Review

Superior Labral Anteroposterior Tear: Classification and Diagnosis on MRI and MR Arthrography

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Lesions affecting the superior labrum were an almost unknown clinical entity before the advent of arthroscopy. Since the description of superior labral lesions in throwing athletes by Andrews et al. [1] in 1985 and the introduction of the acronym SLAP (superior labral anteroposterior) by Snyder et al. [2] in 1990, increasing attention to the diagnosis and treatment of these lesions has been noted in both the orthopedic and radiology literature [3–29]. Although the true prevalence of SLAP lesions in a population of patients with shoulder problems is difficult to determine, arthroscopic studies report a prevalence of SLAP lesions in the range of 3.9–6% [2, 13, 23] in all patients undergoing shoulder arthroscopy. Not only is the SLAP lesion encountered with relative frequency, it is a lesion that has been associated with nonspecific shoulder pain. A detailed understanding of the anatomy, anatomic variations, and primary and associated problems of the SLAP lesion is necessary if the radiologist is to provide the referring physician with adequate information for diagnosis and treatment planning.

Although the four basic types of Snyder's classification are still widely used, several authors have added descriptions of other SLAP lesions. Currently, 10 types or patterns of SLAP lesions have been recognized, with a further subdivision of the type II lesion into A, B, and C subtypes (Table 1).

The purpose of this article is to review this subject, to describe problems related to normal anatomy and variants of the superior and anterosuperior portions of the labrum, to perform a critical analysis of the current 10-grade SLAP lesion classification and mechanisms of injury from the perspective of MRI, and to describe an MRI approach to the diagnosis of such lesions. In addition, a tailored algorithm for SLAP lesions based on MRI findings is introduced.

Normal Anatomy

The glenoid labrum is a cuff of fibrocartilaginous tissue that surrounds the glenoid cavity. It serves to deepen the glenoid fossa and to increase the area of the articular surface that contacts the humeral head, both of which increase joint stability. The labrum allows attachment of the tendon of the long head of the biceps brachii muscle and glenohumeral ligaments [30].

The normal labrum is approximately 3 mm high from base to apex and is 4 mm wide at its base of insertion into the glenoid cartilage. It has low signal intensity with all pulse sequences. However, its shape, size, and configuration vary considerably [31]. The superior part of the labrum is normally more loosely attached and more mobile than the other parts. This normal laxity leads to diagnostic difficulty in identifying SLAP lesions, especially type II lesions [30].

For purposes of localizing abnormalities, the labrum is usually divided into four or six areas or in terms of time zones on the face of a clock. In MRI reports, either of these labral divisions is acceptable, although the description by time zones is preferable because it best characterizes the extension of labral pathology (Fig. 1). For the division into clock zones, the labrum is likened to the face of a clock, with the superior portion positioned at 12 o'clock and the inferior portion at 6 o'clock. By convention, the anterior portion is positioned at 3 o'clock and the posterior portion at 9 o'clock for both shoulders (Resnick D, unpublished data).

Classically, SLAP lesions are centered at the attachment of the biceps tendon, with variable extension to either the anterior or posterior portion of the labrum. Determining the type of attachment of the biceps tendon to the

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TABLE 1 Current Superior Labral Anteroposterior (SLAP) Lesion Classification with Associated Clinical Findings and Mechanisms of Injury

Type	Biceps-Labral Complex	Extension[a]	Comments
Snyder et al. [2]			
I	Fraying	11–1	Could be incidental finding; more significant in young people involved in overhead activities
II	Tear with biceps extension	11–1	Most common type; association with acute traction, repetitive overhead motion, and microinstability; could be associated with type IV
III	Bucket-handle tear with intact biceps	11–1	Less severe than type IV; association with fall on outstretched arm
IV	Bucket-handle tear with biceps extension	11–1	More severe than type III because of biceps extension; could be associated with type II; association with fall on outstretched arm
Maffet et al. [15]			
V	Not specified	11–5	Either a Bankart lesion with superior extension or a SLAP lesion with anterior inferior extension
VI	Anterior or posterior flap tear	11–1	Probably represents type IV or less likely type III with tear of the bucket-handle component
VII	Not specified	11–3	Type of middle glenohumeral ligament extension (avulsion or split) not specified; association with acute trauma with anterior dislocation
Resnick D[b]			
VIII	Not specified	7–1	Similar to type IIB but with more extensive abnormalities; association with acute trauma with posterior dislocation
IX	Not specified	7–5	Global labrum abnormality; probably traumatic event
Beltran J[c]			
X	Not specified	11–1 +	Rotator interval extension; articular side abnormalities
Morgan et al. [21]			
IIA	II	11–3	Similar to type X; association with repetitive overhead motion
IIB	II	9–11	Association with infraspinatus tear
IIC	II	9–3	Association with infraspinatus tear

[a]Clock positions.

[b]Unpublished data.

[c]Presented at the annual meeting of the Radiological Society of North America, Chicago, IL, December 2000.

superior labrum and adjacent supraglenoid notch, as well as the presence of anatomic variations, is the first step in accurate evaluation of this region.

Normal Variants of the Superior and Anterosuperior Labrum: Characteristics and Prevalence

Anatomic variations commonly occur in the 11- to 3-o'clock positions and include sublabral recess, or sulcus; sublabral foramen, or hole; and Buford complex.

The sublabral recess, or sulcus, is located at the 11- to 1-o'clock position and represents a recess between the biceps-labral complex and the superior portion of the glenoid cartilage (Fig. 2). Smith et al. [17] reported an overall prevalence of 73% (19/26 shoulders from donors with an age range at the time of death of 26–79 years). More details were provided in the classic cadaveric study of De Palma et al. [32], in which the authors further separated the specimens into groups according to their age at death. No sublabral recess was observed in a group of fetuses and infants, although it was identified in 17% of the specimens derived from persons in the second decade of life, 50% of the specimens derived from persons older than 20 years, and more than 95% of the specimens derived from persons in the seventh and eighth decades of life. More recently, Fealy et al. [33] reported a normal area of separation of the anterosuperior labrum, located near the 1-o'clock position, in specimens over 22 weeks of gestational age. Although the data are unclear at which age normal labrum separation is found, they agree on the presence of a focus of loose anterosuperior labral attachment. This area may progress to a physiologic labral separation or be converted into pathologic detachments (SLAP lesions) when subjected to excessive stress.

The sublabral foramen, or hole, is located at the 1- to 3-o'clock positions, anterior to the biceps-labral complex, and represents the space between the anterosuperior labrum and the adjacent glenoid cartilage (Fig. 3). Stoller [34] reported its prevalence as 11%, Williams et al. [35] as 12%, and Ellman and Gartsman [36] as 15%.

The Buford complex consists of an absence of the anterosuperior portion of the labrum and is associated with a cordlike middle glenohumeral ligament [35] (Fig. 4). This complex was first described by Williams et al. [35] in 1994, with a prevalence of 1.5%. They considered that the complex was "an unusual-appearing anatomic variation that may lead the surgeon to confuse this complex with a sublabral hole (foramen) or a pathologic labral detachment." If the cordlike middle glenohumeral ligament is mistakenly reattached to the neck of the glenoid cartilage at the time of surgery, severe painful restriction of humeral rotation and elevation can occur.

The reported frequency of these anatomic variations clearly differs because of inconsistent use of the terms "sublabral recess" and "sublabral foramen"; various methods of investigation that have used cadaveric, surgical, or imaging data; and different patient populations. Although the Buford complex is the easiest anatomic variation to differentiate from a SLAP lesion, it is uncommon. Unfortunately, not only is the sublabral recess the most difficult anatomic variation to differentiate from a SLAP lesion, it is also the most frequently occurring. Indeed, some overlap of the position of the sublabral recess and the sublabral foramen may exist, depending on the type of attachment of the biceps tendon and the obliquity of the glenoid bone. A sublabral recess and a sublabral foramen may coexist, and when this configuration is

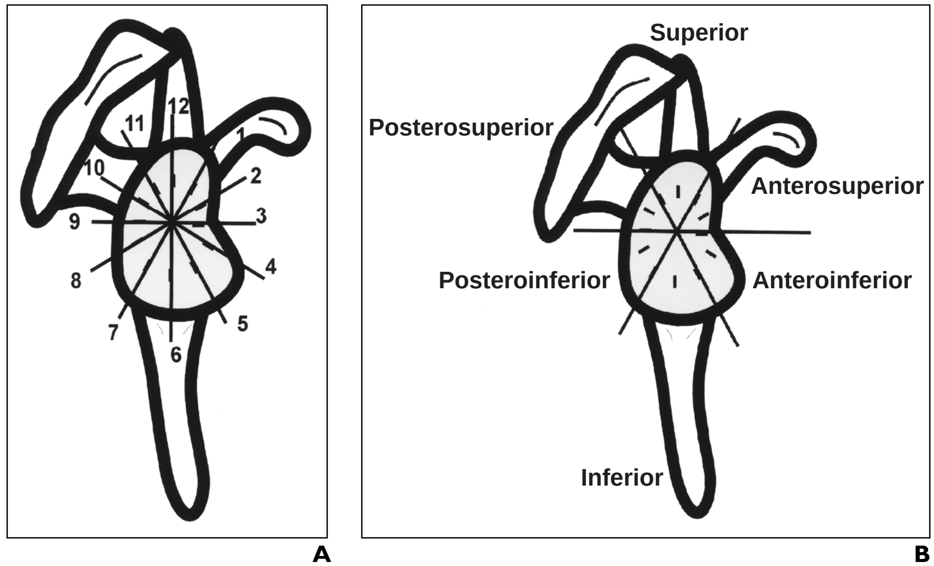


Fig. 1.—Labral division: two nomenclatures used for localization of labral abnormalities.
A, Diagram shows labrum viewed as "time zones" on clock face. For both shoulders, 12- to 6-o'clock position faces anteriorly, and 6- to 12-o'clock position faces posteriorly.
B, Diagram shows labrum divided into six areas.

present, the labral anatomic variation may extend from the 11- to the 3-o'clock position. At times, this variation is impossible to differentiate from a SLAP lesion by means of imaging methods. Furthermore, a recent MRI study suggested that the inferiormost limit of the anterosuperior labral variants may extend two sections below the midpoint of the glenoid bone, which suggests that normal variants may extend below the 3-o'clock position in a small number of people [37].

SLAP Lesion Classification and Mechanisms of Injury

Classification

Snyder et al. [2] classified SLAP lesions into four types on the basis of arthroscopic evaluation (Table 1 and Fig. 5). The 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 (Fig. 6). The type II lesion consists of superior labral fraying with stripping of the superior part of the labrum and attached biceps tendon from the underlying glenoid cartilage (Fig. 7). 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 cartilage (Fig. 8). The biceps tendon and labral-biceps anchor extension were not involved. 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. 9). The reported frequency of types I–IV SLAP lesions has varied in the literature (type I, 9.5–21%; type II, 41–55%; type III, 6–33%; type IV, 3–15%). Type II SLAP lesions are by far the most frequent type identified on arthroscopy, and a similar predominance is expected on MRI [2, 13, 23].

The first revised classification of SLAP lesions was reported by Maffet et al. [15] in 1995 (Table 1 and Fig. 10). Three new categories of lesions were described as follows: type V, Bankart lesion with superior extension to include the biceps tendon and superior labrum (Fig. 11); type VI, anterior or posterior flap tear in conjunction with separation of

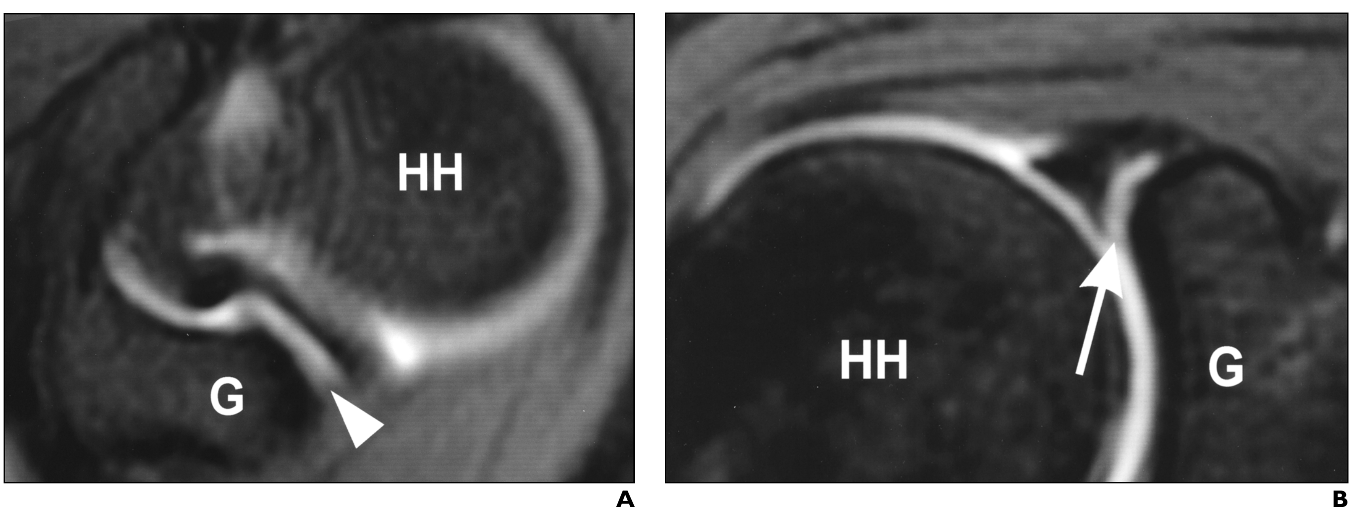


Fig. 2.—MRI features of sublabral recess in 40-year-old woman with MR arthrogram of left shoulder. HH = humeral head, G = glenoid.
A, Axial T1-weighted fat-suppressed spin-echo image (TR/TE, 400/11) shows that sublabral recess (*arrowhead*) has parallel orientation to glenoid cartilage in this plane.
B, Coronal T1-weighted fat-suppressed spin-echo image (400/11) shows that recess outlined by contrast material is linear and follows contour of glenoid cartilage (*arrow*).

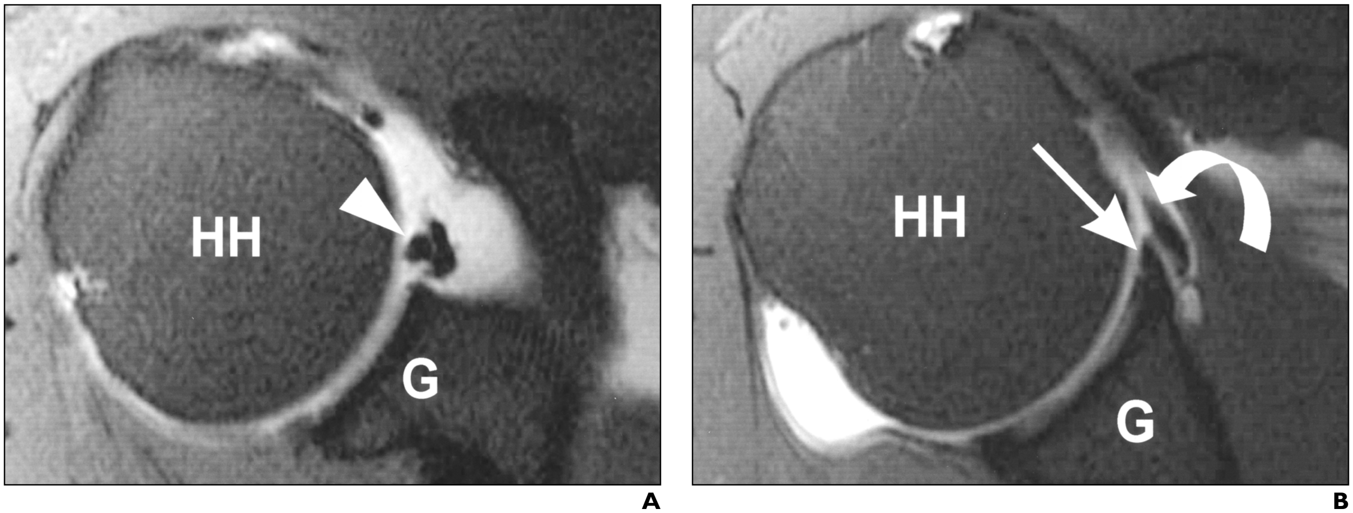


Fig. 3.—MRI features of sublabral foramen in 57-year-old man with superior labral anteroposterior tear. HH = humeral head, G = glenoid.
A, Axial T1-weighted fat-suppressed spin-echo MR arthrogram (TR/TE, 500/15) shows separation of anterosuperior labrum (*arrowhead*) from glenoid cartilage.
B, Axial T1-weighted fat-suppressed spin-echo MR arthrogram (500/15) at 3-o'clock position shows that labrum (*straight arrow*) slips back and reattaches to glenoid cartilage. Curved arrow indicates middle glenohumeral ligament.

the biceps tendon superiorly (Fig. 12); and type VII, biceps tendon–superior labrum separation extending anteriorly to include the middle glenohumeral ligament (Fig. 13).

With the work of Morgan et al. [21] in 1998, the first variation related to the initial SLAP lesions described by Snyder et al. [2] was introduced (Table 1). Three distinct type II SLAP lesions were described on the basis of anatomic 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.

Between 1997 and 2000, three additional types of SLAP lesion (VIII, IX, X) were introduced in informal talks, small meetings, and conferences (Fig. 14 and Table 1). The type VIII lesion is described as a superior labral tear with posterior extension that is similar to Morgan's IIB lesion but more extensive (Resnick D, unpublished data) (Fig. 15). The type IX lesion was described as a complete or almost complete detachment of the entire labrum related to extensive anterior and posterior components of the superior labral tear (Fig. 16). The type X lesion was described as a tear of the superior labrum with extension to the rotator cuff interval (Beltran J, presented at the annual meeting of the Radiological Society of North America, Chicago, IL, December 2000) (Fig. 17).

Although they are controversial, the introduction of different types of SLAP lesions represents an attempt to emphasize associated abnormalities and the variable extension of these lesions that may prove important for treatment. Extension to some structures such as the anteroinferior labrum and the middle glenohumeral ligament implies some sort of glenohumeral instability, and the definition of the precise labrum abnormality may affect presurgical decision making. For example, type I lesions are usually treated with conservative maneuvers or simple surgical débridement, type II lesions are usually treated with biceps anchor stabilization, types III and IV are usually treated with excision of the bucket-handle tear and eventual biceps tenodesis or labral repair, types V and VI are usually treated with labral repair or débridement and biceps anchor stabilization, and type VII is usually treated with biceps anchor stabilization and repair of the middle glenohumeral ligament [38]. From the imaging point of view, however, the

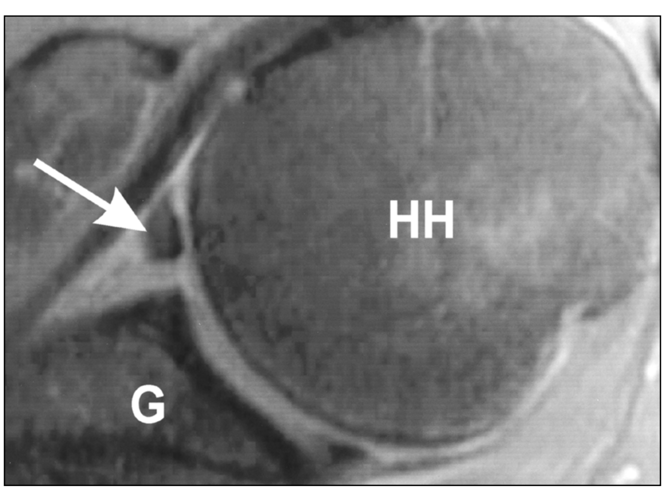


Fig. 4.—MRI features of Buford complex in 65-year-old man. Proton density–weighted fat-suppressed image (TR/TE, 2,000/14) shows absence of anterosuperior labrum associated with cordlike middle glenohumeral ligament (*arrow*). HH = humeral head, G = glenoid.

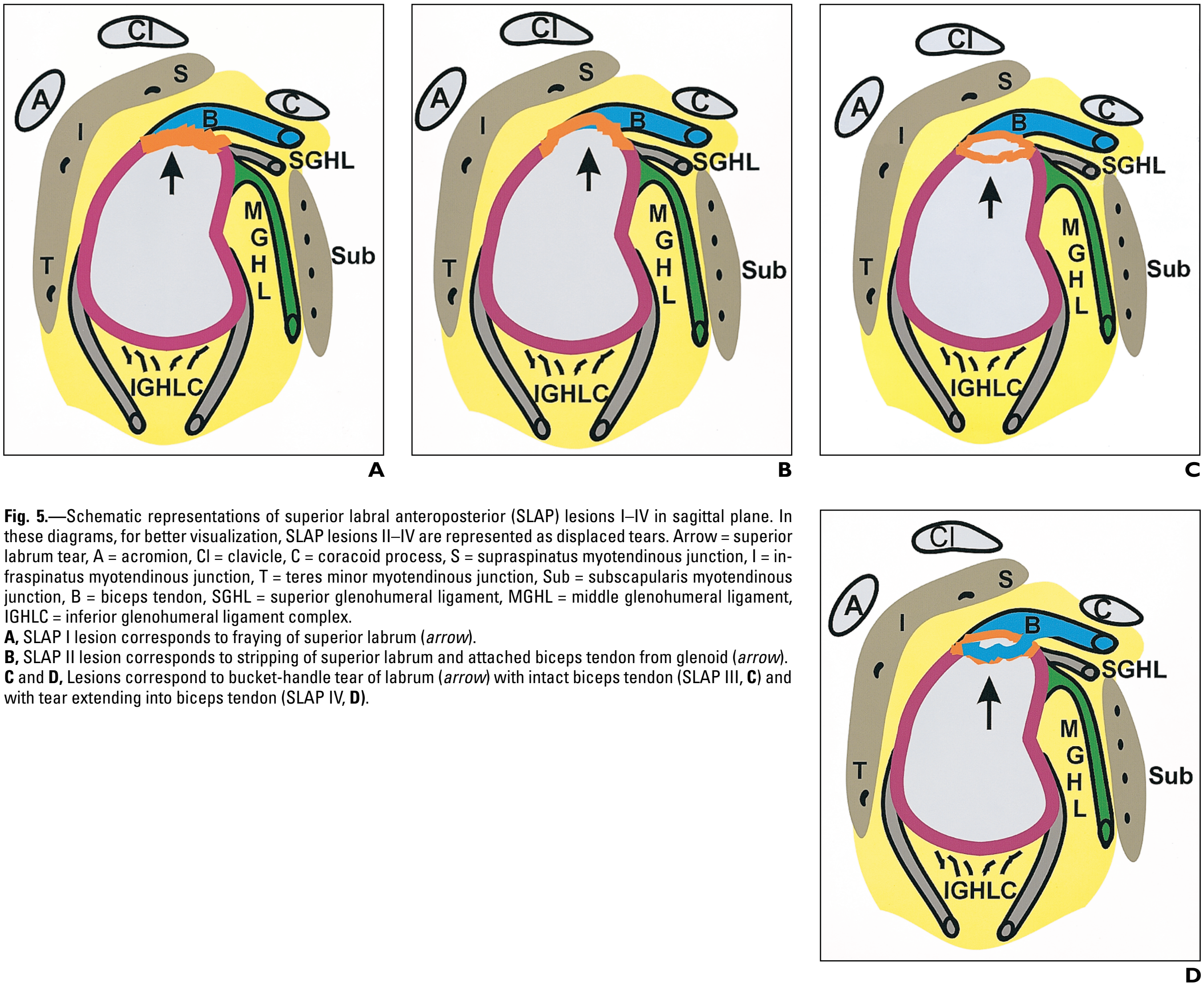


Fig. 5.—Schematic representations of superior labral anteroposterior (SLAP) lesions I–IV in sagittal plane. In these diagrams, for better visualization, SLAP lesions II–IV are represented as displaced tears. Arrow = superior labrum tear, A = acromion, Cl = clavicle, C = coracoid process, S = supraspinatus myotendinous junction, I = infraspinatus myotendinous junction, T = teres minor myotendinous junction, Sub = subscapularis myotendinous junction, B = biceps tendon, SGHL = superior glenohumeral ligament, MGHL = middle glenohumeral ligament, IGHLC = inferior glenohumeral ligament complex.

A, SLAP I lesion corresponds to fraying of superior labrum (*arrow*).

B, SLAP II lesion corresponds to stripping of superior labrum and attached biceps tendon from glenoid (*arrow*).

C and **D,** Lesions correspond to bucket-handle tear of labrum (*arrow*) with intact biceps tendon (SLAP III, **C**) and with tear extending into biceps tendon (SLAP IV, **D**).

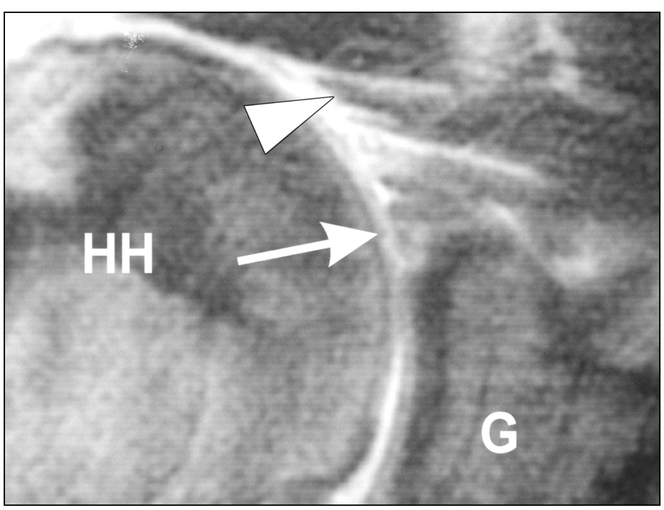


Fig. 6.—Type I superior labral anteroposterior lesion: proton density–weighted fat-suppressed coronal image shows fraying of superior labrum (*arrow*). Note full-thickness tear of supraspinatus tendon (*arrowhead*). HH = humeral head, G = glenoid.

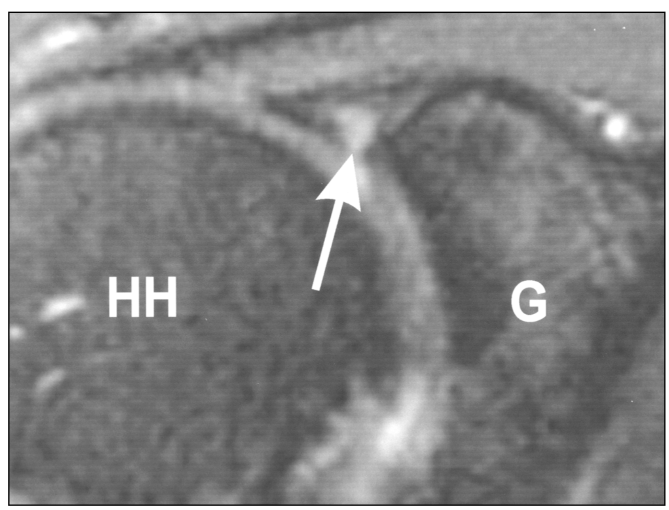


Fig. 7.—Proton density–weighted fat-suppressed coronal image (TR/TE, 3,000/20) shows type II superior labral anteroposterior lesion in 52-year-old man. Note globular area of increased signal intensity at base of superior labrum compatible with labral tear (*arrow*). HH = humeral head, G = glenoid.

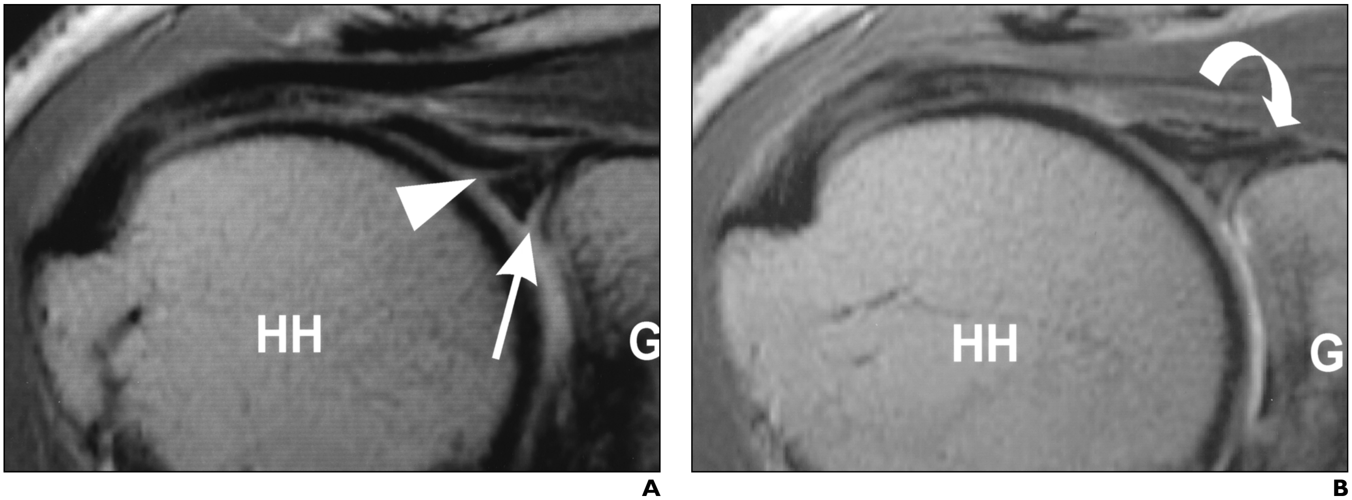


Fig. 8.—Proton density–weighted coronal images (TR/TE, 2,500/15) of type III superior labrum anterior and posterior lesion. HH = humeral head, G = glenoid.
A, Abnormal signal intensity is visible between superior labrum and glenoid cartilage (*arrow*) and between biceps tendon and superior labrum (*arrowhead*).
B, Note that labral abnormality extends posteriorly and biceps insertion (*arrow*) appears preserved.

current SLAP lesion classification is extensive and not easily applied to MRI. Presently, the literature does not support the position that MRI can accurately differentiate all 10 SLAP lesion types. Furthermore, no agreement has been reached as to whether extensive labral lesions such as types VIII and IX should be classified as SLAP varieties or as extensive labral abnormalities.

Mechanisms of Injury

Although several distinct mechanisms of injury have emerged, some controversy exists as to which is the most common cause of a SLAP lesion [2, 15]. One mechanism (the most common in the Snyder et al. [2] series) is a compression force applied to the shoulder, usually occurring as the result of a fall onto an outstretched arm, with the shoulder positioned in abduction and slight forward flexion at the time of impact [2]. Marrow edema resulting from the impact may be identified on MRI; if it is associated with an anteroinferior dislocation, a Hill-Sachs deformity as well as a Bankart lesion may be present. A second mechanism (the most common in the Maffet et al. [15] series) is related to traction on the arm as a result of either a sudden pull, throwing, or other overhead sports-related motion [15]. Once again, associated findings that may be visualized on MRI are undersurface tears of the rotator cuff, cystic lesions in the humeral head (posterosuperior internal impingement), and capsular laxity. In several studies, however, correlation of the mechanism of injury with the type of SLAP lesion has not been provided.

It has been postulated that different mechanisms of injury result in different types of SLAP lesions. Athletes who use repetitive overhead arm motions are prone to develop a type I or type II lesion (fraying or detachment of the labrum), whereas patients who present after a fall onto an outstretched arm are more likely to have a type III, IV, or VI lesion (bucket-handle tear or flap tear) [2, 15, 21, 30]. Type I lesions have also been associated with labral degeneration in older persons. Types V and VII lesions appear to be more frequent in patients with glenohumeral joint instability resulting from an acute injury: a Bankart lesion is associated with anteroinferior instability, and middle glenohumeral ligament tear is associated with straight anterior dislocation.

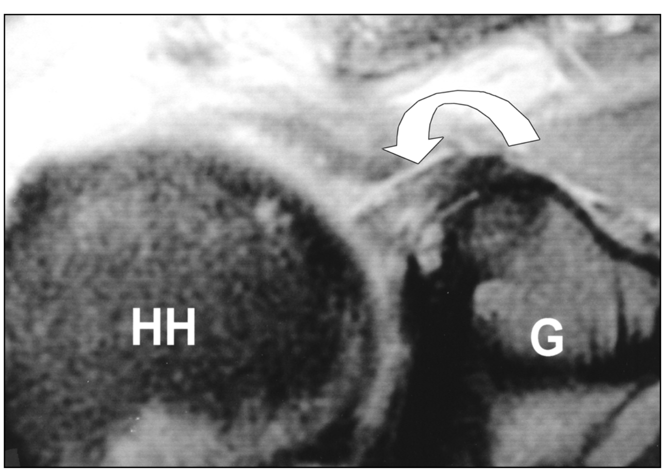
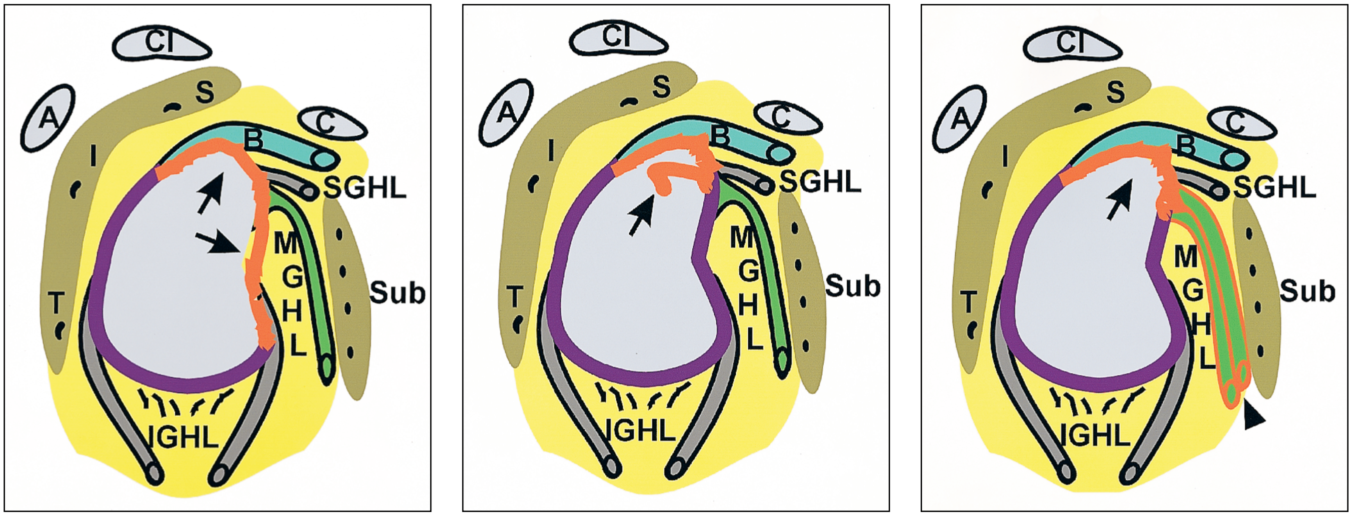


Fig. 9.—Type IV superior labral anteroposterior (SLAP) lesion in 52-year-old man after fall from ladder with progressive shoulder pain and weakness 1 month before MRI evaluation. Coronal proton density–weighted fat-suppressed image (TR/TE, 3,000/13) shows enlargement and abnormal signal intensity of biceps anchor (*arrow*) and adjacent superior labrum. SLAP IV lesion and dislocated torn biceps tendon were identified at surgery. HH = humeral head, G = glenoid.



A B C

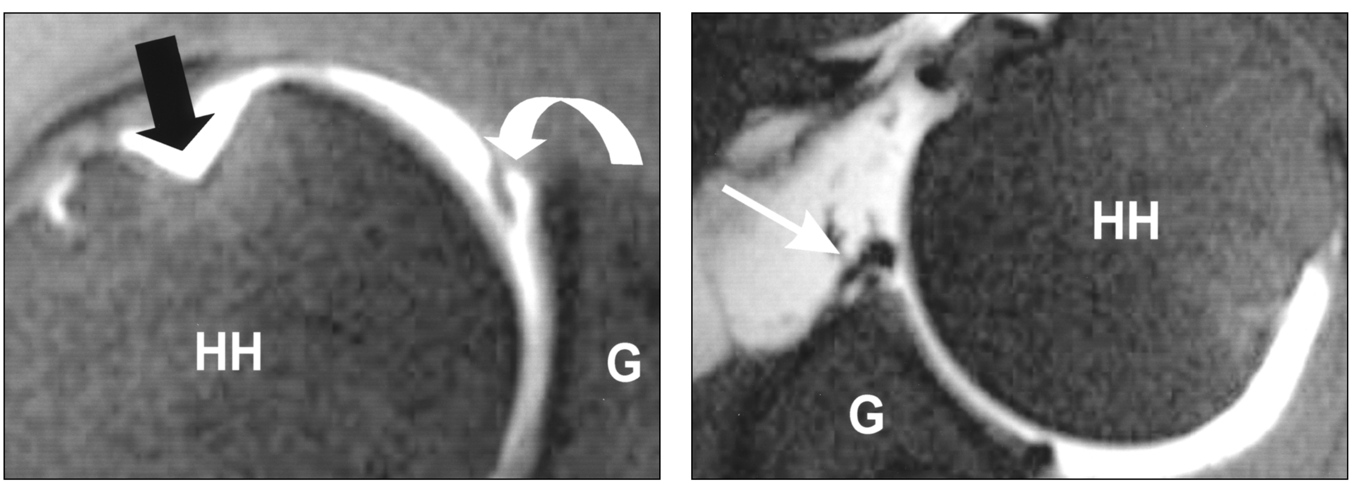
Fig. 10.—Schematic representations of superior labral anteroposterior lesions V–VII in sagittal plane. A = acromion, Cl = clavicle, C = coracoid process, S = supraspinatus myotendinous junction, I = infraspinatus myotendinous junction, T = teres minor myotendinous junction, Sub = subscapularis myotendinous junction, B = biceps tendon, SGHL = superior glenohumeral ligament, IGHL = inferior glenohumeral ligament complex, MGHL = middle glenohumeral ligament.
A, Type V lesion corresponds to Bankart lesion with superior extension (*arrows*) to include biceps tendon and superior labrum.
B, Type VI lesion corresponds to anterior or posterior flap tear (*arrow*) in conjunction with separation of biceps tendon superiorly.
C, Type VII lesion corresponds to biceps-labral complex tear (*arrow*) with extension to MGHL (*arrowhead*).

MRI Techniques

Standard MRI

MRI has proved to be a sensitive, specific, and accurate modality for evaluating the glenoid labrum. It has also proven to be valuable as a noninvasive technique for evaluating patients with possible SLAP lesions. The glenoid labrum is routinely evaluated in all three imaging planes. Although the axial plane is usually emphasized as best for labral evaluation, several authors have found the coronal plane most sensitive in the diagnosis of SLAP lesions [12]. The superior labrum is situated in a more curved area of the glenoid bone and therefore is more subject to partial volume artifacts with the biceps tendon and adjacent glenoid margin in the axial plane as opposed to the coronal plane. The sagittal plane often displays part of the labrum superimposed on the adjacent glenoid margin and is thought to be less useful for the diagnosis of SLAP lesions. However, the sagittal plane is suitable for evaluating displaced fragments (bucket-handle and flap tears) and the extension of lesions in terms of time zones [12].

The diagnosis of SLAP tears is based on abnormalities in signal intensity and morphology (Figs. 18 and 19). MRI findings reported to be characteristic of SLAP lesions include increased signal in the labrum, with or without extension



A B

Fig. 11.—MR arthrography in 31-year-old man with history of shoulder dislocation shows type V superior labral anteroposterior lesion. HH = humeral head, G = glenoid.
A, Coronal T1-weighted fat-suppressed image (TR/TE, 500/13) shows superior labral tear (*curved arrow*) and large Hill-Sachs lesion (*straight arrow*).
B, Axial T1-weighted fat-suppressed image (500/13) shows Bankart lesion (*arrow*). Sequential images in axial plane (not shown) depicted extension of Bankart lesion to superior labrum.

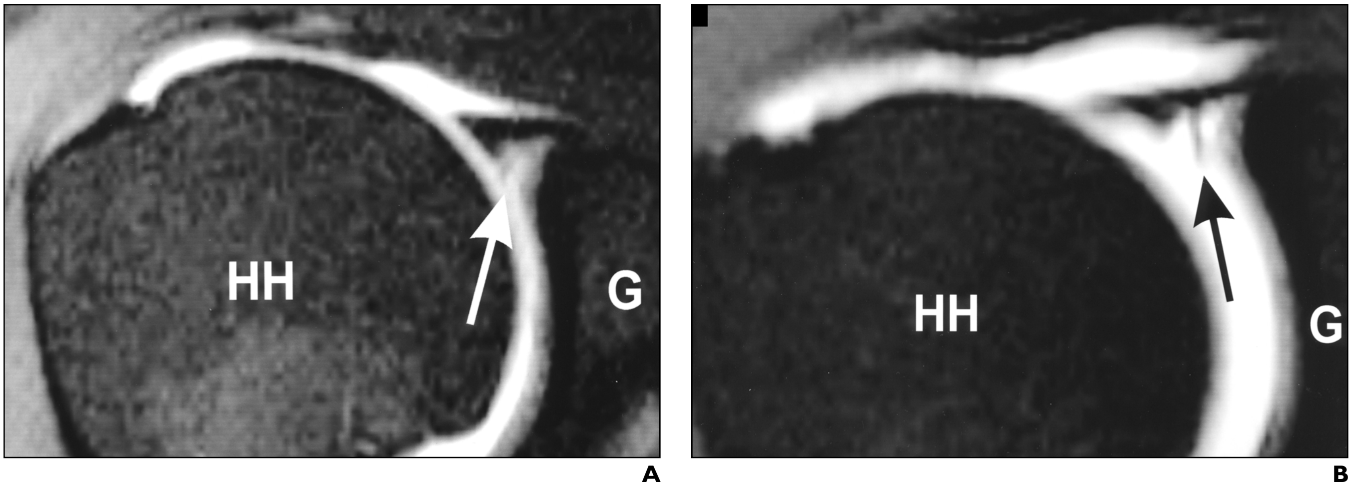


Fig. 12.—Type VI superior labral anteroposterior lesion in 40-year-old man with shoulder pain and superior labral tear. HH = humeral head, G = glenoid.
A and **B,** Fat-suppressed T1-weighted MR arthrograms were obtained before (**A**) and after (**B**) arm traction. Note that morphology of abnormal superior labrum is best shown with arm traction (**B**) and displays small fragment of labrum partially attached to anchor (*arrows*). Pattern of superior labral tear was believed to be complex and most likely represented small flap tear.

to the biceps anchor, and cleavage of the superior labrum [12]. This cleavage may also communicate with a superior paraglenoid cyst.

Pitfalls in standard MRIs are related to the presence of transitional zones, intralabral signal without surface irregularity or definite labral tear, and partial volume with the glenohumeral ligaments. The transitional zone is the area located between the fibrocartilage of the labrum and the hyaline cartilage of the glenoid (Fig. 20). In standard images, higher signal intensity is present between the labrum and glenoid cartilage in short-TE sequences, occurring in the transition zone between two histologic structures. Areas of the transitional zone do not fill with contrast material in arthrographic images [12]. Intralabral signal is a common finding and may be associated with magic angle phenomena or intrasubstance labral degeneration. Partial volume averaging with the glenohumeral ligaments is also a common finding, and careful evaluation of the whole extension of structures usually allows differentiation of a normal structure from a tear (Fig. 21).

MR Arthrography

The need for MR arthrography as a supplement to standard MRI has not been established. Controversies are related to the cost, invasiveness, and marginal improvement in the diagnostic accuracy of MR arthrography when compared with standard MRI in the evaluation of SLAP lesions (Table 2). Contrast material in the joint often leads to a more optimal visualization of a variety of intraarticular structures and increases the confidence level for the diagnosis of SLAP lesions [30].

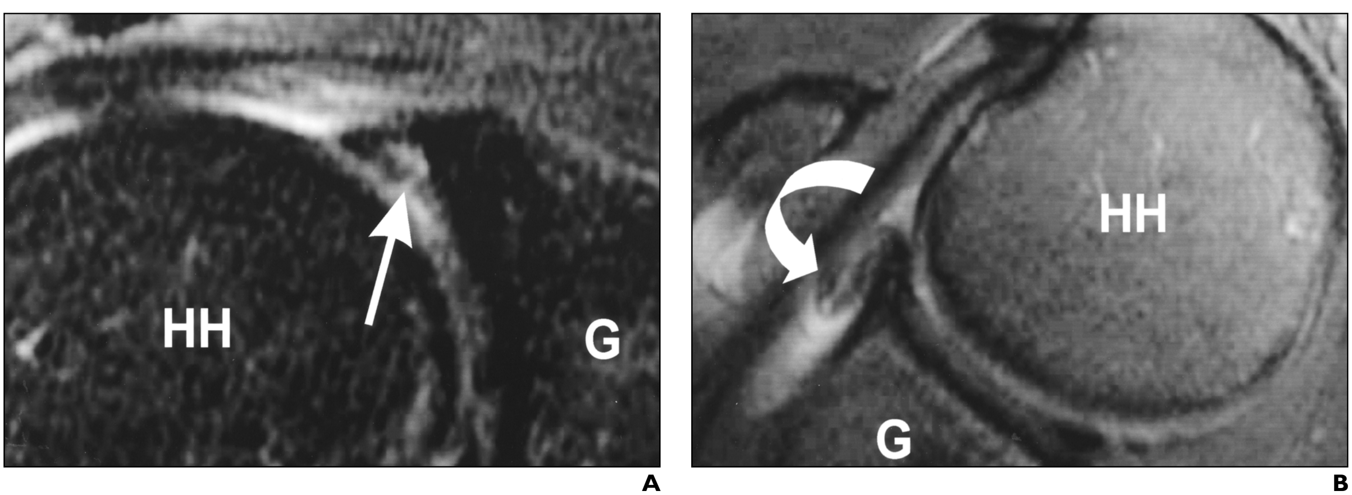


Fig. 13.—66-year-old man with type VII superior labral anteroposterior lesion showing extension to middle glenohumeral ligament. HH = humeral head, G = glenoid.
A, Coronal T2-weighted fat-suppressed image (TR/TE, 2,000/80) obtained in oblique coronal plane shows superior labrum tear (*arrow*).
B, Axial T2-weighted fat-suppressed image (2,600/63) shows thickening of middle glenohumeral ligament (*arrow*) associated with high signal.

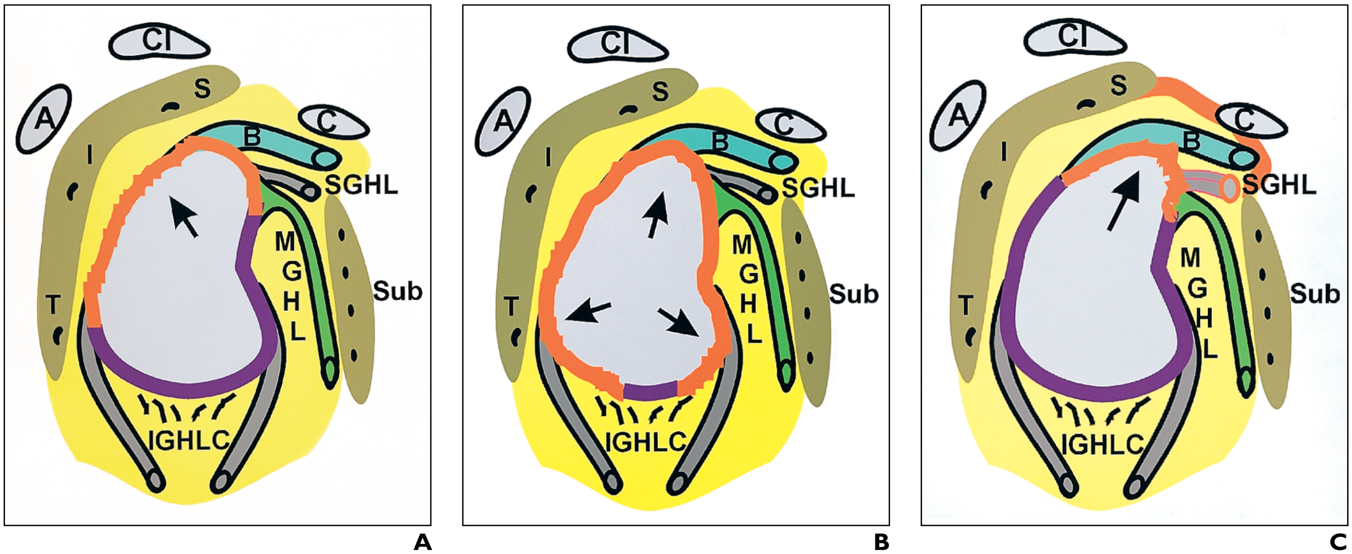


Fig. 14.—Schematic representations of superior labral anteroposterior (SLAP) lesions VIII–X in sagittal plane. A = acromion, C l =clavicle, C = coracoid process, S = supraspinatus myotendinous junction, I = infraspinatus myotendinous junction, T = teres minor myotendinous junction, Sub = subscapularis myotendinous junction, B = biceps tendon, SGHL = superior glenohumeral ligament, MGHL = middle glenohumeral ligament, IGHLC = inferior glenohumeral ligament complex.
A, Type VIII lesion corresponds to superior labral lesion with posterior extension (*arrow*) that is similar to type IIA lesion, although more extensive.
B, Type IX lesion corresponds to complete or almost complete detachment of labrum involving extensive anterior and posterior components (*arrows*).
C, Type X lesion corresponds to SLAP lesion with extension of labral tear (*arrow*) to rotator interval or structures that cross it.

MR arthrographic findings of SLAP tears are associated with the insinuation of the contrast material into the labral tear. Fluid interposed between the glenoid cartilage and the superior labrum in the coronal plane (two bands of low signal intensity surrounding a band of high signal intensity) has the appearance of a single Oreo cookie (Fig. 22). This configuration is observed with either a sublabral recess or a type II SLAP lesion. An interesting analogy was made regarding the appearance of a sublabral recess in conjunction with a SLAP III lesion, which was designated the double "Oreo cookie" configuration (Fig. 22).

In 1997, Beltran et al. [18], in a review of MR arthrography of the shoulder, indicated that the sublabral recess is oriented medially, whereas labral tears in this location are oriented laterally in coronal oblique images. These criteria are based on the anatomic observation that the normal contour of the glenoid cartilage follows the contour of the underlying bone [17]. The normal recess is located between the biceps tendon attachment and the glenoid cartilage, and it has a parallel orientation to the glenoid cartilage, best shown in the coronal and axial planes. SLAP lesions usually extend posteriorly to the biceps anchor in the coronal plane and have a parallel or more oblique orientation with an anterior opening, best shown in the coronal and axial planes, respectively (Fig. 23). Although not an absolute criterion, this observation helps to differentiate these conditions.

Practical MRI Approach to the Diagnosis

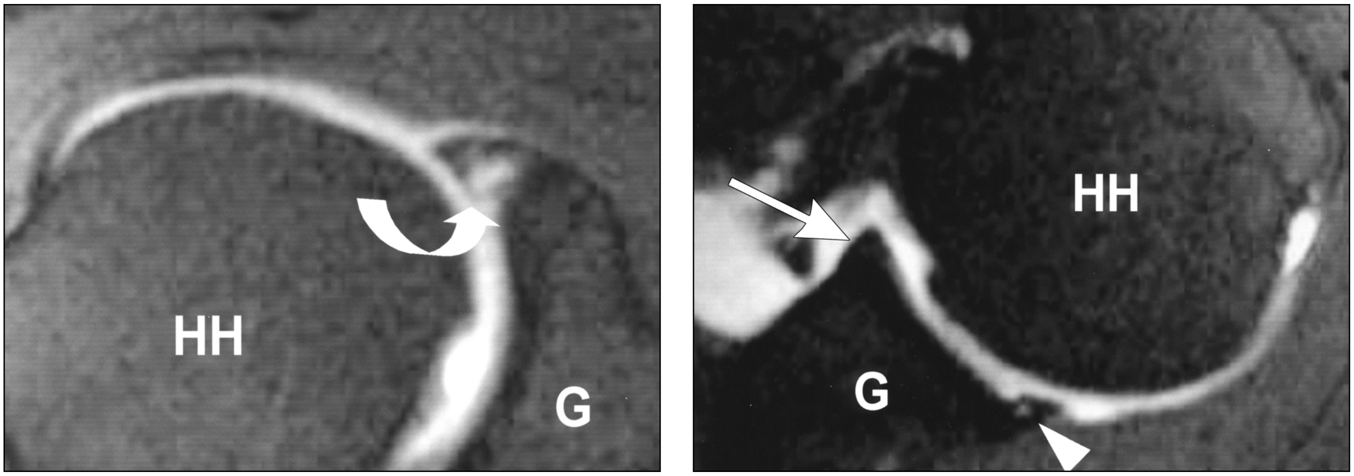
We propose an MRI approach for evaluating suspected SLAP lesions based on specific abnormalities of the biceps-labral complex, presence or absence of extension of the lesion, and presence or absence of abnormalities of a number of additional structures (ligaments, adjacent cartilage, and tendons) (Fig. 24).

The first step of this approach is related to the evaluation of the characteristics of the biceps-labral complex. Snyder's [2] classification is used as the basis for this description because of its simplicity and its widespread use in the literature. The labral tear is further characterized as nondisplaced or displaced. The criteria used are similar to those used for the description of torn menisci in the knee. A nondisplaced tear shows on short-TE sequences as a region of intermediate to high signal intensity that extends to the articular surface of the labrum. In arthrograms, the gadolinium is expected to extend through this defect. A displaced tear is one that has a bucket-handle or flap component (Fig. 24). A displaced tear can also be characterized as a free fragment that has lost its connection with the parent labrum.

TABLE 2 **Efficacy in the Diagnosis of Superior Labral Anteroposterior Lesions with MRI and MR Arthrography**

Variable	MRI				MR Arthrography	
	Legan et al. [3]	Gusmer et al. [16]	Yoneda et al. [19]	Connell et al. [26]	Bencardino et al. [27]	Jee et al. [29]
Patients (no.)	NA	36	22	140	52	80
Sensitivity (%)	75	86	41	98	89	84–92[a]
Specificity (%)	99	100	86	89.5	91	69–84[a]
Accuracy (%)	95	NA	63	95.7	90	74–84[a]

Note.—NA = not available.
[a]Low and high values in a study performed with three reviewers.



A B

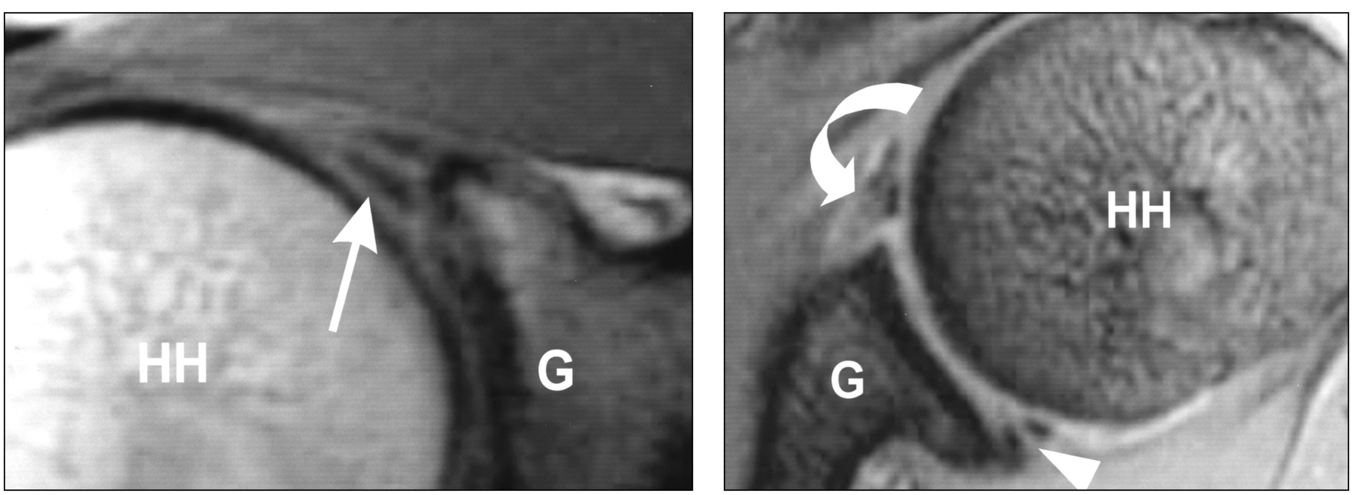
Fig. 15.—Type VIII superior labral anteroposterior lesion in 31-year-old man with shoulder pain. HH = humeral head, G = glenoid.
A, Coronal T1-weighted fat-suppressed image (TR/TE, 400/12) shows superior labral tear (*arrow*).
B, Axial T1-weighted fat-suppressed image (400/12) shows tear extending to posterior labrum (*arrowhead*). Anterior labrum (*arrow*) is normal.

The second step describes the extension of the superior labral lesion to other areas of the labrum. To be considered an extended lesion, the labral abnormality must be in anatomic continuation with the lesion that involves the biceps-labral complex. This step includes the current types V, VIII, and IX SLAP lesions, as well as the three subdivisions of SLAP II lesions.

The third step is related to the description of the associated abnormalities of the glenohumeral ligaments, joint capsule, articular cartilage, and tendons. Examples are extension of the lesion through the middle glenohumeral ligament (type VII SLAP lesion); superior glenohumeral ligament, coracohumeral ligament, rotator interval capsule (type X SLAP lesion); and inferior glenohumeral ligament (not described in the current SLAP lesion classifications). Abnormality of the adjacent cartilage such as a chondral flap, chondral defect, or chondral irregularity should also be considered. Associated abnormalities of the cuff tendons include undersurface tears of the supraspinatus and infraspinatus tendons attributed to posterosuperior and anterosuperior internal impingement and tears of the superior part of the subscapularis tendon and the most anterior part of the supraspinatus tendon that are associated with rotator interval lesions.

Conclusion

In summary, we suggest a tailored approach to MRI diagnosis of SLAP tears based on analysis



A B

Fig. 16.—Type IX superior labral anteroposterior lesion in 34-year-old man with history of shoulder trauma. HH = humeral head, G = glenoid.
A, Coronal proton density–weighted image (TR/TE, 2,600/15) reveals superior labral tear (*arrow*).
B, Axial gradient-echo image (450/15; flip angle, 30°) shows superior labral tear that extends anteriorly (*arrow*) and posteriorly (*arrowhead*) below 3- and 9-o'clock positions.

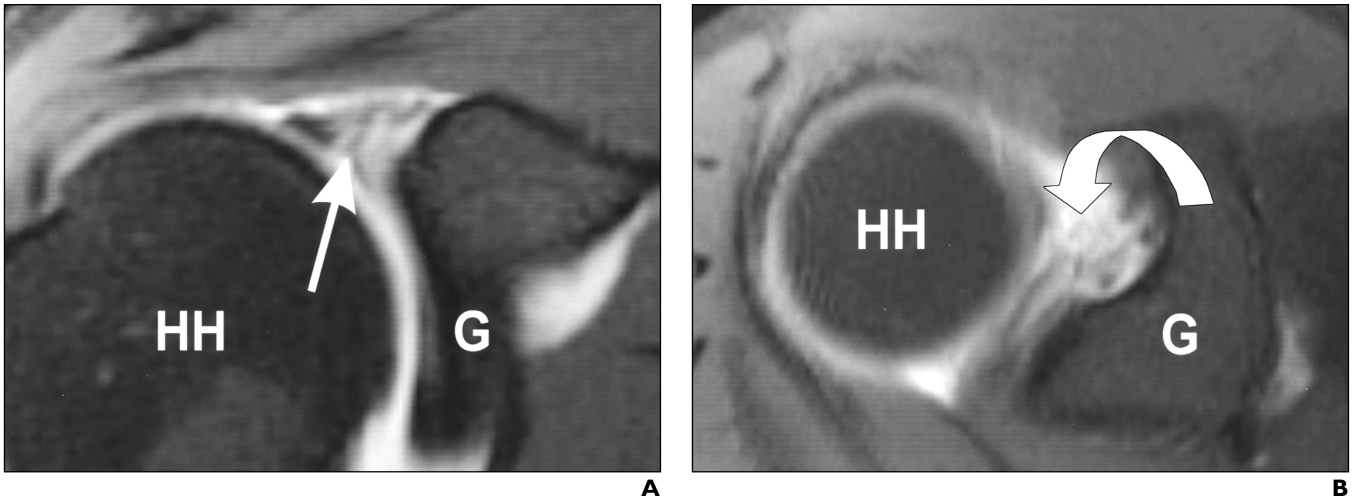


Fig. 17.—Type X superior labral anteroposterior lesion in man with history of labral tear. HH = humeral head, G = glenoid.
A, Coronal fat-suppressed T1-weighted arthrogram of right shoulder shows superior labral tear (*arrow*).
B, Axial fat-suppressed T1-weighted arthrogram shows tear extending to area of rotator interval (*arrow*).

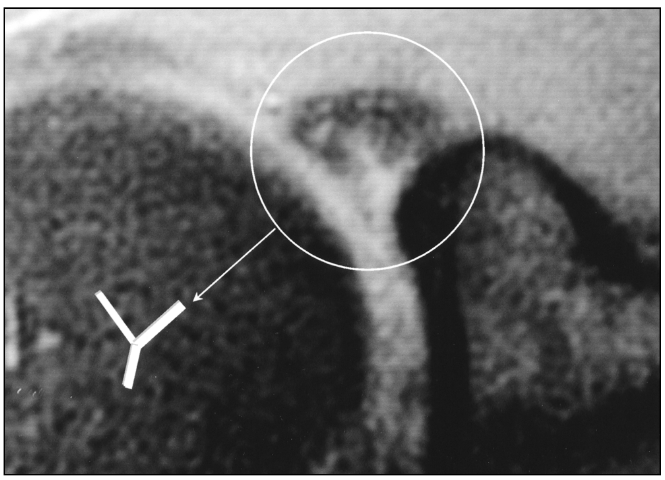


Fig. 18.—36-year-old man with shoulder pain and clinical findings suggestive of impingement. Unstable superior labral anteroposterior II lesion was surgically confirmed. Coronal proton density–weighted fat-suppressed image (TR/TE, 2816/13) shows abnormal signal intensity at base of superior labrum with Y-shaped appearance.

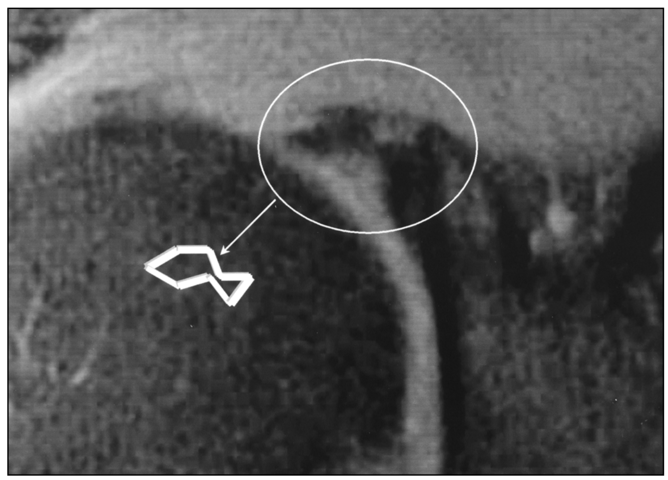


Fig. 19.—Coronal proton density–weighted fat-suppressed image (TR/TE, 3,000/30) obtained in 61-year-old man with superior labral anteroposterior lesion surgically confirmed. Note abnormal morphology of superior labrum. Sequential image (not shown) showed adjacent paraglenoid cyst.

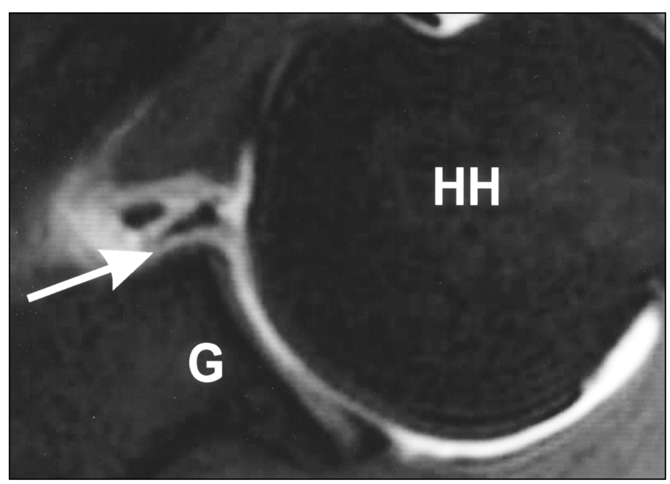


Fig. 20.—MR arthrogram in 38-year-old man shows transitional zone. Axial T2-weighted fat-suppressed image (TR/TE, 3,000/60) shows no fluid between anterosuperior labrum and adjacent glenoid cartilage. Area of intermediate signal intensity (*arrow*) represents transitional zone between fibrocartilage of labrum and hyaline cartilage of glenoid. HH = humeral head, G = glenoid.

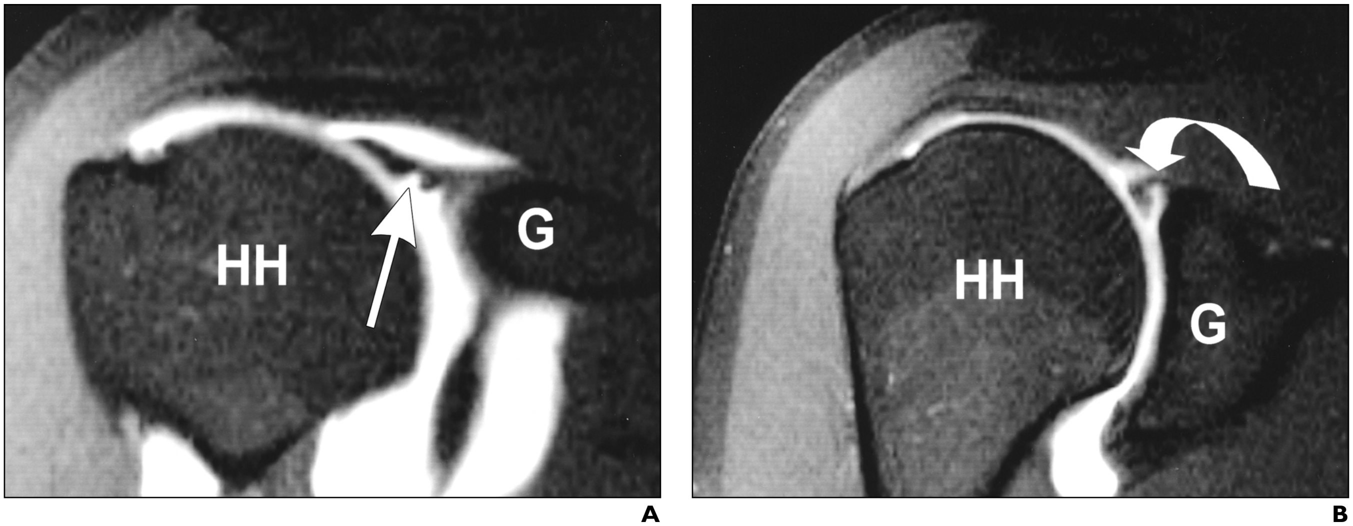


Fig. 21.—MR arthrograms of right shoulder in man with shoulder pain and superior labral anteroposterior (SLAP) lesion. HH = humeral head, G = glenoid.
A, Coronal T1-weighted fat-suppressed image (TR/TE, 600/15) shows abnormal morphology at insertion site of biceps tendon (*arrow*). This finding was initially interpreted as double Oreo cookie sign. Sequential images (not shown) revealed partial volume with superior glenohumeral ligament.
B, Coronal T1-weighted fat-suppressed image (600/15) obtained posterior to level of **A** reveals labral tear (*arrow*) characterized as SLAP II tear.

of the biceps-labral complex, the extension of tears, and the associated lesions in other structures. MRI analysis in multiple planes and close attention to clinical history and mechanisms of injury are strongly recommended. When appropriate, radiologists should describe the lesion as indeterminate for sublabral recess versus SLAP lesion and suggest clinical correlation or MR arthrography for better delineation of the labral abnormality. In tailored examinations, stress maneuvers such as arm traction [39] or additional planes such as the one parallel to the biceps tendon [40] may be implemented. Radiologists should perform a dedicated approach to these lesions with the description of the biceps-labral complex abnormality; extension of lesions in terms of time zones; and associated lesions in ligaments, adjacent cartilage, and tendons.

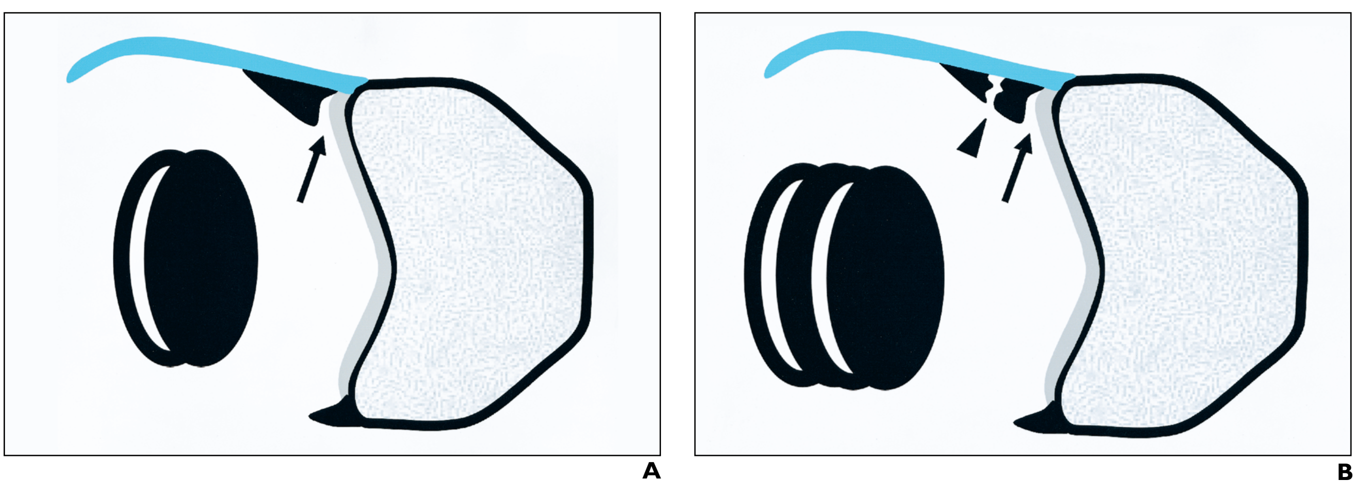


Fig. 22.—Schematic representations in coronal plane of single and double "Oreo cookie" configurations.
A, Single Oreo cookie configuration is characterized by fluid between labrum and glenoid cartilage. This finding could be observed with either sublabral recess (*arrow*) or type II superior labral anteroposterior lesion.
B, Double Oreo cookie configuration is characterized by fluid between labrum and glenoid cartilage and between two pieces of labrum. Arrow indicates sublabral recess and arrowhead indicates labral tear.

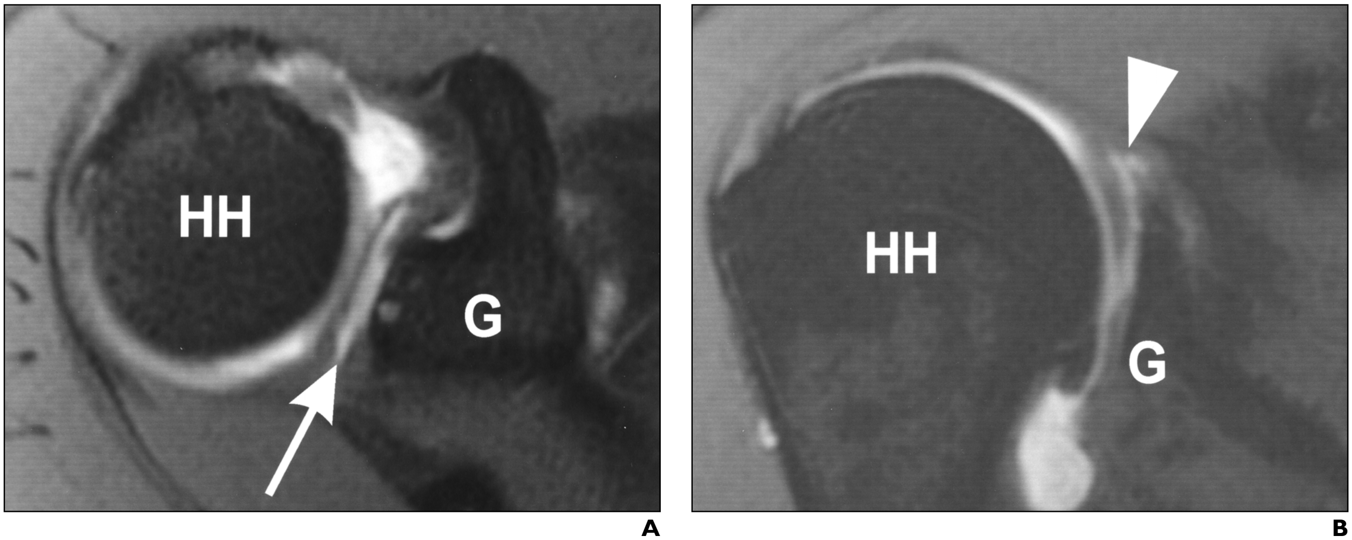


Fig. 23.—42-year-old man with posterior extension of superior labral anteroposterior tear on MR arthrograms. HH = humeral head, G = glenoid.
A, Axial T1-weighted fat-suppressed image (TR/TE, 600/13) shows irregular margin of superior labral tear (*arrow*), oriented parallel to glenoid surface.
B, Oblique coronal T1-weighted fat-suppressed image (600/13) shows tear extending posteriorly to biceps tendon origin (*arrowhead*).

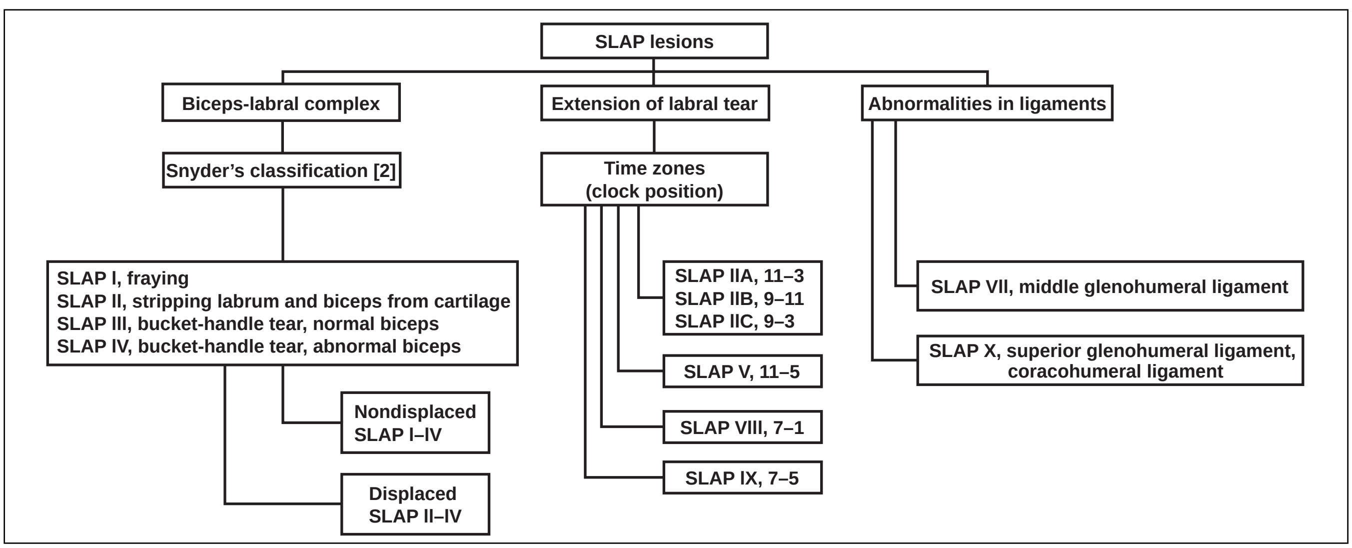


Fig. 24.—Diagram shows MRI algorithm for superior labral anteroposterior (SLAP) lesions based on specific abnormalities of biceps-labral complex, presence or absence of extension of tear, and presence or absence of abnormalities of additional structures.

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