

# Knotless Arthroscopic Repair of Subscapularis Avulsion Fracture Using a Single Anterior Portal



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**Abstract:** Proximal humerus lesser tuberosity avulsions are uncommon injuries; however, when present, they can be debilitating for patients. As such, they pose a unique clinical challenge. These fractures were traditionally treated through an open approach to the proximal humerus; however, arthroscopic techniques continue to evolve and are increasingly used for these types of injuries. We describe our minimally invasive arthroscopic technique to repair lesser tuberosity avulsions using standard arthroscopic equipment. This method is safe, efficient, and applies basic shoulder arthroscopic techniques.

Compared with subscapularis tears, which are now known to be relatively common, lesser tuberosity avulsions are relatively rare.<sup>1,2</sup> Typically seen in the adolescent population, surgical treatment of lesser tuberosity avulsions has undergone a marked evolution as more advanced techniques are developed and arthroscopic techniques have advanced.

The subscapularis origin lies in the anterior scapular fossa and inserts on the proximal humerus.<sup>3</sup> Its insertion on the lesser tuberosity has been well described by Richards et al.<sup>4</sup> to be trapezoidal in shape with mean width 18 mm superiorly and 3 mm inferiorly. The superior fibers of the subscapularis are most critical for load transmission, while also forming a sling for the biceps tendon.<sup>5-7</sup> The primary function of the subscapularis is for internal rotation of the humerus, but also aids in shoulder stability acting as a restraint to anterior humeral head translation.<sup>8</sup>

The incidence of lesser tuberosity fractures is described in adults as 0.46 per 100,000 population years.<sup>9</sup> There are numerous case reports of these injuries in adolescents.<sup>1,9-12</sup> Nondisplaced lesser tuberosity avulsions have been successfully treated nonoperatively with good

results. However, displacement of 5 mm or angulation  $>45^\circ$  have been described as a surgical indication because of risk for nonunion, malunion, and biceps subluxation.<sup>11</sup>

Identification of these injuries requires a thorough history, examination, and imaging. The injury mechanism classically involves traumatic forced abduction and external rotation of the affected shoulder. Examination will identify anterior shoulder pain, positive bear hug, "lift off," and belly press tests. Imaging, particularly axillary radiographs (Fig 1) and magnetic resonance imaging (Fig 2), will confirm the diagnosis and degree of displacement of the fragment. This will help document amount of displacement, and, thus, the potential need for surgical intervention.<sup>13</sup> Vavek et al.<sup>14</sup> recommended a "high index of suspicion should be maintained in adolescent males with anterior shoulder pain and subscapularis weakness, especially after a fall."

With the advancement of arthroscopic techniques, several methods have been described to address the displaced lesser tuberosity avulsion fracture. Classically, these injuries were managed by open reduction and internal fixation, which has fallen out of favor with the

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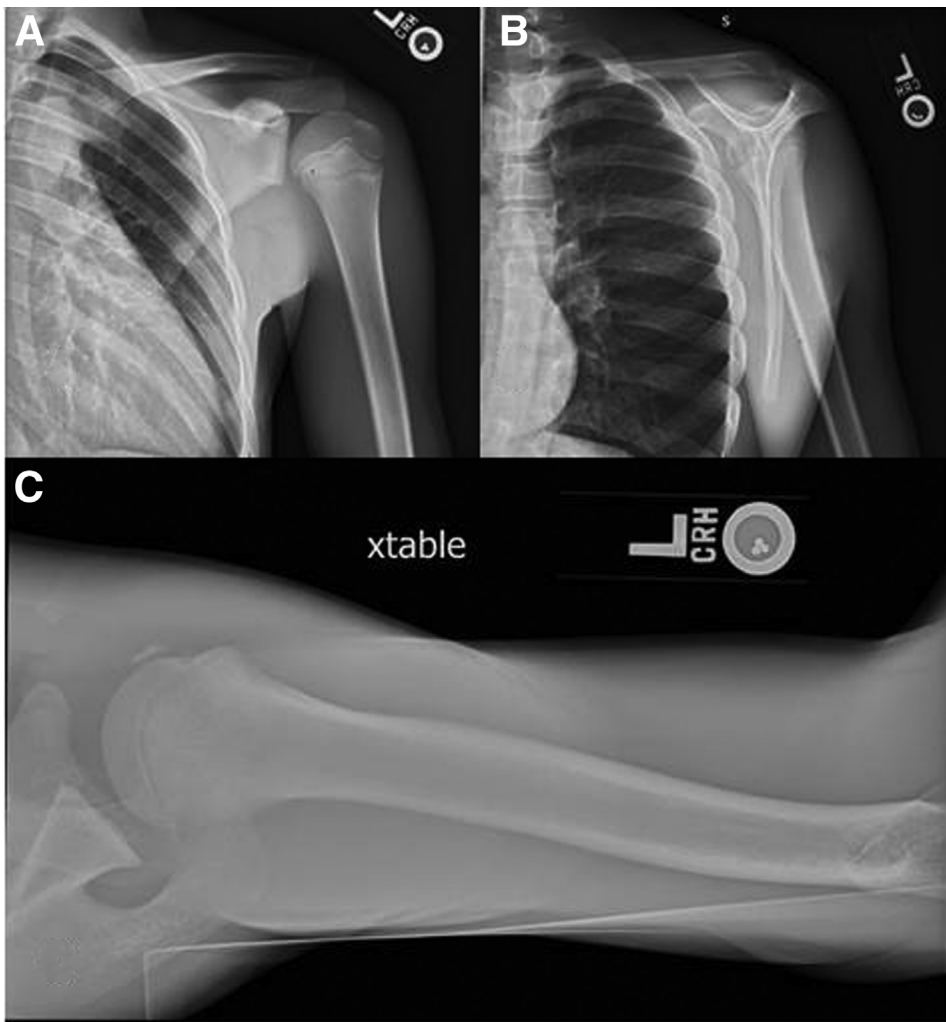
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**Fig 1.** Radiographic assessment of the left shoulder in a patient with exam concerning for subscapular avulsion fracture. (A) Grashey, (B) scapular Y, and (C) axillary views of the left shoulder. Axillary view best shows a proximal anterior radiodensity and associated bony defect in the humeral head, which is consistent with examination concerning for subscapular avulsion fracture.

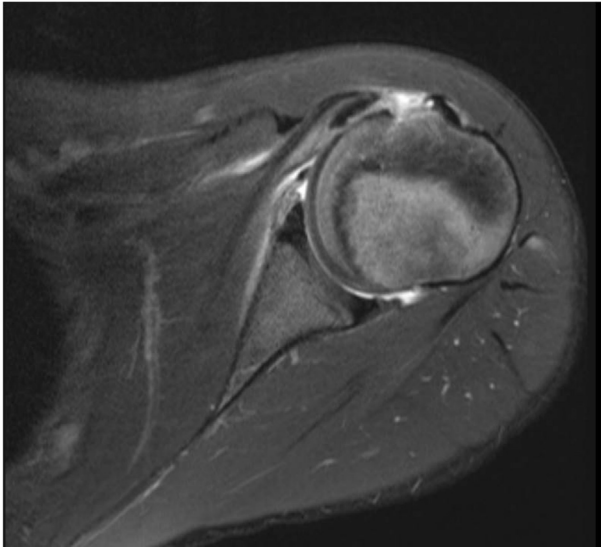
demonstrated success and decreased morbidity of arthroscopic techniques. There are currently 3 all-arthroscopic techniques described by Scheibel et al.,<sup>12</sup> Heyworth et al.,<sup>15</sup> and Cregar et al.,<sup>16</sup> which have built upon one another to achieve maximum fracture healing area and secure fixation. The following technique is a natural advancement of these prior descriptions to achieve secure fixation in a streamlined fashion.

### Technique

The patient is brought to the operating room, placed on a standard operative table, and undergoes general anesthesia. The patient is then positioned in the beach chair position, and the operative extremity is prepped and draped in the standard sterile fashion. We prefer a high beach chair (dinner table) position for shoulder arthroscopy; however, the procedure could also be

performed in the lateral decubitus position based on surgeon preference.

The procedure begins with creating a standard high posterolateral viewing portal and performing a standard diagnostic shoulder arthroscopy examination with a 30° arthroscope (Video 1). An anterior working portal is created under direct visualization from outside-in. This portal should enter the joint immediately above the subscapularis tendon, midway between the glenoid and humerus. Using a needle and outside in technique increases accuracy. Without tension, the needle should sit in the center of the joint (Fig 3A). Next, an extensive rotator interval debridement is performed using shaver and radiofrequency ablation (Fig 3B). We rely predominantly on ablation given the vascular nature of this tissue (Fig 3C). The fracture fragment is identified, typically found retracted slightly medially.



**Fig 2.** Axial T2-weighted magnetic resonance imaging (MRI) of the left shoulder in a patient with examination and initial radiographs concerning for subscapularis avulsion fracture. Axial MRI sections demonstrate displaced osseocartilaginous fragment that maintains its attachment to the subscapularis tendon. This confirms the diagnosis of subscapularis avulsion fracture.

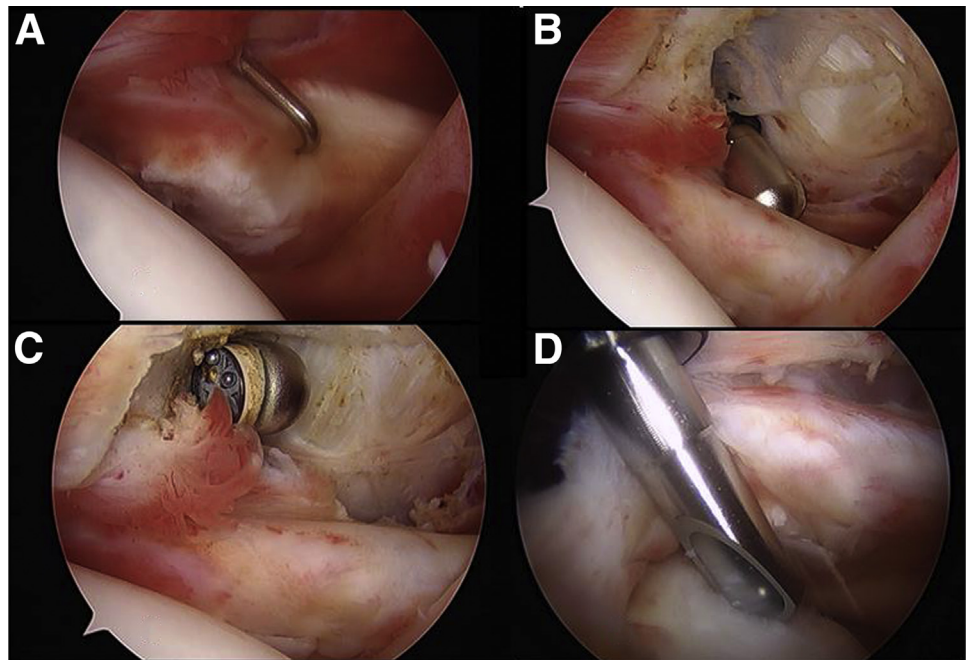
After opening the rotator interval, the anterior portal can be switched to a larger portal (8.25 mm x 7 cm). This will allow passage of lassos, sutures, and anchors. A 70° camera is then placed through the posterior portal to view the lesser tuberosity avulsion site (Fig 3D). The arm is placed in flexion and internal

rotation. This will allow an improved view of the lesser tuberosity donor site. A gentle posterior force on the humerus (lever push) will increase the amount of space available to work in the front of the shoulder, and can improve the view of the donor site. A shaver (Arthrex, Naples, FL) is then placed through the anterior portal and the avulsion site is debrided to bleeding bone for improved healing upon reduction and fixation.

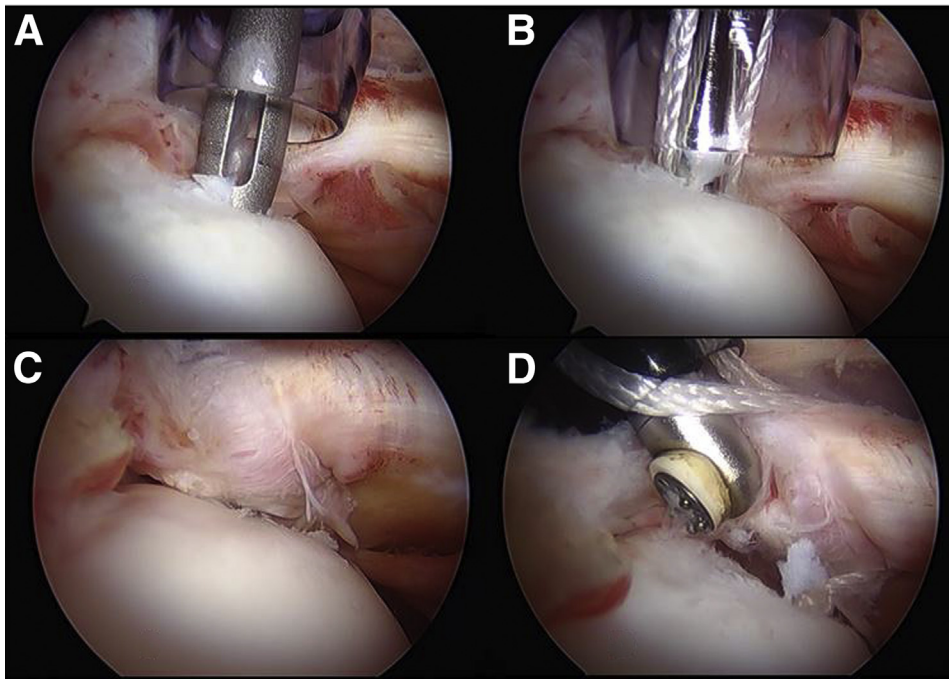
After debriding the fracture site and the tuberosity fragment, the repair is completed. A 2.9-m PushLock (Arthrex) anchor is loaded with LabralTape (Arthrex) and introduced through the anterior portal and placed medial to the avulsion site, just at the articular cartilage junction (Fig 4 A and B). A suture lasso is then introduced and passed just medial to the avulsed fragment. Redundant lasso is passed into the joint, and the lasso is continually advanced as the lasso handle is withdrawn from the cannula. The lasso is then retrieved through the anterior portal. The 2 sutures from the medial anchor are then shuttled through the subscapularis medial to the fragment (Fig 4C).

The LabralTape is then loaded into a second PushLock anchor. The second anchor is placed through the anterior portal and inserted lateral to the avulsion site (Fig 4D, Fig 5A). This reduces the fragment into the avulsion site via knotless technique with all anchors outside the fracture site (Fig 5 B and C). It allows excellent, low profile compression of the fragment.

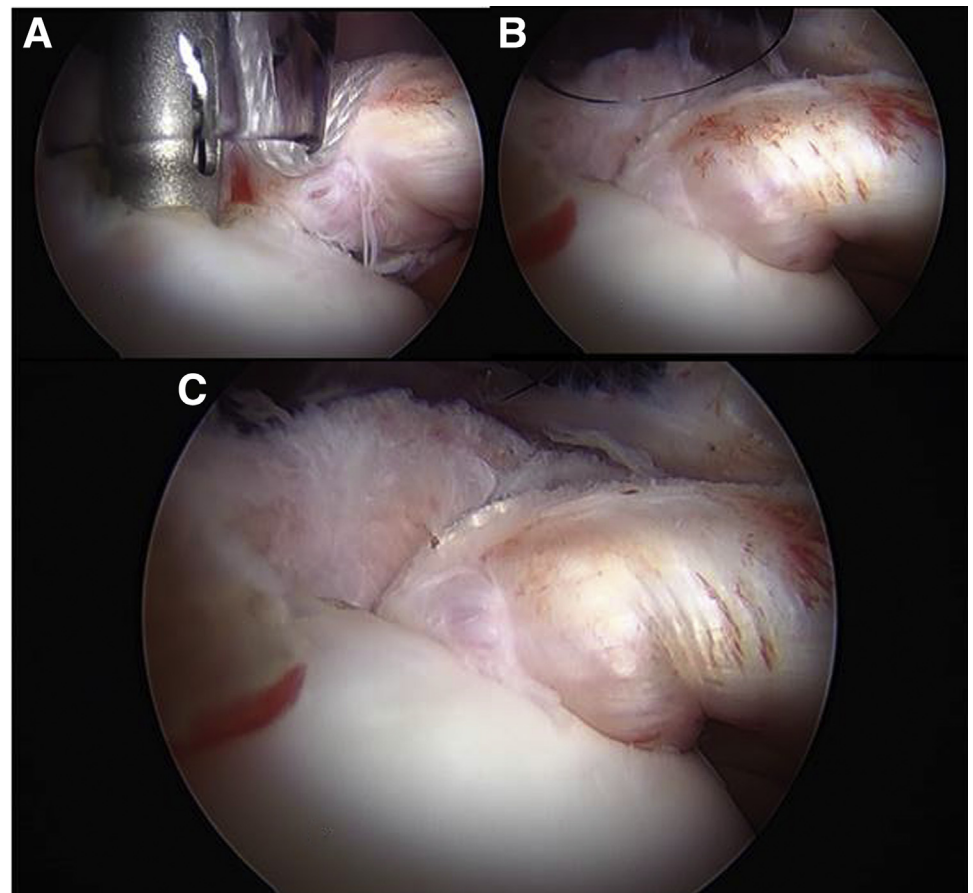
**Fig 3.** Intraoperative arthroscopic photos of the left shoulder from a standard posterior portal with the patient in the beach chair position. (A) The fracture is identified via anterior portal through rotator interval. (B and C) A thorough debridement of the rotator interval is completed. (D) A 70° arthroscope is inserted via the anterior portal and the fracture site is debrided to stimulate fracture healing.







**Fig 4.** Intraoperative arthroscopic photos of the left shoulder using a 70° arthroscope from standard posterior portal with the patient in the beach chair position. (A and B) The first anchor is placed medial to the fracture. (C) Labral tape is pulled deep to superficial through subscapularis tendon medial to avulsion fragment. (D) The second anchor site is defined lateral to the avulsion site.



**Fig 5.** Intraoperative arthroscopic photos of the left shoulder using 70° arthroscope from standard posterior portal with the patient in the beach chair position. (A) Place second anchor lateral to humeral avulsion site. (B) Tension the subscapularis in place. (C) Final construct.

**Table 1.** Comparison of Published Arthroscopic Subscapularis Avulsion Fracture Repair Techniques

	Scheibel et al. <sup>12</sup>	Heyworth et al. <sup>15</sup>	Cregar et al. <sup>16</sup>	Barlow et al.
Position	Beach chair	Not specified	Lateral	Beach chair
Knots	Mattress stitch, single stitch	Horizontal mattress	Luggage loop, knotless	Knotless
Anchor position	Inside fracture	Inside fracture	Outside fracture	Outside fracture
No. of portals	3	3	4	2

The arm is immobilized in a sling for 6 weeks. At 2 weeks, passive range of motion of the shoulder is begun, limiting external rotation to neutral for the first 6 weeks. At 6 weeks, the sling is discontinued, and additional passive stretching exercises are completed (without restriction). Strengthening is initiated at 3 months.

## Discussion

Lesser tuberosity avulsion fractures are rare injuries that are frequently missed because of diagnostic examination and imaging challenges. This can lead to delays in management.<sup>10,17</sup> Delays in management have been associated with worse outcomes, including pain, weakness, loss of motion, nonunion, and associated biceps pathology.<sup>10,18,19</sup>

Although these injuries can be managed through open techniques, equivalent outcomes were demonstrated by open or arthroscopic techniques in a meta-analysis by Vavken et al.<sup>14</sup> Given the decreased morbidity and equivalent outcomes of arthroscopic techniques, it is now accepted and our preference to perform these repairs through an all arthroscopic technique.

Currently, multiple all arthroscopic techniques have been described (Table 1). These techniques have progressed from knotted to knotless suture technique, anchor fixation within the defect to adjacent bone, and, finally, multiple portal sites to a single viewing and single working portal. This technique uses previous advancements of knotless technique to create a low profile construct and anchors outside of the fracture site to maximize bone-to-bone healing potential.<sup>16</sup> It goes beyond prior techniques to use only 1 anterior working

**Table 2.** Key Points for Completing Knotless Single Anterior Portal Subscapularis Avulsion Fracture Repair

- Generous rotator interval debridement
- Mobilize subscapularis if retracted
- Thorough debridement of the fracture site
- Medial and lateral anchors close enough to fracture site without compromising fixation
- 70° arthroscope

**Table 3.** Equipment Required

- Standard arthroscopic camera and fluid management
- Radiofrequency ablation\*
- PushLock anchors†
- FiberTape suture‡
- Spyder limb positioner‡

\*DePuy Synthes.

†Arthrex.

‡Smith and Nephew.

portal for a more efficient surgical technique and uses the beach chair position (Table 2). The surgery is accomplished through only 2 total portals through a wide rotator interval debridement and use of a 70° camera to visualize the anterior humerus from a posterior portal (Table 3).

Cregar et al.<sup>16</sup> previously described a similar all arthroscopic technique. The authors described using primarily a lateral viewing portal along with a subacromial bursectomy. They also used an accessory biceps portal in addition to an anterior working portal. The current technique differs in using a traditional posterior viewing portal and 70° camera to achieve adequate visualization of the avulsion site, saving time and preserving adjacent structures. To aid in visualization of the subscapularis footprint, the arm is placed in elevation and internal rotation. This is similar to the technique described by Denard and Burkhart to “see around the corner” for articular-sided subscapularis repairs.<sup>20</sup> The limitations to the technique include surgeon comfort with the 70° camera and size of avulsion fragment. The technique may not be appropriate for larger avulsions that require more than 2 anchors to provide sufficient stability (Table 4).

Although displaced lesser tuberosity avulsion fractures are a rare injury, precise surgical management is critical to return patients to full function. This technique facilitates a safe, predictable, effective repair using standard arthroscopy equipment and skills.

**Table 4.** Strengths and Limitations of Single Anterior Portal Repair

Strengths	Limitations
<ul style="list-style-type: none"> <li>• Beach chair position can convert to open</li> <li>• Only 2 portals</li> <li>• Knotless construct</li> <li>• No anchors in the fracture site</li> <li>• Decreased morbidity because of minimally invasive nature of procedure</li> <li>• No violation of the deltopectoral interval</li> <li>• Minimal implants needed</li> <li>• Uses existing techniques and equipment</li> </ul>	<ul style="list-style-type: none"> <li>• 70° scope/technically demanding</li> <li>• Two anchor construct limited to smaller avulsion</li> </ul>

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