

The Original Mini-Open Technique for Repair of Humeral Avulsion of the Glenohumeral Ligament



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Abstract: Anterior shoulder dislocations commonly occur in the young, athletic population. The mechanism of dislocation occurs when the shoulder is placed in an abducted, externally rotated position while a forceful anterior moment is applied to the humerus. This position, combined with the force applied, results in an anterior and inferiorly directed dislocation of the humeral head away from the glenoid. Due to the limited stretching capacity of the glenohumeral capsule and associated glenohumeral ligaments, the force of the traumatic dislocation overcomes the tensile strength of these ligaments, resulting in a tear. Although the injury more commonly results in an avulsion of the anteroinferior capsulolabral complex from the glenoid, called a Bankart lesion, other injuries have been described. The anterior inferior glenohumeral ligaments (aIGHLs), may be torn from their humeral attachment, which is referred to as a humeral avulsion of the glenohumeral ligament (HAGL). Although other structures may be injured, the topic of this surgical technique focuses on a mini-open approach for repair of the HAGL lesion.

The overall incidence of shoulder dislocations has been estimated to be 23.9 per 100,000 person-years.¹ Risk factors include male sex, young age, collision athletes, and military personnel.² Of the dislocations that occur during sports, American football and basketball represent more than twice as many events than any other sports or recreational activities.¹ Of the many associated injuries that may occur with an anterior shoulder dislocation, the humeral avulsion of the glenohumeral ligament (HAGL) lesion is of particular importance, as failing to identify this injury pattern can result in persistent shoulder instability. These lesions are more commonly seen in adults >35 years old after an initial dislocation event,³ with a reported incidence of 7.5% to 9.3% in primary dislocation events.⁴

The inferior glenohumeral ligament (IGHL) complex is a hammock-like structure that spans the inferior aspect of the glenoid, made up of both anterior (aIGHL) and posterior (pIGHL) bands, with an axillary pouch spanning the 2 bands⁵ (Fig 1). The anterior band has fibers that insert into the labrum medially and fibers that insert into the neck of the glenoid laterally. On the humeral side, the aIGHL inserts distal to the lesser tuberosity at the inferior margin of the articular surface of the humeral head/anatomic neck junction.⁵ Given the attachment sites and shape of the aIGHL, it tightens with 90° of abduction and external rotation, which stabilizes the glenohumeral joint by acting as a passive restraint to anterior inferior translation of the humerus during overhead activities.⁶ When in its taut position, it is vulnerable to injury during an anterior shoulder dislocation. Bui-Mansfield et al.⁷ described several variations of tear location and pattern that may occur to the IGHL.

Injury to the aIGHL associated with an anterior shoulder dislocation may occur at its medial insertion into the glenohumeral capsule and labrum, referred to as a Bankart lesion,⁸ or from its lateral insertion onto the humerus, referred to as a HAGL lesion.⁹ This can result in persistent instability and kinematic dysfunction of the shoulder if left untreated or inadvertently missed.⁴ Arciero and Mazzocca¹⁰ first described a mini-open technique in 2005. As mentioned, several variations of HAGL lesions have been described.⁷ Those that are purely anterior or posterior can be managed arthroscopically, and all-arthroscopic techniques have been described.^{11,12} However, the all-arthroscopic technique is

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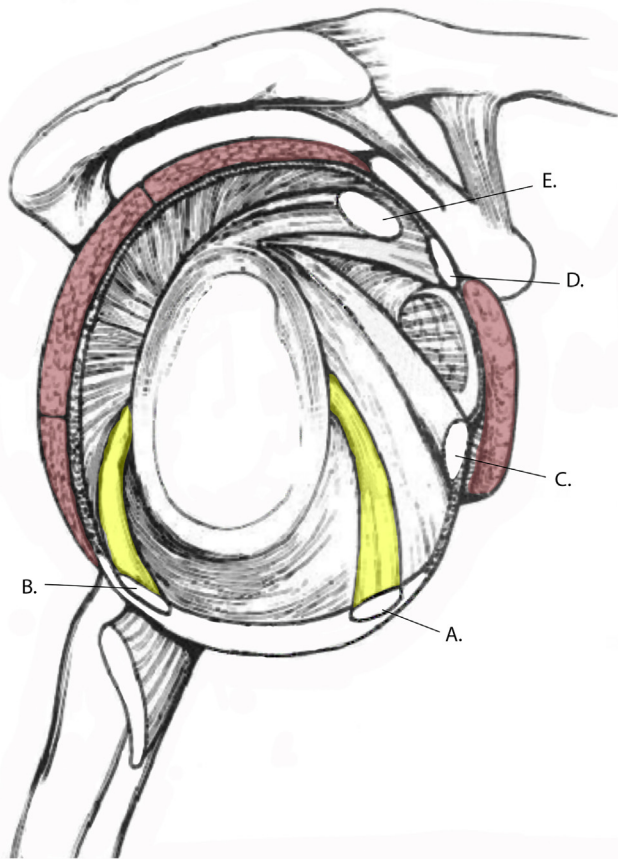


Fig 1. Anatomic diagram of the glenohumeral joint capsular structures. Anterior (A) and posterior (B) inferior glenohumeral ligament, middle glenohumeral ligament (C), superior glenohumeral ligament (D), and long head of biceps tendon (E). The structures in red are the muscles of the rotator cuff.

extremely difficult when the humeral detachment involves the entire inferior glenohumeral ligament, as access to this area on the humerus for reattachment is difficult, and visualization is poor. Moreover, anchor placement along the inferior neck and proximity of the axillary nerve limit exposure along the anterior-inferior pouch and the humeral neck region. In this setting, an open approach is used. Here we describe the technique by Arciero, which is a mini-open technique that spares the superior 50% of the subscapularis tendon (Video 1).

Surgical Technique

Preoperative Planning

Imaging assessment of the injured shoulder should begin with a standard radiographic assessment of the shoulder with anterior-posterior (AP), Grashey (true AP), scapular Y, and axillary views. The authors' preferred special views for all shoulder dislocations include the Stryker Notch view to assess for the Hill-Sachs lesion and the West Point view to assess for anterior glenoid fracture.¹³ In some instances of HAGL lesions, a bony avulsion off of the humerus may be seen radiographically.¹⁴

The authors' preferred modality for all shoulder dislocations is magnetic resonance imaging (MRI).¹⁵ The value of obtaining an MR arthrogram of the shoulder is debatable, as these patients typically already have a large joint effusion that causes distension and proves helpful in visualization of the defect.¹⁶ Furthermore, the utility of the MRI is a complete evaluation of the glenohumeral joint soft tissue structures in detail. HAGL lesions may also be associated with subscapularis tears, injury to the anterior labrum, and Hill-Sachs lesions.¹⁷ The injury at the humeral neck, where the aIGHL tears, is best seen on a T2-weighted oblique coronal image¹⁷ (Fig 2). The extent of the HAGL anterior to posterior and the proximity of the axillary nerve can be visualized on the sagittal image (Fig 3). In contrast, the Bankart lesion, which may occur in association with a HAGL, is best seen on axial images at the level of the mid to inferior glenoid.¹⁷ Although not typically ordered by the senior author, arthrogram images demonstrating contrast extravasation have been shown to be a positive predictor of HAGL in $\leq 83\%$ of cases as a means of diagnosis.¹⁸ A nonspecific sign that may be found in both noncontrast MRI with an effusion and contrast MRI is a "J sign."¹⁸ This is caused by an attenuated inferior capsular pouch that forms a J shape rather than its normal U shape¹⁴ (Fig 4).

Positioning

The patient is positioned in the supine position with the surgical extremity draped free and supported by a

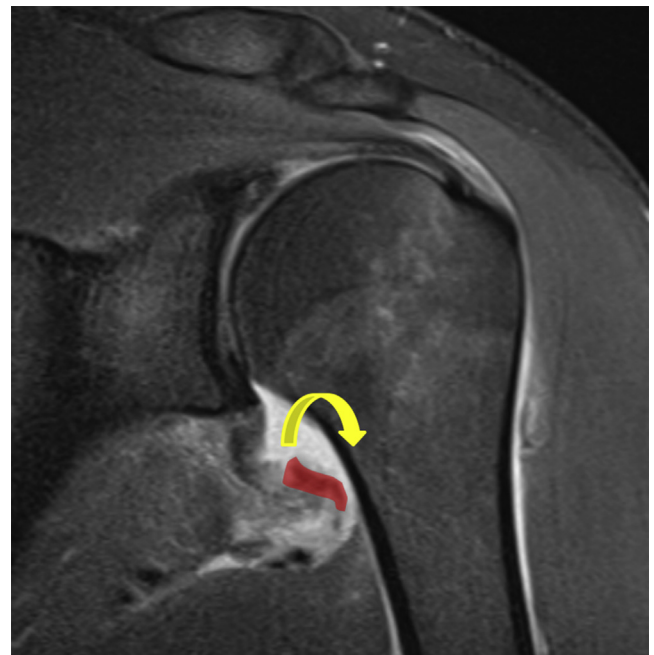


Fig 2. Coronal T2-weighted magnetic resonance imaging sequence of left shoulder showing avulsion of the inferior glenohumeral ligament (red outline) from its native attachment site on the medial humeral neck (yellow arrow).

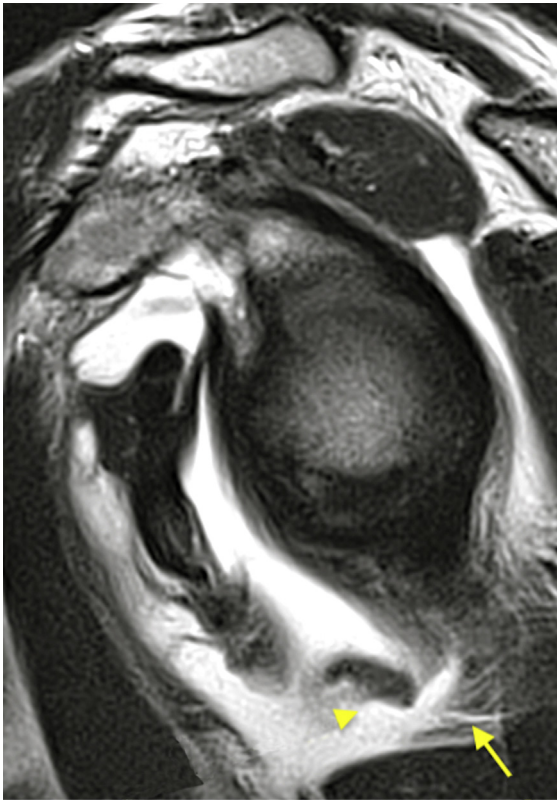


Fig 3. Sagittal magnetic resonance imaging demonstrating proximity of humeral avulsion of the glenohumeral ligament lesion (yellow arrowhead) to the neurovascular bundle (yellow arrow).

padding, sterile Mayo stand. The back of the operative table is flexed slightly (20° to 30°) in elevation, which



Fig 4. Illustrating J sign of the torn anterior inferior glenohumeral ligament from its humeral attachment (red outline).



Fig 5. The skin incision is made in line with the axillary fold and extends 3 to 4 cm toward the coracoid process.

results in a more reclined position than the classic beach-chair. A padded Mayo stand is used to support the arm. The anterior skin incision of 3 to 4 cm is made extending from the axillary fold toward the coracoid process (Fig 5).

Surgical Approach

Before creating the mini-open incision, the authors like to perform a diagnostic arthroscopy to evaluate for associated soft tissue injuries. Frequently, the avulsed

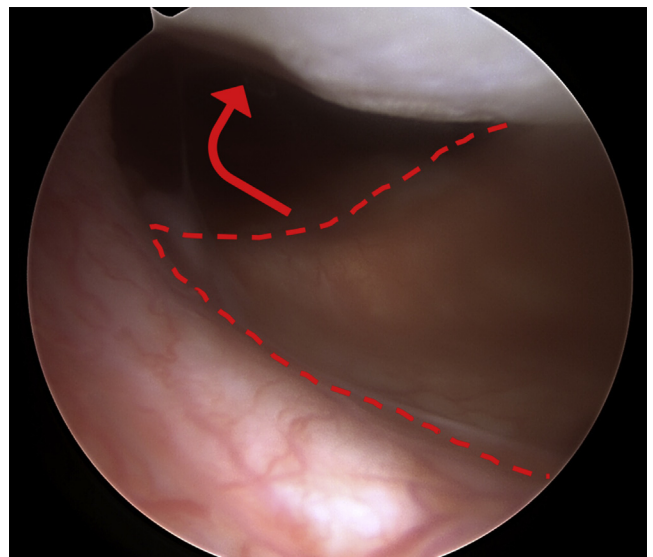


Fig 6. Arthroscopic view from the posterior portal of the left shoulder showing avulsion of the anterior inferior glenohumeral ligament (dashed red line) from the neck of the humerus (red arrow).

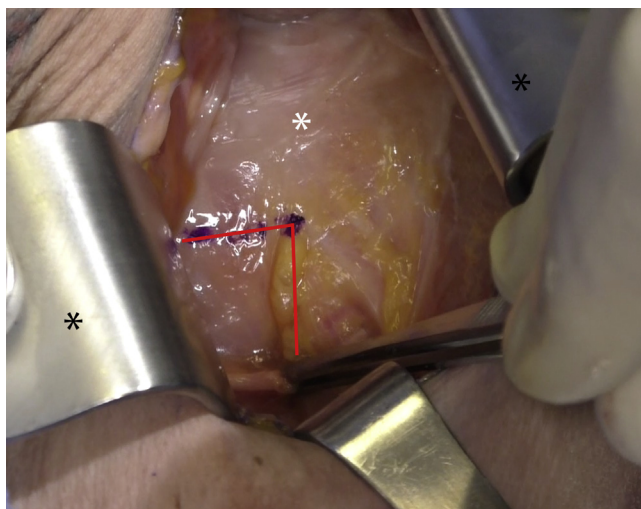


Fig 7. Kolbel retractor in place (black asterisks) with exposed subscapularis tendon and planned L-shaped split (red line). This leaves the remaining subscapularis tendon intact (white asterisk).

aIGHL will be easily apparent when visualizing the inferior pouch (Fig 6). Using the small, 3- to 4-cm incision, a standard deltopectoral interval is opened with lateral retraction of the cephalic vein. The clavipectoral fascia is incised and extended to the tip of the coracoid, with care taken to avoid an anatomically aberrant musculocutaneous nerve. The conjoined tendon is then retracted medially, and the deltoid musculature is retracted laterally with a Kolbel retractor. This provides exposure of the subscapularis tendon (Fig 7).

A key portion of the procedure is the creation of an L-shaped incision made in the lower half of the subscapularis tendon. The vertical limb starts at the inferior half of the subscapularis insertion 1.5 cm medial to the lesser tuberosity. It can then be extended distally and stopped just proximal to the circumflex vasculature. The subscapularis, which is mostly muscle at this

inferior level, is then incised medially 1.5 to 2 cm, which creates the horizontal portion of the L (Fig 7). Before making this horizontal limb, a finger should be placed to palpate for the axillary nerve and ensure that it is medial and inferior.

A blunt Cobb or Metzenbaum scissors can be used to spread the fibers of the subscapularis just proximal to the circumflex vessels. By gently spreading medially through the fibers and retracting on the inferior corner of the subscapularis tendon superiorly, the HAGL lesion can be identified (Fig 8). A tagging suture using a 2-0 braided, nonabsorbable, Ethibond suture (Ethicon, Somerville, NJ) is placed in the leading edge of the avulsed inferior glenohumeral ligament (Fig 8). Traction is placed on the tag suture to allow for inspection of the joint by using a humeral head retractor.

Depending on the timing of the surgery since the initial injury, it is not uncommon to see scarring of the inferior muscular portion of the subscapularis and capsule near the insertion of the HAGL lesion on the humerus. It is therefore important to remove this tissue to expose the footprint of the avulsed capsuloligamentous complex to support a healthy surface for healing. The medial humeral neck is roughened to create a bleeding bony surface. This can be done using a rongeur to remove soft tissue and then a rasp to roughen the cortical bone. Alternatively, a 3-mm high-speed bur (Stryker, Kalamazoo, MI) can be used to gently decorticate the cortical bone to a healthy bleeding bone bed.

After this, the senior author, on average, uses two 4.5-mm biocomposite, double-loaded suture anchors (Arthrex, Naples, FL) placed on the neck of the humerus, and the avulsed inferior glenohumeral ligament is repaired in a horizontal mattress fashion (Fig 9). The inferior half of the subscapularis tendon insertion is repaired anatomically with side-to-side sutures.¹⁰ The open wound is irrigated with copious amounts of sterile fluid, and closure is performed sequentially in layers.



Fig 8. (A) Tag sutures placed in the inferior aspect of the subscapularis tendon for retraction. (B) Humeral avulsion of the glenohumeral ligament (HAGL) lesion exposed (black asterisk). (C) HAGL reduced to its footprint on the humeral neck (black arrow). Note: The upper two thirds of the subscapularis is left intact (white asterisk).

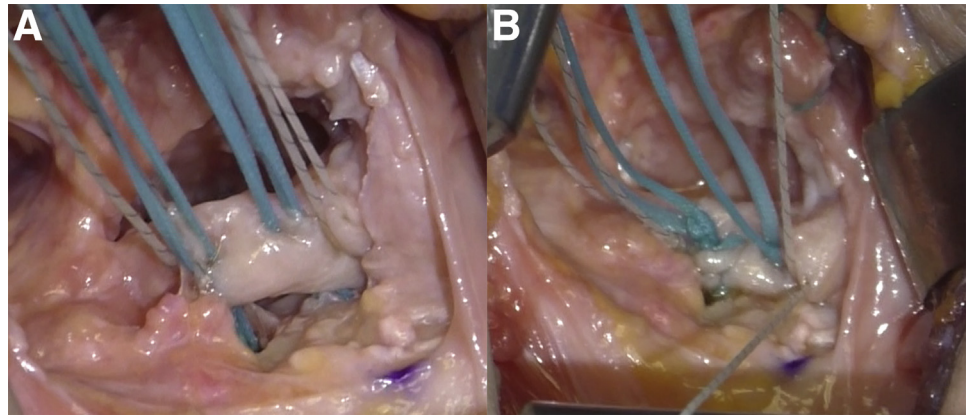


Fig 9. (A) Two double-loaded suture anchors placed in the humerus with sutures passed in horizontal mattress fashion. (B) Sutures tied sequentially from distal to proximal completing the humeral avulsion of the glenohumeral ligament repair.

The deltopectoral interval is reapproximated with 0 Vicryl suture in a simple running fashion. The subcutaneous tissue closed with a 2-0 Vicryl suture in a simple interrupted fashion, and the skin is closed with a nonabsorbable monofilament suture in a running subcuticular fashion, which is to be removed 2 weeks postoperatively. Steri strips are placed over the incision and remain in place until they fall off (typically 10 to 14 days). Sterile dressings are applied with a clear adherent dressing that should remain in place until the 1-week follow-up visit.

Postoperative Rehabilitation

Postoperatively, the shoulder is placed into an immobilizer with the arm in neutral or slight internal rotation for ~4 weeks.¹⁰ Codman exercises and supine well-arm–assisted forward elevation are allowed for the first 4 weeks. Starting at 4 weeks postoperatively and up to 6 weeks, range of motion exercises are aimed at increasing external rotation. Isometric exercises involving all components of the rotator cuff can initiate within 2 to 3 weeks after surgery. Progressive resistance training using bands, cords, or weights is allowed starting 6 weeks after surgery. Typically at 4 months, the patient is allowed to return to all activities including contact sports.¹⁰

Table 1. Advantages and Disadvantages

Advantages
Allows good visualization of the humeral avulsion of the glenohumeral ligament lesion
Allows for preservation of a majority of the subscapularis insertion
Allows for visualization and protection of neurovascular structures
Disadvantages
Risk of increased stiffness after an open procedure
The inferior one third of the subscapularis must be taken down for visualization

Discussion

Anterior shoulder instability as the result of an acute or recurrent shoulder dislocation is an extremely debilitating injury, especially to the young, overhead athlete. Several associated injuries can occur with an anterior shoulder dislocation. Of these associated injuries, the HAGL lesion can represent a challenge to the surgeon, in both diagnosis and management. The importance of accurately diagnosing these injuries cannot be overstressed. Failure to recognize and adequately treat HAGL lesions can result in continued pain, instability, and loss of sport-related skill.

Several techniques have been described to surgically address HAGL lesions. These include open, mini-open, and arthroscopic techniques.^{11,12,19} It is important to recognize that not all HAGL lesions can be addressed with a single surgical technique, and it is therefore important for the treating surgeon to be familiar with each technique. Our mini-open technique has several advantages and disadvantages (Table 1) and it is important to understand these, as well as pearls and pitfalls of the procedure (Table 2), when choosing the most appropriate surgical technique for the patient. Anatomic repair of the HAGL lesion and appropriate postoperative rehabilitation will give the patient the highest probability of resuming normal activities.

Table 2. Pearls and Pitfalls

Pearls
The cephalic vein should be mobilized laterally to preserve its branches to the deltoid
Initial diagnostic arthroscopy allows for visualization of associated injury
Care should be taken to avoid injury to the anterior circumflex vessels while releasing the inferior one third of the subscapularis
Pitfalls
Increases the risk of arthrofibrosis
Meticulous closure should be done given the proximity of the incision to the axilla

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