



Arthroscopic repair of an anteriorly malunited greater tuberosity after a posterior shoulder fracture-dislocation in a 16-year-old male



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Posterior shoulder dislocation is a rare but potentially devastating injury. The overall prevalence is 1.1 per 100,000 individuals¹⁴ and they make up less than 3% of all shoulder dislocations.¹³ However, the true prevalence is difficult to estimate as posterior shoulder dislocations are often missed and go undiagnosed.¹⁴

Common associated fracture patterns with a posterior shoulder dislocation include a posteroinferior glenoid rim fracture and impaction fracture of the anterolateral humeral head.^{3,5,12} Fractures of the greater tuberosity can occur with alternative mechanisms and sometimes with high-level trauma or with unclear injury mechanisms.² A greater tuberosity fracture typically displaces in a posterosuperior direction due to the pull of the rotator cuff muscles and their relative attachments.¹⁰ Greater tuberosity malunion associated with posterior shoulder fracture dislocation is rare, is associated with chronic, missed dislocation, and results in severe shoulder dysfunction. A previous report detailed an anteriorly incarcerated infraspinatus tendon due to greater tuberosity nonunion in the bicipital groove.¹⁵ However, no study to our knowledge has identified an anteriorly malunited greater tuberosity on the proximal humerus, its effect on shoulder function, or the appropriate management for this injury pattern.

The purpose of this case report was to present an anteriorly malunited greater tuberosity fracture after a posterior shoulder fracture-dislocation in a 16-year-old male, the subsequent management, and the outcome.

No institutional review board approval was needed for this nonexperimental surgical procedure. Informed consent was obtained for creation of this case report. All procedures were performed in compliance with relevant laws and institutional guidelines.

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Case presentation

A 16-year-old male presented for evaluation of left shoulder dysfunction with a loss of active external rotation (ER) and forward elevation. The patient's past medical history was significant for an All-Terrain-Vehicle crash two and a half years prior to presentation during which he sustained an isolated left shoulder fracture dislocation. He was treated nonoperatively after an initial closed reduction. The patient underwent extensive physical therapy and felt he had maximized his shoulder function attainable through nonoperative interventions. He presented to outpatient orthopedic surgery and sports medicine clinic due to ongoing shoulder dysfunction and frustration with his inability to throw a baseball or lift weights to his satisfaction. He did not experience pain at rest or with activity. He did not experience any further episodes of instability.

On general examination, he appeared an overall healthy male of stated age. Focused examination of the left shoulder revealed a stooped posture with mild scapular winging. He exhibited asymmetric decreased active forward elevation, abduction, internal and external rotation compared to the contralateral side. His left shoulder passive ER with the arm adducted was 30° and with the arm abducted to 90°, was 70°. His passive range of motion (ROM) in forward elevation and abduction was otherwise full and symmetric compared to the contralateral side. He had a markedly positive ER lag sign and Hornblower's sign on the left side. He had asymmetric pain and weakness with Jobe's test on the left side compared to the right side. The patient was able to activate his serratus anterior and lower trapezius muscles and had shrugging capability. His distal neurovascular examination was normal.

Plain film radiographs of the left shoulder revealed a 75% posteriorly subluxated humeral head. There was a large, displaced malunion of the entire greater tuberosity (Fig. 1). The greater

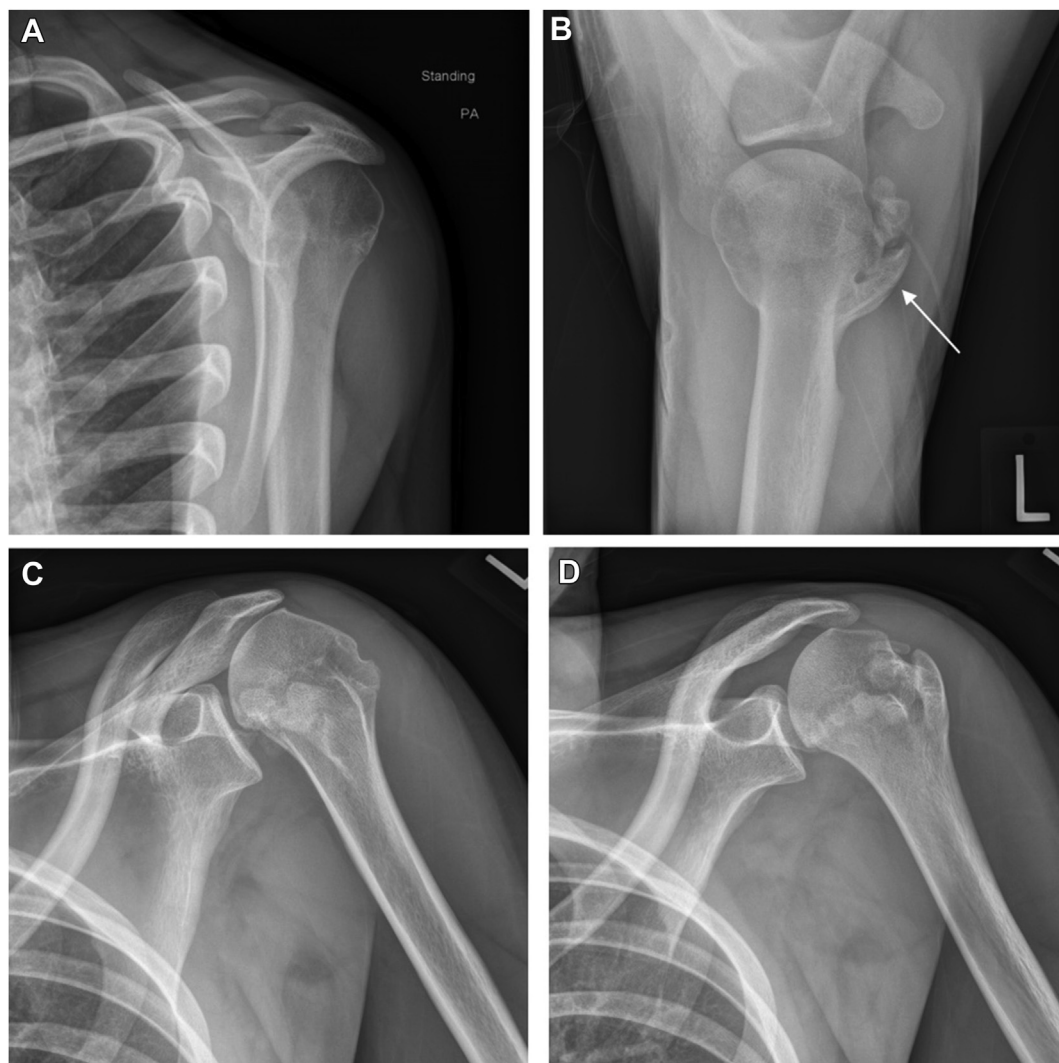


Figure 1 Preoperative plain film radiographs of the left shoulder. (A) Scapular Y view shows a 75% posteriorly subluxated humeral head. (B) Axillary view showing fragmented greater tuberosity malunion healed anterior to the lesser tuberosity (arrow). (C) Anteroposterior view showing significant humeral head superiorization and previous greater tuberosity fracture and malunion. (D) Grashey view redemonstrating humeral head superiorization and greater tuberosity fracture malunion.

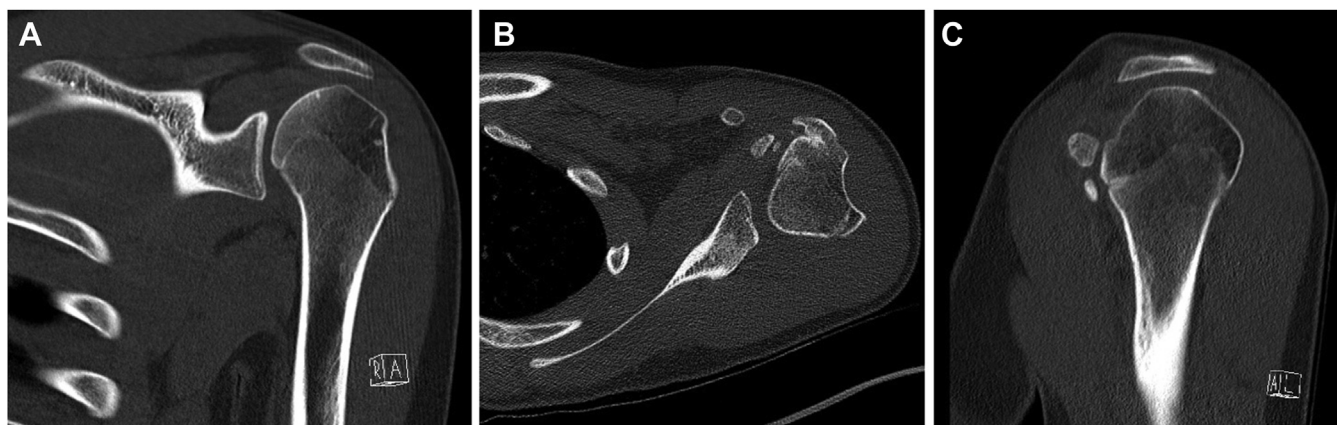


Figure 2 Preoperative computed tomography selected cuts of the left shoulder. (A) Select coronal cut showing significant superiorization of the humeral head and previous greater tuberosity fracture line. (B) Select axial cut showing fragmented malunion of the greater tuberosity anterior to the lesser tuberosity. (C) Select sagittal cut showing fragmented malunion of the greater tuberosity anterior to the lesser tuberosity.

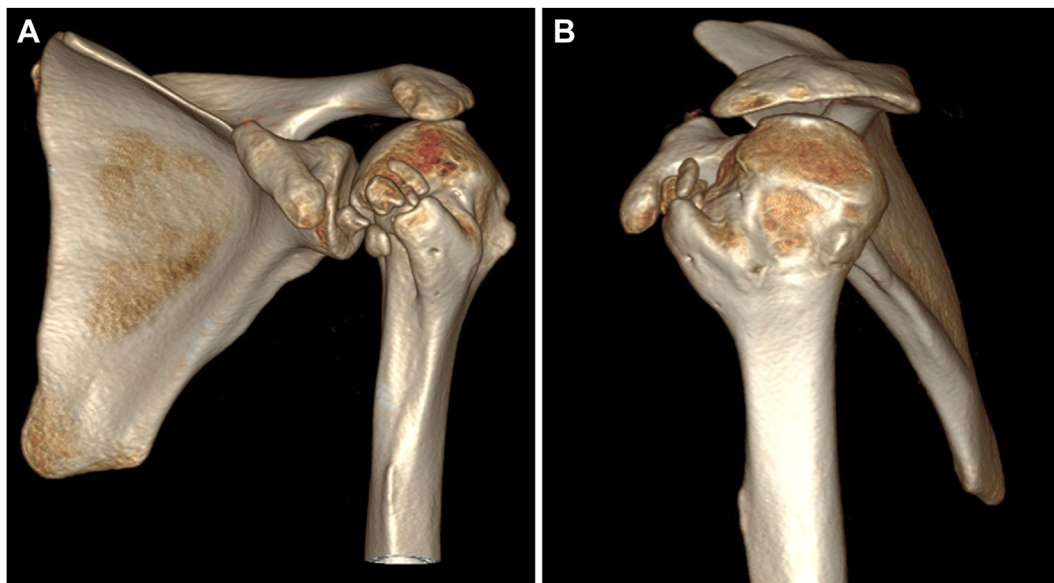


Figure 3 Preoperative computed tomography three-dimensional reformat of the left shoulder. (A) Anterior view showing the fragmented malunion of the greater tuberosity anterior to the lesser tuberosity. (B) Lateral view showing the extent of the greater tuberosity malunion, almost abutting against the coracoid process.

tuberosity fragmented and malunited lateral and superior to the lesser tuberosity. The lesser tuberosity itself appeared to have fractured and healed in a near-anatomic position. The acromio-humeral interval was 5 mm, with superior translation of the humeral head.

A computed tomography (CT) scan was completed that confirmed a fragmented malunion of the greater tuberosity lateral and superior to the lesser tuberosity (Figs. 2 and 3). The CT scan also confirmed a healed lesser tuberosity fracture and middle facet fracture fragment along the anterolateral humeral head-neck junction. Interestingly, the humeral head was well reduced in an anteroposterior direction on CT but was superior compared to the glenoid. A magnetic resonance imaging examination was also completed that showed abnormal, anterior positioning of both the supraspinatus and infraspinatus tendons, still largely attached to the greater tuberosity malunion at the anterior aspect of the proximal humerus (Fig. 4). The long head of the biceps brachii tendon was subluxated medially, displaced by fragments of the greater tuberosity malunion within the bicipital groove (Fig. 5). A complex superior labrum anterior-to-posterior tear with posterior-inferior extension was also present.

Nonsurgical and surgical treatment options were discussed with the patient and his family. The primary surgical plan was an arthroscopic-assisted osteoclasis and refixation of the greater tuberosity with the associated supraspinatus and infraspinatus to the posterolateral proximal humerus. If this was unattainable, a lower-trapezius tendon transfer with Achilles bone-block allograft to restore ER would be completed. The patient and his family chose to proceed with surgical intervention after the risks and alternatives for all treatment options were explored thoroughly.

The patient was initially placed in a beach chair position. An examination under anesthesia revealed gross posterior instability of the humerus, even in abduction, which was significantly different than his findings while awake. While awake, he had no signs or symptoms of instability. This new information was discussed with the patient's parents and through a shared decision-making model the surgical plans were adjusted to proceed with arthroscopic posterior labral repair, with either a remplissage or

take-down and anatomic fixation of the patient's rotator cuff, depending on the results of diagnostic arthroscopy.

The patient position was changed to lateral decubitus on a deflatable beanbag for shoulder arthroscopy. Standard posterior, anterior-superior, and mid-glenoid portals were established, as well as a lateral portal and an accessory anterolateral portal. Diagnostic arthroscopy confirmed a posterior labral tear, articular injury of the anterolateral humeral head, and revealed the infraspinatus in an intra-articular position across the anterior shoulder, with the tendon attached to the fragmented malunited greater tuberosity anteriorly (Fig. 6). A posterior labral repair with concomitant small capsulolabral shift was completed first with three knotless suture anchors placed at the posterior glenoid edge at 7:00, 8:30, and 10:00 positions (Fig. 7).

The rotator interval adhesions were released to address anterior capsular tightness and loss of ER with the arm adducted. A sub-acromial decompression was completed (Fig. 8). The infraspinatus and supraspinatus tendons were abnormally positioned anteriorly within the floor of the subacromial space. The supraspinatus was partially healed to the front of the long head of the biceps brachii tendon, displacing it medially (Fig. 9). The infraspinatus was followed to its intact insertion on the fragmented greater tuberosity and was released subperiosteally from bone using a radiofrequency ablator (Fig. 10). The greater tuberosity fragments that were nonfunctional were removed with a high-speed burr to avoid anterior impingement and improve mechanical function.

The subdeltoid space was cleared of significant adhesions. The supraspinatus and infraspinatus tendons were mobilized completely (Fig. 11). Modified Mason-Allen stitches were placed in the supraspinatus tendon anteriorly and it was moved posteriorly to its native footprint and fixed with a 4.75 mm suture anchor. The infraspinatus tendon reduced with the supraspinatus tendon and was fixed posteriorly with Mason-Allen sutures through four 4.75 mm suture anchors (Fig. 12). The final fixation was satisfactory and done without undue tension to the rotator cuff. The portal sites were closed in standard fashion. The patient was placed in a compressive bandage and abduction sling. There were no immediate postoperative complications.

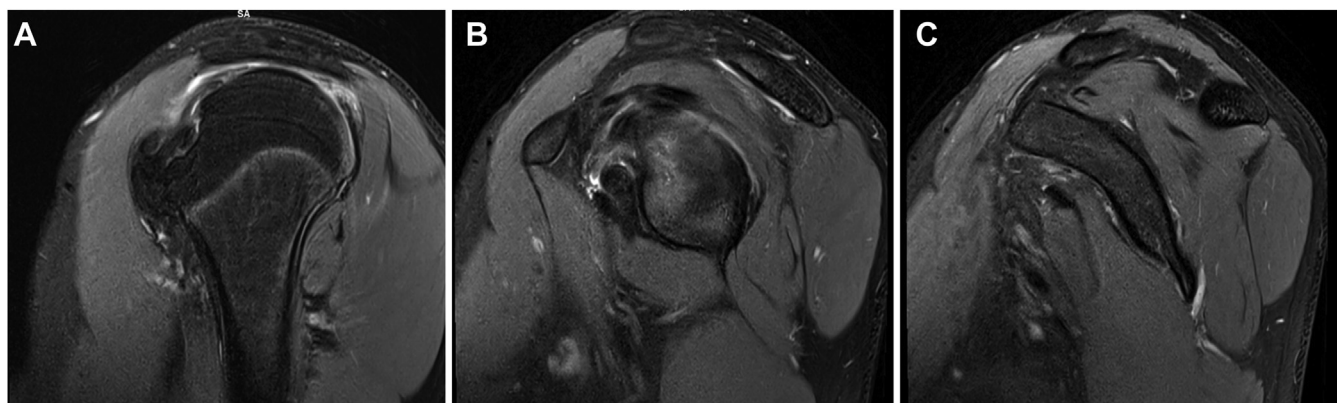


Figure 4 Preoperative T2 sequence sagittal cuts of magnetic resonance imaging of the left shoulder. (A) Lateral sagittal cut showing the supraspinatus and infraspinatus attaching to the greater tuberosity malunion at the anterior aspect of the humerus, anterior to the lesser tuberosity. (B) Midsection sagittal cut showing the abnormal positioning of the supraspinatus and infraspinatus tendons anterosuperior. (C) Medial sagittal cut showing the maintained muscle bellies of the supraspinatus, infraspinatus, and subscapularis.



Figure 5 Preoperative magnetic resonance imaging of the left shoulder. (A) T1 sequence coronal cut demonstrating superiorization of the humeral head with complete displacement of the associated supraspinatus. (B) T2 sequence coronal cut redemonstrating complete displacement of the supraspinatus. (C) T1 sequence axial cut showing greater tuberosity malunion anterior to the lesser tuberosity with partial visualization of the posterior-superior cuff attached to it and abnormally positioned. (D) T2 sequence axial cut showing complete dislocation of the long head of the biceps tendon associated with partial visualization of the posterior-superior cuff abnormally positioned but still attached to the malunited greater tuberosity.

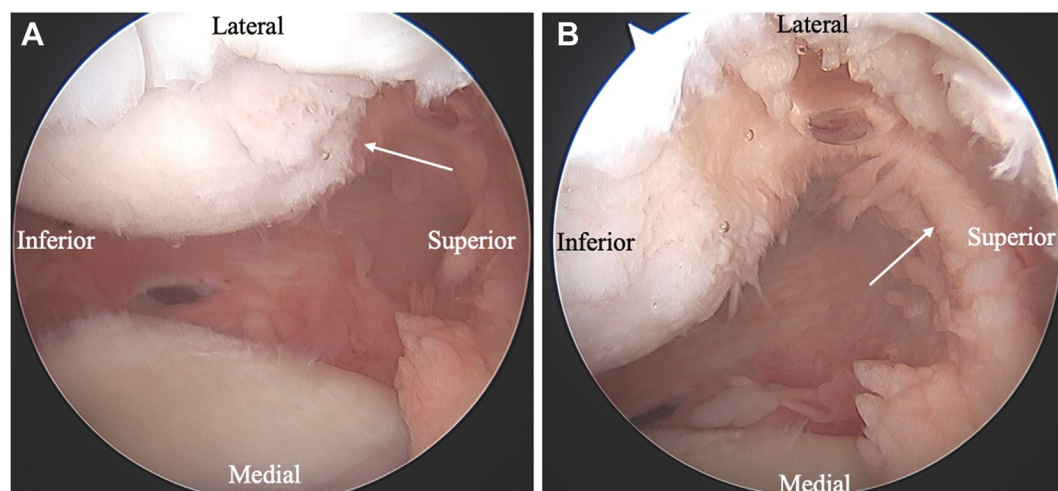


Figure 6 Arthroscopic view from posterior portal of the left shoulder. (A) Evidence of anterolateral articular wear (arrow) of the humeral head associated with the initial injury. (B) Anterior displacement of the supraspinatus tendon (arrow), and anterolateral humeral head wear visualized.

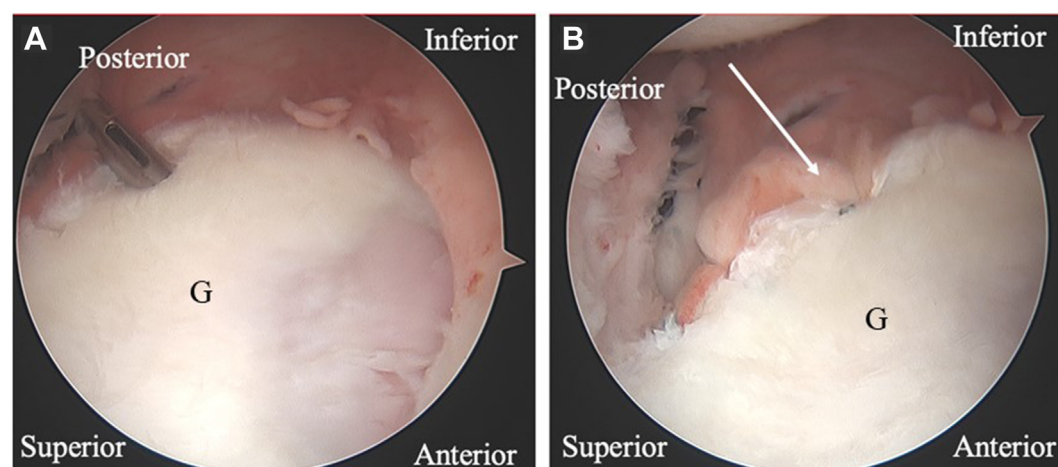


Figure 7 Arthroscopic view from the posterior portal of the left shoulder. (A) Anchor placement on glenoid (G) for posterior labral repair and capsular shift. (B) Completed posterior labral repair and capsular shift (arrow) back to the glenoid (G).

Standard rotator cuff repair activity restrictions including an abduction sling full time and passive ROM via pendulum exercises were observed for 6 weeks after surgery. At the six-week follow-up visit, full passive ROM was initiated with a physical therapist. At 8 weeks postoperatively, active ROM was initiated with a physical therapist. At 10 weeks follow-up, the patient's overhead arm position was greatly improved compared to preoperatively with 140° of active forward elevation, 20° of active ER in adduction, and 70° of active ER in 90° of abduction. At 6 months follow-up, the patient had no pain, full active FE, 30° of ER in adduction, and 75° of ER in 90° of abduction, was able to do pushups, place his hand on top of his head and behind his neck. He continued with physical therapy and was able to return to baseball and weightlifting in a progressive fashion.

Discussion

We presented a rare case of an anteriorly malunited greater tuberosity after a posterior shoulder fracture-dislocation in a 16-

year-old male treated with arthroscopic posterior labral repair and rotator cuff repair. Arthroscopic repair of greater tuberosity malunion has been previously reported.^{1,4,6,9} However, most reports occurred after an anterior shoulder dislocation or in isolation in older patients. To our knowledge, anterior malunion of the greater tuberosity after a posterior shoulder fracture dislocation with a complete loss of both supraspinatus and infraspinatus function has not been reported.

Posterior shoulder fracture-dislocations are rare and account for 0.9% of all shoulder fracture-dislocations.⁷ Lesser tuberosity fracture is more common than greater tuberosity fracture when the shoulder dislocates posteriorly.⁸ Greater tuberosity fractures are exceedingly rare, with only a handful of previous reported cases.^{11,15} One previous case described a greater tuberosity nonunion on the bicipital groove with the infraspinatus tendon incarcerated in the anterior aspect of the joint.¹⁵ Our case is similar in that the greater tuberosity malunited anteriorly on the proximal humerus, but the reduction and fixation strategies were quite different. We used an arthroscopic approach and rotator cuff

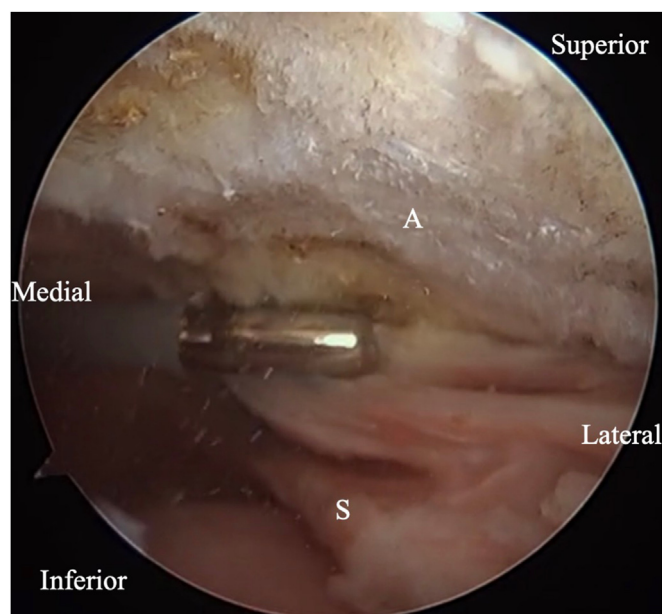


Figure 8 Arthroscopic view from posterior portal of the left subacromial space. The radiofrequency ablator cleared the underside of the acromion (A) to visualize the displaced supraspinatus (S).

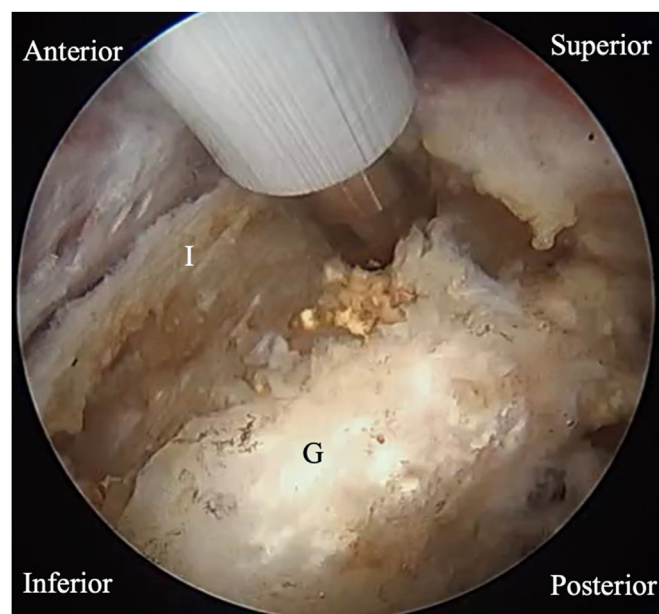


Figure 10 Arthroscopic view from the lateral portal of the left shoulder. The infraspinatus (I) was subperiosteally dissected off the fragmented greater tuberosity malunion (G) with the radiofrequency ablator.

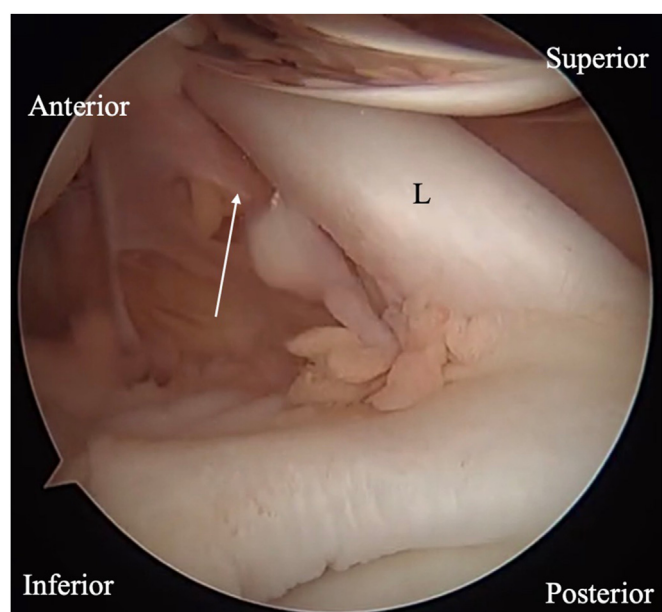


Figure 9 Arthroscopic view from posterior portal of the left shoulder. The long head of the biceps (L) was medially displaced by adhesions of the supraspinatus (arrow).

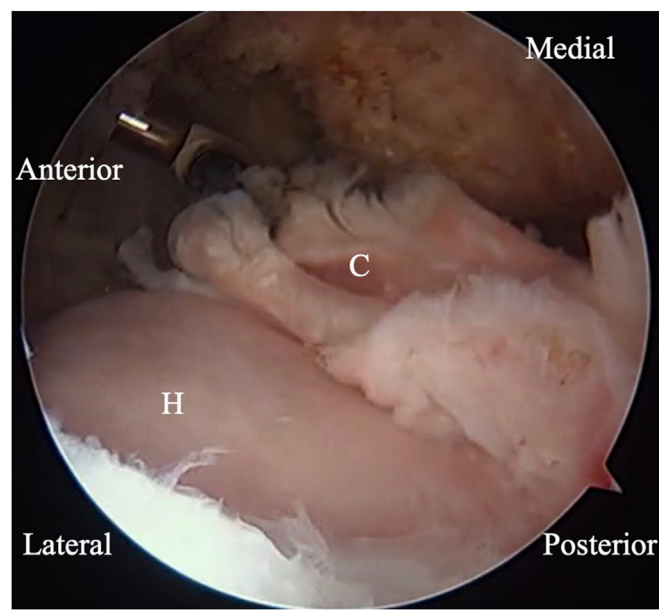


Figure 11 Arthroscopic view from the lateral portal of the left shoulder. The posterior-superior rotator cuff (C) has been completely mobilized with the radiofrequency ablator from the anterior portal. The proximal humerus cuff insertion (H) is visible.

fixation with suture anchors, compared to an open approach and screw fixation used by Teruya et al. Both management strategies appear to lead to satisfactory outcomes. The treatment for this rare injury pattern should be tailored to patient and injury specifics as well as the approach that the surgeon is most comfortable with.

This case also demonstrated the importance of timing in the management of shoulder fracture-dislocations. The patient presented two and a half years after his original injury, during which

time the greater tuberosity fragments healed to his anterior proximal humerus resulting in a loss of infraspinatus and supraspinatus function and decreased active forward elevation and ER. The patient lost significant muscle strength and experienced significant stiffness of his shoulder associated with rotator interval scarring and adhesions. Although the patient's shoulder ROM and function improved postoperatively, it is likely he would have obtained an even better result if he underwent urgent

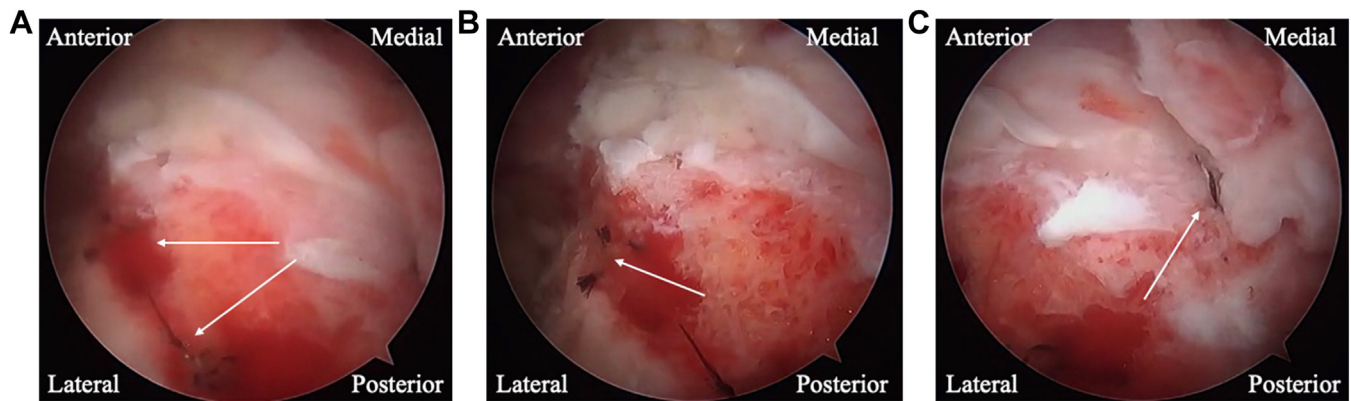


Figure 12 Arthroscopic view from the lateral portal of the left shoulder. The posterior-superior rotator cuff has been re-established in anatomic position with suture anchors (arrows). (A) anterior, (B) posterior, (C) medial.

surgical management and avoided the atrophy and stiffness associated with his chronic greater tuberosity malunion. Furthermore, the surgical intervention required in the acute scenario would have likely been technically simpler, in the form of open reduction and internal fixation with a combination of a metal plate and screws and possible reinforcement with rotator cuff repair via suture anchor fixation. Despite this, the patient's young age and biologic healing potential were instrumental in his ability to recover from his traumatic injury and corrective surgery. The surgical outcome may not have been achievable in an older patient, and both clinical and demographic factors should be considered when making surgical decisions with patients to achieve optimal results.

Conclusion

Anterior greater tuberosity malunion after posterior shoulder fracture dislocation is a rare and debilitating condition. Arthroscopic posterior labral repair, infraspinatus and supraspinatus tendon mobilization, and rotator cuff repair are safe and effective procedures for this injury pattern to restore ROM and function. This patient's successful recovery was likely augmented by his young age and ability to recover from trauma.

Disclaimers:

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Conflicts of interest: John M Tokish reports a relationship with Arthrex Inc. and DePuy Synthes Mitek Sports Medicine that includes consulting or advisory; he is on the board of the Arthroscopy Association of North America, Presidential line, and an Associate Editor for *The Journal of Shoulder and Elbow Surgery*. The other authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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