

Review

SLAP lesions: Anatomy, clinical presentation, MR imaging diagnosis and characterization

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ABSTRACT

Superior labral anterior posterior (SLAP) tears are an abnormality of the superior labrum usually centered on the attachment of the long head of the biceps tendon. Tears are commonly caused by repetitive overhead motion or fall on an outstretched arm. SLAP lesions can lead to shoulder pain and instability. Clinical diagnosis is difficult thus imaging plays a key diagnostic role. The normal anatomic variability of the capsulolabral complex can make SLAP lesions a diagnostic challenge. Concurrent shoulder injuries are often present including rotator cuff tears, cystic changes or marrow edema in the humeral head, capsular laxity, Hill-Sachs or Bankart lesion. The relevant anatomy, capsulolabral anatomic variants, primary and secondary findings of SLAP tears including MR arthrography findings, types of SLAP lesions and a practical approach to labral lesions are reviewed.

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Keywords: Superior labral anterior posterior lesion SLAP lesion; Glenoid labrum; Shoulder anatomy; MR arthrography; Review

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Superior labral anterior posterior (SLAP) tears are a common cause of labral pathology, leading to shoulder pain and

instability. A SLAP lesion is an acquired abnormality of the labrum, usually centered on the attachment of the long head of biceps tendon. It can extend to involve the anterior and posterior labrum, as well as the surrounding anatomic structures. The superior labrum is functionally important as an anchor for the insertion of the biceps tendon on the glenoid rim. Andrews et al. [1] first described detachment and fraying of the anterior superior labrum, which may be accompanied by partial tearing of the

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biceps tendon, in a group of high-level throwing athletes. The term SLAP was subsequently coined by Snyder et al. [2], who described a similar but more global injury of the superior labrum that extended anterior and posterior to the biceps tendon. Diagnosis of a SLAP lesion can be difficult clinically, and imaging plays a key role in detecting a SLAP lesion.

Arthroscopic studies have reported a prevalence of SLAP lesions of 3.9–11.8%. Snyder et al. [3] analyzed 700 shoulder arthroscopies and found a SLAP incidence of 3.9%. Maffet et al. [4] identified 84 SLAP-type lesions in 712 consecutive shoulders arthroscopies, constituting an incidence rate of 11.8%. Common mechanisms of injury include repetitive overhead arm motion, found in throwers and swimmers, as well as a fall on the outstretched arm in the acute setting.

This review will familiarize the reader with the anatomy and anatomic variations of the capsulolabral complex of the glenohumeral joint, as we review the clinical presentation and etiology of SLAP pathology, and describe the MR imaging techniques and findings that aid in the diagnosis and characterization of SLAP pathology.

1. Clinical presentation, etiology, and physical exam

The clinical diagnosis of a SLAP lesion is difficult. Non-specific shoulder pain, particularly with overhead or cross-body motion, is the most common clinical presentation. Additional symptoms include popping, clicking, catching, weakness, stiffness and instability. The majority of patients present with concurrent shoulder injuries. In a retrospective review of 140 arthroscopically-proven SLAP lesions by Snyder et al. [3], the reported incidence of associated intra-articular disease included 29% with partial rotator cuff tears, 11% with full rotator cuff tears, 22% with Bankart lesions and 10% with glenohumeral chondromalacia.

Clinical history may involve a traction injury, direct trauma to the shoulder, or fall on an outstretched arm. Frequently, no antecedent injury or activity is reported. On physical exam, the patient may have increased shoulder laxity and positive findings with many provocative shoulder tests. No single physical test or sign is specific for SLAP lesions and physical findings can be confusing due to associated lesions (e.g. rotator cuff tears). The clinical diagnosis of a SLAP lesion is difficult and imaging plays a key role in diagnosis.

Recently, a cadaveric study has confirmed the peel-back theory of SLAP lesions. In the abducted and externally rotated shoulder, the biceps tendon assumes a more vertical and posteriorly directed orientation, which transmits a force to the superior labrum, causing it to peel off the glenoid [5]. Common mechanisms of injury include microtrauma secondary to repetitive overhead arm motion, and direct trauma due to falling on an outstretched hand. Repetitive overhead arm motions, such as those used in throwing and swimming, are thought to cause injury secondary to traction on the arm due to sudden pulling, throwing or other overhead motion [4]. Additional findings in repetitive overhead motion injury include, undersurface rotator cuff tears, cystic change in the humeral head related to posterolateral impingement and capsular laxity. Falling on an

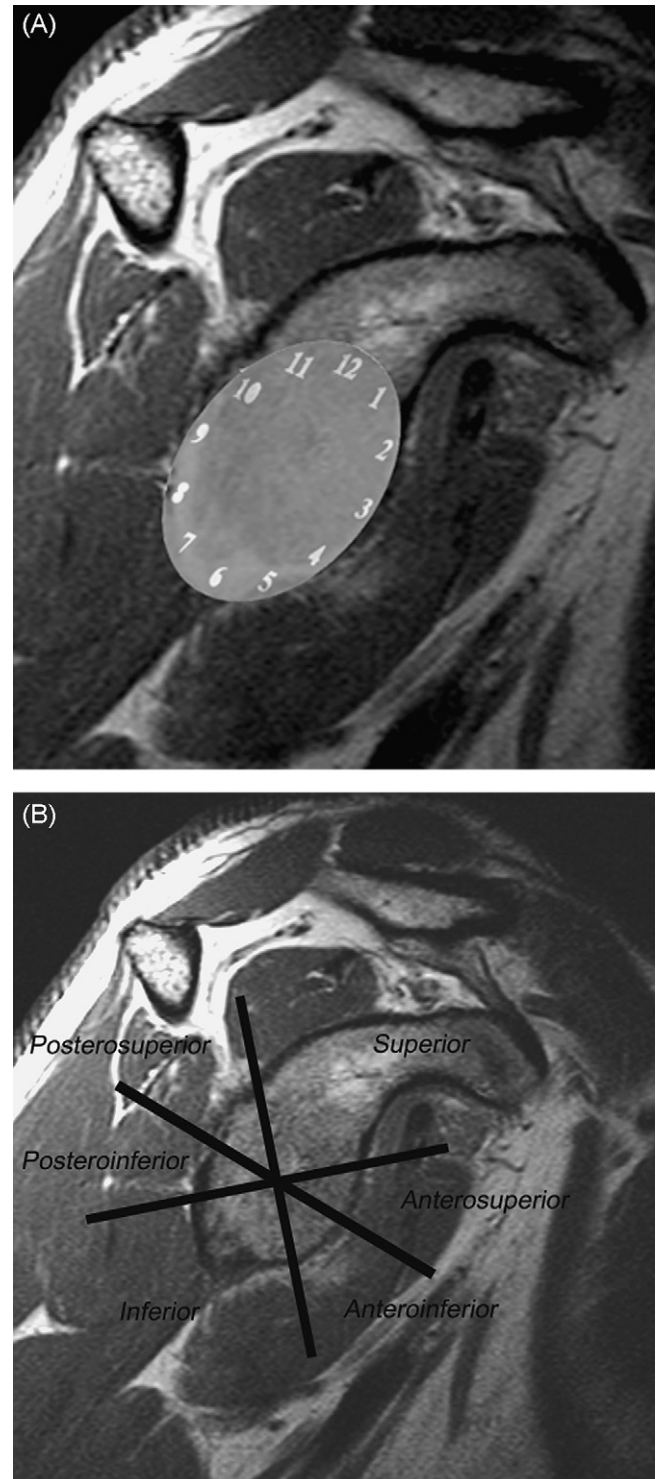


Fig. 1. Labral localization. (A) Clockface superimposed upon the glenoid in the sagittal plane allows precise localization of labral pathology. Note that the 3 o'clock position is always anterior, 9 o'clock posterior, 12 o'clock superior and 6 o'clock inferior, regardless of right versus left side. (B) Labral localization can also be performed in a slightly more general fashion by dividing the glenoid into segments.

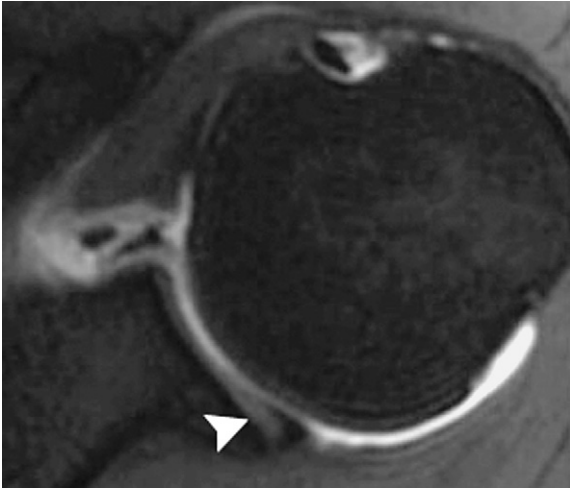


Fig. 2. Transitional zone. Axial T1-weighted fat-suppressed MR arthrogram image demonstrates intermediate signal undercutting the contour of the posterior superior glenoid labrum (arrowhead) representing the histologic transitional area from labral fibrocartilage to hyaline articular cartilage of the glenoid.

outstretched arm causes injury secondary to a compressive force applied to the shoulder, usually with the shoulder abducted and slightly anteriorly flexed [2]. This mechanism can result in marrow edema secondary to impaction of the humeral head against the glenoid. If an associated anterior dislocation is present, a Hill-Sachs deformity and a Bankart lesion may occur.

2. Anatomy of the capsulolabral complex

The labrum is a fibrocartilaginous structure that forms a cuff around the periphery of the glenoid. The labrum deepens the glenoid fossa and provides shoulder stability. It serves as the attachment for the glenohumeral ligaments and the tendon of the long head of the biceps muscle to the glenoid. Anteri-



Fig. 3. Buford complex. Axial proton density-weighted fat-suppressed MR image demonstrates absence of the anterior superior labrum (straight arrow) with a thickened cord-like MGHL (curved arrow).

orly, the labrum blends with the anterior band of the inferior glenohumeral ligament (IGHL). Superiorly, it blends with the biceps tendon and superior glenohumeral ligament (SGHL). The labrum is variable in shape, size and attachment to the glenoid [6]. The labrum is usually rounded or triangular. Its superior portion is more loosely attached and more mobile than the rest of the labrum. This normal laxity can be confused with SLAP lesions. The labrum normally displays low signal on all MR sequences.

For descriptive purposes, labral position is localized by superimposing the face of a clock onto the surface of the glenoid, and by convention 3 o'clock is anterior, 9 o'clock is posterior, 12 o'clock is superior, and 6 o'clock is inferior. An alternative is

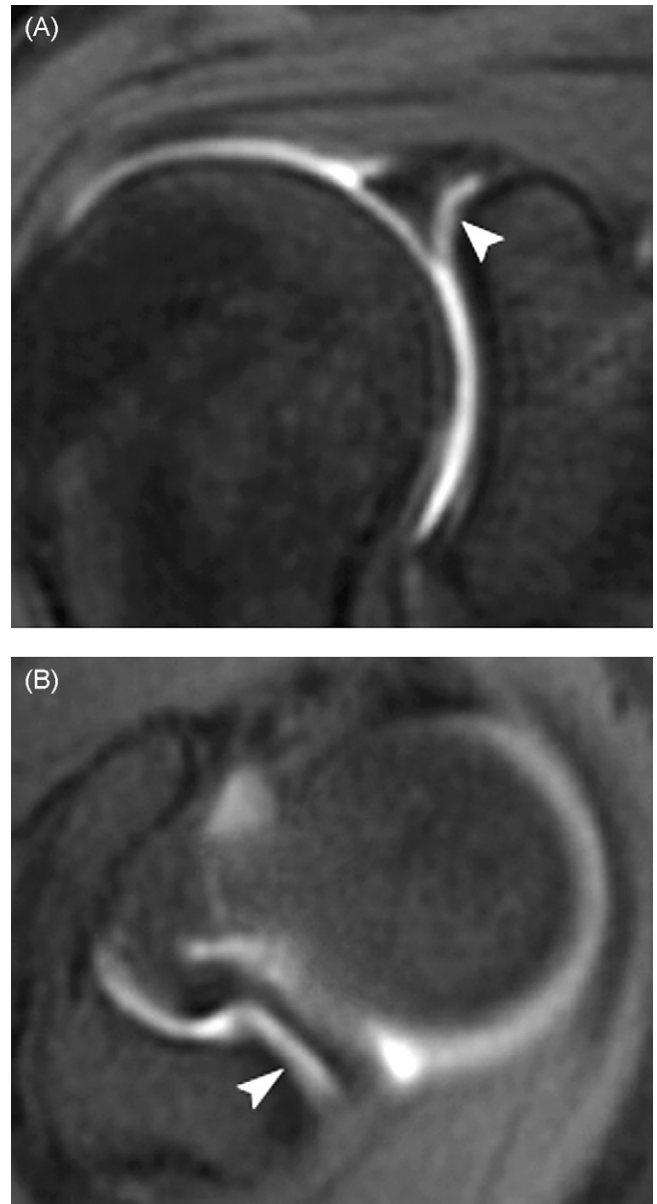


Fig. 4. Sublabral recess or sulcus. Coronal (A) and axial (B) T1-weighted fat-suppressed MR arthrogram images demonstrate a linear, well-defined space between the superior labrum and the adjacent osseous glenoid that parallels the glenoid margin. The sulcus is usually confined to the superior labrum at the 11–1 o'clock position at the site of attachment of the long head of biceps tendon.

to divide the labrum into six segments—superior, anterosuperior, anteroinferior, inferior, posteroinferior, and posterosuperior (Fig. 1A and B).

The three-glenohumeral ligaments are focal thickenings of the anterior joint capsule and can have significant variation in anatomy. The superior glenohumeral ligament can arise from the anterosuperior labrum, the biceps tendon attachment, or the middle glenohumeral ligament (MGHL). The SGHL is oriented in an axial plane extending from the superior glenoid to the lesser tuberosity, and it blends with the coracohumeral ligament. The SGHL is a minor contributor to glenohumeral stability. The MGHL courses deep to the subscapularis tendon to blend and insert with the posterior aspect of the subscapularis tendon at the base of the lesser tuberosity. The MGHL is the most variable of the glenohumeral ligaments, varying in size, attachment site and presence or absence. The MGHL may be attenuated or absent in up to 30% of shoulders. The MGHL commonly arises medially

on the glenoid neck but it may be attached to the anterosuperior labrum. It is an important secondary stabilizer of the shoulder and it is frequently injured during anterior glenohumeral dislocation. The inferior glenohumeral ligament is the primary stabilizer of the shoulder beyond 60 degrees of abduction. The IGHL is the single most important component of the capsulolabral complex for maintaining glenohumeral stability in the abducted and externally rotated arm. It inserts on the entire inferior glenoid labrum and extends to the inferior anatomic neck of the humerus. The IGHL is composed of the anterior band, axillary pouch and posterior band. Common glenohumeral ligament variants include a common origin of the SGHL and MGHL, thinning, thickening or absence of a ligament.

The tendon of the long head of the biceps muscle attaches to the anterosuperior glenoid rim. It courses laterally through the rotator interval and turns inferiorly within the bicipital groove of the humerus.

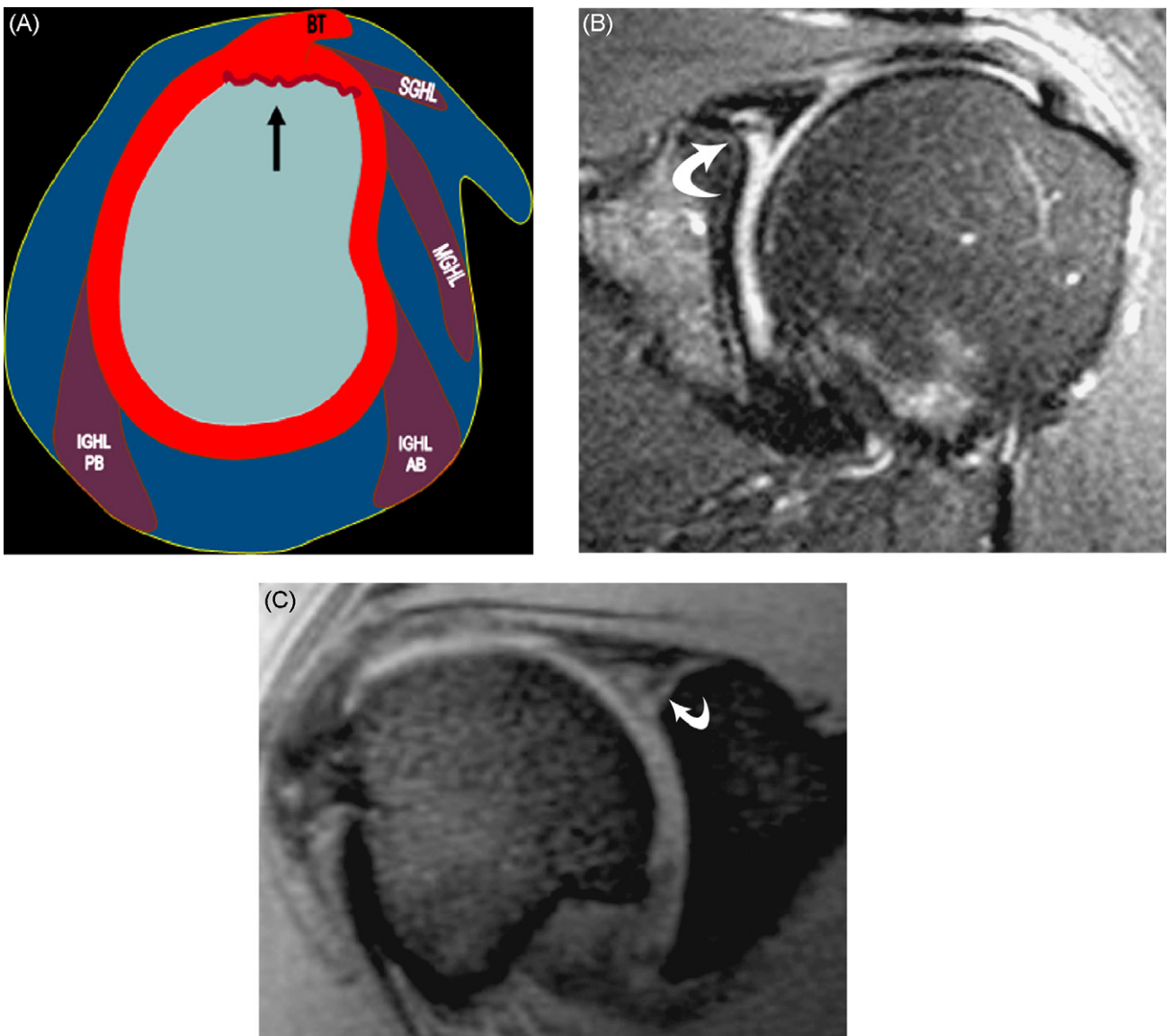


Fig. 5. SLAP 1. (A) Diagram, (B) coronal proton density-weighted fat-suppressed coronal and (C) gradient coronal images demonstrate fraying (curved arrow) but no frank labral tear.

Table 1
Summary of MRA study results

Study	Imaging technique	Patients (N)	Sensitivity	Specificity	Accuracy
Connell et al. [38]	MRI	140	98	89.5	95.7
Applegate et al. [25]	dMRA	36	100	88	92
Bencardino et al. [26]	dMRA	52	89	91	90
Waldt et al. [24]	dMRA	265	82	98	94
Jee et al. [27] ^a	dMRA	80	92, 92, 84	84, 82, 69	86, 85, 74
Dinauer et al. [28]	iMRA	104	91, 84	71, 58	87, 78
Herold et al. [23]	MRI	35	85, 66	75, 83	83, 70
	iMRA		91	85	89
	MRI		73	85	77

MRI = unenhanced MR, dMRA = direct MR arthrography, iMRA = indirect MR arthrography.

^a Multiple numbers correspond to the individual sensitivities, specificities and accuracies of multiple reviewers.

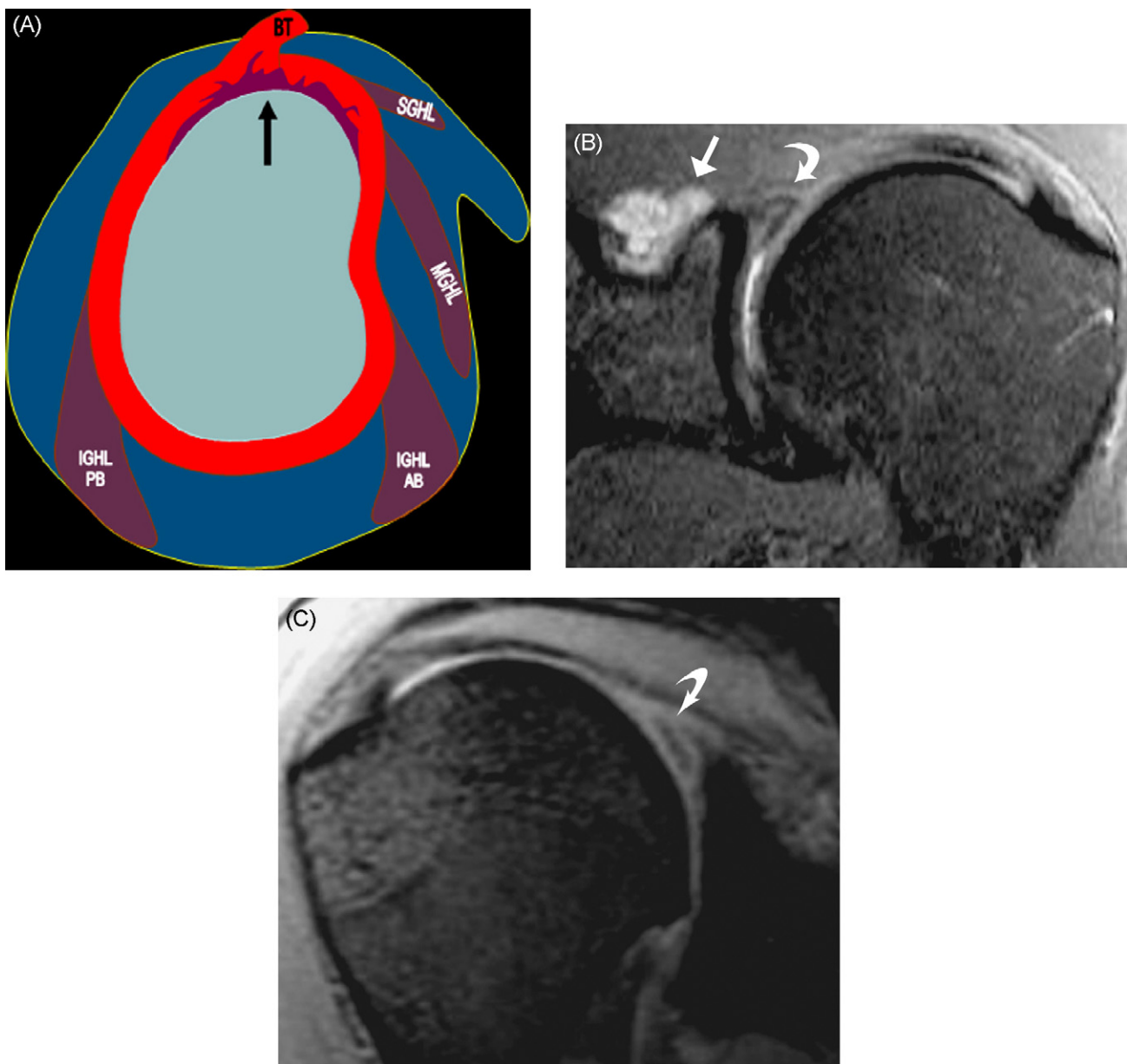


Fig. 6. SLAP II. (A) Diagram, (B) coronal T2-weighted fat-suppressed, and (C) coronal proton density-weighted images demonstrate a superior labral tear with linear signal intensity extending into the labral substance (curved arrow). A perilabral cyst (straight arrow, B), a specific secondary MR imaging finding of labral tear is seen in one patient.

3. Normal variants of the superior and anterosuperior labrum

The area of greatest anatomic variation in the labrum is between the 11 and 3 o'clock positions. This variability frequently poses a diagnostic challenge since it is also a common location for pathology. Variations can occur in signal intensity, morphology, attachment and presence or absence of the anterior superior labrum. Normal variants include the sublabyrinthal recess or

sulcus, the sublabyrinthal foramen or hole, the Buford complex and other less common variants.

The normal signal intensity of the labrum is low signal on all pulse sequences. The labral signal can be variable with increased signal, particularly in older individuals. The clinical significance of high signal is unclear, particularly if the underlying morphology of the labrum is normal. The signal characteristics could be a variant of normal or represent early degenerative or post-traumatic changes. High signal that follows

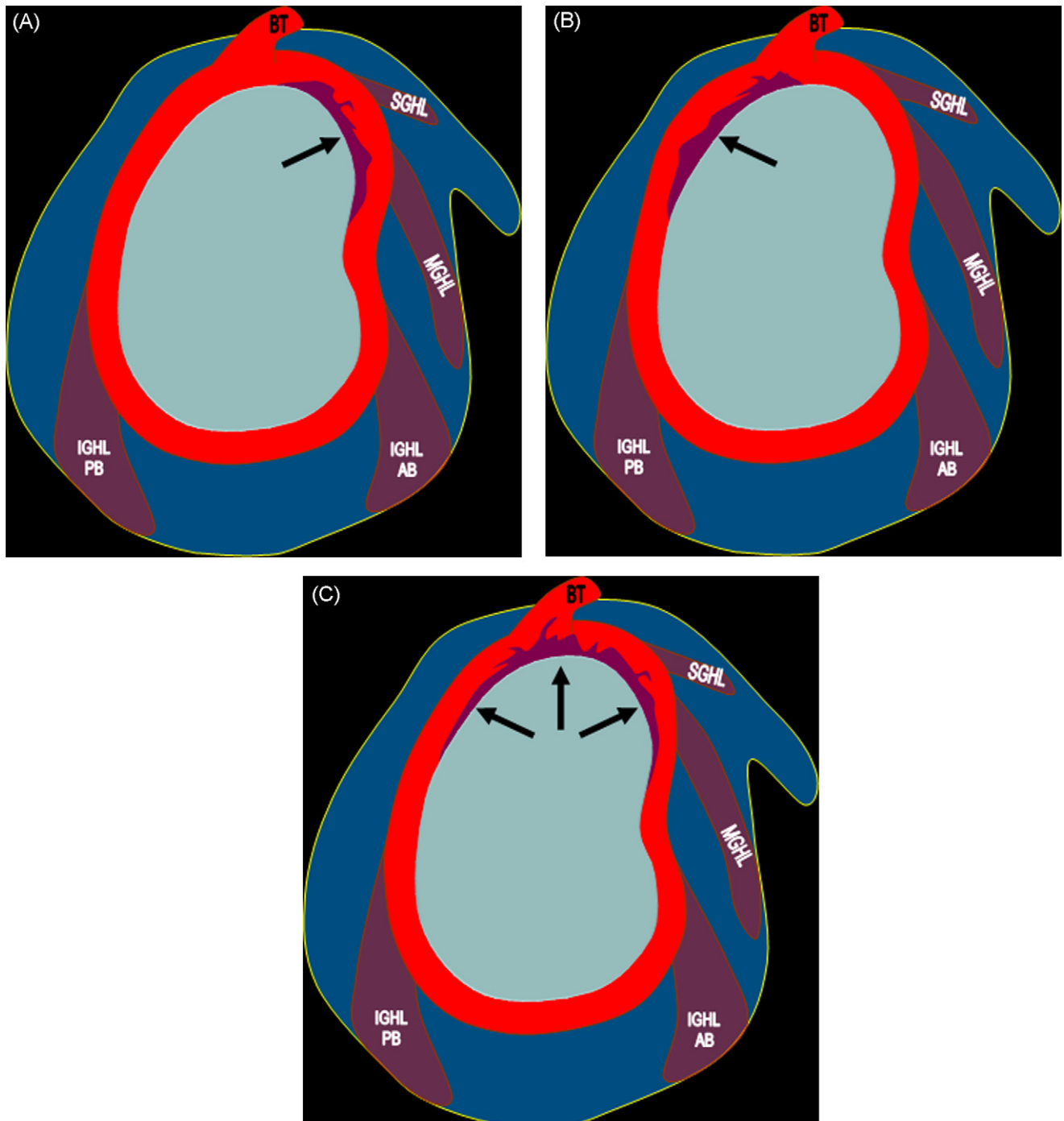


Fig. 7. SLAP II subgroup. The SLAP II lesion is further divided into three subcategories: (A) SLAP IIA is an anterosuperior labral tear, (B) SLAP IIB is a posteriosuperior tear and (C) SLAP IIC is a superior tear that extends both anteriorly and posteriorly.

the contours of the superior glenoid margin can be a normal appearance of the labrum, representing the histologic transitional area from fibrocartilage of the labrum to hyaline cartilage of the glenoid (Fig. 2). This cartilage interface is found particularly in the superior half of the glenoid. It is distinguished from pathology in that its signal does not extend into the labral substance.

The most common shape of the labrum is triangular or rounded on cross-sectional images; however, the morphology of the normal labrum is also quite variable. Globular or irregular morphology can be a sign of a tear or degenerative changes.

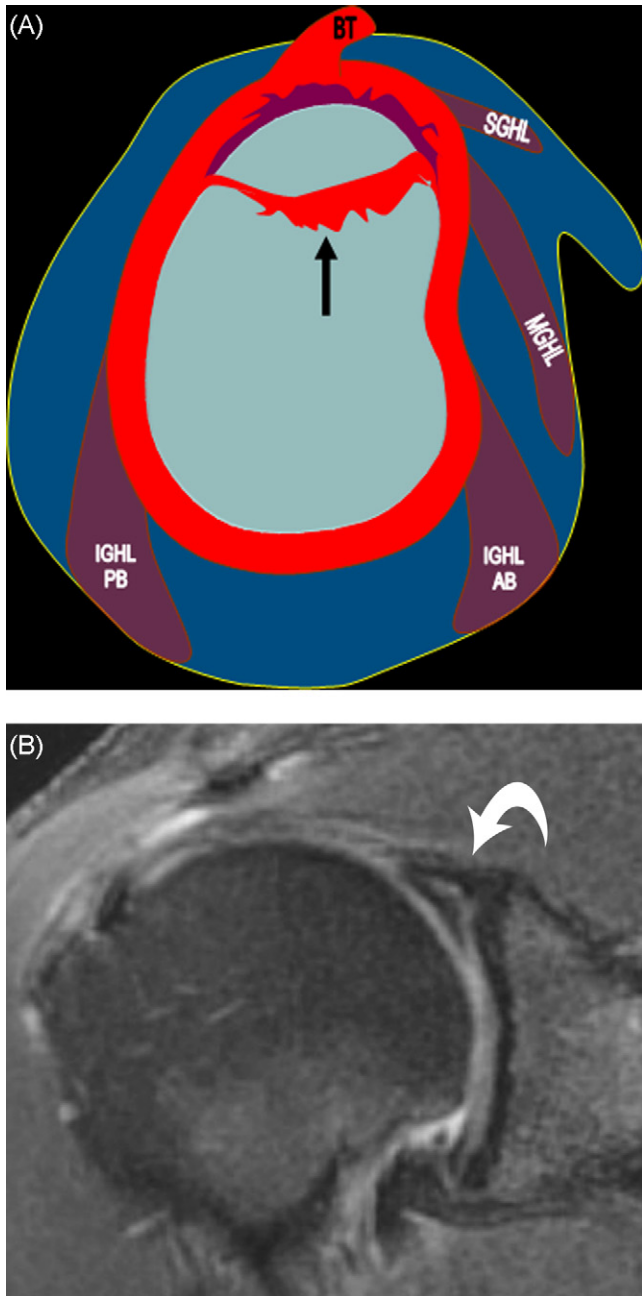


Fig. 8. SLAP III. (A) Diagram and (B) axial T1-weighted fat-suppressed MR arthrogram image demonstrated a bucket-handle tear of the superior labrum with the central portion of the tear displaced into the joint, and no involvement of the biceps anchor (curved arrow).

Smooth margins of the labrum, regardless of the labral morphology, are more likely to be associated with a normal variant versus the irregular margins of labral pathology.

A Buford complex, found in 1.5% of individuals [11], is the absence of the anterior superior labrum in conjunction with a thickened cord-like MGHL. The thick MGHL attaches directly to the anterosuperior glenoid (Fig. 3). It can be confused with a sublabral hole or pathologic labral detachment. If mistakenly surgically reattached to the neck of the glenoid cartilage, severe painful restriction of humeral rotation and elevation can occur.

The sublabral sulcus, or recess, is usually confined to the superior labrum at the 11–1 o'clock position at the site of attachment of the long head of biceps tendon (Fig. 4A and B). It is a sulcus between the capsulolabral complex and the supe-

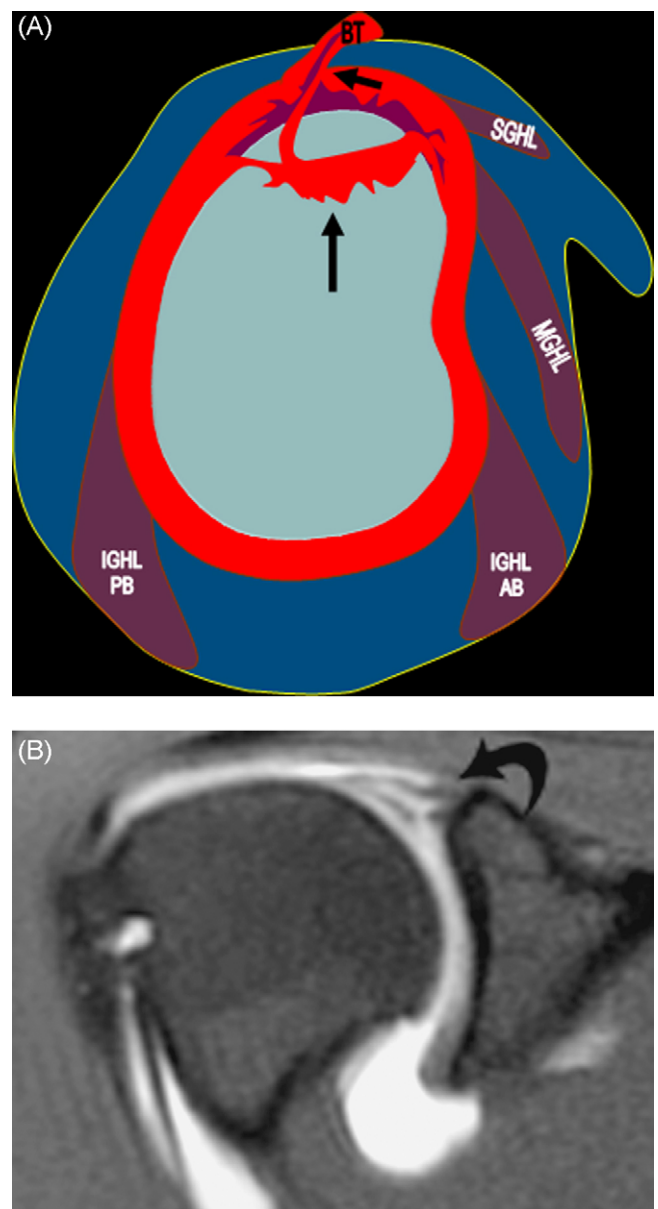


Fig. 9. SLAP IV. (A) Diagram and (B) coronal T1-weighted fat-suppressed MR arthrogram image shows a bucket-handle tear of the superior labrum with extension into the biceps tendon (curved arrow).

rior glenoid cartilage. Conventionally, it does not extend behind the biceps anchor although recent research has revealed that this configuration is not uncommon [7]. The normal sulcus has smooth edges and usually measures less than 2 mm in width.

There are three types of attachment of the capsulolabral complex to the glenoid. A type I attachment of the capsulolabral complex is a firm attachment of the labrum to the glenoid rim with no sulcus. A type II or III labral attachment is a progres-

sively deeper sublabral sulcus between the labrum and glenoid rim. It can be difficult to differentiate a type III labral attachment, which is a deep sublabral sulcus, from a SLAP II lesion. On arthroscopy, the sulcus allows a probe to be inserted between the labrum and glenoid cartilage. A sulcus may also be continuous with a sublabral foramen. The prevalence of sublabral sulci in a study of patients from 26 to 79 years of age demonstrated an overall prevalence of 73% [8]. It is uncertain when the sublabral

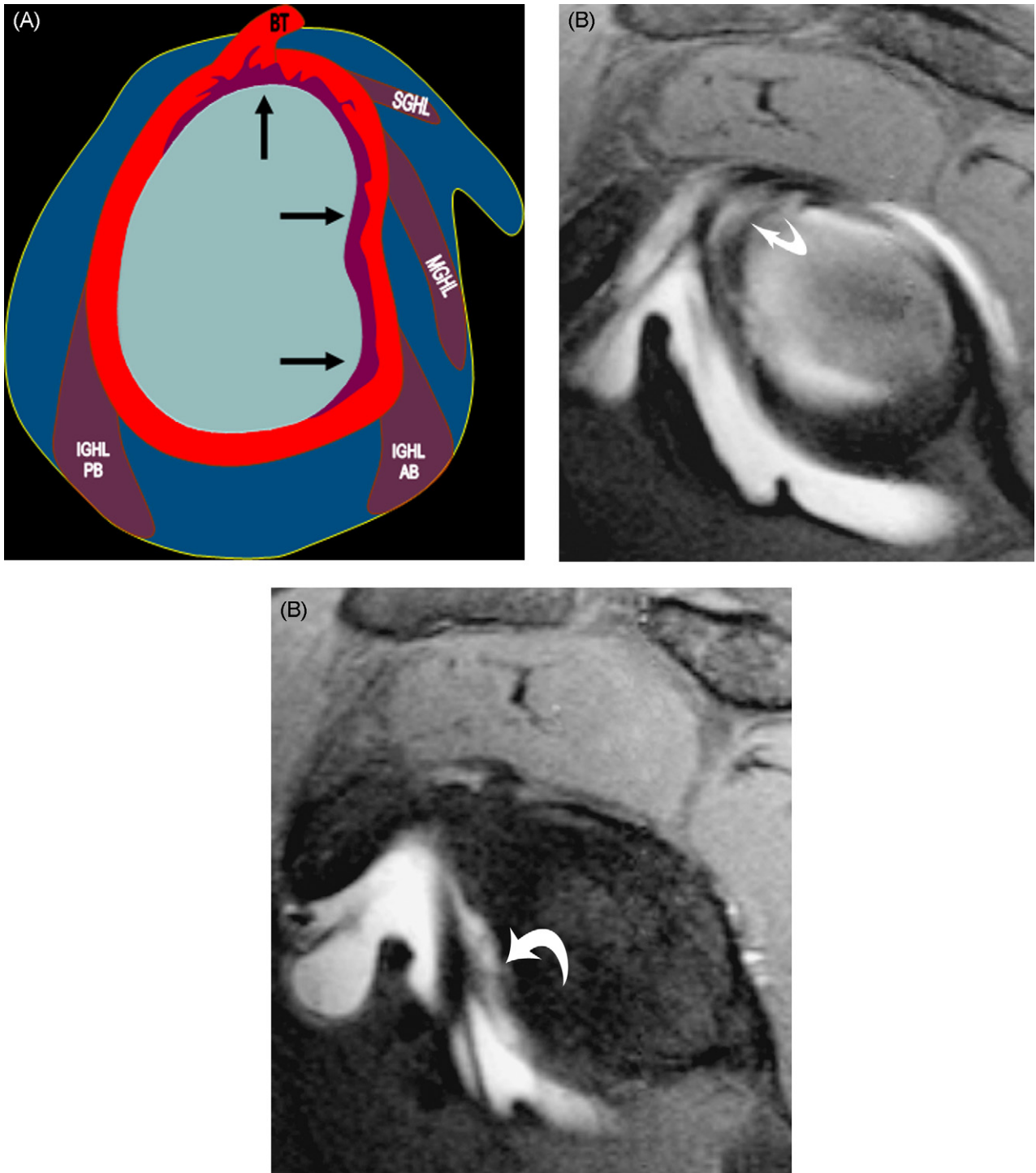


Fig. 10. SLAP V. (A) Diagram and (B, C) sequential sagittal T1-weighted fat-suppressed MR arthrogram images show a superior labral tear that extends to involve the anterior inferior labrum (curved arrow).

recess develops, having been reported to be found in specimens over 22 weeks gestational age [9]. It is known that the sublabral recess occurs with increasing frequency with increasing age. A sulcus may progress to a pathologic SLAP lesion with excessive stress.

The sublabral hole, or foramen, is located anterior to the biceps tendon attachment and involves the anterior labrum. Typically, a foramen is located from the 12 o'clock to the 2 o'clock position [10]. It is found in 11–15% of patients [11–13]. The sublabral hole has smooth edges. A key find-

ing to identifying a hole versus a tear is a medial slip which courses medially and posteriorly towards the glenoid, and attaches to the anterior labrum more inferiorly. In contrast, a tear is usually oriented laterally away from the glenoid.

Other less common anatomic variants also exist. A pseudo-SLAP lesion is a sulcus between the origins of biceps tendon just above the superior labrum. It is a small contrast-filled sulcus with variable depth observed on oblique coronal images. A deep sulcus may simulate a SLAP lesion [14,15]. This recess may be

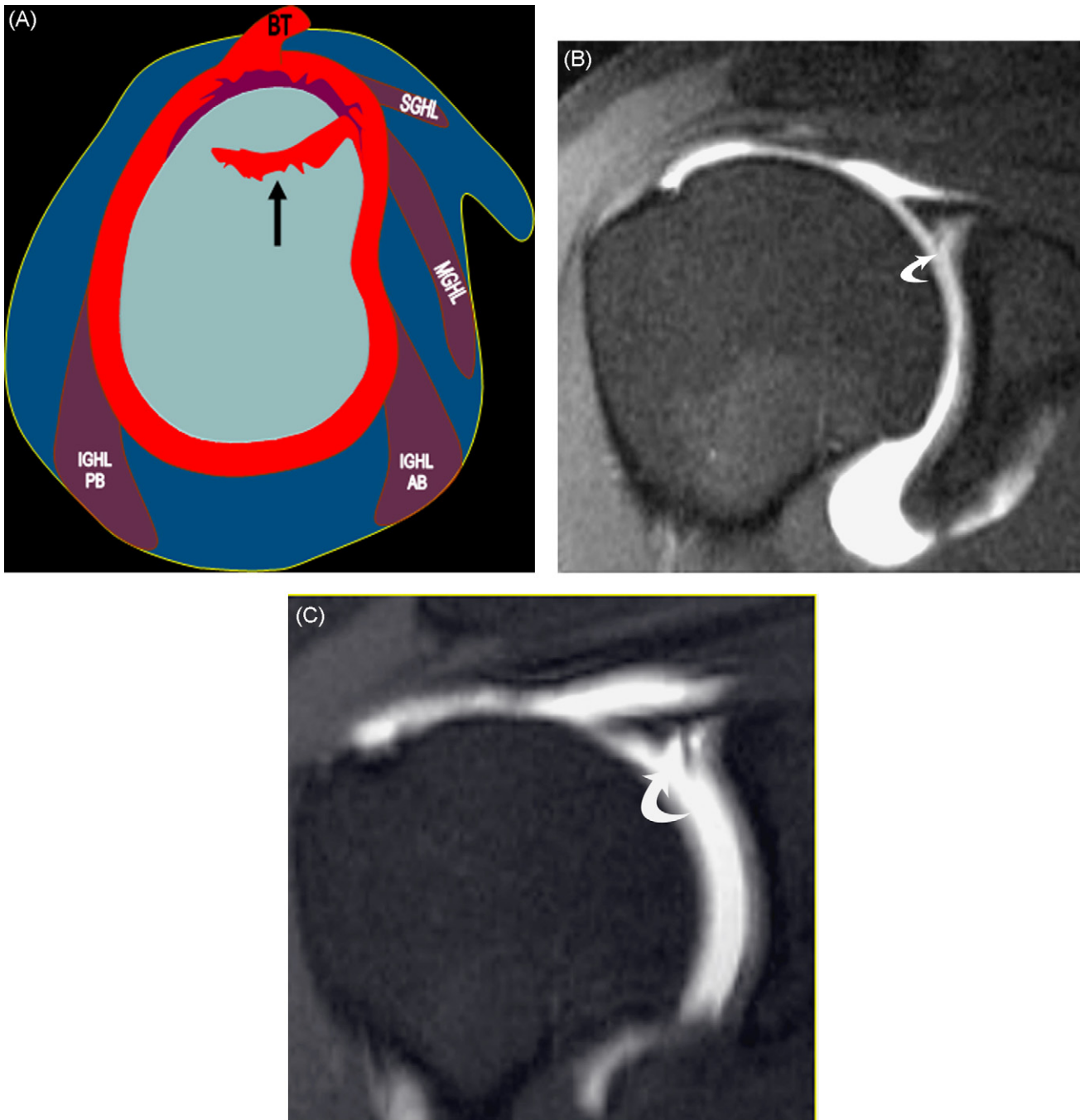


Fig. 11. SLAP VI. (A) Diagram and (B, C) sequential coronal T1-weighted fat-suppressed MR arthrogram images demonstrate a flap tear with separation of the biceps tendon superiorly (curved arrow).

present at the sites of glenohumeral ligament attachments or may be evident along the entire labrum. The anterior labrum may also be very thin and replaced by a thick IGHL [6].

The reported frequency of anatomic variants varies widely and the true incidence is unknown. This variability is due to the inconsistent use of the terms recess and foramen, different methods of investigation whether using cadaveric, surgical or

imaging data, and the type of patient population investigated. In addition, normal variants may co-exist with SLAP pathology. Unfortunately, the sublabral recess is not only the most difficult normal anatomic variant to differentiate from a SLAP lesion, but also the most common anatomic variant. In some cases, it may be impossible to differentiate a SLAP lesion from a normal variant. In addition, MRI studies have shown that the anterosuperior labral variants may extend below the 3 o'clock positions as well as behind the biceps tendon attachment [7,16].

4. Differentiating normal labral variants from pathology

Primary and secondary MR findings can aid the radiologist in differentiating normal anatomic variants from pathology. The use of contrast, either intra-articular or intravenous, can also be helpful.

Linear high signal within the normal low-signal labrum is a primary finding. The orientation of the linear signal is important in differentiating a tear from a normal variant, such as a sulcus, sublabral hole or articular cartilage. Signal within the labrum is more likely to be abnormal than signal paralleling the glenoid margin. Features of labral tears include a lateral orientation of the high signal intensity on oblique coronal images, irregular margins, increased depth of separation from the glenoid articular surface greater than 2 mm, extension posterior to the biceps tendon, and abnormal morphology or signal of the labrum. In contrast, normal variants demonstrate medially oriented high signal intensity on oblique coronal images, smooth margins, minimal separation and normal dark labral signal. Overlap between these distinguishing features can make the diagnosis of labral tears challenging, particularly in differentiating SLAP II tears versus a sublabral sulcus. Articular hyaline cartilage is frequently found between the labrum and glenoid cortical bone, predominantly in the superior half of the joint. The articular cartilage can simulate a tear because it constitutes an area of linear high signal between the glenoid and the labrum. Distinguishing features of normal articular cartilage include a medially oriented linear signal on coronal oblique images, smooth edges, thickness less than 2 mm and normal adjacent labral signal.

An important secondary sign of labral tear is a perilabral cyst (Figs. 6B and 14C) A perilabral cyst may be the first indication of a labral tear and almost always means a labral tear is present. Intra-articular diseases associated with labral pathology include rotator cuff tears, Bankart lesions and glenohumeral chondromalacia.

A superior sulcus has many overlapping findings with SLAP II lesions. It is often a diagnostic challenge to differentiate a SLAP II tear from a deep sublabral recess. Useful differentiating findings include laterally curved high signal intensity on oblique coronal images, anteroposterior extension of high signal on axial images and a concomitant anterosuperior labral tear. MR findings that demonstrate no statistically significant difference between SLAP II lesions and sublabral recess include, extension of high signal behind the biceps anchor on oblique coronal images, and globular or irregular shape of the supe-

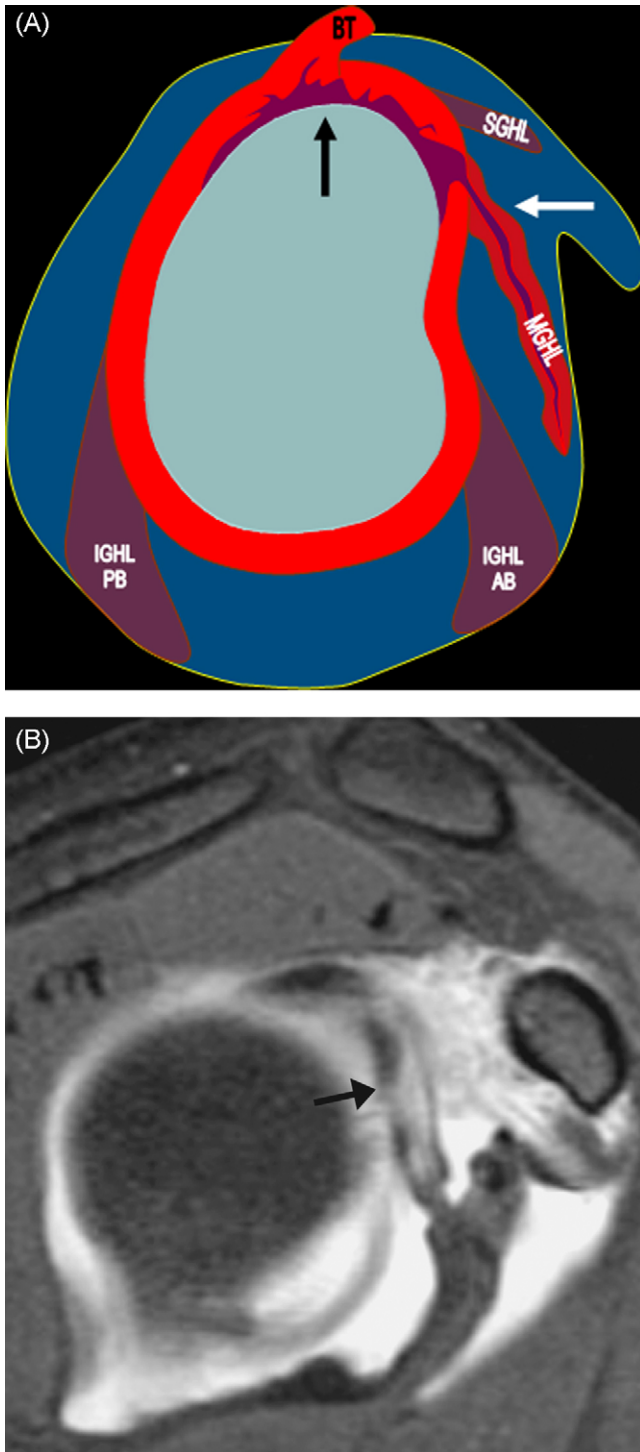


Fig. 12. SLAP VII. (A) Diagram and (B) sagittal T1-weighted fat-suppressed MR arthrogram image demonstrates an abnormal MGHHL (arrow) in a SLAP VII lesion.

rior labrum [7]. The clinical significance of differentiating a deep sublabral sulcus from a SLAP II lesion may not be as critical in the symptomatic patient since both will be treated arthroscopically.

5. MR arthrography

The role of arthrography for the evaluation of labral pathology has been somewhat controversial. Some authors advocate the use of pulse sequence optimization for evaluation of the superior labrum, with high sensitivity and accuracy [17]. How-

ever, the majority of literature establishes the superiority of MR arthrography over conventional MR for evaluation of the labrum. This is especially true in cases involving young, athletic patients with chronic instability, and therefore, in the diagnosis of SLAP lesions [2,7,17–22]. Multiple recent studies have confirmed the utility of MR arthrography in the detection of SLAP lesions, reporting sensitivities ranging from 82 to 100%, specificities between 71 and 98%, and accuracies between 83 and 94% [23–28]. Studies directly comparing MR arthrography to conventional MR demonstrated a significant improvement in sensitivity and accuracy with little or no reduction in speci-

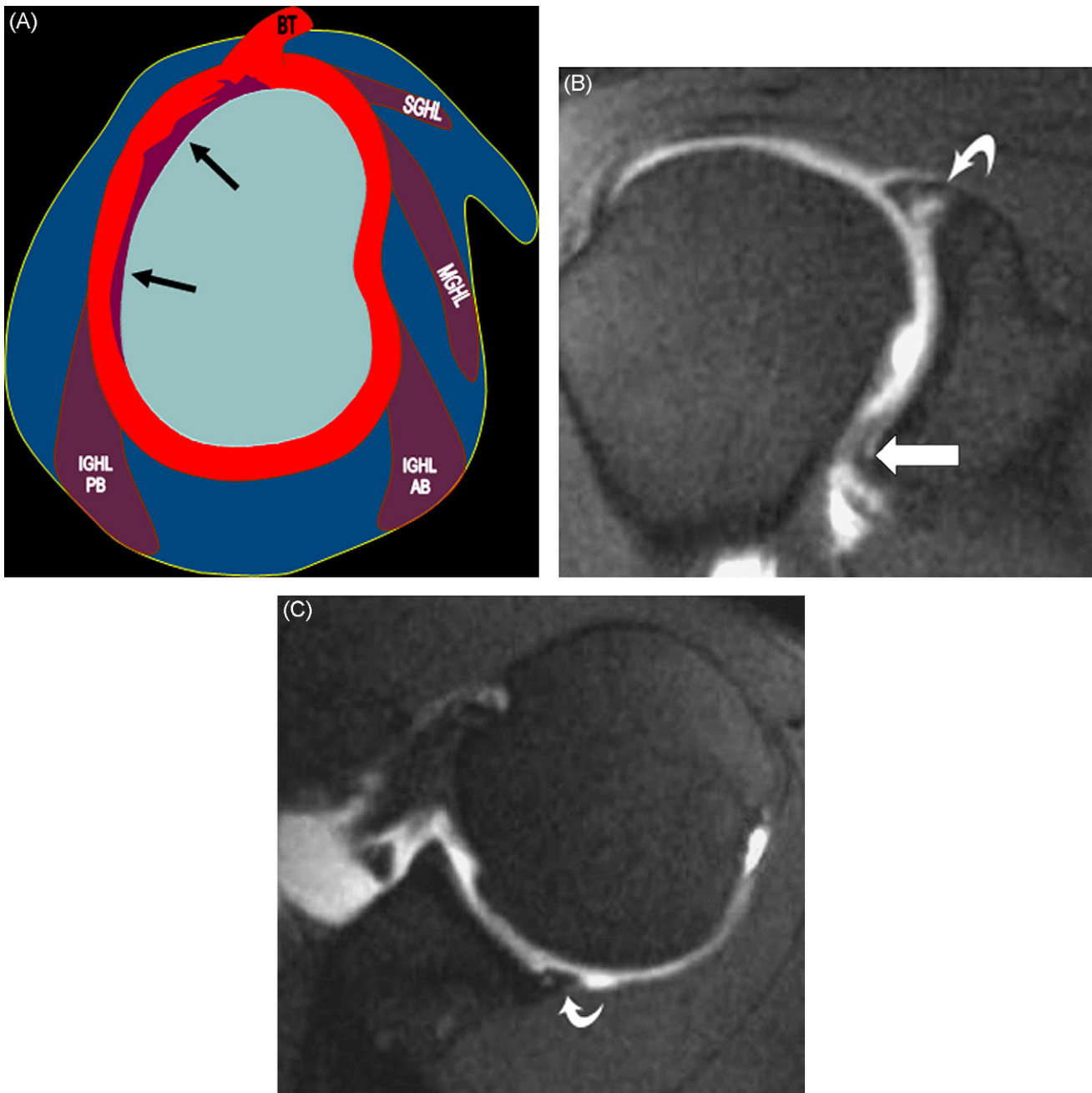


Fig. 13. SLAP VIII. (A) Diagram, (B) axial and (C) coronal T1-weighted fat-suppressed MR arthrogram images show a superior labral tear (curved arrow, B), with posterior (curved arrow, C) and inferior (straight arrow, B) extension.

ficity [23,28]. MR arthrography can be performed directly with intra-articular injection (dMRA) or indirectly with intravenous injection (iMRA), with or without subsequent exercising of the shoulder (Table 1).

The improved diagnostic capability of MR arthrography relates to the controlled distention of the joint, outlining of intra-articular and synovial surfaces, and leakage of contrast through abnormalities resulting in increased conspicuity of pathology. Intra-articular contrast has been shown to be especially useful in the differentiation of SLAP lesions from the anatomic variants, such as sublabral recess and sublabral foramen [6–8,27,29].

Disadvantages of MR arthrography include the invasive nature of the procedure (i.e. risk of pain, bleeding and infection),

although these risks have been demonstrated to be negligible. Additional drawbacks include the use of ionizing radiation, the expense, and administrative issues such as scheduling fluoroscopic time concurrently with MR and the required “active” involvement of a radiologist. Rarely, diagnostic problems arise from the use of MR arthrography such as injection of air mimicking a loose body or extra-articular leak [30–32].

Indirect MR arthrography has increased in popularity recently. The absence of basement membranes and increased vascularity of blood vessels within synovial surfaces is exploited with indirect MR arthrography, such that intravenous injection of gadolinium subsequently diffuses into the joint [18,32,33]. Indirect MR arthrography is non-invasive and obviates the need

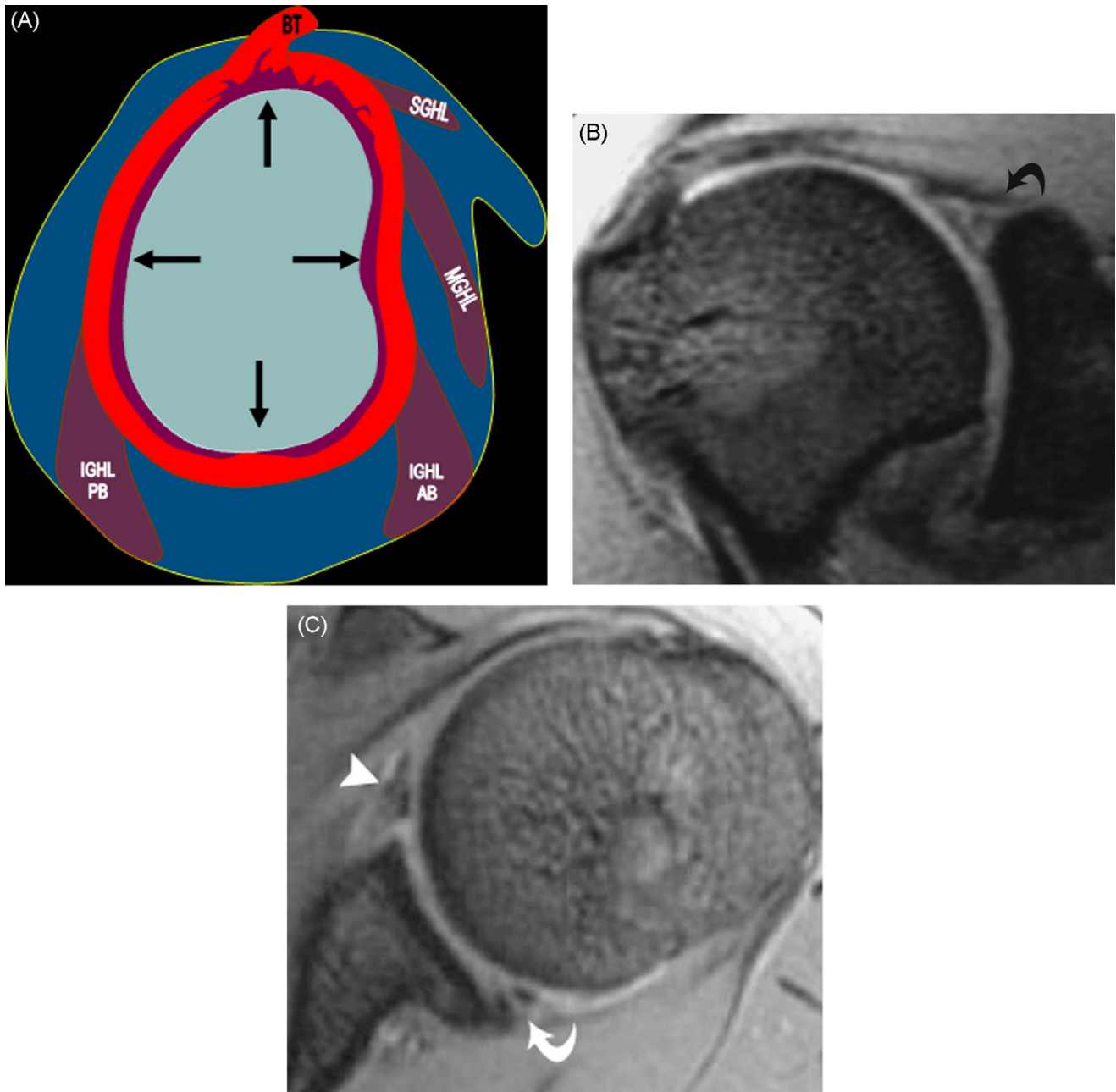


Fig. 14. SLAP IX. (A) Diagram, (B) coronal and (C) axial gradient MR images show a superior labral tear (curved arrow, B) with anterior (arrowhead, C) and posterior extension (curved arrow, C).

for fluoroscopy, removing exposure to ionizing radiation and decreasing radiologist time and the cost of the exam. The drawbacks of indirect arthrography include lack of controlled joint distension and enhancement of all vascularized structures, not just the joint, which can lead to the overestimation of pathology [18,32].

6. Types of SLAP lesions

The SLAP lesion is centered at the attachment of the biceps tendon. Originally, Snyder et al. [2] described four types of SLAP lesions. This classification is still the most widely used and includes SLAP I–IV. Snyder also recognized that a complex of two or more SLAP lesions could occur concurrently. The combination of type II and IV lesions is the most common.

Subsequently, SLAP II lesions were subtyped into SLAP IIA, B and C [34]. Further classifications of SLAP have been developed, and currently, in radiology literature, 10 different types of SLAP lesions have been described.

A type I lesion is fraying with no frank tear of the superior portion of the glenoid labrum with an intact biceps tendon. It is most commonly associated with age-related degenerative changes, and repetitive microtrauma from overhead arm motion. SLAP I lesions have a frequency of 9.5–21% (Fig. 5) [2,35,36].

A type II lesion is labral fraying with stripping of the superior labrum and the attachment of the biceps tendon from the glenoid (Fig. 6). These lesions are the most frequent type of SLAP lesion with a reported frequency of 41–55% [2,3,35,36]. It is associated with repetitive microtrauma. SLAP II was then

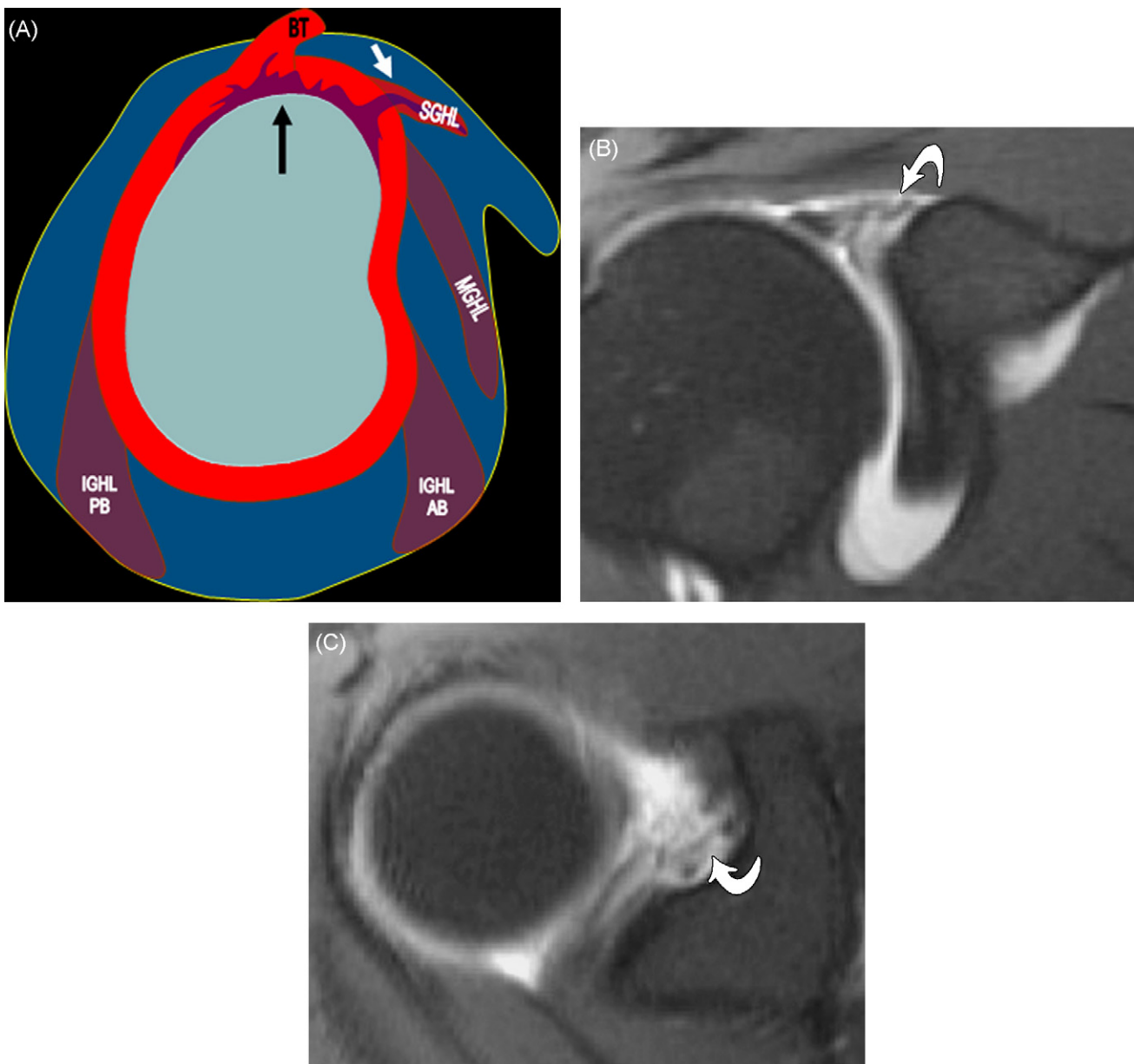


Fig. 15. SLAP X. (A) Diagram, (B) coronal and (C) axial T1-weighted fat-suppressed MR arthrogram images demonstrate a superior labral tear (curved arrow, A), with extension into the superior glenohumeral ligament (curved arrow, B), the articular side of the rotator cuff interval capsule.

further divided into three subcategories. A type IIA SLAP is an anterosuperior labral lesion (Fig. 7A). A type IIB is a posterosuperior lesion (Fig. 7B). Type IIC is a superior lesion, which extends both anteriorly and posteriorly (Fig. 7C) [34].

A type III lesion is a bucket-handle tear of the superior labrum with the central portion of the tear displaced into the joint, similar to a bucket-handle meniscal tear of the knee (Fig. 8). There is no involvement of the biceps tendon. SLAP III lesions have a reported frequency of 3–15% [2,35,36].

A type IV lesion is a bucket-handle tear of the superior labrum with extension into the biceps tendon (Fig. 9). SLAP IV lesions have a frequency of 3–15% [2,3,35].

A type V lesion is a Bankart lesion (anterior inferior glenolabral injury) with superior extension to include the superior labrum and biceps tendon (Fig. 10). A Type VI lesion is a flap tear, either anterior or posterior, with separation of the biceps tendon superiorly (Fig. 11). A type VII lesion is a superior labrum and biceps tendon separation, which extends anteriorly to involve the MGHL (Fig. 12).

A type VIII lesion is a superior labral tear with posterior extension, similar but more extensive than a type IIB lesion (Fig. 13). The SLAP IX lesion is a superior tear with extensive anterior and posterior extension resulting in complete or almost complete detachment of the labrum (Fig. 14). A type X lesion is a tear of the superior labrum with extension into the rotator cuff interval (Fig. 15).

Current literature does not support that MRI can accurately differentiate all 10 SLAP types. It is also controversial whether

extensive labral lesions such as SLAP VIII and IX should be classified as SLAP lesions or as extensive labral abnormalities [37].

Although no proven correlation has been found between mechanism of injury and SLAP lesions, it has been postulated that different mechanisms of injury are more often associated with certain types of SLAP lesions. Repetitive overhead motion injury is thought to cause SLAP I or II lesions. SLAP III, IV and V lesions are more likely associated with falls on an outstretched arm. SLAP V and VII lesions are associated with glenohumeral instability secondary to an acute injury. Degenerative labral changes occur with increasing age and are associated with SLAP I lesions [37]. Bankart lesions are associated with anteroinferior instability. Middle glenohumeral tears are found with straight anterior dislocation (Table 2).

7. A practical approach to SLAP lesions

Differentiating a SLAP lesion from normal variants, such as a sublabral sulcus, may not be as critical in the symptomatic patient, since any abnormal finding usually warrants arthroscopy. Although 10 types of SLAP lesions have been described, most surgeons will be most familiar with the original Snyder classification of SLAP I–IV. In addition, MRI has not been proven to reliably distinguish between the different types of SLAP lesions. Practically speaking, it is more important to accurately describe a few key features of the lesion, including location, morphology, extent of the abnormality and associated injuries.

Table 2
SLAP classification

Type	Location (clock)	Description	Comments
Snyder et al. [2]			
I	11–1	Fraying	More significant in young people with repetitive overhead motion; may be an incidental finding
II	11–1	Tear of biceps labral complex	Most common SLAP, associated with SLAP IV
III	11–1	Bucket-handle tear	Associated with fall on outstretched arm
IV	11–1	Bucket-handle tear with biceps extension	Associated with SLAP II, fall on an outstretched arm
Morgan et al. [34]			
IIA	11–3	Tear of biceps labral complex with more anterior extension	Associated with repetitive overhead motion
IIB	9–11	Tear of biceps labral complex with more posterior extension	Associated infraspinatus tear
IIC	9–3	Tear of biceps labral complex with exaggerated anterior and posterior extension	Associated infraspinatus tear
Maffet et al. [4]			
V	11–5	Bankart lesion with superior extension	
VI	11–1	Anterior or posterior flap tear	Probably represents a bucket-handle tear (SLAP III, IV) with tear of the handle
VII	11–3	Tear extends into middle glenohumeral ligament	Acute trauma with anterior dislocation
Resnick ^a			
VIII	7–1	Superior labral tear with posterior extension, similar but more extensive than SLAP IIB	Associated with acute posterior dislocation
IX	7–5	Global labral abnormality	Probably secondary to trauma
Beltran ^b			
X	11–1+	Rotator interval extension	Articular-sided abnormalities

^a Unpublished data.

^b Presented at the annual meeting of the Radiological Society of North America, Chicago, IL, December 2000.

The location should be described, either using the clock face or the six segments. SLAP lesions are centered around the biceps attachment so it is important to indicate whether the biceps tendon is involved, in addition to the anterior and posterior extension of the lesion. The morphology of the lesion should then be described, taking care to differentiate between fraying or complete tearing. The location of any displaced (bucket-handle) or free fragments should also be indicated.

Associated injuries should be described including abnormalities of the glenohumeral ligaments, rotator interval, articular cartilage and joint capsule. Rotator cuff abnormalities include undersurface tears of the supraspinatus and infraspinatus tendons, secondary to posterosuperior and anterosuperior internal impingement. Rotator interval lesions are associated with tears of the superior fibers of the subscapularis tendon and the anterior fibers of the supraspinatus tendon. Bone marrow edema and bony abnormalities, such as Bankart and Hill-Sachs lesions are also associated. Extension into the anteroinferior labrum and MGHL implies glenohumeral instability and can affect surgical treatment.

8. Treatment

Conservative treatment is generally unsuccessful. Shoulder arthroscopy is the mainstay for classification and treatment. The primary goal of surgery is to reattach the biceps tendon to the superior glenoid rim. During arthroscopy, the biceps anchor is assessed with probing to assess stability and repaired if unstable. SLAP I lesions are debrided. SLAP II lesions are debrided and arthroscopically repaired with sutures. For SLAP III and IV lesions, any bucket-handle fragments are excised.

Type IV lesion treatment is also dependent on the degree of involvement of the substance of the biceps tendon. If less than 30% of the biceps tendon is involved, the biceps anchor is left intact and the affected portion is resected. If greater than 30% of the biceps tendon is involved, the treatment is age-dependent. In younger patients, the labrum and biceps tendon are re-attached. In older patients, labral debridement and biceps tenodesis is performed. All associated shoulder pathology is also usually addressed at the time of surgery (e.g. rotator cuff lesions, glenohumeral instability, acromioclavicular joint degeneration).

9. Conclusion

SLAP lesions are an important cause of shoulder pain and instability. These lesions can represent a diagnostic challenge for radiologists due to the normal anatomic variability of the capsulolabral complex, particularly the anterior superior labrum. Knowledge of the anatomic variants, primary and secondary MR findings of tears, and arthrography can help in distinguishing SLAP lesions from variant anatomy. Although up to 10 types of SLAP lesions exist, it is most important for the radiologist to describe key features of the labral lesion, including location, morphology, extent of the abnormality and associated injuries.

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