MRI of HAGL Lesions: Four Arthroscopically Confirmed Cases of False-Positive Diagnosis

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OBJECTIVE. The purpose of this article is to present the cases of four consecutive patients with preoperative MR diagnosis of humeral avulsion of the glenohumeral ligament (HAGL) who had no evidence of HAGL at arthroscopy.

CONCLUSION. These four cases suggest that the diagnosis of HAGL should be reserved for arthroscopy and illustrate the difficulty in distinguishing HAGL from other abnormalities of the inferior glenohumeral ligament complex with MRI. Thus, MRI findings classically associated with HAGL should be more broadly described as defects of the inferior glenohumeral ligament complex. This terminology more accurately describes the abnormalities of the inferior glenohumeral ligament complex that may be depicted by MRI.

Keywords: anterior shoulder instability, arthroscopy, humeral avulsion of the glenohumeral ligament (HAGL), MRI, shoulder dislocation

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Shoulder instability is a common problem encountered in orthopedic practice and can lead to significant long-term disability. The majority of cases are caused by avulsion of the anterior capsulolabral complex, known as a Bankart lesion [1, 2]. Avulsion of the inferior glenohumeral ligament from its humeral insertion, known as humeral avulsion of the glenohumeral ligament (HAGL), is a less common cause of shoulder instability occurring in 7.5–9.3% of cases of anterior shoulder instability [3, 4].

The inferior glenohumeral ligament complex plays a large role in buttressing anterior and inferior translation of the humeral head. The inferior glenohumeral ligament complex consists of an anterior band, a posterior band, and an interposed axillary pouch. It is a major restraint to anterior and posterior translation at 90° of abduction [5]. Failure of this ligament has been shown to occur at three sites: the glenoid insertion, the midsubstance, and the humeral insertion. In cadaver studies, the humeral insertion of the inferior glenohumeral ligament is the least common site of failure [6].

Recognition of this lesion preoperatively can prove to be difficult because the history and physical examination findings are nonspecific. Thus, MRI is often used in the preoperative evaluation for patients with shoulder instability or suspected labral abnormality for which HAGL would be included in the differential diagnosis. The MRI characteristics of HAGL that have been described in the literature include increased signal intensity and thickening of the inferior capsule, extravasation of contrast material or joint effusion along the medial humeral neck, and a J-shaped axillary pouch ("J" sign) as opposed to the normal U-shaped structure [7, 8]. However, the sensitivity and specificity of the MRI diagnosis of HAGL are currently unknown.

At arthroscopy, HAGL appears as a defect in the capsular reflection along the insertion of the inferior glenohumeral ligament onto the humeral neck. The four consecutive patients presented in this article had a preoperative diagnosis of HAGL made by MRI (according to the aforementioned diagnostic criteria); however, these patients failed to show HAGL on shoulder arthroscopy and instead had other lesions that could explain the MRI findings.

Materials and Methods

Patient 1

A 14-year-old girl who was a right-hand-dominant swimmer presented to the senior surgeon with recurrent right shoulder pain and a painful popping sensation. The patient denied any history of acute trauma or dislocation but noted exacerbation of symptoms while swimming and playing volleyball. The patient had undergone physical therapy without improvement in her symptoms before presentation. On physical examination of the right shoulder, no atrophy or tenderness to

palpation was noted. Although the patient had full active and passive range of motion, the load-and-shift and O'Brien's tests were both positive.

Patient 2

A 14-year-old girl who was a right-hand-dominant swimmer presented to the senior surgeon with a 3-month history of right shoulder pain associated with a popping and clicking sensation. Swimming exacerbated her symptoms. The patient denied any acute trauma or dislocation. Before presentation, she had undergone a course of physical therapy without improvement. Physical examination of her right shoulder revealed no atrophy or tenderness to palpation. Strength and range of motion were normal. There was a mild sulcus sign and O'Brien's test was mildly positive. Load-and-shift test was negative.

Patient 3

A 25-year-old woman who was a left-hand-dominant competitive weightlifter presented to the senior surgeon with complaints of right shoulder pain since a traumatic injury 6 years earlier in a motor vehicle accident. There was a questionable history of prior dislocation with the previous injury.

Physical examination revealed no tenderness to palpation. She showed full active and passive range of motion and normal strength. There was mild discomfort with cross-body positions and resisted abduction but no pain on internal and external rotation against resistance. Marked grinding and popping were noted during the O'Brien's test.

Patient 4

A 21-year-old man who was right-hand dominant presented to the senior surgeon with continued shoulder pain and limited range of motion after a traumatic anterior dislocation of his right shoulder sustained while participating in a flag football game 4 weeks earlier. He had no history of previous shoulder injuries.

Physical examination revealed tenderness to palpation over the greater tuberosity. There was decreased forward flexion and external rotation with guarding but normal strength and sensation. Load-and-shift test and O'Brien's test were both negative. MRI without intraarticular contrast material was performed 10 days after reduction of the anterior dislocation.

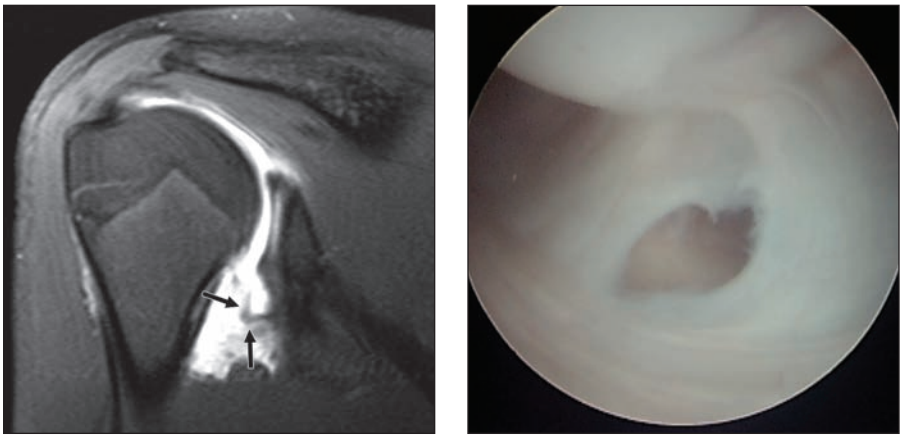


Fig. 1—14-year-old girl (patient 1) with recurrent right shoulder pain and painful popping sensation.
A, Coronal oblique fat-saturated T1-weighted MR arthrogram shows apparent "J" sign with disruption of humeral attachment of inferior glenohumeral ligament and subsequent contrast extravasation along medial humeral neck. Arrows show disruption of humeral attachment of inferior glenohumeral ligament complex outlined by "white" contrast dye in glenohumeral joint.
B, Arthroscopic image depicts rent in inferior glenohumeral ligament without extension to humeral insertion.

Results

Patient 1

Shoulder MR arthrography revealed extravasation of intraarticular contrast material into the extraarticular soft tissues about the axilla and along the medial humeral neck (Fig. 1A). No other lesion beyond the diagnosis of HAGL was suggested on the MR images or in the radiology report.

On the arthroscopic examination, an anterior Bankart lesion and a small Hill-Sachs lesion were noted. In addition, a hole in the inferior glenohumeral ligament was observed in the axillary recess, without evidence of detachment from the humerus (Fig. 1B).

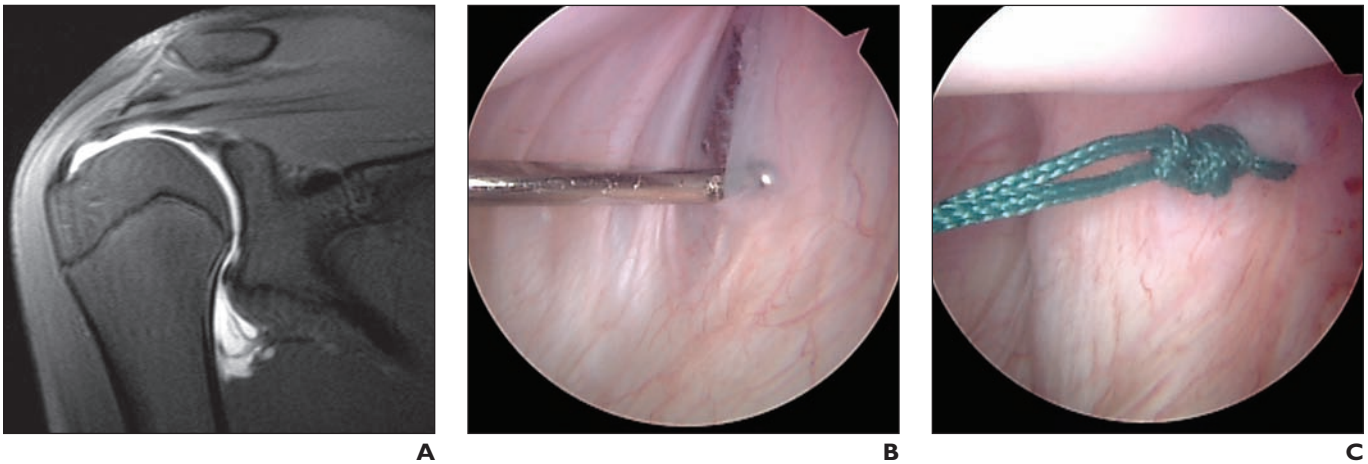


Fig. 2—14-year-old girl (patient 2) with 3-month history of right shoulder pain associated with popping and clicking sensation.
A, Coronal oblique fat-saturated T1-weighted MR arthrogram shows apparent "J" sign with disruption of humeral attachment of inferior glenohumeral ligament and subsequent contrast extravasation along medial humeral neck.
B, Arthroscopic image shows rent in inferior glenohumeral ligament in line with ligament fibers. Rent does not extend to humeral insertion.
C, Arthroscopic image shows side-to-side repair of inferior glenohumeral ligament defect.

This hole in the inferior glenohumeral ligament complex likely explains the finding on MR arthrography of extravasation of contrast material. This lesion was repaired with an arthroscopic side-to-side suture repair. The Bankart lesion was addressed arthroscopically with suture anchors.

Patient 2

MR arthrography revealed widening of the axillary pouch with contrast extravasation inferiorly along the medial humeral neck (Fig. 2A). This finding was interpreted as HAGL. Increased signal was also noted in the posterior labrum, which was thought to be related to the HAGL. No other abnormalities were observed.

Arthroscopy revealed an anterior Bankart lesion and a small Hill-Sachs lesion. In addition, an intrasubstance tear of the inferior glenohumeral ligament complex in line with the ligament fibers was noted (Fig. 2B). The intrasubstance tear was repaired arthroscopically with a side-to-side suture technique (Fig. 2C). The Bankart lesion was addressed at the time of arthroscopy with suture anchors.

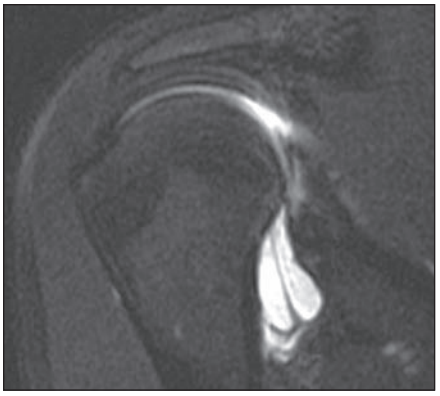
Patient 3

MR arthrography suggested avulsion of the posterior band of the inferior glenohumeral ligament from its humeral attachment (Fig. 3A). A tear of the posteroinferior glenoid labrum was also noted.

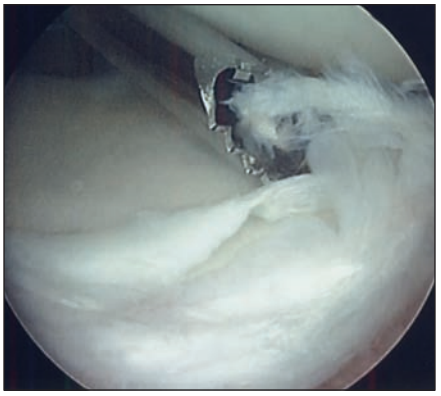
Arthroscopic examination revealed a posterior Bankart lesion with extension into the posterior capsule (Fig. 3B). There was no evidence of inferior glenohumeral ligament avulsion from the humerus. An arthroscopic posterior Bankart repair with suture anchors was performed (Fig. 3C). In addition, a posterior capsular plication to address the posterior capsular rent was used.

Patient 4

MRI revealed a tear of the inferior glenohumeral ligament with associated soft-tissue edema about the axillary recess and along the medial proximal humeral shaft (Fig. 4A). These findings were believed to support the diagnosis of HAGL. In addition, a small Hill-Sachs lesion and tear of the anterior inferior glenoid labrum were noted. Arthroscopy revealed an anterior Bankart lesion and a small Hill-Sachs lesion (Fig. 4B). No HAGL was seen. An arthroscopic Bankart repair with suture anchors was performed (Fig. 4C).



A



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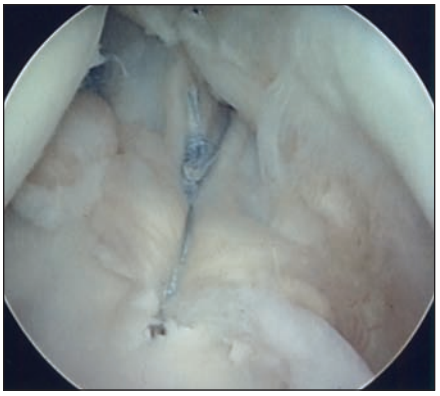

C

Fig. 3—25-year-old woman (patient 3) with right shoulder pain and history of traumatic injury 6 years earlier in motor vehicle accident.
A, Coronal oblique fat-saturated T2-weighted MR arthrogram shows strands of tissue in axillary pouch thought to represent tear of inferior glenohumeral ligament and subsequent contrast extravasation along medial humeral neck.
B, Arthroscopic image shows tear of posterior labrum.
C, Arthroscopic image shows repair of posterior labrum.

Discussion

HAGL has been shown to be an infrequent cause of shoulder instability. In two large series regarding anterior instability, HAGL was found to occur in 7.5% and 9.3% of cases [3, 4]. Nicola [9] is often credited as first describing this lesion in 1942. In a cadaver study, he showed that the lesion occurred anteriorly with a hyperabduction and external rotation force. Although this lesion occurs most commonly along the anterior humeral insertion, avulsion of the posterior inferior glenohumeral ligament has also been described. A recent review of the literature found that the HAGL lesion occurred anteriorly in 93% of cases, with the remaining 7% being located posteriorly [10].

Despite the relative infrequency of HAGL, a precise diagnosis of this lesion is important. A high index of suspicion for HAGL should be maintained when performing arthroscopy for instability or suspected labral abnormality because nearly two thirds of the HAGL lesions described in the literature had other associated shoulder abnormality at the time of arthroscopy [10]. Because HAGL tends to occur in tandem with other shoulder abnormalities, a systematic inspection of the shoulder during arthroscopy should always include the inferior glenohumeral ligament complex to avoid missing an HAGL lesion [11, 12]. Failure to recognize this lesion may lead to persistent instability and pain [10].

Although arthroscopy is the reference standard for detection of HAGL, preoperative diagnosis is valuable because it may change the treatment plan or operative approach [10]. For example, a Bankart lesion with an associated HAGL lesion may make conservative treatment a less successful treatment option, whereas preoperative knowledge of HAGL would decrease the likelihood of missing the lesion at surgery and would necessitate that a method of soft-tissue fixation to bone be available at the time of surgery. Because of the exquisite soft-tissue contrast of MRI, that technique has been suggested as a method for the preoperative diagnosis of HAGL, and the MRI findings associated with the HAGL lesion have been described.

Stoller [8] has suggested that the presence of a joint effusion, either pathologic or intro-

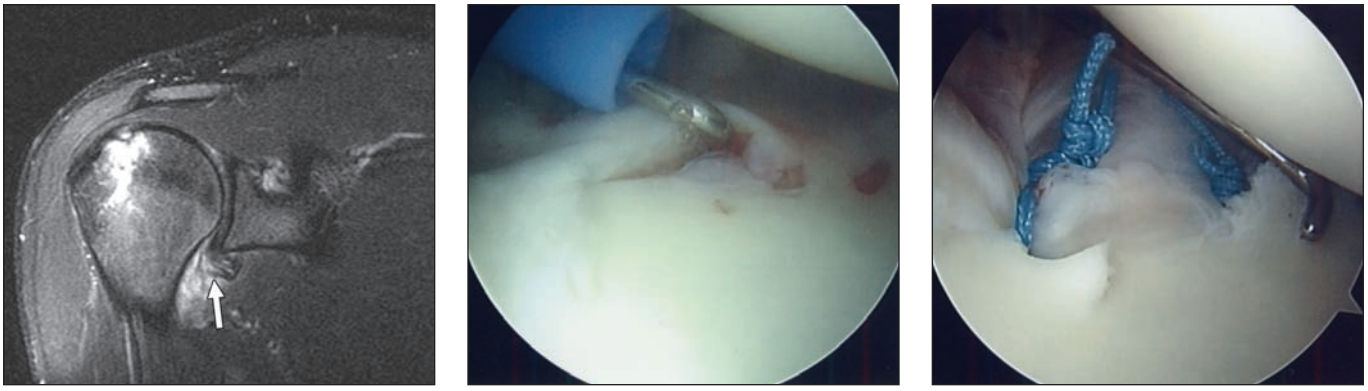

Fig. 4—21-year-old man (patient 4) who presented with continuing shoulder pain and limited range of motion after traumatic anterior dislocation of right shoulder 4 weeks earlier.
A, Coronal oblique fat-saturated T2-weighted MR image appears to show disruption of inferior glenohumeral ligament at its humeral insertion (*arrow*), with associated soft-tissue edema tracking along medial humeral neck.
B, Arthroscopic image shows anterior Bankart lesion.
C, Arthroscopic image shows repair of anterior Bankart lesion.

duced through MR arthrography is a prerequisite for identifying HAGL on MRI. Arthrographic fluid distends the joint and helps reveal soft-tissue structures that are normally apposed. In addition to arthrographic fluid, the choices of imaging plane and T1- or T2-weighting are important.

The characteristic MRI appearance of HAGL is best depicted on the fat-suppressed T1-weighted images in the coronal oblique and sagittal oblique planes [7]. On the coronal oblique plane, the axillary pouch is normally U-shaped when distended with fluid. Conversion of this U-shaped pouch to a J-shape (J sign) and extravasation of arthrographic fluid across the torn humeral attachment and along the medial humeral neck are the typical imaging findings [7, 8]. Similar findings may also be seen on conventional fat-suppressed T2-weighted images.

Occasionally, HAGL lesions occur with bone avulsion of the inferior glenohumeral ligament from the medial cortex of the humeral neck and thus may be observed on radiographs of the shoulder [11]. This bone fragment may be observed on radiographs, CT, and MRI. Unfortunately, bone avulsion occurs in only a minority of HAGL lesions, and, when present, the bone fragment is small and may be overlooked. In addition, all forms of HAGL are relatively infrequent in the spectrum of shoulder abnormality, and to date we know of no studies that have been reported to define the sensitivity or specificity of the published MRI criteria for the noninvasive diagnosis of HAGL. Thus, the accuracy of MRI in detecting HAGL is unknown.

Currently, MR arthrography is considered the best method of detecting HAGL. However, only two series describe the MRI characteristics of HAGL with clinical correlation, but in these series a significant proportion of the cases lack arthroscopic confirmation of the lesion. Bui-Mansfield et al. [7] reported on the imaging findings of six patients with HAGL. Four patients underwent preoperative MRI and subsequently underwent arthroscopy that discovered HAGL. Two of these patients had no evidence of HAGL on MRI and thus were false-negative. An additional patient with an MRI suggesting HAGL was included in their series without arthroscopic confirmation. Chung et al. [13] described the MR characteristics of posterior HAGL, but only eight of 17 patients underwent arthroscopy to confirm the lesion. A recent series of avulsion of the posterior inferior glenohumeral ligament cases diagnosed at arthroscopy found that no lesion was suspected preoperatively despite 77% of patients undergoing preoperative MR arthrography. Only on retrospective review of the MR arthrograms were findings consistent with avulsion of the posterior inferior glenohumeral ligament found in 67% of the cases, leading the authors to conclude that a high index of clinical suspicion is necessary for preoperative MR diagnosis with a sensitivity likely well below 100% [14].

Our series presents four consecutive false-positive diagnoses of HAGL by MRI. All four patients underwent preoperative MR arthrography or MRI in the acute posttraumatic setting and, subsequently, diagnostic arthroscopy revealed shoulder abnormality other than HAGL. On arthroscopy, all patients had a Bankart lesion (posterior or anterior) and three of the four had injuries in the inferior glenohumeral ligament that did not extend to the humeral insertion. Thus, all patients in this series had defects in the inferior glenohumeral ligament complex that simulated the appearance of HAGL on MRI, but no patient actually had an HAGL lesion at arthroscopy. Traumatic defects in the inferior glenohumeral ligament complex that spared the humeral attachment may account for the MRI finding of extravasation of arthrographic fluid. In addition, the intrasubstance rents in the inferior glenohumeral ligament or the soft-tissue trauma from the anterior shoulder instability may explain the abnormal MRI appearance of the axillary pouch.

To our knowledge, this is the first reported case series for false-positive MR diagnoses of HAGL lesions with arthroscopic correlation. This case series illustrates the challenges presented by relying on MRI criteria for diagnosis of HAGL. These criteria were created by observing MRI findings common to the small number of arthroscopically confirmed cases of HAGL in these studies. Thus, although the J sign and arthrographic fluid extravasation on MRI may be useful findings to suggest a diagnosis of HAGL, the cases presented here suggest the MRI findings may not offer a precise diagnosis of HAGL as previously described. In fact, the false diagnosis of HAGL has been common in our experience. Our four cases represent the sum total experience with preoperative MR diagnosis of HAGL for the two senior orthopedic sports surgeons

(combined 29 years of practice beyond orthopedic fellowship training).

Although at first glance it may appear that patients will undergo similar management irrespective of the MRI description (HAGL vs defect of the inferior glenohumeral ligament complex), we think that the precise imaging description of this lesion is important for several reasons. First, surgical and nonsurgical treatments continue to evolve as our understanding and experience deepen and will be based on accurate diagnosis of pathology. Treatment will become more specific and likely improve with an accurate description of inferior glenohumeral ligament lesions. As we reviewed the literature, we found that some of the articles relied on the MRI diagnosis without the reference standard of arthroscopic confirmation. Our experience, as reflected by this series of consecutive cases, underscores the importance of the reference standard for a true understanding of these lesions. Second, preoperative imaging plays an important role in surgical management and planning. Precise radiographic diagnosis of inferior glenohumeral ligament complex lesions may change the treatment plan and, if surgery is indicated, will dictate the surgical approach and materials that need to be on hand for the given inferior glenohumeral ligament lesion. We hope that this case series will stimulate further research that will more accurately define the clinical characteristics of HAGL lesions and lead to a better noninvasive characterization of inferior glenohumeral ligament lesions before arthroscopy.

More work should be done to compare how well MRI detection correlates with arthroscopy before a final conclusion is made. However, for the time being we propose that in the absence of a bone avulsion at the medial humeral neck, the MRI findings of the J sign or fluid extravasation along the medial humeral neck be termed more broadly as a defect in the inferior glenohumeral ligament complex rather than being attributed to an HAGL lesion. This more precisely describes the abnormality that may be currently detected and characterized by MRI. Diagnosis of HAGL should be reserved for arthroscopy. In addition, this case series highlights the importance of a thorough diagnostic arthroscopic examination regardless of the preoperative MRI findings.

This series is certainly limited by its small number of cases and its retrospective design. However, because this lesion occurs infrequently and requires intraarticular fluid to adequately image, larger studies of a prospective nature would prove difficult. A large prospective cohort study of patients with symptoms of instability or labral abnormality who would undergo MR arthrography and subsequent diagnostic arthroscopy would be needed to help define the sensitivity and specificity of the present MRI diagnostic criteria for HAGL. Lastly, because three of the four patients in this series had an intrasubstance defect in the inferior glenohumeral ligament in association with a Bankart lesion, the frequency and consequence of this combined abnormality should be explored.

In conclusion, MRI may reveal injury to the inferior glenohumeral ligament complex, but the four cases described in this report suggest that pinpointing the precise location of injury within the inferior glenohumeral ligament complex is best reserved for arthroscopy. The MRI findings usually described as indicating a HAGL lesion likely overlap with other injuries to the inferior glenohumeral ligament complex. Instead of suggesting a precise diagnosis of HAGL on MRI, we propose that the MRI findings described be interpreted more broadly and described as a defect of the inferior glenohumeral ligament complex. We hope that this case series will stimulate further imaging research that will ultimately lead to a better noninvasive characterization of inferior glenohumeral ligament lesions before arthroscopy.

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