRI) features of common, sports-related shoulder pathology.

Rotator cuff tears may be either partial or full thickness and involve the supraspinatus tendon. Partial-thickness tears mostly occur on the articular surface (70%) and appear as fraying of an intact tendon. They can be either rim-rent tears or partial articular-sided tears, and they are often overlooked on MRI scans. Bursal surface and interstitial or intrasubstance tears account for the remaining partial-thickness rotator cuff tears. Partial-thickness rotator cuff tears are seen on MRI as increased signal intensity on the articular or bursal side of the tendon and tendon thinning.

Full-thickness tears are complete and often seen as a hole in the tendon, or complete detachment of the tendon from the humeral head. A rotator cuff tear MRI report should describe which rotator cuff tendons are torn, the size and degree of the tear, whether it involves the articular or bursal surface, the degree of retraction, the quality of tendinous remnant, and whether muscular atrophy is present.

Rotator cuff tears can be accompanied by a split or tear in the subscapularis tendon and subluxation of the biceps tendon. Biceps tendon dislocation is associated with superior labral tear anterior-to-posterior (SLAP) lesions. Failure to diagnose this type of tendon tear preoperatively has been implicated in subcoracoid impingement after shoulder dislocation as well as failed rotator cuff repair. Biceps tendon pathology can be isolated or in conjunction with biceps pulley and subscapularis tears.

Peer-Reviewed Highlights From the

Radiological Society of North America 100th Scientific Assembly and Annual Meeting

November 30–December 5, 2014
Chicago, IL, USA

A SLAP tear or lesion is associated with damage to the superior area of the glenoid labrum. SLAP tears or lesions can be type I (frayed and degenerative superior labrum at the biceps–labral complex), type II (avulsion of the superior labrum and biceps anchor; long head of the biceps attachment onto the supraglenoid tubercle is not disrupted), type III (bucket-handle tear through the superior labrum and intact biceps anchor), or type IV (bucket-handle tear of the superior labrum and extension into the biceps tendon).

Common sports-related injuries seen in children include Little Leaguer's shoulder (epiphysiolysis) and superior labral injuries, which are due to the high rotational and repetitive nature of the forces placed on the shoulder during the throwing motion [May MM, Bishop JY. *Pediatr Radiol.* 2013]. Little Leaguer's shoulder is described as tenderness over the proximal humerus physis, fragmentation of the lateral (LAT) metaphysis, sclerosis, cystic changes, and demineralization. Labral tears may involve any portion of the labrum and may be associated with paralabral cyst formation.

There are >200 000 anterior cruciate ligament (ACL) injuries and 100 000 reconstructions each year in the United States that are commonly associated with sports. Lynne S. Steinbach, MD, University of California San Francisco, San Francisco, California, USA, described MRI of a normal ACL graft reconstruction and a graft failure.

Before deciding to perform an ACL reconstruction, an MRI evaluation is helpful to reveal the anatomy and type of tear (partial thickness, isolated bundle, full thickness, and secondary signs). The condition of the proximal and distal attachments and ACL bundles (anteromedial and posterolateral) should be included in the assessment. Routine sagittal imaging and oblique planes or isometric volume imaging may be used for further delineation.

Partial tears are recognized as having one or more of the following features: (1) high T2 signal, thinning; (2) abnormal orientation; and (3) abnormal morphology on the MRI scan. A full-thickness tear may show discontinuity of fibers, increased T2 signal, abnormal orientation, detachment at insertion sites, and/or effusion in >75% of cases.

The mechanisms of ACL injury include internal rotation and valgus stress, hyperextension, and varus stress with external rotation. One of the sequelae of a valgus injury with ACL tear is impaction of the bone and cartilage overlying the LAT femoral condylopatellar sulcus (notch), which causes injuries seen on MRI including a deep LAT femoral notch sign along with abnormal signal in the marrow and occasional overlying cartilage loss. This is seen in approximately 10% of ACL tears.

Chronic ACL tears are often difficult to distinguish from an intact ACL because edema and increased signal intensity are not seen on T2-weighted images >6 months following injury. Sometimes, the ACL looks completely normal. It may be thickened. It can also attach to the posterior cruciate ligament or have abnormal angulation.

ACL reconstruction is best performed with autograft (bone–patellar tendon–bone graft or distal hamstring tendons) or allograft. Graft failure can be the result of poor surgical technique, failure of graft incorporation, errors in rehabilitation, new trauma, or graft tearing. Hardware complications include bone graft–screw migration, screw impingement on the graft, pin or screw failure, or dislodged screws.

Bruce B. Forster, MD, MSc, University of British Columbia, Vancouver, British Columbia, Canada, reviewed the indications and technique for shoulder magnetic resonance arthrography (MRA), the most sensitive and specific imaging test for evaluating the shoulder labroligamentous complex.

Dr Forster recommends MRA over conventional MRI for shoulder pain in athletes and patients aged <40 years as these patients are more likely to have clinically occult instability. Age is important because the stabilizing function of the shoulder transfers from labra to cuff as we age; thus, older patients with instability are more likely to have rotator cuff tears [Rowan KR et al. *Clin Rad.* 2004]. In addition, clinical [Norregaard J et al. *Ann Rheum Dis.* 2002] and sonographic diagnoses of labral injury have low accuracy when compared with MRA.

MRA is better than 3T MRI for diagnosing labral tears in the shoulder, particularly for tears of the anterior labrum [Major NM et al. *AJR Am J Roentgenol.* 2011], and it can discriminate normal variants such as a sublabral foramen or Buford complex with a high degree of accuracy.

MRA of the shoulder in patients in the abduction external rotation position improves detection of Perthes lesions.

When interpreting a shoulder MRA, it is important to have a solid knowledge of both the normal anatomy and these normal variants (which also include the superior sublabral recess). Dr Forster recommends concentrating on the anterior labrum below the 3-o'clock arthroscopic position and checking morphology of the gadolinium-enhanced MRI signal for superior labrum abnormalities. He concluded by recommending using a simplified 5-step approach to interpret a shoulder MRA (Table 1).

Table 1. Five-Step Checklist

Location	Key Considerations
1a. Labrum: anterior	Is contrast material interposed between the labrum and hyaline cartilage? Beware of hyaline cartilage undercutting Does it extend below the 3-o'clock position of the glenoid? Beware of sublabral foramen If yes, look for Bankart lesion or variant
1b. Labrum: superior	Is contrast material interposed between the superior labrum and hyaline cartilage? If yes and there are linear curves medially, this indicates superior sublabral recess If yes and stellate or curves laterally, this indicates a superior labral tear anterior-to-posterior lesion
2. Scapular periosteum	Is it intact, disrupted, or stripped off? If disrupted, this indicates a classic Bankart lesion If stripped off, this indicates a Bankart variant Perthes lesion Anterior labroligamentous–periosteal sleeve avulsion lesion
3. Glenoid articular hyaline cartilage	Check contour If defect, this indicates a glenolabral articular disruption lesion
4. Glenohumeral ligaments	Middle glenohumeral ligament: Is it thickened or cord-like? If yes, favors Buford complex over isolated anterosuperior labral tear, if there is a superior labral defect Inferior glenohumeral ligament (major joint stabilizer) If tear at the labral attachment, this indicates Bankart If tear at the humeral attachment, this indicates a humeral avulsion of the glenohumeral ligament
5. Indirect signs of instability	Hills–Sachs lesion Paralabral cysts

Reproduced with permission from BB Forster, MD, MSc.