



# Treatment of the ‘The Naked Humeral Head’: Repair of Supraspinatus Avulsion, Subscapularis Tear, and Humeral Avulsion of the Glenohumeral Ligament

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**Abstract:** A humeral avulsion of the glenohumeral ligament, or HAGL, lesion is a rare yet debilitating shoulder injury, which can lead to recurrent instability, pain, and overall shoulder dysfunction. The diagnosis is often difficult, requiring both high clinical suspicion, as well as identification on magnetic resonance imaging. In patients with an anterior HAGL, repair often requires an open approach. In extremely rare circumstances, the initial traumatic event that causes a HAGL can also cause disruption of the supraspinatus and subscapularis insertions on the humeral head. We have termed this the “naked humeral head”. The purpose of this technical note is to describe our preferred technique to surgically treat the naked humeral head by repairing a supraspinatus avulsion fracture, HAGL lesion, and complete subscapularis tear.

## Introduction

**H**umeral avulsion of the glenohumeral ligament (HAGL) lesions are traumatic injuries almost always associated with anterior shoulder dislocations, causing the anterior inferior glenohumeral ligament (IGHL) to avulse from its humeral attachment site.<sup>1-3</sup> These lesions are likely to occur with external rotation and abduction.<sup>1,4</sup> Some of the common presenting symptoms include glenohumeral joint instability, pain, and functional loss.<sup>5</sup> HAGL lesions account for

anywhere from 2.8 to 9.3%<sup>6-8</sup> of patients presenting with shoulder instability and pain, and frequently present with associated rotator cuff pathologies and/or various avulsion fractures.<sup>9-10</sup> The clinical diagnosis of these injuries is very difficult, as patients often have more obvious other injuries related to the traumatic event.

A multitude of imaging modalities may be used to aid in diagnosis of HAGL lesions and concurrent pathology. Preoperative ultrasonography (US) and magnetic resonance imaging (MRI) for partial articular supraspinatus tendon avulsion (PASTA) have been used in the current literature.<sup>11-13</sup> Radiographs can be used to evaluate a bony avulsion of the ligaments on the humeral neck.<sup>14</sup> MRI, MR arthrography (MRA), and arthroscopic evaluation are all tools that are often used for diagnosing HAGL lesions. The coronal oblique or sagittal oblique T2-weighted, fat-suppressed view on MRI best demonstrates disruption of the IGHL at the humeral attachment site.<sup>9</sup> MRA is most sensitive for detecting the labral detachment and degeneration.<sup>5</sup> Using arthroscopy to visualize HAGL lesions is accomplished by carefully examining the entire humeral attachment of the capsule.<sup>14</sup>

HAGL lesions with associated pathologies can be treated either conservatively or with surgical repair. Tennant and Green found that current literature suggests decreased pain and improved functional outcomes was seen with all techniques used in PASTA lesion repairs.<sup>11</sup> Longo et al. found reduced recurrence of

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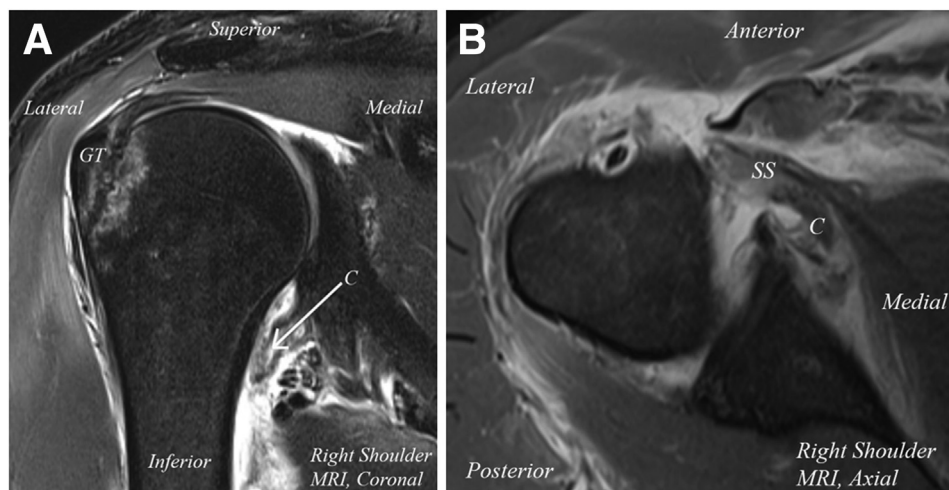
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**Fig 1.** (A) Preoperative magnetic resonance imaging (MRI) of the patient's right shoulder demonstrate an avulsion fracture of the greater tuberosity (GT), as well as capsular separation of the anterior capsular complex (C) from the inferior humeral head, otherwise known as a humeral avulsion of the glenohumeral ligament (HAGL). (B) Axial views of the right shoulder demonstrate medial retraction of a complete tear of the subscapularis tendon from its insertion on the lesser tuberosity (SS), as well as evidence of anterior-inferior capsular injury (C).

luxation or subluxation in shoulders with HAGL lesions treated surgically compared to conservatively.<sup>15</sup> In extremely rare circumstances, the initial traumatic event that causes a HAGL can also cause disruption of the supraspinatus and subscapularis insertions on the humeral head. We have termed this the "naked humeral head". The purpose of this technical note is to describe our preferred technique to surgically treat the naked humeral head by repairing a supraspinatus avulsion fracture, HAGL lesion, and complete subscapularis tear (Fig 1), being outlined in Video 1.

## Surgical Technique

### Arthroscopy and Approach

The patient is positioned in a standard beach chair position with the body at approximately 45-60°. The case is started by performing a standard diagnostic arthroscopy to evaluate for coexisting intra-articular pathology. Arthroscopy time should be kept to a minimum to prevent fluid infiltration into soft tissue (Table 1). The anterior portal should be made in line with the anticipated deltopectoral incision. Following this, a Bankart incision and standard delto-pectoral approach are used to gain access to the shoulder joint (Fig 2).

### Humeral Head Preparation

Once the humeral head is exposed, tagging sutures are placed through the supraspinatus, as well as the subscapularis. Excursion should be assessed and, if necessary, medial adhesions released. Tendinous insertion sites are then prepped by removing any early callus at the greater tuberosity avulsion and lightly decorticating the lesser tuberosity.

### Repair of Supraspinatus

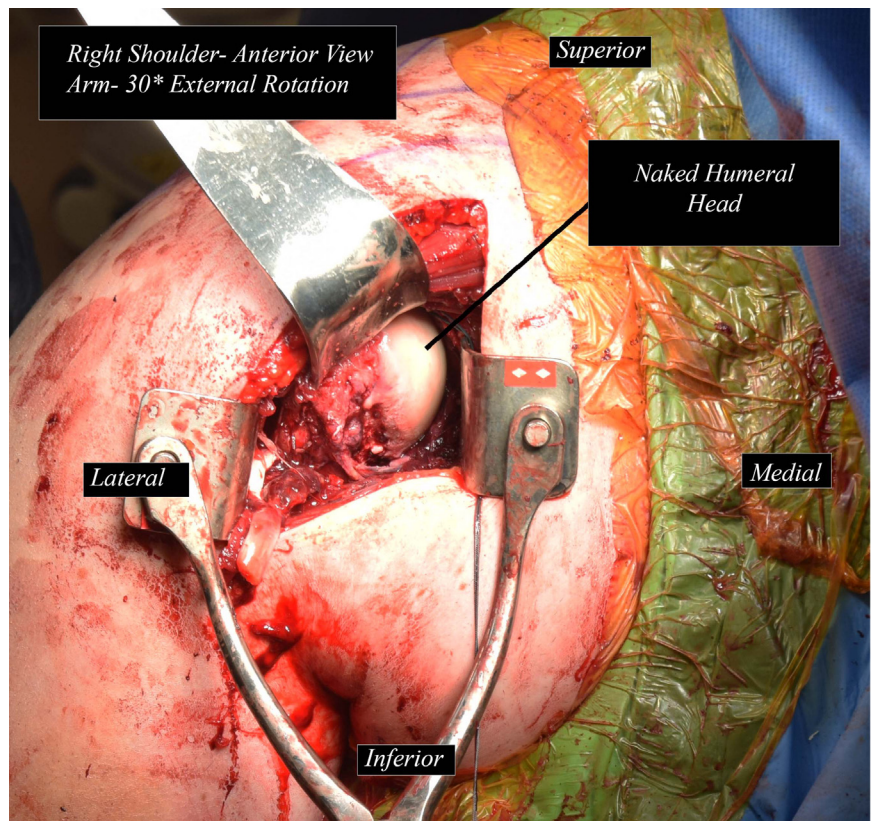
The arm is positioned in 30° of abduction and 30° of internal rotation. Two swivel lock suture anchors (Arthrex, Inc., Naples, FL) loaded with a FiberTape and FiberWire are inserted at the articular margin in standard fashion. The sutures are passed through the supraspinatus approximately 1 cm medial to the tendon margin and loaded into the lateral row of anchors in a standard transosseous equivalent double-row technique, with the reasoning explained in Table 2. The FiberWire sutures are passed separately, with one suture anterior and one posterior to the FiberTape. The FiberWire sutures are then tied on top of the cuff and function as a spot weld, making sure to avoid overtensioning the repair (Table 3 and Figs 3 and 4).

### Repair of Humeral Avulsion of the Glenohumeral Ligament

The arm is positioned in 40-50° of external rotation. The HAGL lesion is identified, and the capsule of the inferior humeral head is identified, tagged, and released from surrounding tissue using Metzenbaum scissors and blunt dissection. The interval between the subscapularis and capsule is also released, and the tagging suture is used to reduce the capsule to the inferomedial aspect of the humeral head metaphyseal flare. We then placed two separate 3-mm biocomposite SutureTak suture anchors (Arthrex) loaded with #2 FiberWire into the humeral head. The anchors are positioned ~5 mm off of the articular margin, with the superior anchor at the mid aspect of the humeral head and the inferior anchor at the most inferior aspect of the humeral head

**Table 1.** Pearls and pitfalls for Our Preferred Technique to Surgically Treat the Naked Humeral Head by Repairing a Supraspinatus Avulsion Fracture, HAGL Lesion, and Complete Subscapularis Tear

Surgical Portion	Pearls	Pitfalls
Arthroscopy	Keep arthroscopic portion of case short in order to avoid fluid extravasation Minimize pressure as much as possible Anterior portal should be made in line with the planned anterior open incision.	If the posterior repair is required, perform the open portion first before returning to the posterior structures. Retractor placement during open surgery runs the risk of damaging posterior labral or rotator cuff repair.
Supraspinatus	Circumferential release should be performed prior to repair. Use the free needle to allow for each suture strand to be passed separately through the supraspinatus. Ensure arm position is in 30° of abduction and 30° of internal rotation.	Over-tensioning the supraspinatus risks potential failure of repair. If the tendon excursion is not adequate following complete release, consider medializing articular margin 5 mm and using stay sutures as a rip stop for medial repair sutures.
Humeral avulsion of the glenohumeral ligament	Capsular dissection and identification of the inferior glenohumeral ligament that is often entrapped in adhesions and scar Test arm to ensure position of 90° abduction and external rotation can be achieved following repair. Ensure arm position is in neutral with 40-50° of external rotation.	The loss of external rotation is at significant risk with this repair. Avoid taking too much capsule and testing range of motion following repair to avoid this.
Subscapularis	The best bone for this portion will be the medial aspect of the bicipital groove. Use the coracoid as the superior reference for the tendon placement. Separately passing the sutures through the medial subscapularis similarly to the supraspinatus portion	

**Fig 2.** Immediately after the delto-pectoral interval is opened, the “Naked Humeral Head” is encountered. The humeral head sits superior and is anteriorly subluxated with evidence of detachment of the supraspinatus, subscapularis, and anterior inferior capsular complex.

**Table 2.** Repair of Supraspinatus

Structure	Arm Position	Notes
Supraspinatus	30° Abduction 30° Internal Rotation	Repair order: 1st Repair Construct: Speed bridge Medial anchor placement: At articular margin. Pass sutures individually through tendon. A “spot weld” repair overlying the tissue adjacent to the anchor can take tension off of the bony avulsion. Lateral anchor placement: Place anchors lateral to the greater tuberosity avulsion. This will allow direct compression over the full fractured fragment.
Anterior Capsule	Neutral 40-50° External Rotation	Repair order: 2 <sup>nd</sup> Repair Construct: 2 anchors; 3 mm biocomposite SutureTak suture anchors (Arthrex, Inc., Naples, FL) loaded with #2 FiberWire. Anchor placement: Approximately 5 mm off of the articular margin, with the superior anchor at the mid aspect of the humeral head and the inferior anchor at the most inferior aspect of the humeral head and superior aspect of the calcar. All sutures passed through capsule overlying anchor. Superior anchor repair stitch is then shuttled through inferior anchor looped shuttle suture, and vice versa. The sutures are then tied overtop of the capsule, creating a cross bridge construct
Subscapularis	Neutral Neutral to slight external rotation	Repair order: 3rd Repair construct: speed bridge Medial anchor placement: Superior/inferior position is in line with anatomic subscapularis footprint. Medial/lateral position is at medial aspect of lesser tuberosity, just lateral to capsular repair. Lateral anchor placement: Superior/inferior position is in line with anatomic subscapularis footprint. Medial/lateral position is at bicipital groove or just medial. This bone is very strong and should be tapped.
Long head biceps tendon	Neutral	Repair Order: 4th Repair Construct: FiberLoop suture (Arthrex, Inc., Naples, FL) Anchor Placement: Incorporate FiberLoop suture into inferior lateral row anchor from subscapularis repair. May back-up repair with incorporation into bicipital sheath or pectoralis major tendon, if necessary.

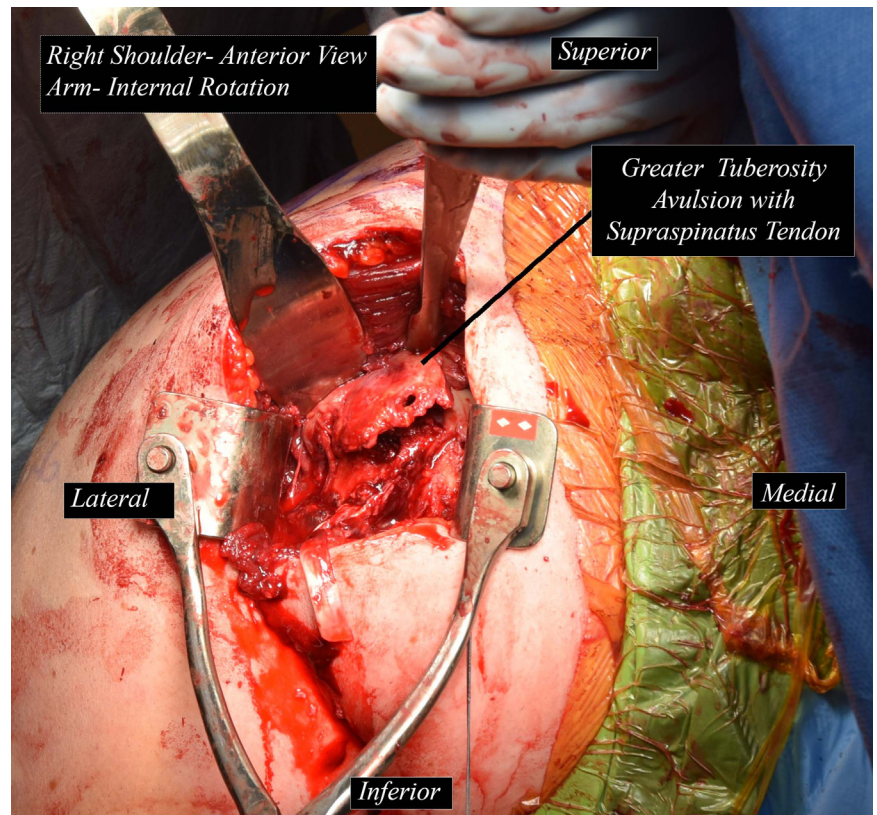
Order of operations and position of the arm during open repair of the supraspinatus, humeral avulsion of the glenohumeral ligament (HAGL), and subscapularis can be challenging. We recommend the following positions and recommendations to improve operative success.

and superior aspect of the calcar (Table 2 and Fig 5). Each anchor is triple loaded with a repair suture, a passing suture, and a suture loop. Once the anchors are inserted, a free needle is used to pass all 3 sutures through the lateral margin of the inferior capsule (Fig 6). The repair suture from the superior anchor is passed through the inferior anchor using the suture loop. This is repeated in similar fashion for the inferior anchor repair suture, so that a cross-bridge construct was created. The passed repair suture ends were then tied to one another on top of the capsule using a knot pusher.

### Repair of Subscapularis

Once tagged, the subscapularis is reduced to the lesser and adhesions are released to aid in reduction. Two swivel lock anchors are then placed into the lesser tuberosity, just lateral to the capsular repair and at the height of the anatomic subscapularis. The anchors are loaded with FiberTape and #2 FiberWire suture. The sutures are passed through the subscapularis using a Scorpion device, and the suture tapes are loaded into the lateral row anchors. The lateral anchors are then placed just medial to or within the bicipital groove, with each anchor containing 1 limb of FiberTape from each medial





**Fig 3.** With the arm in approximately 30° of internal rotation, the greater tuberosity avulsion can be visualized. The tendinous insertion remains intact at its bony insertion without evidence of concurrent tear of the supraspinatus tendon.

anchor (Table 2). The FiberWire sutures are then tied over top of the subscapularis in a spot weld configuration. Figs 7-9 show the completed repair construct.

### Biceps Tenodesis

The long head of the biceps tendon (LHBT) is released at the start of the case to aid in reduction of the supraspinatus and subscapularis. During repair of the subscapularis, a tenodesis of the LHBT is performed. A FiberLoop (Arthrex) is passed through the tendon in a looped locking whipstitch configuration. The free end of the suture is then loaded into the proximal lateral anchor of the subscapularis repair and reduces the LHBT when the anchor is inserted. The

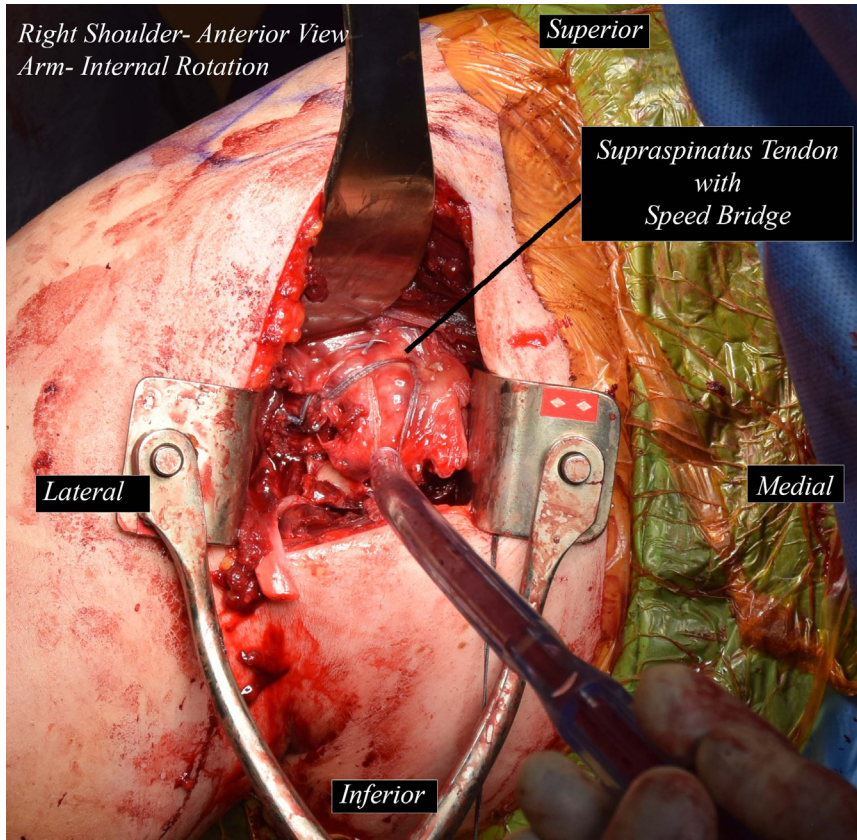
repair is then backed up by suturing the tendon directly to the bicipital sheath using a #2 FiberWire suture (Table 2).

### Discussion

HAGL lesions result from, and contribute to, anterior shoulder instability. Their incidence is thought to be underreported due to the difficulty of diagnosis both in the clinical setting and with imaging. The optimal method for diagnosis is a thorough history, physical exam, and advanced imaging, and suspicion should be increased in patients presenting following an instability event.<sup>15</sup> Concurrent rotator cuff pathology incidence following an anterior shoulder instability event varies

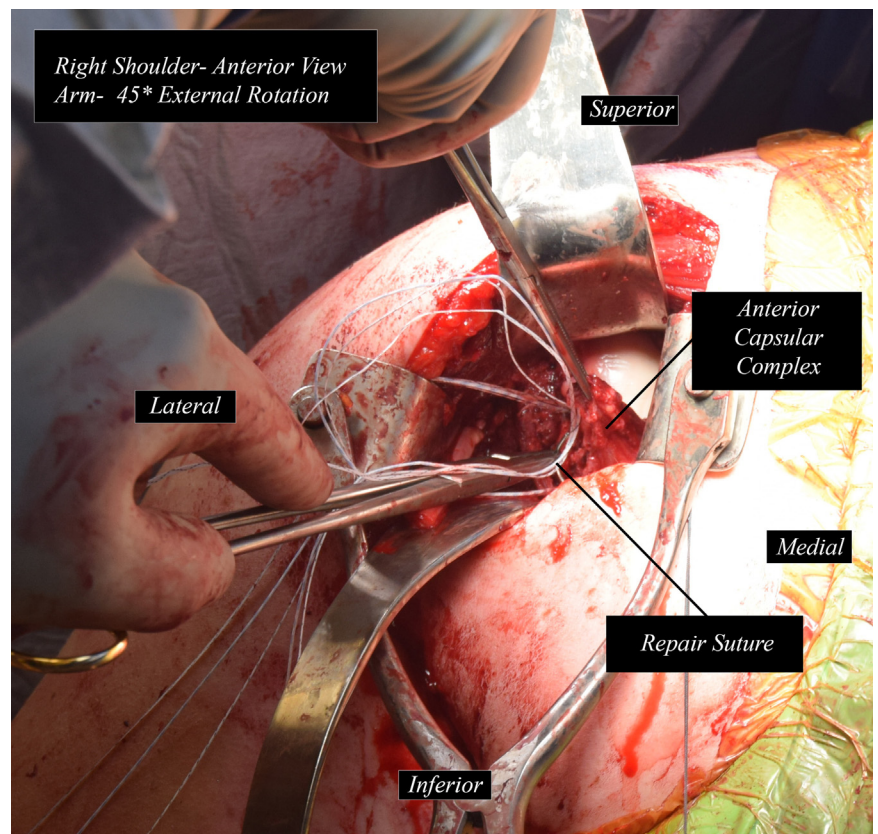
**Table 3.** Advantages and Disadvantages for Our Preferred Technique to Surgically Treat the Naked Humeral Head by Repairing a Supraspinatus Avulsion Fracture, HAGL Lesion, and Complete Subscapularis Tear

Advantages	Disadvantages
Arthroscopy prior to the open portion of the procedure allows all potential injuries to be identified and evaluated.	Arthroscopy prior to the open portion of the procedure can distort tissue planes.
Arthroscopic debridement of the callus and hematoma can be easier for certain medial structures.	Open surgery can increase the risk of postoperative adhesions and can potentially increase pain.
Complete and direct visualization gives the best opportunity to avoid repair failure.	Overtightening the repair is theoretically easier to do with open surgery when compared to arthroscopy.



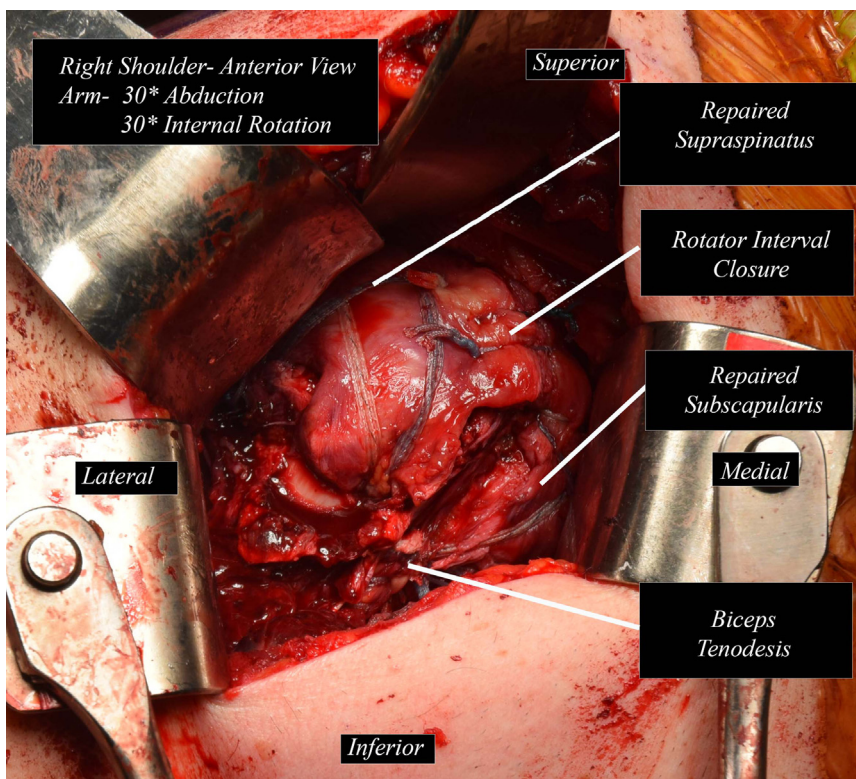
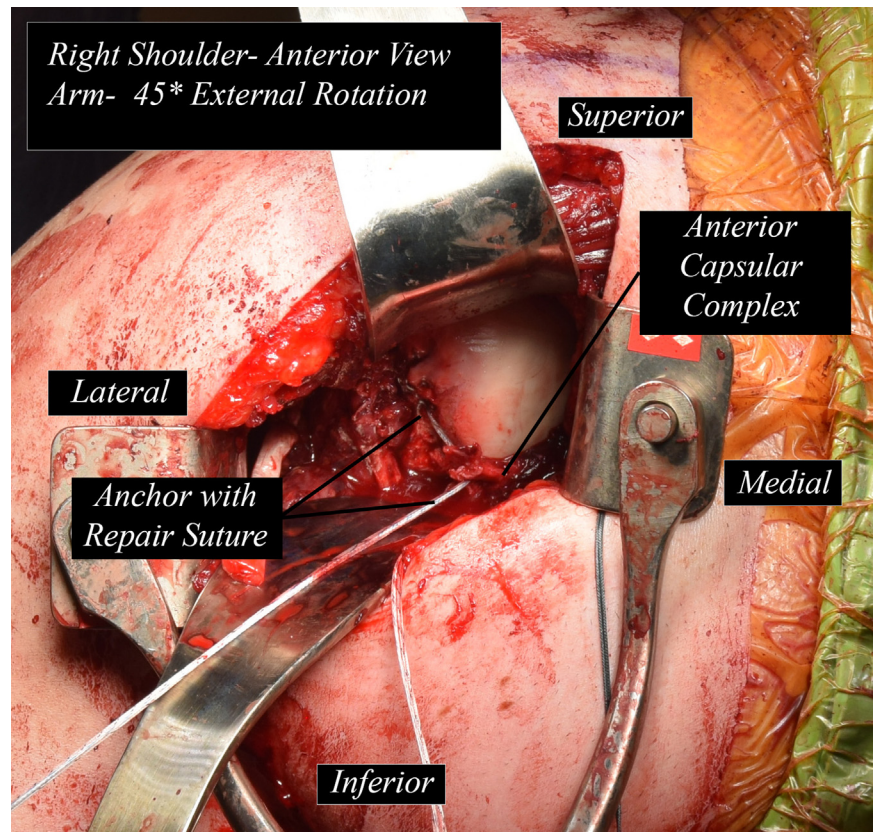
**Fig 4.** Following repair of the greater tuberosity avulsion fracture using a speed bridge construct, the greater tuberosity can be seen in an anatomically reduced back to its footprint. The medial anchors are placed at the articular margin, and the lateral row anchors are placed just lateral to the avulsed fragment to provide uniform compression over the avulsion fragment.

**Fig 5.** With the arm in  $\sim 45^\circ$  of external rotation, the capsular complex avulsion, otherwise known as a humeral avulsion of the glenohumeral ligament, is mobilized and reduced to the capsular insertion at the inferior half of the humeral head. Anchors are placed just off the articular margin, at the metaphyseal flair and  $\sim 1$  cm apart.



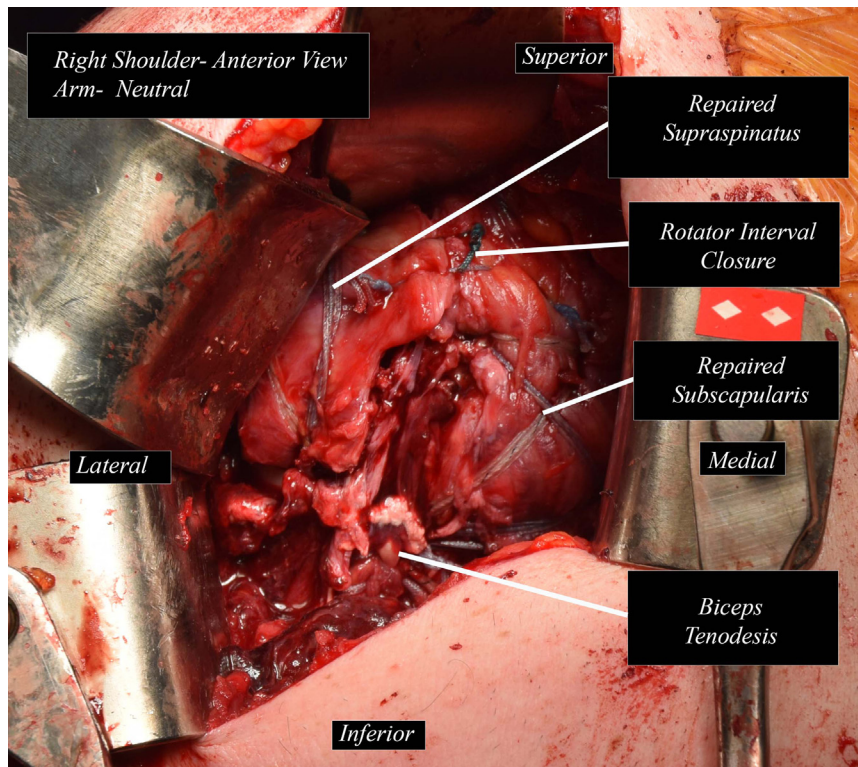


**Fig 6.** With the arm in approximately 45° of external rotation, the capsular complex avulsion, otherwise known as a humeral avulsion of the glenohumeral ligament, is mobilized and reduced to the capsular insertion at the inferior half of the humeral head. The anchors are triple loaded with a repair suture, a shuttle suture, and a suture loop. All three sutures are passed through the capsule at the anatomic position of the capsule overlying the anchor when reduced.



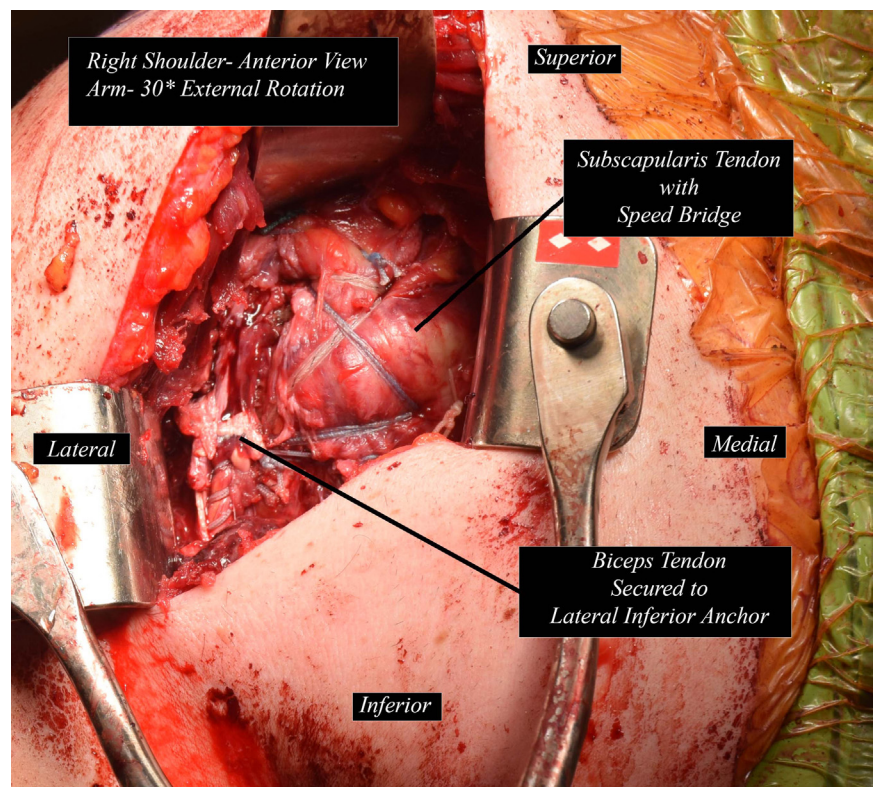
**Fig 7.** The humeral head is now reduced following repair of the greater tuberosity avulsion, Subscapularis tear, and humeral avulsion of the glenohumeral ligament injury. The right shoulder is visualized with the arm in 30° of abduction and 30° of internal rotation.





**Fig 8.** The humeral head is now reduced following repair of the greater tuberosity avulsion, Subscapularis tear, and humeral avulsion of the glenohumeral ligament injury. The right shoulder is visualized with the arm in neutral alignment.

**Fig 9.** The humeral head is now reduced following repair of the greater tuberosity avulsion, Subscapularis tear, and humeral avulsion of the glenohumeral ligament injury. The right shoulder is visualized with the arm in 30° of external rotation.





in frequency from 7 to 32% and increases with increasing age and dislocation events.<sup>16</sup>

Once the diagnosis has been established, conservative or surgical treatment should be considered. Biomechanical studies have found that small HAGL lesions do not drastically alter the biomechanics of the glenohumeral joint and may be considered for conservative management in these smaller lesions.<sup>17</sup> These studies also reported that larger HAGL lesions increase the passive motion of the glenohumeral joint in external rotation and anterior-inferior translation, and surgical repair normalized these abnormalities.<sup>17,18</sup> Additionally, numerous studies have shown that surgical repair is necessary in order to avoid continued instability.<sup>5,7,8,15,19</sup> Surgical repair is recommended for young athletes, manual laborers, and patients with recurrent instability and pain following physical therapy. The main indications for surgical repair in HAGL lesions was instability, followed by pain.<sup>19</sup>

Comparisons of open and arthroscopic repairs in HAGL lesions have shown similar results with successful outcomes.<sup>1,15,19</sup> Saltzman et al. have expressed that the open approach for subscapularis repair is the “gold standard”, while Green and Izzi have found that both open and arthroscopic techniques are safe for greater tuberosity supraspinatus avulsion fractures.<sup>20,21</sup>

In cases of significant concurrent pathology, complete arthroscopic management is extremely difficult, and prolonged pump time can cause fluid infiltration, which will limit the surgeon’s ability to anatomically repair all aspects of the soft tissue. Although our technique can theoretically be limited by the increased risk of post-operative adhesions, increased pain, and overtightening of the repair, it allows all potential injuries to be identified and evaluated, while providing complete and direct visualization to optimize the repair (Table 3). In addition, our technique is reproducible and restores glenohumeral joint stability. Long-term studies using patient-reported outcomes following this open repair are needed to ensure the validation of this described technique.

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