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REVIEW

Long head of the biceps tendon and rotator interval

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Abstract The term "biceps brachii" is a Latin phrase meaning "two-headed (muscle) of the arm." As its name suggests, this muscle has two separate origins. The short head of biceps is extraarticular in location, originates from the coracoid process of the scapula, having a common tendon with the coracobrachialis muscle. The long head of biceps tendon (LBT) has a much more complex course, having an intracapsular and an extracapsular portion. The LBT originates from the supraglenoid tubercle, and in part, from the glenoid labrum; the main labral attachments vary arising from the posterior, the anterior of both aspects of the superior labrum (Bletran et al. in Top Magn Reson Imaging 14:35–49, 2003; Vangsness et al. in J Bone Joint Surg Br 76:951–954, 1994). Before entering the bicipital groove (extracapsular portion), the LBT passes across the "rotator cuff interval" (intracapsular portion). Lesions of the pulley system, the LBT, and the supraspinatus tendon, as well as the subscapularis, are commonly associated (Valadie et al. in J Should Elbow Surg 9:36–46, 2000). The pulley lesion can be caused by trauma or degenerative changes (LeHuec et al. in J Should Elbow Surg 5:41–46, 1996). MR arthrography appears to be a promising imaging modality for evaluation of the biceps pulley, through the distention of the capsule of the rotator interval space and depiction of the associated ligaments.

Keywords Rotator interval lesion · Biceps pulley · Long head biceps · MRI arthrography

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Normal anatomy

The term "biceps brachii" is a Latin phrase meaning "two-headed (muscle) of the arm." As its name suggests, this muscle has two separate origins. The short head of biceps is extraarticular in location, originates from the coracoid process of the scapula, having a common tendon with the coracobrachialis muscle [1–4].

The LBT has a much more complex course, having an intracapsular and an extracapsular portion. The LBT originates from the supraglenoid tubercle, and in part, from the glenoid labrum; the main labral attachments vary arising from the posterior, the anterior of both aspects of the superior labrum [1, 2]. Before entering the bicipital groove (extracapsular portion), the LBT passes across the "rotator cuff interval" (intracapsular portion).

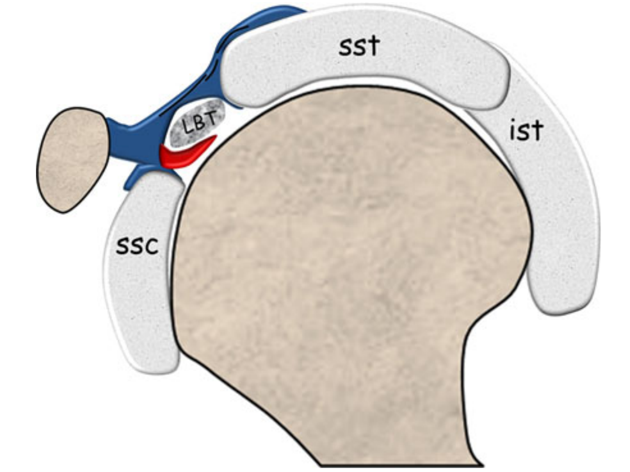


Fig. 1 Illustration of sagittal oblique view depicts distal portion of the coracohumeral (*blue*) and superior glenohumeral ligaments (*red*) and long head of biceps brachii tendon (LBT). *ssc* Subscapularis tendon, *sst* supraspinatus tendon, *ist* infraspinatus tendon (color figure online)

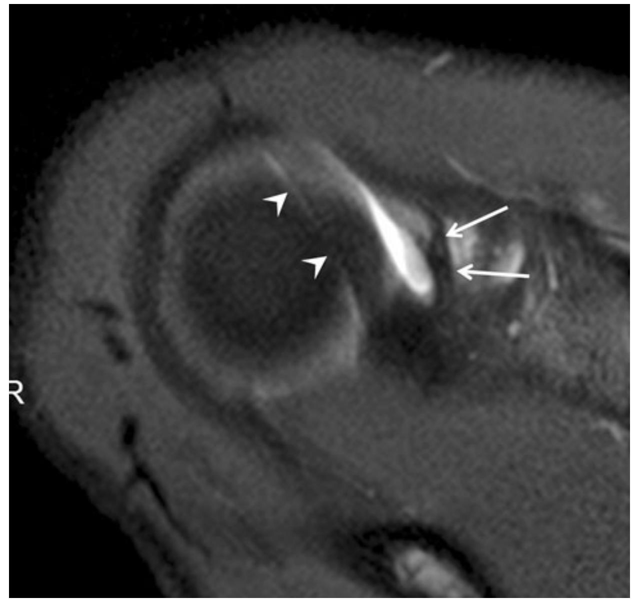
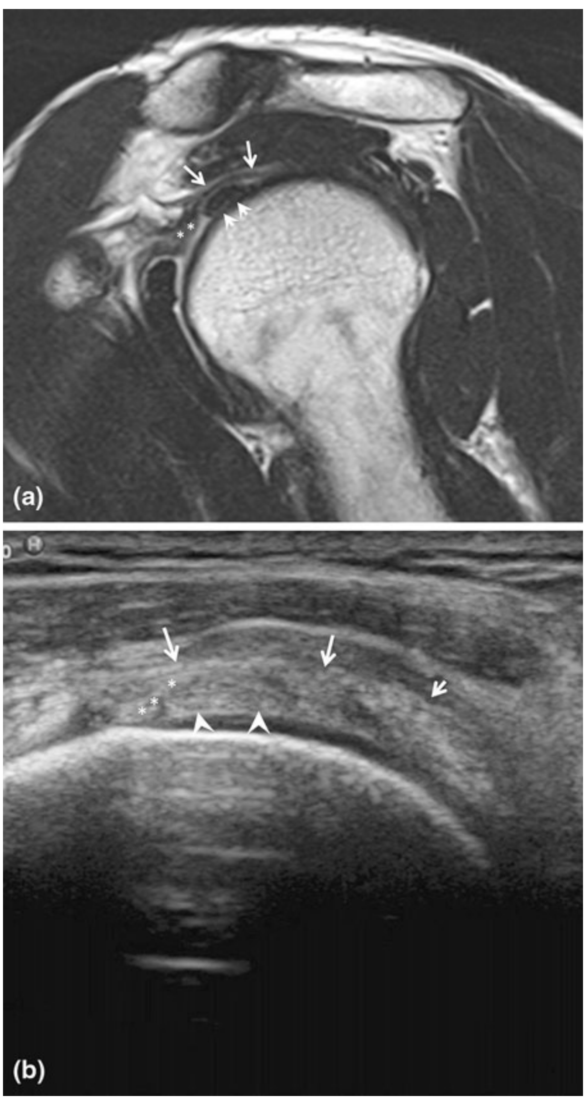


Fig. 3 Normal anatomy as depicted on axial T1-weighted MR arthrographic image with fat saturation. Superior glenohumeral ligaments (*arrows*) arise from the superior glenoid tubercle, anterior to the biceps tendon (*arrowed*)



The rotator interval is a triangular space defined superiorly by the anterior border of the supraspinatus tendon and inferiorly by the superior border of subscapularis. The base of the triangle is at the base of coracoid process, and its apex is at the transverse ligament. The rotator interval represents a defect in the rotator cuff resulting from the protrusion of the coracoid process between the supraspinatus and subscapularis tendon [5].

Along its course in the rotator interval, the LBT is stabilized by the so-called biceps pulley (or "reflection pulley"), formed by the coracohumeral ligament (CHL) and superior glenohumeral ligament (GHL) [6] (Fig. 1). The CHL originates from the lateral aspect of the base of the coracoid process, and distally it forms two bands. The medial and smaller band crosses over the LBT and inserts at the lesser tuberosity; the lateral and larger band inserts on the grater tuberosity and on the anterior portion of the supraspinatus tendon. The superior GHL arise from the superior glenoid tubercle, anterior to the biceps tendon and inserts to the lesser tuberosity.

◀**Fig. 2** Normal anatomy depicted on sagittal T1-weighted MR arthrographic image (**a**) and on short-axis ultrasound image (**b**). Coracohumeral ligament (*arrows*) and blended coracohumeral and superior glenohumeral ligaments (*asterisks*) trace inferiorly and medially to long head of the biceps brachii tendon (*arrowed*) before inserting on lesser tuberosity

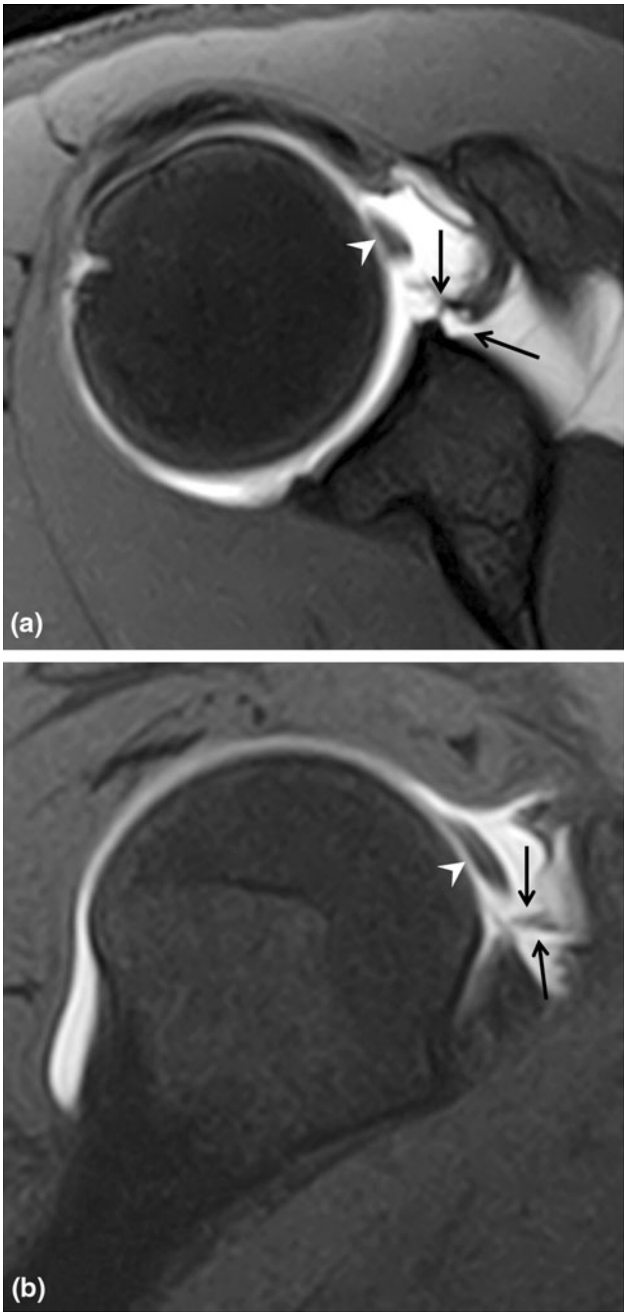


Fig. 4 Traumatic tear of superior GHL in a 42-year-old man. Axial (**a**) and oblique sagittal (**b**) fat-saturated T1-weighted MR arthrographic images show avulsion of the superior GHL (*arrows*) with glenoid labrum. Note biceps tendon (*arrowed*) "free" in the rotator interval

Imaging

The biceps pulley is a complex structure, formed by more ligaments which cross the rotator interval very close to one another and blend together at their distal attachment sites [7].

Fig. 5 Biceps pulley tear in a 42-year-old man who suffered recurrent shoulder dislocation. Axial fat-saturated T1-weighted MR arthrographic images show absence of the biceps pulley (*asterisks*). Long head biceps tendon (*arrowed*)

In a cadaveric study by Chung et al., only direct MR arthrography has demonstrated sufficient accuracy in depicting the rotator interval anatomy [8–10]. In their study at the routine MR imaging, only some parts of intraarticular portion of LBT were demonstrated, and the ligaments of biceps pulley were poorly identified, while at direct MR arthrography, all parts of LBT, the CHL and superior GHL were seen in all cases. Oblique sagittal images should be the best to the structures of the rotator interval [11, 12] (Fig. 2); axial images are also valid to identify the ligaments of the biceps pulley [13, 14] (Fig. 3). Sequences with high image matrix are recommended [15, 16].

At ultrasound (US), the CHL is best identified on short-axis scans, as a homogeneous echogenic band located over the LBT, tightened between the subscapularis and the supraspinatus. Although US cannot identify the superior GHL, the portion of ligament that merges with the medial portion of the CHL and inserts into lesser tuberosity (the biceps pulley) can be detected [17, 18] (Fig. 2).

Rotator interval lesions

The "cuff rotator interval" can be considered as a single functional complex, and its structures, including the LBT, the biceps anchor, the CHL, the superior GHL, the anterior

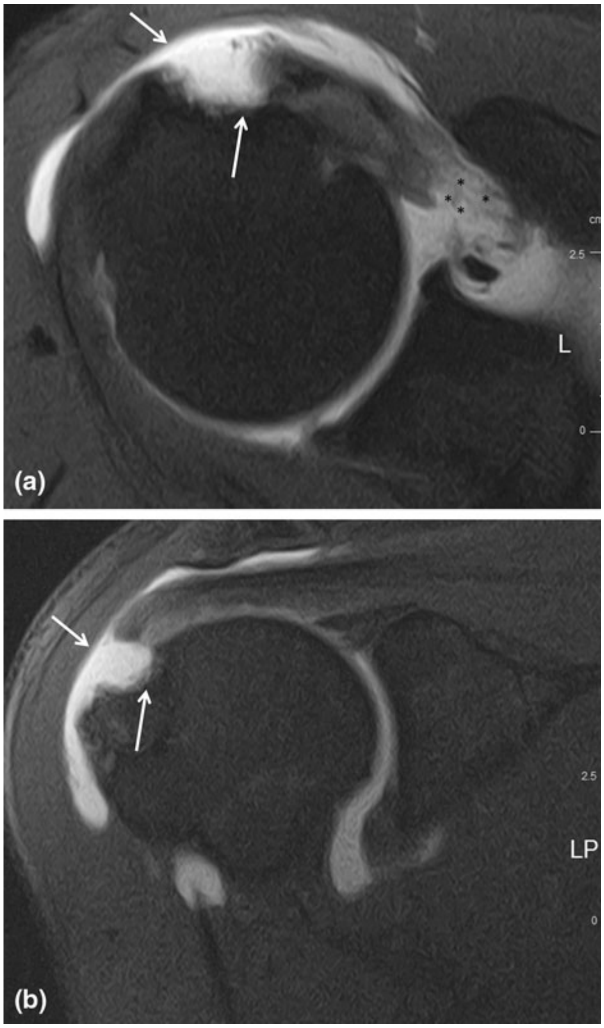


Fig. 6 Axial (**a**) and oblique coronal (**b**) fat-saturated T1-weighted MR arthrographic images shows traumatic tears of the supraspinatus tendon at the level of its merger with CHL (*arrows*) and sGHL (*asterisks*) in a 42-year-old man

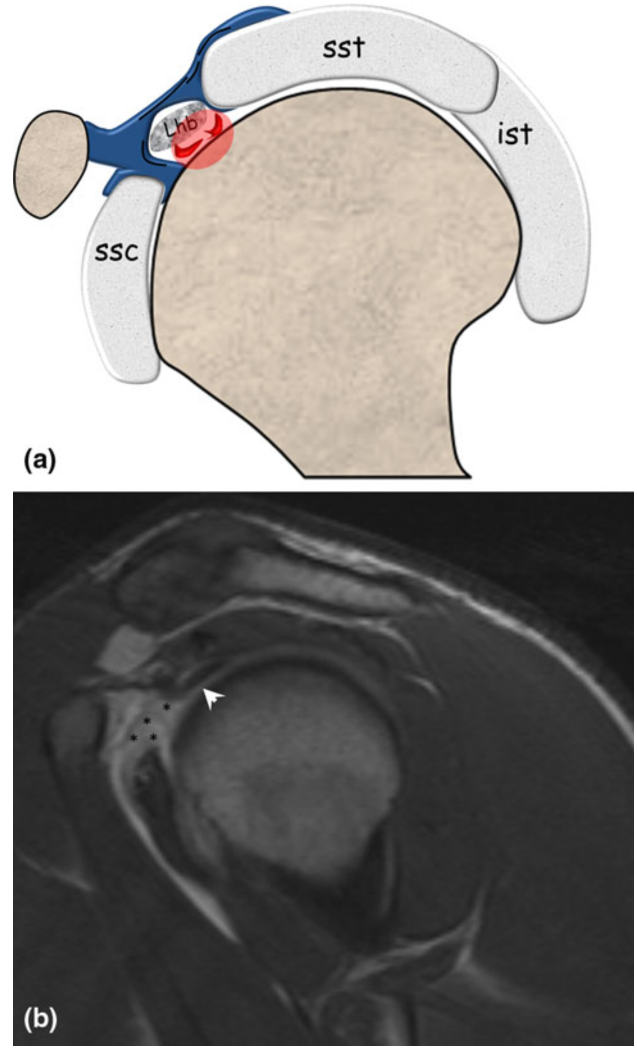


Fig. 7 Illustration (**a**) and oblique sagittal (**b**) T1-weighted MR arthrographic image shows Habermeyer group 1 lesion with isolated sGHL tear (*asterisks*)

portion of supraspinatus and superior portion of subscapularis, are closely associated with each other.

Rotator interval abnormalities have been called "hidden" lesions, a phrase first used by Walch et al. [19] referring to the difficult arthroscopic visualization. A rotator interval lesion can be caused by acute trauma, repetitive microtrauma or degenerative changes [5].

In acute trauma, the rotator interval structures may be thickened, irregular or disrupted [2] (Fig. 4a, b).

Some authors have described the rotator interval tears in association with glenohumeral instability [20] (Fig. 5), in some cases resulting as isolated lesion [21].

Baumann et al. have suggested that traumatic injuries resulting from a fall on an outstretched arm in combination with full external or internal rotation, a fall backward on the hand or elbow, or direct anterior impact may cause lesion of the biceps pulley [5, 22].

A rotator interval tear may also occur as an extension of injury from the tendons of the rotator cuff [8, 19, 23, 24] (Fig. 6a, b).

Degenerative lesions of the rotator interval may be due to anatomical variations that cause instability of the LBT [13, 25, 26].

A cause of repeated microtrauma that causes the injury of the pulley is the "anterosuperior impingement."

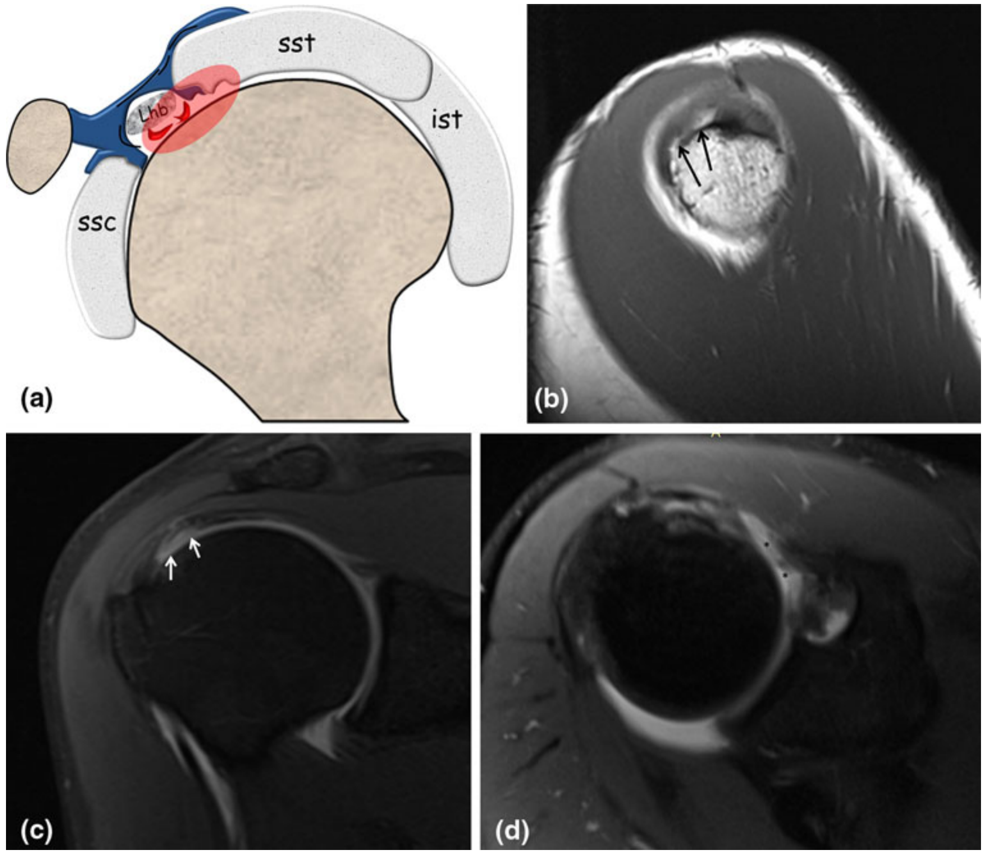


Fig. 8 Illustration (**a**), oblique sagittal (**b**), oblique coronal fat saturated (**c**) and axial fat saturated (**d**) T1-weighted MR arthrographic image shows Habermeyer group 2 lesion with sGHL tear (*asterisks*) and articular-side partial tear of supraspinatus tendon (*arrows*)

Gerber and Sebesta [27] first described the intraarticular impingement. In a position of horizontal adduction and internal rotation of the arm, the undersurface of subscapularis tendon and of the biceps pulley impinges against the anterosuperior glenoid rim.

Subsequently, Habermeyer et al. [28] have identified four groups of pulley lesions. Group 1: isolated superior GHL lesion (Fig. 7a, b); group 2: superior GHL lesion with a partial articular-side supraspinatus tendon tear (Fig. 8a–d); group 3: superior GHL lesion with a partial articular-side subscapularis tendon tear (Fig. 9a–d) and; group 4: superior GHL lesion with a partial articular-side tears of both supraspinatus and subscapularis tendon (Fig. 10a, b).

Only few studies report the values of the accuracy of MR in the evaluation of lesions of the superior GHL. Chandnani et al. [29] reported that MR arthrography had a sensitivity of 100 %, a specificity of 94 % and an accuracy of 94 % in the diagnosis of superior GHL tears.

Long head biceps instability

Dislocation or subluxation of the LBT is the possible complication of the rotator interval lesion.

Walch et al. defined [23] biceps dislocation as non-reducible and complete loss of contact between the long head of the biceps brachii tendon and the bicipital groove. They classified dislocations in four types: (a) dislocation of the LBT inside the subscapularis tendon with intact anterior fascia (Fig. 11a, b); (b) intraarticular dislocation with a complete tear of the all insertions of the lesser tuberosity, but intact anterior fascia (Fig. 12a, b); (c) intraarticular

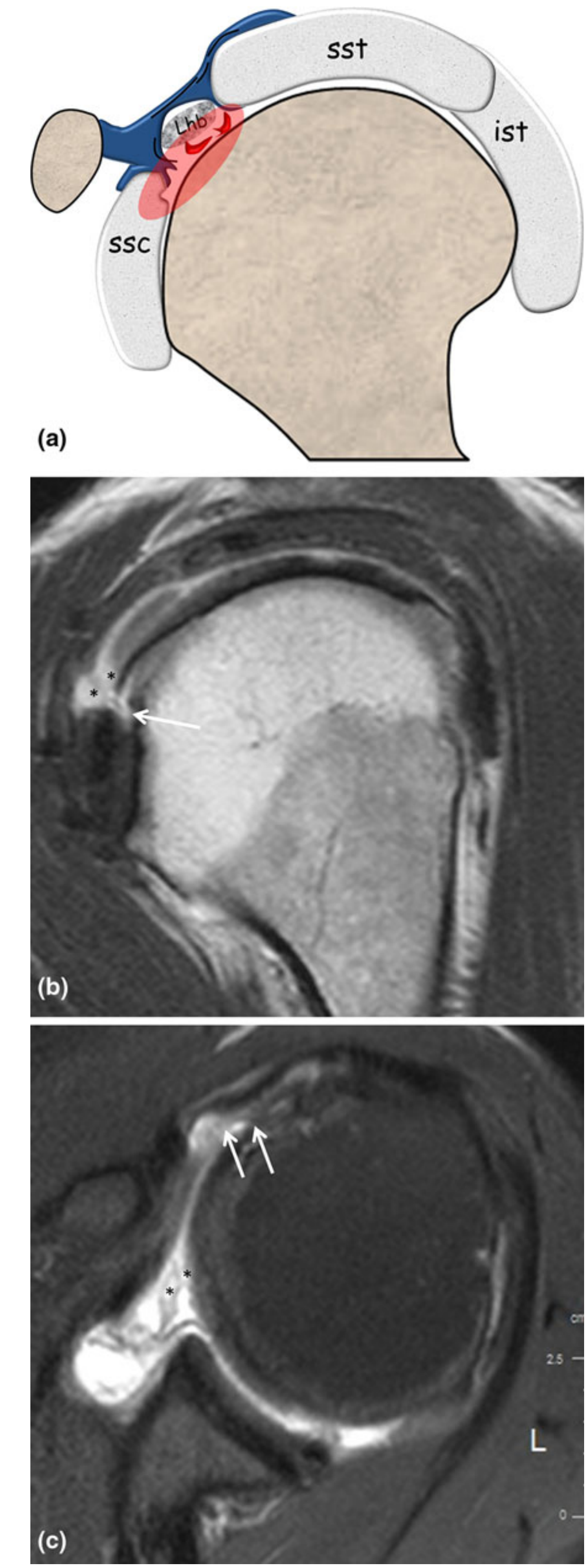


Fig. 9 Illustration (**a**), oblique sagittal (**b**) and axial fat saturated (**c**) T1-weighted MR arthrographic image shows Habermeyer group 3 lesion with sGHL tear (*asterisks*) and articular-side partial tear of subscapularis tendon (*arrows*)

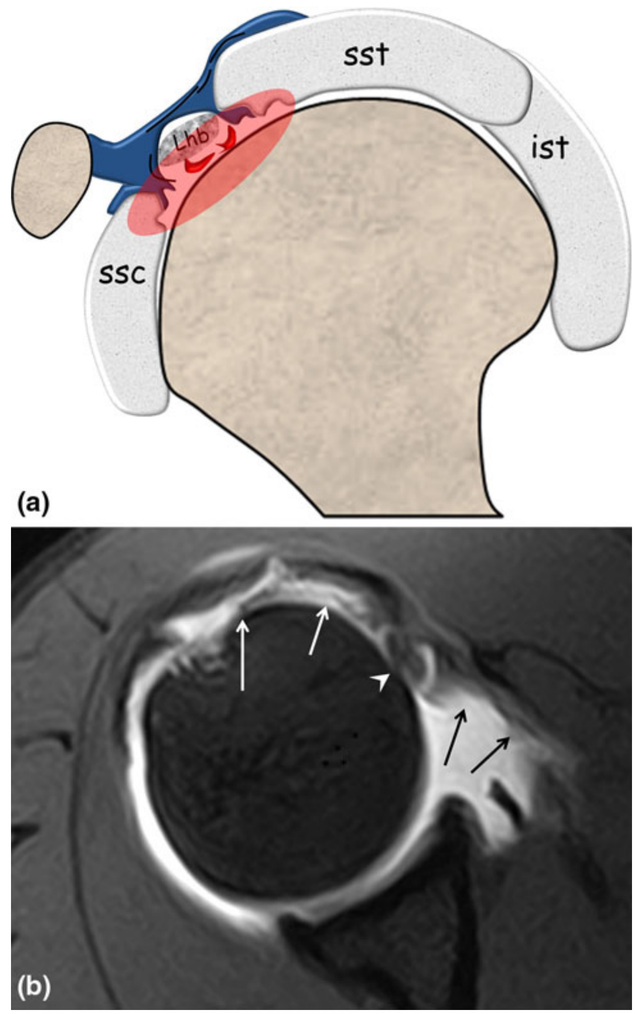


Fig. 10 Illustration (**a**) and axial fat saturated (**b**) T1-weighted MR arthrographic image shows Habermeyer group 4 lesion with sGHL tear (*asterisks*), articular-side partial tear of supraspinatus tendon (*white arrows*) and articular-side partial tear of subscapularis tendon (*black arrows*)

dislocation with a complete tear of the all insertions of the lesser tuberosity and anterior fascia (Fig. 13a, b) and; (d) dislocation over an intact subscapularis tendon due to a supraspinatus tear that extends to involve the lateral CHL ligament (Fig. 14a–c).

Biceps subluxation was defined by Walch et al. as tendon fixed over the medial rim at the superior part of the groove or recentred into the groove before disappearance of the groove. In their study, in the cases of subluxation, the subscapularis tendon was torn, with an intact pulley [20].

Superior labrum anterior and posterior lesions

The rotator interval lesion is often associated with superior labrum anterior and posterior (SLAP) lesions [6].

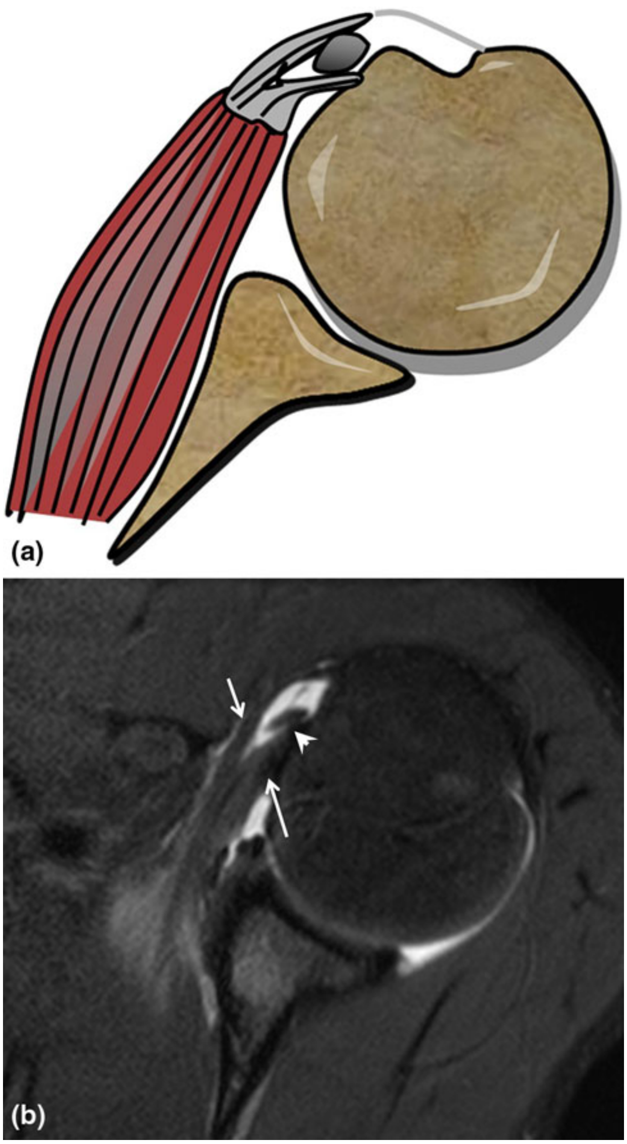


Fig. 11 Illustration (**a**) and axial fat saturated (**b**) PD-weighted MR image shows the biceps tendon (*arrowed*) dislocation between the fibres of subscapularis tendon (*arrows*)

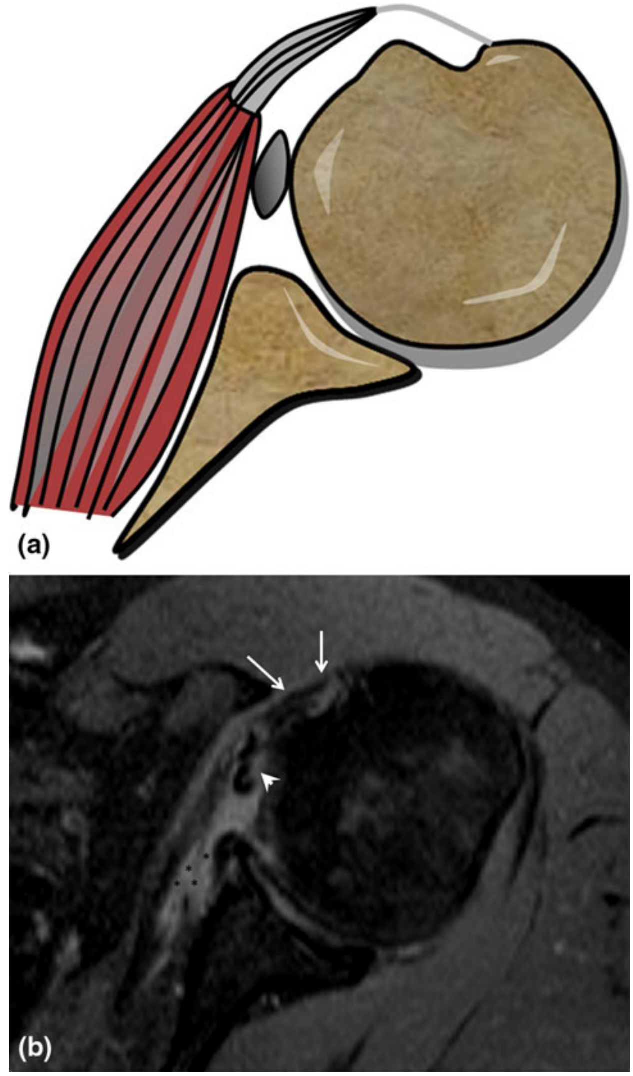


Fig. 12 Illustration (**a**) and axial fat saturated (**b**) PD-weighted MR image shows the intraarticular biceps tendon (*arrowed*) dislocation, the subscapularis tendon rupture (*asterisks*) and the intact anterior fascia (*arrows*)

Snyder et al. [30] described four types of SLAP lesions. Type I lesion is characterized by fraying but with no frank tear of the articulating surface of the superior portion of the glenoid labrum and with an intact biceps tendon. The type II lesion consists of superior labral fraying with stripping of the labrum and attached biceps tendon from the underlying glenoid cartilage (Fig. 15a, b). The type III lesion is a bucket-handle tear of the superior portion of the labrum with the central portion of the tear often displaced into the joint and the peripheral portion firmly attached to the glenoid rim; the biceps tendon remains intact. The type IV lesion consists of a bucket-handle tear of the superior portion of the labrum similar to the type III lesion, but with the tear extending into the biceps tendon (Fig. 16).

Three distinct type II SLAP lesions were described on the basis of anatomical location. A type IIA abnormality represents an anterosuperior labral lesion, a type IIB abnormality represents a posterosuperior lesion and a type IIC abnormality represents a superior lesion with both anterior and posterior components [31].

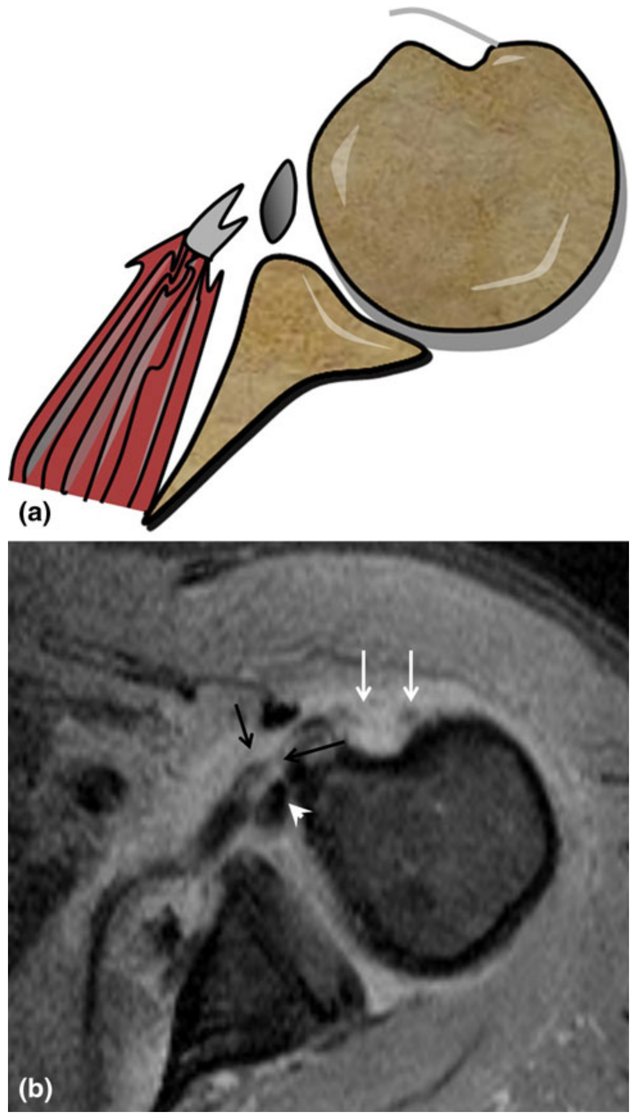


Fig. 13 Illustration (**a**) and axial fat saturated (**b**) PD-weighted MR image shows the intraarticular biceps tendon (*arrowed*) dislocation, the subscapularis tendon rupture (*asterisks*) and the anterior fascia tear (*arrows*)

MR arthrography and CT arthrography have demonstrated sufficient accuracy in identifying the labral tears [32, 33].

It is important to assess the direction and signal morphology of the lesion in order not to confuse the lesion with the frequent normal variants of the superior labrum, such us sublabral recess, sublabral foramen and Buford complex [34].

Conclusion

Lesions of the pulley system, the LBT, and the supraspinatus tendon, as well as the subscapularis, are commonly associated [3]. The pulley lesion can be caused by trauma or

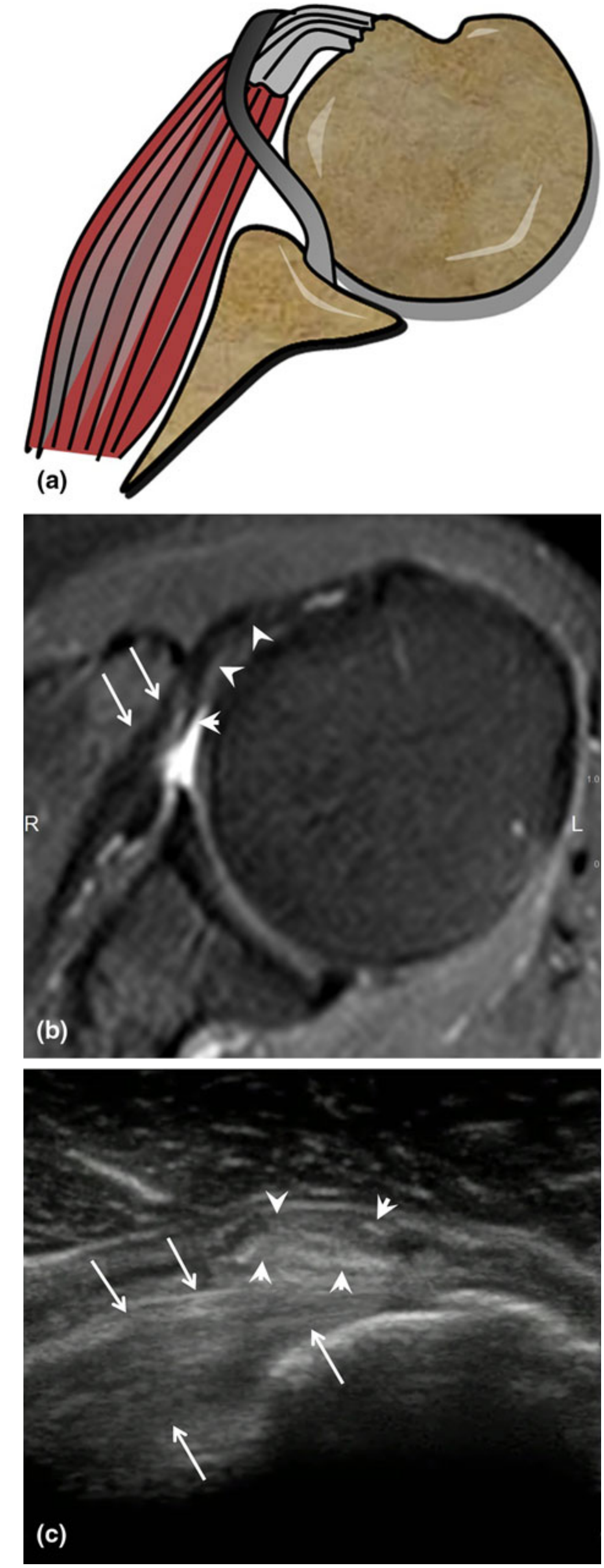


Fig. 14 Illustration (**a**), axial fat-saturated PD-weighted MR (**b**) and ultrasound image shows the extracapsular biceps tendon (*arrowed*) dislocation over the intact fibers of the subscapularis tendon (*arrows*)

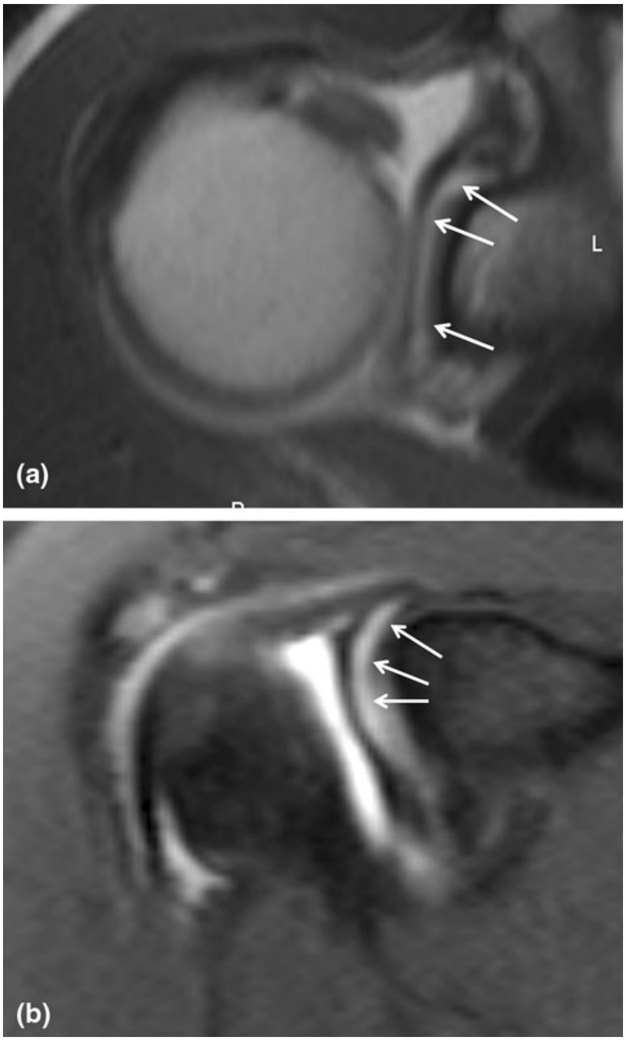


Fig. 15 Axial (**a**) and coronal (**b**) fat-saturated T1-weighted MR arthrographic shows type II SLAP lesion (*arrows*)

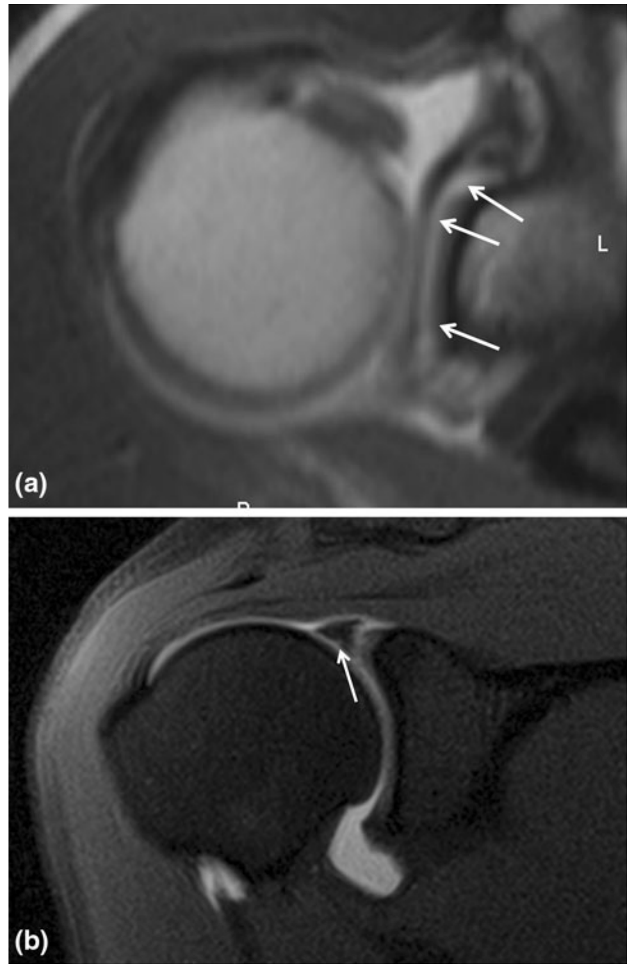


Fig. 16 Coronal (**b**) fat-saturated T1-weighted MR arthrographic shows type III SLAP lesion

degenerative changes [4]. MR arthrography appears to be a promising imaging modality for evaluation of the biceps pulley, through the distention of the capsule of the rotator interval space and depiction of the associated ligaments [1].

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Conflict of interest The authors declare that they have no competing interests.

Ethical standards The study described in this article did not include any procedures involving humans or animal.

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