

Shoulder Update

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SHOULDER INSTABILITY

Classification and Anatomic Considerations

The clinical definition of shoulder instability is slipping of the humeral head out of the glenoid socket during activities causing symptoms. Instability varies from subluxation to dislocation. Patients may be classified into two broad categories: traumatic unidirectional anterior-inferior instability with a Bankart lesion (referred to by the acronym **TUBS** – **t**raumatic, **u**nidirectional, **B**ankart, **s**urgical) and **AMBRI** (**a**traumatic, **m**ultidirectional, **b**ilateral instability) [4,5,6]. This classification primarily applies to the younger patient. TUBS patients are usually surgical candidates if the dislocation is recurrent while AMBRI patients are usually not [4,5,6].

The usual dislocation occurs during a fall on the outstretched externally rotated, abducted arm (**FOOSH** – **f**all **o**n an **o**utstretched **h**and). These patients (post traumatic) fit into the TUBS category and usually have a capsulolabral disruption (Bankart or Bankart variation lesion) and imaging beyond plain films is usually not requested as the patients are initially treated conservatively. There is a growing tendency to image the first time dislocator to document the type of lesion resulting from the trauma. There are traumatic episodes where the patients feel that their shoulder popped out and relocated but the dislocation was difficult to document clinically and not documented radiographically. Some of these episodes represent true dislocations and some are severe subluxations [5]. Imaging may be required in these patients to document the damage done and to plan further therapy. In the older patient as the spectrum of lesions resulting are generally quite different than a typical capsulolabral disruption (Bankart lesion) [7,8].

The anatomic causes of recurrent dislocation are varied. The cause of instability in these patients may be hypermobility or laxity perhaps due to stretching of the supporting structures from overuse and reliable standards of normal have not yet been defined with imaging.

Recurrent instability in TUBS patients is anterior-inferior resulting from previous dislocation. In order to understand the cause of recurrent instability it is useful to consider the stabilizing structures of the shoulder as a unit – the anterior capsular mechanism

consisting of the capsule and capsular ligaments (glenohumeral ligaments), the glenoid labrum, subscapularis muscle and tendon. **The most important structure stabilizing the shoulder and limiting gross anterior-inferior subluxations and dislocations is the inferior glenohumeral labral-ligamentous complex (IGHLC)** [1,9]. The ligament itself is a thickening of the inferior capsule and is lax when the humerus is in the neutral position, allowing normal shoulder motion. The ligamentous complex becomes taut in abduction and external rotation (ABER), and stabilizes the joint at the end range of shoulder movement in this. The threshold of restraint of this ligamentous complex is exceeded during a dislocation which leads to tears and/or stretching of the inferior glenohumeral-labral complex. This in turn may lead to laxity and symptomatic instability [10].

The anterior capsular mechanism components are all important stabilizing structures [1,9] and any or all of these structures may be injured after dislocation thus leading to a spectrum of abnormalities that may be shown with MR imaging. Usually, especially in the younger patient, a labral ligamentous avulsion (Bankart lesion) results.

It is critically important to know the history of the patient before the imaging examination is interpreted as the spectrum of lesions differs depending upon the age of the patient and mechanism of injury. These factors must be kept in mind for the radiologist to consider the type of lesions that may result in continued instability. Sometimes neither the patient nor the orthopedist knows for certain what the exact mechanism of injury was and whether the patient dislocated or not. Is the injury of a repetitive nature? These are all important questions. We ask our technologists to ask historical questions and document these on the intake requisition for additional information.

TECHNIQUE CONSIDERATIONS: WHY ASK FOR WHICH TYPE OF MR STUDY?

The technique of magnetic resonance evaluation employed is dependent upon the clinical history. Conventional MRI allows direct visualization of most of the important anatomical structures of the shoulder. For instance, in the older patient where rotator cuff disease is suspected, conventional MRI

is indicated. The limitation of conventional MRI is that small intra-articular structures such as the glenoid labrum, glenohumeral ligaments and articular surface of the rotator cuff can be difficult to evaluate in the absence of a joint effusion.

MR arthrography improves the diagnostic accuracy of the examination [10,11,12] but this controversial and with new gradients and high resolution scans it is often not necessary to perform MR arthrography. However in the chronic instability patient where healing (fibrosis and resynovialization) may obscure the true lesion to MRI, MR arthrography especially with ABER imaging may be helpful. The anterior capsule will fold on itself in the neutral position and become closely applied to the anterior labrum in the absence of a joint effusion. Additionally, the MRI phenomenon “magic angle artifact” affects the collagenous tissues present in the shoulder joint especially in the anterior-inferior region of the glenoid and in the critical zone of the rotator cuff. These are the two areas of the shoulder where accurate imaging is essential and arthrography may be helpful [10,13,14,15]. In the younger patient with *chronic* (healing and resynovialization) recurrent instability, MRI arthrography is often the method of choice to help avoid a misdiagnosis [10,13,14,16].

Placing stress on the stabilizing structures of the shoulder may bring out an otherwise undetected lesion. Abduction and external rotation stresses the inferior glenohumeral labral-ligamentous complex and “opens up” some partially healed or healed and incompetent labral ligamentous attachments to the underlying glenoid. MR arthrography utilizing the standard position should be coupled with imaging in the abducted externally rotated (ABER) position for adequate visualization of this region in problem cases [15,16,18].

INSTABILITY LESIONS

Subluxation

Abduction external rotation injury resulting in a subluxation of the shoulder may result in a partial tear of the capsule, labrum or both or stretch the capsule. These lesions may lead to repeated subluxation. These abnormalities may be difficult to diagnose by conventional MRI and MR arthrography is helpful to demonstrate the lesion. Subluxation resulting from a stretched capsule in the absence of a labral tear is a

diagnosis of exclusion as no reproducible imaging criteria have been developed to characterize this abnormality.

Posttraumatic Anterior Dislocation

The types of lesions that occur after anterior dislocation can be conveniently divided into two broad categories based upon the patient's age at time of first dislocation. MR arthrography helps in the evaluation of the younger patient with glenohumeral instability.

THE YOUNGER PATIENT – ADOLESCENCE FOR FORTY YEARS

The Bankart Lesion

Damage to the anterior inferior glenoid labrum and inferior glenohumeral ligament (labral-ligamentous complex) is the most common injury after anterior shoulder dislocation in the younger age group [19,20,21]. Typically these patients have a labral-ligamentous avulsion with a disrupted scapular periosteum (Bankart lesion). The Bankart lesion represents a detachment of the inferior glenohumeral labral-ligamentous complex from the anterior inferior glenoid with or without a fracture of the bony glenoid. Conventional MRI findings include labral/capsular tear seen as increased signal intensity through the substance of the labrum. If the dislocation was recent, an effusion is often present and one may visualize detachment or "pulling away" of the labral-ligamentous complex. Usually the tear is large enough to involve not only the labrum where the anterior band of the inferior glenohumeral ligament inserts but also the mid and sometimes superior anterior labrum as the tear dissects upward. This lesion is usually visualized using conventional (nonarthrographic) technique especially in the acute setting. There is often surrounding soft tissue edema in the region and bone marrow edema or fracture may be present increasing the likelihood of detection. In the chronic case, healing of the lesion may take place which involves fibrosis and resynovialization. If the lesion does not heal correctly, the patient will continue to be unstable. If the lesion heals or partially heals, it is difficult to fully demonstrate using conventional MRI and MR arthrography including the ABER position is helpful.

Bankart Variation Lesions: Avulsion with an Intact

Periosteum

The Bankart lesion results in a disrupted scapular periosteum. Perthes described a labral ligamentous avulsion where the scapular periosteum remained intact but was stripped medially creating a potential space of variable size anterior and medial to the scapula between the scapula and stripped periosteum [22]. This variant has been termed the "Perthes lesion". The labrum may reapproximate its normal position and partially heal and resynovialize in place. In this situation, the scapular periosteal anchor may be incompetent and result in recurrent instability. Perthes recommended a finger probe at surgery to uncover this lesion as it may be occult at first inspection [22]. This has potential dramatic implications for imaging as well. The lesion may appear deceptively normal on standard MR imaging and MR arthrography [15,18,23].

Since the labral ligamentous avulsion may reapproximate its normal position during healing/resynovialization, anatomic closure of the labrocapsular tear results. This phenomenon may prevent contrast material from entering the potential tear and make it invisible to conventional MRI and potentially to arthroscopy. If the labrum has partially healed, it may regain normal signal intensity. In this situation imaging in the ABER position significantly increases lesion detection [15,18,22,23]. Adding ABER imaging to the study protocol results in a significant increase in lesion detection over conventional MR arthrography obtained in the neutral position [18]. The MRI findings of a Perthes lesion ranges from normal (false negative study) to those seen with a Bankart lesion, to visualization of the torn, detached labrum and periosteum.

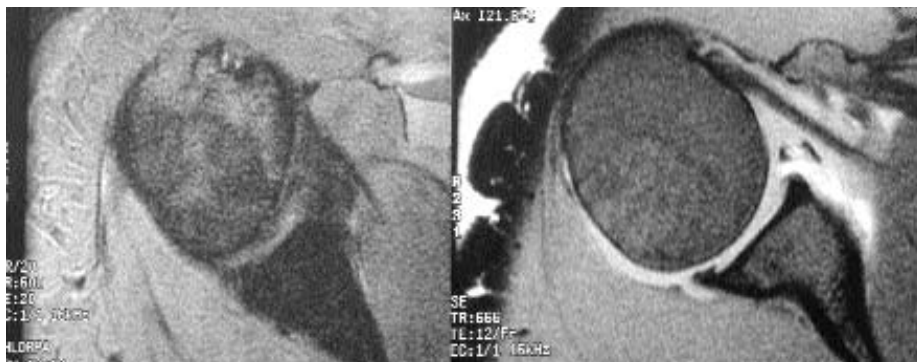
Another variation of the labrocapsular disruption is termed the **anterior labroligamentous periosteal sleeve avulsion lesion (ALPSA)** described by Nevaiser in 1993. The ALPSA lesion is an avulsion of the

anterior inferior glenoid labrum with an intact scapular periosteum where the labral-ligamentous complex "rolls up" in a sleeve like fashion and becomes displaced medially and inferiorly. Using this analogy, the labrum/ligament is the shirtcuff and the periosteum is the long sleeve where one rolls the sleeve up as on a hot day. The ALPSA has also been termed a "medialized" Bankart lesion emphasizing the characteristic that the lesion is "tacked down" in a medially displaced location [17]. The labrum and capsule will not heal in an anatomic position as a result [17]. The shoulder may heal by fibrosis and granulation tissue heaping up over the displaced labral-ligamentous complex and then the region is resynovialized [17]. The lesion may become difficult to identify in the chronic state to the arthroscopist [17]. Awareness of the possibility of the lesion is desirable because the surgery to correct an ALPSA lesion is different than a typical Bankart lesion repair [17]. MRI arthrography helps delineate the anterior inferior region to best advantage demonstrating the ALPSA lesion alerting the surgeon to probe the region and discover the potentially occult abnormality.

PATIENTS OVER FORTY

Rotator Cuff Tears

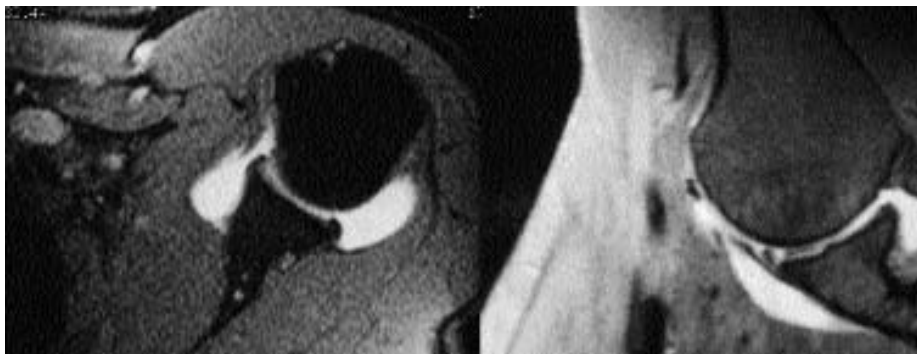
The clinical presentation of an older patient after first-time anterior glenohumeral dislocation may be confusing and misleading. These patients are often diagnosed with axillary neuropraxia, nerve tear, or rotator cuff (supraspinatus) disruption [7,8]. Awareness of the mechanism of injury and correlation with radiological findings is desirable so that the correct diagnosis can be made, allowing for appropriate treatment and avoidance of continued anterior instability. The injuries occurring to the older patient can be roughly divided into [7,8,21]. According to the orthopedic literature, one third of patients



Pre

Post

Pre and Post arthrography Bankart lesion in a difficult case. Because of the lack of joint fluid in this case, the avulsed labrum was difficult to see before arthrography



Perthes: note normal appearing labrum

ABER: note tear

is adducted and internally rotated. This is the position of function of the posterior capsule (the posterior portion of the inferior glenohumeral ligament). When the arm is adducted and internally rotated, the posterior capsule is tight and injury in this position leads to dysfunction of the capsule and labrum with resultant posterior instability. These instability lesions carry the familiar eponyms associated with anterior instability except with the word reverse is added to them. A reverse Bankart lesion refers to a labrocapsular disruption of the posterior labrum resulting from a posteriorly dislocated humerus. The resultant impaction fracture of the anterior-superior humerus is known as a reverse Hill Sach’s lesion. MRI findings include visualization of the labral/capsular tear, bony injury to the posterior glenoid and an anterior humeral injury (lesser tuberosity). The subscapularis may partially or completely tear.

Multi-Directional Instability

Imaging is often not employed in cases of multi-directional instability, except when the diagnosis is in question or the multi-directional instability is a cause of shoulder pain but is not suspected as the cause. In this patient with instability of unknown cause, imaging may be helpful. Also MR may be used in the patient with multidirectional instability to rule out conventional causes of the instability such as a labral abnormality.

Non instability Anterior Labral Abnormalities

If an injury occurs that results in a torn labrum the patient may or may not be unstable as a result. Pappas described a functional instability of the shoulder caused by damage confined to the glenoid labrum [27] which may result from such an injury. The lesion may result in mechanical locking of the joint due to torn labral fragments between the articulating surfaces. While the patient suffers from anterior shoulder pain, they are not unstable in the classical sense and therefore the term instability is somewhat misleading. MR arthrography may help define the lesion. Similarly, Neviasser described the **GLAD** lesion (**Glenolabral Articular Disruption**) which refers to a partial labral tear associated with an articular (hyaline) cartilage divot [28]. He postulated the injury resulted from a forced adduction injury [28]. Again the lesion is found in a stable patient, may be subtle, and may be mistaken for an instability lesion by the radiologist. MR arthrography helps define the lesion to best advantage.

will tear the supraspinatus tendon [7,8,21] and another third will suffer a fracture of the greater tuberosity (essentially a cuff-tuberosity avulsion or large Hill-Sachs fracture although we and others have found that greater tuberosity fractures can occur in any age group [7,8,21]). The final one third will avulse the subscapularis and anterior capsule from the humerus [7,8,21]. This latter subset may result in continued anterior instability as the glenohumeral capsule and subscapularis tendon together are considered important anterior stabilizing structures. This is generally considered a surgical lesion whereas the fracture may be treated conservatively. The supraspinatus tear may be treated conservatively or surgically depending on the size of the tear and the clinical symptoms. MRI potentially may play a pivotal role in distinguishing between the lesions and direct patient therapy. The MRI findings depend upon the injury sustained and in general, conventional technique in these patients will

suffice.

OTHER ANTERIOR INSTABILITY ABNORMALITIES

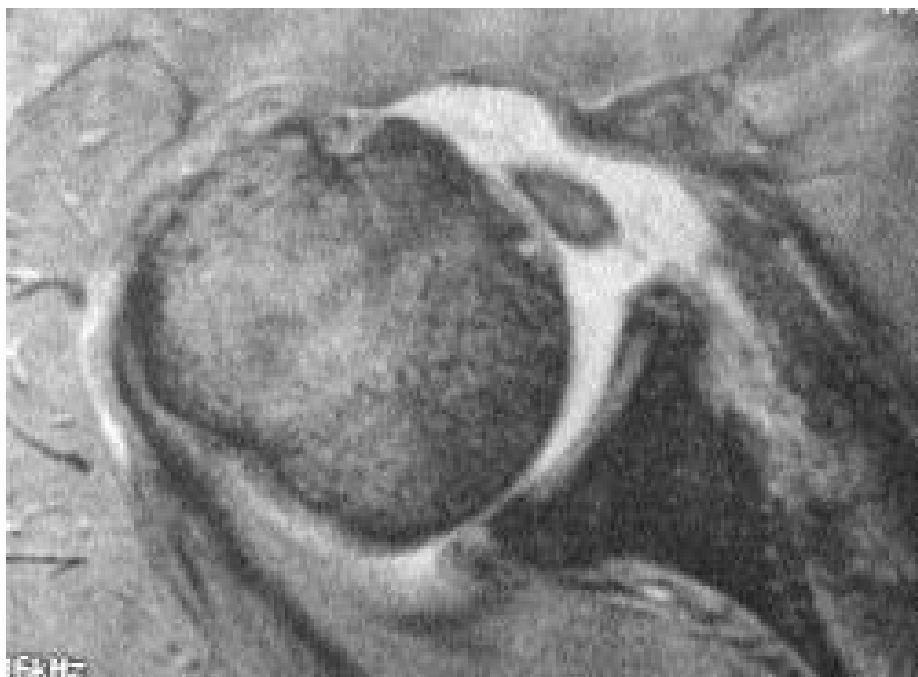
Avulsion of the IGHLC from the humerus [24,25,26] has also been described (**H**umeral **A**vuulsion of the **G**lenohumeral **L**igament – **HAGL**) resulting from dislocation. MR arthrography helps with the diagnosis. Arthrographic findings include visualization of contrast material extravasating from the joint through the capsular disruption at its humeral insertion. The inferior glenohumeral ligament may tear in its mid substance. This is felt to be rare or at least is rarely diagnosed with imaging and may also be an arthrographic diagnosis.

Posterior Instability

Posterior instability results from excessive force directed at the shoulder when the arm



ALPSA Lesion. Note the medially displaced labral ligamentous attachment on this ABER image. Note that the humeral head is also subluxed anteriorly seen only on the ABER view in this patient.



Subscapularis avulsion after anterior dislocation. Note the torn avulsed tendon and dislocated biceps tendon which may mimic a torn detached labrum.

Anatomic variations of the labrum may mimic an anterior labral abnormality. This variation occurs in the anterior superior quadrant where the labrum may be detached or absent and be normal [29,30]. A detached labrum is referred to as a sublabral hole and an absent labrum is termed a Buford complex as the absent labrum is found in combination with a cord-like middle glenohumeral ligament. The history of the patient is critical as differentiation between an anatomic variation and an isolated anterior superior labral injury is difficult.

Superior Labral Abnormalities

Snyder described superior labral tears anterior and posterior to the attachment of the biceps tendon to the supraglenoid tubercle [31]. These lesions are not thought of as being associated with classical instability when they are by themselves even



HAGL lesion. Note the torn edematous IGHL avulsed from the humerus.

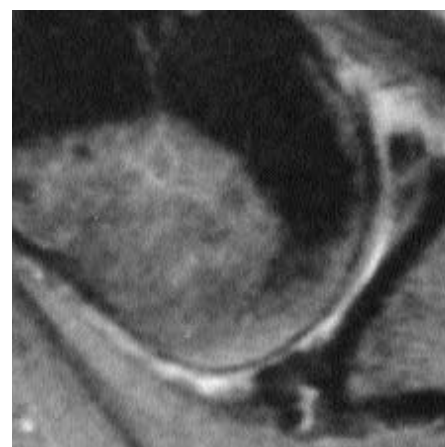
though the biceps tendon may be an important anterior stabilizer [32]. Snyder described 4 types ranging from fraying and fragmentation to a bucket handle tear [31]. MR arthrography may lift the torn labrum from the attachment to the glenoid, and show insinuation of contrast material into the torn biceps anchor. In the case of the bucket handle variety of SLAP lesion, contrast may help define the fragment by lifting it from the remainder of the torn biceps anchor. Care must be taken to avoid interpreting a sub labral hole from a SLAP lesion. Good communication between the orthopedist and the radiologist is helpful in avoiding this potential pitfall. Beltran and Tuite have described findings associated with SLAP lesions including high signal on short TE sequences oriented away from the glenoid and also high signal on T2 weighted images within the substance of the labrum.

GLENOID LABRAL CYSTS

It has been shown that cysts about the shoulder joint are often associated with labral tears and with instability [33]. In this way they are analogous to meniscal cysts of the knee which originate with tears of the meniscus. Cysts in the posterior and anterior paralabral region are associated with posterior and anterior instability respectively [33]. Those cysts seen superiorly are associated with SLAP lesions and may or may not be seen with instability [33]. MRI findings include visualization of a cystic structure usually but not always intimately related to a labral tear. Occasionally at

arthrography, the cyst may demonstrate communication with the joint. Cysts may arise from a region of age related degeneration and or dehiscence. Unlike the usual case of the knee meniscal cyst, in the shoulder the tears may completely or partially heal preventing communication with the joint. This accounts for detection of labral cysts in locations associated with instability in patients that are currently stable. Arthroscopic evaluation of these patients usually demonstrates evidence of prior capsulolabral disruption with fibrous healing.

The cyst may cause problems secondary to mass effect. If the cyst arises from a break in the integrity of the posterosuperior joint (a



Posterior and anterior labral tear in a patient with multidirectional instability

common location) it may extend into the spinoglenoid notch, posterior to the scapula between the scapular spine and the glenoid. The suprascapular nerve passes through this notch and may be compressed, resulting in a denervation syndrome. The suprascapular nerve innervates the supraspinatus, infraspinatus and provides some pain fibers to the shoulder joint. Therefore, denervation results in weakness in those muscles and pain simulating impingement syndrome which may accompany a rotator cuff tear. MRI may be the only method capable of revealing the true cause of symptoms in these cases.

CONCLUSIONS AND RECOMMENDATIONS

Suggested Indications for Conventional MRI

- 1) Insidious onset of shoulder pain especially in the over forty age group.
- 2) Impingement
- 3) Trauma including dislocation in the over forty age group.

- 4) Initial evaluation of a patient with suspected suprascapular nerve dysfunction.
- 5) AC joint evaluation
- 6) Suspected muscle dysfunction (i.e. deltoid).

Suggested Indications for MRI Arthrography

- 1) Chronic recurring instability – especially if damage to the IGHLC is suspected and other studies are inconclusive.
- 2) Evaluation of labral cysts to determine the patency of a suspected cyst – labral tear communication. (CT arthrography may be helpful)
- 3) Biceps anchor visualization.

References Instability

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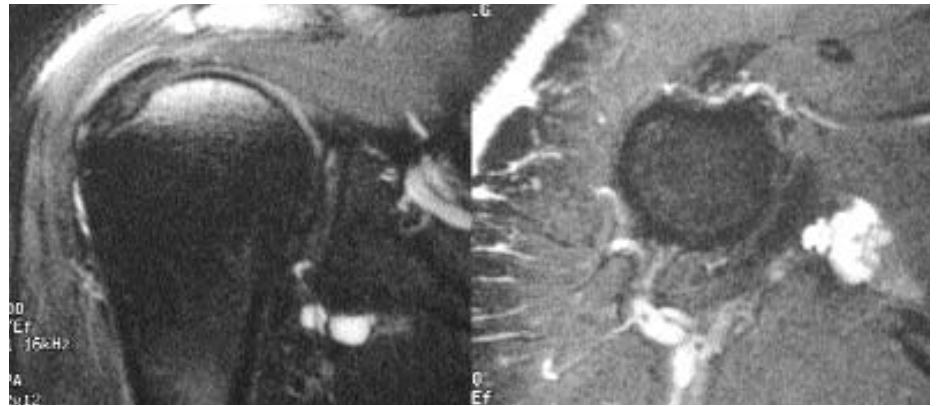
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Glenoid Labral Cyst. Note the inferior cyst.

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Slap lesion (arrows). Note high signal in biceps anchor.