Anatomic Variants and Pitfalls of the Labrum, Glenoid Cartilage, and Glenohumeral Ligaments

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Magnetic resonance (MR) imaging is the primary diagnostic imaging modality for the evaluation of patients with suspected internal derangement of the shoulder joint. Awareness and understanding of the complex anatomy of the shoulder articulation and the ability to recognize normal anatomic variants and potential imaging pitfalls are critical to accurate interpretation of conventional and arthrographic MR imaging studies.[1,2] This review discusses the normal anatomy and anatomic variants of the glenoid labrum, articular cartilage, and glenohumeral ligaments (GHLs). An improved understanding of normal anatomy, biomechanics, and variants helps to avoid potential pitfalls in the interpretation of noncontrast and arthrographic shoulder MR examinations.

LABRUM

Function/Biomechanics

The glenoid labrum acts as a passive stabilizer to the glenohumeral articulation by adding depth to the shallow glenoid fossa.[3] It also serves as a primary attachment site for the GHLs, joint capsule, and long head of the biceps tendon. The labrum demonstrates considerable anatomic variability in its appearance, which may pose a diagnostic challenge to image interpretation.

The labral outline is ovoid in configuration, conforming to the underlying glenoid rim, and is most firmly attached to the glenoid posteriorly and inferiorly.[4] Previous reports have shown the labrum to be predominantly composed of fibrous tissue with some fibrocartilaginous components at the chondrolabral junction.[5,6] At the central interface of the glenoid labrum and the glenoid cartilage, 2 specific types of chondrolabral junctions have been described. There may be an abrupt transition with the labrum demonstrating a free edge margin (type A) or there may be a transition zone where the fibrous labrum blends with the glenoid hyaline cartilage (type B attachment) (**Fig. 1**). Initially the labrum was considered to normally be of low signal intensity on all MR pulse sequences; however, more recent studies have identified areas of increased linear or globular signal intensity in nearly a third of arthroscopically normal labral tissue.[7] In type B attachments, intermediate signal

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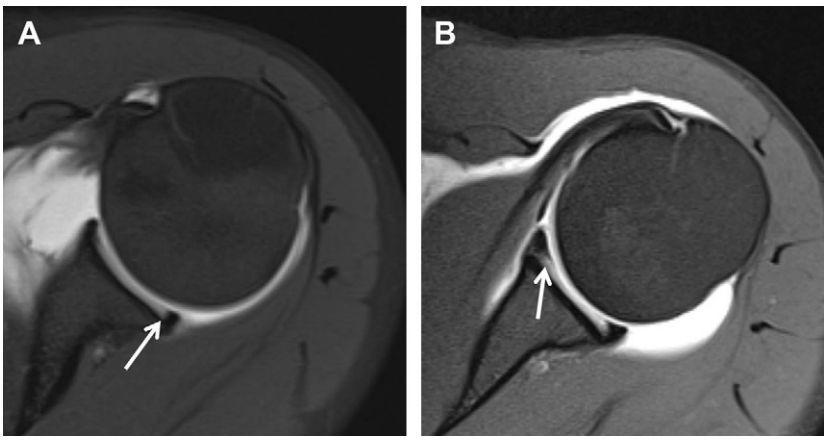

Fig. 1. Type A and B labrum. Axial fat-suppressed T1-weighted (repetition time/echo time, 514/8.6) MR arthrographic images demonstrate type A versus type B labrum. (*A*) Type A labrum characterized by abrupt chondrolabral transition and sharp marginated labral free edge is shown (*arrow*). (*B*) Ill-defined heterogeneous signal at the chondrolabral interface attributed to undercutting of the labral fibrocartilage by glenoid hyaline cartilage typical of a type B labrum is demonstrated (*arrow*).

intensity may be noted at the chondrolabral junction corresponding to the transitional zone of fibrocartilage, which should not be misinterpreted as a labral tear.[8]

Typically considered to be triangular or rounded in cross section, a range of glenoid labral morphologies has been described. Park and colleagues[9] evaluated labral shape on 108 arthrograms of asymptomatic volunteers and found a triangular shape to be most common (anterior, 64%; posterior, 47%) followed by rounded (17%, 33%). Flat, cleaved, notched, or absent labrum was also seen. The labrum typically measures approximately 4 mm in width and 3 mm in thickness; however, broad variation in labral size from 2 to 14 mm between normal individuals exist, thus rendering size criteria of little diagnostic utility.[7]

Superior Labrum

The labrum demonstrates its greatest variation in morphology and attachment above the equator. At the superior labrum, fibers from the proximal origin of the long head of the biceps tendon blend with the labrum forming the biceps labral complex (BLC). Three distinct types of complexes have been described (**Fig. 2**).[4] In a type I BLC, the labrum is firmly attached to the glenoid rim, with no intervening cartilage or central free edge. In a type II BLC, the attachment of the glenoid labrum and biceps tendon to the glenoid occurs more medially and there is continuation of the hyaline cartilage under the labrum accompanied by a small synovial-lined sulcus between the labral free edge and cartilage. In a type III BLC, a prominent triangular meniscoid labrum projects into the joint space and results in a deep recess that may be continuous with a sublabral foramen (**Fig. 3**).

The sublabral sulcus or recess present in type II and III BLCs represents the most frequent normal anatomic variant of the superior labrum. A cadaveric study by Smith and colleagues[10] demonstrated a recess deeper than 2 mm to be present in 39% of specimens. The recess can be identified on routine MR imaging and is enhanced by the presence of a joint effusion or an intra-articular contrast solution.[10] Mischaracterization of this finding as a superior labral anterior-posterior (SLAP) II tear is a potential diagnostic pitfall.[11] Tuite and Orwin[12] described 3 key features of the superior recess to help differentiate it from an SLAP tear: (1) location: a sulcus typically extends only to the most posterior insertion point of the biceps tendon attachment to the labrum and glenoid[13]; (2) contour: a sulcus should demonstrate smooth margins, any irregularity in the contour should be considered suspicious for SLAP tear; and (3) orientation: the direction of increased signal intensity/fluid should extend medially, paralleling the underlying glenoid cartilage; any extension laterally into the substance of the labrum should be considered pathologic. A shallow contrast-filled cleft can sometimes be depicted between the labrum and the biceps, the so-called bicipital labral sulcus (**Fig. 4**).[14]

A second normal anatomic variant of the superior labrum is the sublabral foramen that may be seen in association with a sublabral sulcus or in isolation. Present in 11% of normal patients,[15] the foramen represents a focal developmental