Technical Note

Arthroscopic Humeral Avulsion of the Glenohumeral Ligament (HAGL) Repair Utilized Accessory Posterior Portal in the Beach-Chair Position

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Abstract: Shoulder instability, often associated with both soft tissue and bone lesions, can result in shoulder pain and dysfunction. To address this, the combined procedure of a Bankart repair in conjunction with humeral avulsion of the glenohumeral ligament (HAGL) repair aims to minimize failure rates in a single procedure. While HAGL repair is imperative for preventing recurrent instability, there remains a lack of consensus on the optimal surgical technique. This Technical Note aims to elucidate a surgical approach for addressing and repairing HAGL lesions using arthroscopy, specifically employing a combined posterior viewing portal and posteroinferior working portal in the beach-chair position.

Recurrent shoulder dislocations can result from a variety of underlying pathologies. Numerous studies have emphasized the significance of the glenoid track, which involves a combination of glenoid and humeral bone loss.[1] Addressing these bony defects and performing procedures such as restoration and Remplissage are primary considerations in the management of such conditions.[2-6] However, it is crucial to acknowledge that humeral avulsion of the glenohumeral ligament (HAGL) represents a relatively uncommon condition that can lead to recurrent shoulder instability, demanding equal attention and consideration in the assessment and treatment of these cases.

The prevalence of HAGL ranges from 7.5% to 9.3% in cases of anterior shoulder instability, particularly in instances of recurrent anterior shoulder dislocation observed in young athletes.[7,8] Noteworthy pathologies such as Bankart's lesion and Hill-Sachs lesion require careful attention to mitigate the risk of recurrent anterior shoulder instability. HAGL, although frequently overlooked, emerges as a significant pathology that can be the underlying cause of failed Bankart repair.[9-14] The inferior glenohumeral ligament (IGHL) serves as the primary restraint for the glenohumeral joint in the abduction and external rotation positions, with injury to the anterior band of IGHL identified in 93% of HAGL cases.[13,14] While clinical diagnosis is seldom supported by imaging revealing various soft tissue and bone defects, underdiagnosis prevails due to concomitant injuries.

Longo et al.[15] proposed that operative management of HAGL lesions leads to improved outcomes and decreased rates of recurrent instability. The most prevalent indications for surgical treatment included instability (n = 97, 81.5%), pain (n = 40, 33.6%), and recurrent instability (n = 11, 9.2%). Recurrent instability and failed conservative treatment were also identified as indicators for surgical intervention.

While IGHL avulsion repair stands as the main procedure to reduce the rate of recurrent instability in multiple lesions, there is currently no standard consensus on whether an open or arthroscopic surgical technique is preferable. This Technical Note aims to

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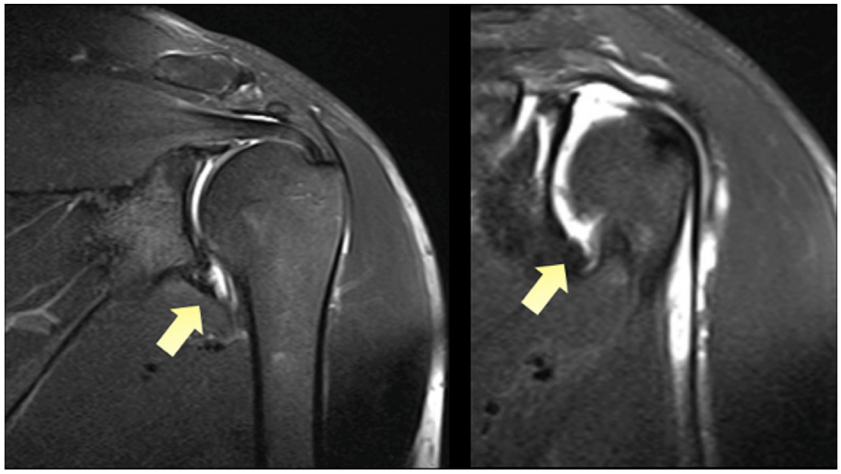

Fig 1. In the T2-weighted coronal view MRI of the left shoulder, the J-sign is observed inferior to the axillary pouch (yellow arrow), illustrating the complete detachment of both the anterior and posterior IGHL from the humeral neck insertion. (IGHL, inferior glenohumeral ligament; MRI, magnetic resonance imaging.)

elucidate the surgical approach for fixing and repairing HAGL lesions, using an arthroscopic combined posterior viewing portal and posteroinferior accessory working portal in the beach-chair position.

Surgical Technique (With Video Illustration)

Preoperative Planning

The history and physical examination for HAGL lesions mirror those conducted for recurrent anterior shoulder instability. However, the duration of symptoms may manifest as either acute or chronic.[16] Essential physical examinations were conducted, encompassing assessments of range of motion and anterior instability. Generalized ligamentous laxity was evaluated with a focus on detecting signs of posteroinferior instability.[17]

Standard plain radiographs were routinely obtained to assess bony Bankart, glenoid fractures, or Hill-Sachs lesions. Magnetic resonance imaging (MRI) with intra-articular contrast was employed to evaluate additional soft tissue pathologies such as SLAP lesions and HAGL lesions, aiding in preoperative planning.[18]

Preoperative MRI of the patient revealed the presence of a J-sign at the inferior axillary pouch and complete detachment of the IGHL from the humeral neck periosteum (Fig 1).

Step 1: Patient Position

After administering general anesthesia, the patient is positioned in the beach-chair sitting orientation at an 80° upright angle. The skin is meticulously prepped and draped using a sterile technique, and the arthroscopic drape is equipped with an antimicrobial incise drape.

Under anesthesia, a thorough shoulder examination is conducted, revealing a positive anterior apprehension test and successful relocation of the humeral head. Examination for inferior laxity identifies positive results in both the hyperabduction test and the inferior sulcus test. Bony landmarks, including the coracoid process and acromioclavicular joint, are palpated and subsequently marked with a sterile marker before the incision is made (Fig 2, Video 1).

Step 2: Arthroscopic Examination

A standard posterior viewing portal is established to assess the posteroinferior corner of the humeral head, where the HAGL lesion is identified (Fig 3). Prior to debriding synovial and fraying soft tissue, a posteroinferior working portal is created 3 cm inferior to the posterior viewing portal using an outside-in technique under arthroscopic visualization. The posterior band of the IGHL is grasped and pulled to evaluate the soft tissue tension. A standard anterior working portal is then created between the rotator interval, and a probe is inserted to assess the rotator cuff, labral pathology, long head of the biceps, and the HAGL lesion.

Step 3: HAGL Repair

After the debridement of fraying tissue, the IGHL is prepared for suture passing. An 8.0-mm portal cannula (Smith & Nephew) is inserted at the posteroinferior portal for working. Using an antegrade suture passer (FIRSTPASS MINI suture passer; Smith & Nephew) with Hi-Fi No.2 (ConMed Linvatec), the suture is passed through the anterior part of the IGHL and then retrieved to the posteroinferior accessory portal (Fig 4).

A curved drill guide is placed at the posterior humeral head-neck junction distal to the articular junction, followed by the insertion of the drill sleeve to avoid iatrogenic injury to the articular surface of the humeral head. A curved twist drill is used to create a pilot hole, and a 1.8-mm soft anchor (1.8-mm double-loaded Y-Knot Flex all-suture anchor; ConMed Linvatec) is positioned inferior to the articular junction of the humeral head from the posteroinferior working portal (Fig 5).

Fig 2. The left side beach-chair sitting position facilitates shoulder manipulation during intraoperative procedures and provides a more familiar anatomic orientation compared with the lateral decubitus position. The sitting inclination angle is set at 70° to 80° upright. To ensure adequate anatomic exposure, the arthroscopic drape is applied medial to the coracoid process.

After verifying anchor stability and rerouting sutures to prevent premature knots, a shuttling relay with sutures from the anchor in each limb is performed. One limb is passed through the most anterior part of the IGHL, while another limb is passed through the middle part of the IGHL. The posterior IGHL is penetrated using a retrograde suture passer (BirdBeak; Arthrex), and another limb is retrieved from the anchor (Fig 6).

The suture pattern is designed for a modified Mason-Allen technique (Fig 7), and knot tying is executed from medial to lateral, followed by anterior to posterior knots. Nonsliding knots are applied, and tightening is assisted by a knot pusher. During knot tightening, forward flexion and internal rotation of the shoulder are performed by an assistant. The anterior and posterior IGHL are then reattached to the humeral neck footprint with viewing from the posterior portal.

After repairing the HAGL from the posteroinferior working portal, an anterior portal is created at the rotator interval superior to the subscapularis, and an anterolateral working portal is established to address concomitant labral lesions and long head of the biceps pathology. Excellent shoulder stability is achieved following the complete repair of labral lesions and humeral avulsion of the glenohumeral ligament. The postoperative rehabilitation protocol includes the use of an arm sling, gentle pendulum exercises, and slightly passive forward flexion exercises.

Discussion

The purpose of this Technical Note is to describe our preferred technique for performing arthroscopic HAGL repair in the beach-chair position. The advantages of the beach-chair position include a familiar anatomic orientation, allowing access to the inferior axillary pouch with a lower risk of damage to the brachial plexus traction injury compared with the lateral decubitus position.[19] The posteroinferior portal enables addressing the posterior to anterior bands of the IGHL with a view from the posterior portal. A 30° arthroscope was used in this surgical technique for enhanced visualization. Our technique is not without limitations (Table 1). Repairing the IGHL in the beach-chair position may pose an increased risk of axillary nerve injury.[19]

There is a lack of guidelines and consensus for repairing HAGL lesions due to their lower incidence and the challenges in diagnosing multiple concomitant labral pathologies. Godin et al.[20] reported that an open surgical technique allows access to inferior pathology with good visualization, facilitating the restoration of native anatomy. The axillary nerve presents a primary

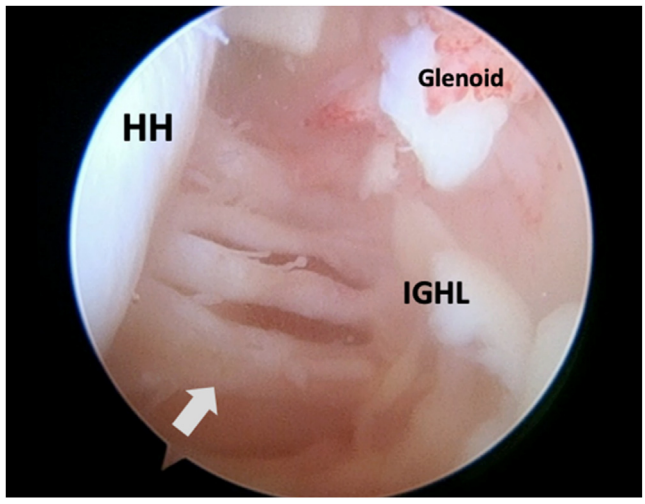

Fig 3. Arthroscopic view of the left shoulder from the posterior viewing portal, illustrating fraying of the capsule and ligament detachment at the inferior axillary pouch. Complete injury to both the anterior and posterior bands of the IGHL is evident (indicated by the white arrow) following arthroscopic examination. (HH, humeral head; IGHL, inferior glenohumeral ligament.)

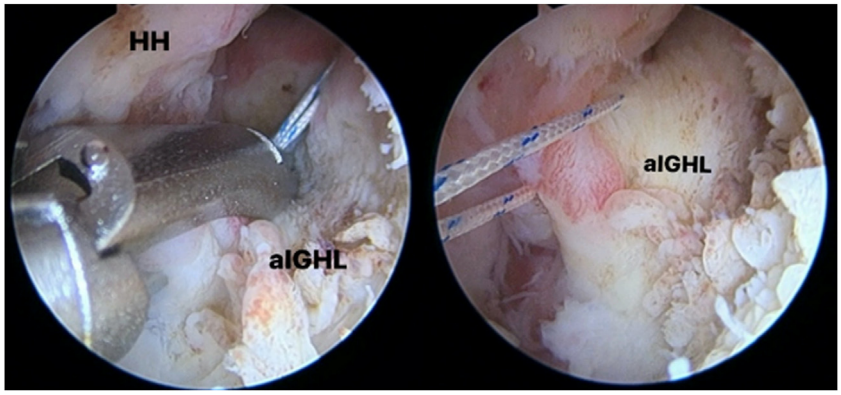

Fig 4. Arthroscopic view of the left shoulder from the posterior viewing portal at the 6-o'clock position: pass the initial suture (Hi-Fi; ConMed Linvatec) using an antegrade suture passer (FIRSTPASS MINI suture passer; Smith & Nephew) through the aIGHL, and subsequently assess for mobility. (aIGHL, anterior band of the inferior glenohumeral ligament.)

anatomic obstacle in addressing inferior glenohumeral ligament pathology. Aman et al.[21] recommended a mini-open incision for repairing HAGL to restore the anatomic footprint of the ligament. Additionally, Arciero and Mazzocca[22] also preferred a mini-open approach to reduce the risk of axillary nerve injury. In a systematic review, Longo et al.[15] compared operative and nonoperative groups in 42 shoulders with associated HAGL lesions, revealing that surgical treatment exhibited a lower recurrence rate than the nonoperative group (odds ratio, 0.05). Markus et al.[23] reported outcomes of arthroscopic HAGL repair, with a 2% recurrence of dislocation among 49 patients. Postoperatively, 81.2% reported being able to return to sports, and 70.5% were able to play at an equal or higher level. Hamada et al.[24] documented postoperative axillary nerve palsy in 2% of 47 HAGL repairs. The closest distance between the nerve and capsule was 3.4 $\pm$ 3.2 mm in shoulders with HAGL lesions and less than 1 mm in the 3 shoulders with palsy. Cuéllar et al.[19] conducted a cadaveric study comparing the risk of axillary nerve injury between the beach-chair position and lateral decubitus position. No cases of axillary nerve injury or suture-passing devices closer than 10 mm were observed. However, the median distance when inserting a suture-passing device at the posterior band of the IGHL was statistically significantly closer than in the lateral decubitus position (median, 13 vs 22.5 mm; $P < .001$). In contrast, no difference was observed when inserting the device at the anterior band of IGHL (beach-chair position: median, 16 vs 18 mm).

Common symptoms in axillary nerve palsy cases include delayed postoperative rehabilitation, deltoid weakness, and atrophy. A definitive diagnosis was established through electromyography.[24] Bokor et al.[25] also reported the location of HAGL lesions related to the axillary nerve in MRI, with an average distance found to be 5.60 $\pm$ 2.56 mm. The benefits of the beach-chair position for HAGL repair, compared with the lateral decubitus position, include a decreased risk of traction injury and a more familiar anatomic landmark. Anz et al.[26] described arthroscopic HAGL repair in a cadaver study using a knotless suture anchor at anterior 5-o'clock portals within the footprint of the anterior band of the IGHL or at the articular margin. Bhatia et al.[27] outlined a 1-inch incision through the anterior

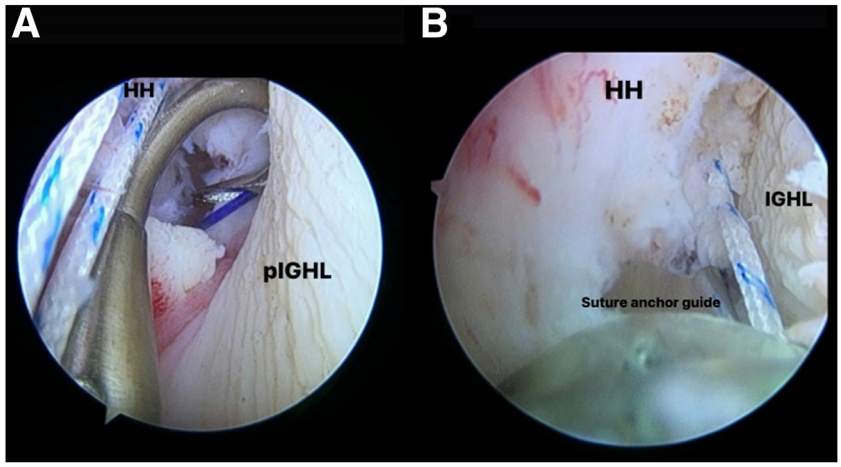

Fig 5. Arthroscopic view of the left shoulder from the posterior viewing portal. (A) A retrograde suture passer (90° curve, left; SutureLasso; Arthrex) penetrates through the IGHL from the glenoid side at the middle part of IGHL and is then retrieved to the posteroinferior portal for a shuttling relay with the anchor limbs. (B) The suture anchor guide sleeve is positioned at the humeral neck inferior to the articular junction. A curved 1.9-mm twist drill creates a pilot hole before placing the double-loaded soft anchor (1.8-mm double-loaded Y-Knot Flex all-suture anchor; ConMed Linvatec). (HH, humeral head; IGHL, inferior glenohumeral ligament.)

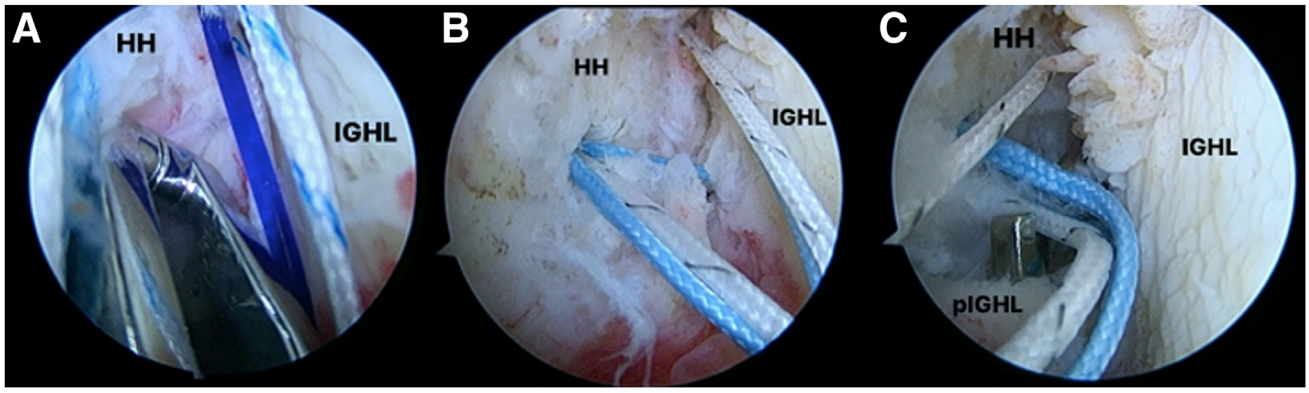

Fig 6. Arthroscopic view of the left shoulder from the posterior viewing portal. (A) Retrieved sutures from the anchor were separated, with stitches in the IGHL directed to the accessory posteroinferior portal. A shuttling relay was planned to replace the previous 2 stitches that had already passed through the IGHL. (B) Following the shuttling relay, sutures were retrieved back to the accessory portal. (C) A retrograde suture passer (BirdBeak; Arthrex) penetrated through the pIGHL and retrieved another limb of the suture, following a planned modified Mason-Allen stitch method. (HH, humeral head; IGHL, inferior glenohumeral ligament; pIGHL, posterior band of inferior glenohumeral ligament.)

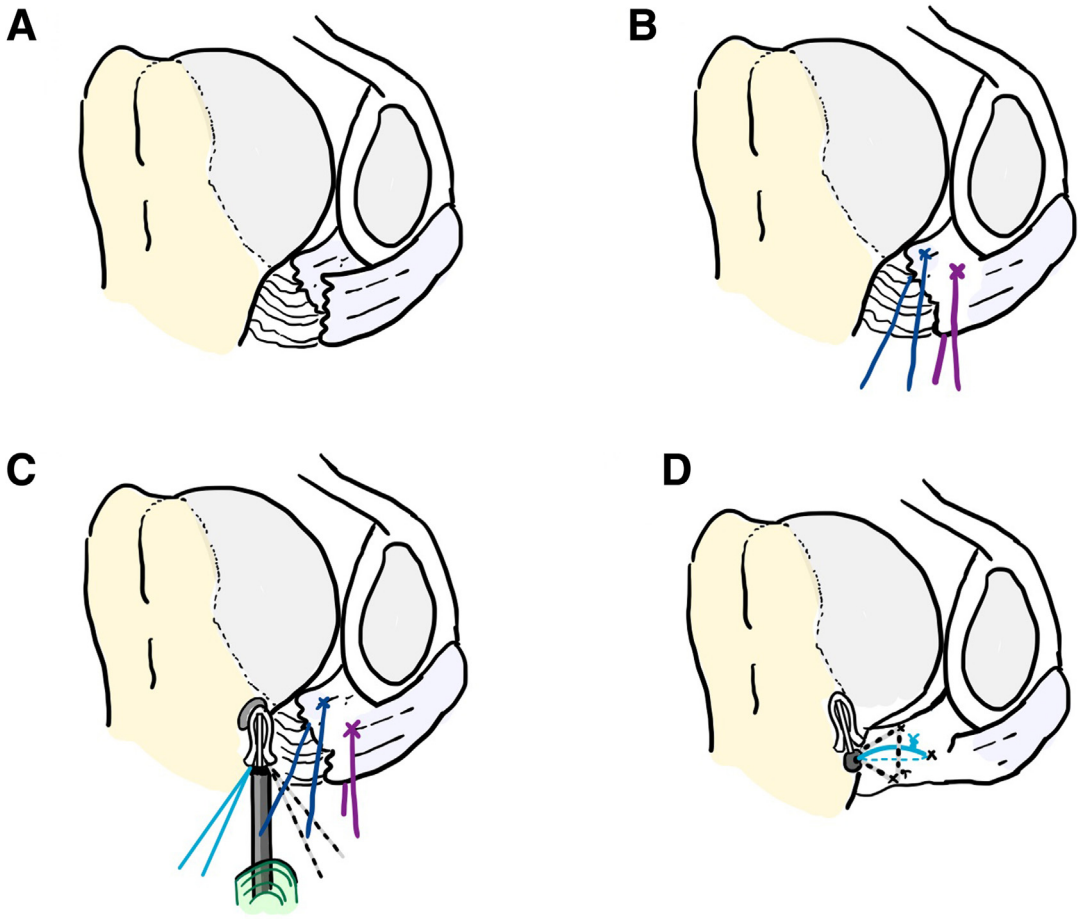

Fig 7. The illustration demonstrates the pathology of IGHL avulsion from the humeral neck footprint, resulting in inferior shoulder instability. (A) Depicts IGHL avulsion from the humeral neck footprint. (B) Involves passing the most anterior stitches and middle part of IGHL stitches for assessing mobility and planning for shuttling relay sutures. (C) The soft anchor suture (Y-knot 1.8 mm; ConMed Linvatec) is placed inferior to the articular junction from posterior to anterior, with a slightly cephalad tilt for perpendicular anchor placement. (D) Uses the modified Mason-Allen stitch to reattach the IGHL to the humeral neck footprint. The advantages of this method include an increased contact area of the footprint and prevention of suture cutting out. (IGHL, inferior glenohumeral ligament.)

Table 1. Advantages/Disadvantages/Pearls

Advantages	- Minimally invasive approaches facilitate postoperative rehabilitation and reduce wound complications. - Enable the assessment of concomitant intra-articular lesions such as Bankart lesions, SLAP lesions, and rotator cuff pathology. - The beach-chair position with a posterior viewing portal provides good visualization and a familiar viewing perspective. - Decrease risk of traction injury compared with lateral decubitus position.
Disadvantages	- Technically demanding. - Possible increased risk of axillary nerve injury.
Pearls	- The posteroinferior working portal is created using an outside-in technique with direct visualization provided by the posterior viewing portal in a 30° arthroscope. - The modified Mason-Allen suture configuration at the inferior glenohumeral ligament allows for compression without suture cutting through enabling reattachment to the humeral head footprint. - Anchor placement is achieved using curved drill guides, coupled with humeral head forward flexion and internal rotation to ensure proper anchor direction to the footprint.

axillary fold for addressing the humeral neck inferior to the subscapularis and superior to the pectoralis major tendon. Consequently, Albers et al.[28] reported an arthroscopic direct transaxillary portal for deploying a perpendicular angle suture anchor to the bone.

Treating HAGL lesions with an open approach requires a double incision, an anterior approach for repairing Bankart lesions, and a posterior approach for addressing HAGL separately. The technical limitation from an inferior location and the associated neurovascular risks stem from the perpendicular placement of the anchor.

Huberty and Burkhart[29] described "the killer angle," highlighting the challenges in anchor placement with compensatory humeral neck rotation and the use of curved drill guides for proper positioning. The open deltopectoral approach for repairing posterior HAGL lesions necessitates the complete detachment of the subscapularis tendon, affecting postoperative outcomes and rehabilitation. Our technique employs a knotted suture anchor and curved drill guides (Y-knot 1.8 mm; ConMed Linvatec) for posterior anchor placement. Additionally, we created a posteroinferior portal using an outside-in technique with direct visualization from a 30° arthroscope, aiming to decrease axillary nerve injury. Nevertheless, arthroscopic repair still poses a higher risk to the neurovascular structures inferior to the axillary pouch compared with an open approach.

In conclusion, this Technical Note outlines a minimally invasive procedure for assessing and repairing HAGL lesions concomitant with other pathologies. The beach-chair positioning allows access to the inferior axillary pouch with a decreased risk of traction injury and provides a more familiar view from the posterior portal.

Disclosures

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

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