



Reconstruction of a massive avulsion fracture of the lesser tuberosity using the arthroscopic tension band technique: a case report and brief review of the literature

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Isolated avulsion fractures of the lesser tuberosity (LT) of the humerus are uncommon injuries, most occurring in young patients.^{11,17} Except for nondisplaced fractures, multiple authors have recommended surgical treatment to restore the subscapularis rotator cuff and prevent nonunion/malunion with subcoracoid impingement.^{1,6,9,10} Surgical repair is most often performed by open internal fixation with screws or suture fixation.^{3,14,15,18,19} Although shoulder arthroscopy has the benefits of minimally invasive surgery, its use in the treatment of these lesions has rarely been reported.^{2,9,12} We present an original case of a massive avulsion fracture of the LT in an adult woman who was treated arthroscopically using the tension band technique.

Case report

A healthy 57-year-old woman presented with right shoulder pain after falling 1 month before onto her right shoulder with her right arm forcefully abducted and externally rotated. Our initial physical examination showed tenderness over the anterior aspect of her right shoulder and painful passive and active range of movement, particularly active internal rotation. Although not entirely reliable because of pain, evaluation of the rotator cuff revealed preserved function of the supraspinatus and infraspinatus muscles but weakness of the subscapularis cuff along with positive belly-press and bear-hug tests.

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Computed tomography examination showed a 2-fragment retracted avulsion fracture of the entire LT dislocated under the coracoid (Fig. 1). Magnetic resonance imaging demonstrated an intact subscapularis tendon attached to the LT; the glenohumeral joint and posterosuperior cuff appeared normal (Fig. 2).

Because of the amount of displacement of the fracture and knowing the consequences of this injury in the functionality of the subscapularis rotator cuff, we planned an arthroscopic-assisted internal fixation of the LT.

Under general anesthesia combined with an interscalene block, the patient was placed in the beach-chair position. An arthroscopic evaluation of the glenohumeral joint was carried out using a posterior portal, revealing the fractured LT displaced under the coracoid and conjoint tendons and the integrity of the biceps tendon and pulley. No other intra-articular pathology was observed.

Thereafter, we established standard portals such as those used for subscapularis tendon repair: a lateral viewing portal, a working anterior rotator interval portal, and a biceps accessory anterolateral portal for suture management. Next, the LT was mobilized and the integrity of the subscapularis tendon was confirmed. Using a suture passer, a FiberWire (Arthrex, Naples, FL, USA) traction suture was passed through the subscapularis tendon to embrace the entire LT and aid in further mobilization of the fractured fragment to its anatomical reposition (Fig. 3).

Inspection of the avulsion bed revealed very soft cancellous bone, thus preventing adequate purchase of suture anchors (Fig. 4). Similar to the repair of LT osteotomy for shoulder arthroplasty as described by Gerber,⁴ we planned to fix the fracture by placing sutures in a “back-pack” configuration through the outer part of the



Figure 1 3D computed tomography reconstruction demonstrating an avulsion fracture of the lesser tuberosity dislocated under the coracoid and conjoint tendons.

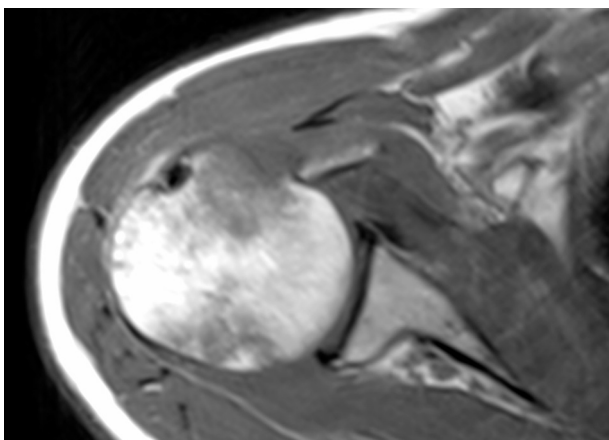


Figure 2 Axial cut of T1-weighted-turbo spin-echo magnetic resonance imaging demonstrating an avulsed and retracted lesser tuberosity fracture with an intact attached subscapularis tendon.

subscapularis tendon to secure the LT in a tension-band construct (Fig. 5). Three all-suture anchors (Iconix; Stryker) were placed adjacent to the fracture—1 in an inferior position and 2 laterally located in the intertubercular groove. The sutures were passed through the outer part of the subscapularis tendon, avoiding piercing the avulsed fragment (Fig. 6). By consecutive traction of the sutures, the LT was reduced and fixed in its anatomical position (Figs. 7 and 8). Finally, biceps tenotomy with suprapectoral tenodesis was performed using the threads of the lateral anchors. The shoulder was mobilized to verify the stability of the LT and its free slide under the coracoid and conjoint tendons.

The postoperative rehabilitation protocol was similar to that of subscapularis tendon repair. The shoulder was immobilized with a sling for 3 weeks, allowing limited passive motion in abduction-elevation ($<60^\circ$) and avoiding external rotation. Thereafter, the patient was sent to physical therapy, progressing with an active range of motion. Postoperative magnetic resonance imaging at 5 months showed stable fixation of the LT (Fig. 9). The evaluation performed 6 months after surgery showed a very satisfied patient

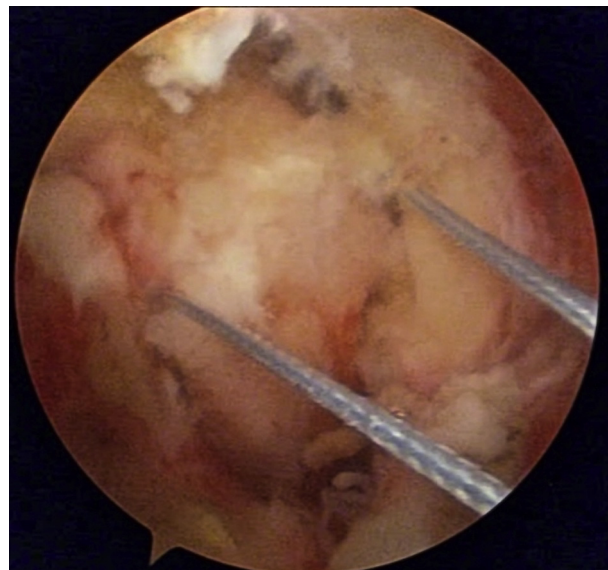


Figure 3 Arthroscopic view from the lateral portal: lesser tuberosity fragment mobilized using a traction suture.

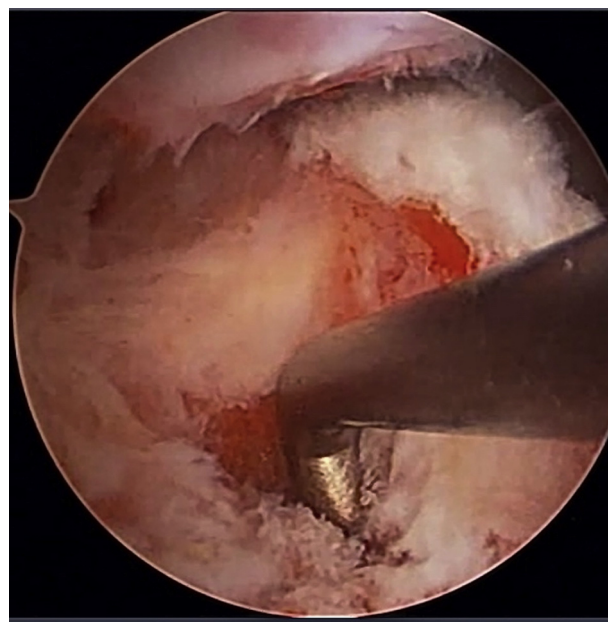


Figure 4 Osteoporotic avulsed fracture bed.

who can perform all daily activities with a pain-free range of motion.

Discussion

Isolated fractures of the LT, either 2-part or in association with dislocation, are extremely rare injuries in adults, occurring at an estimated annual incidence of 0.46 per 100,000 population.¹¹ The literature lacks consensus about the amount of fracture displacement that is acceptable for a good outcome. Traditional criteria for the surgical repair of LT fractures are displacement >5 mm or angulation $>45^\circ$.⁸ Nevertheless, multiple authors have recommended early surgical stabilization, even in minimally displaced fractures, to prevent complications related to progressive displacement, malunion with subcoracoid impingement, nonunion,

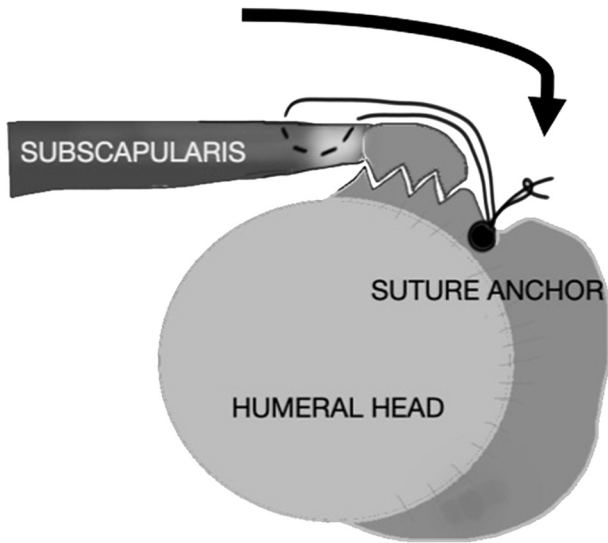


Figure 5 Schematic representation of the arthroscopic tension band repair of the lesser tuberosity fracture.

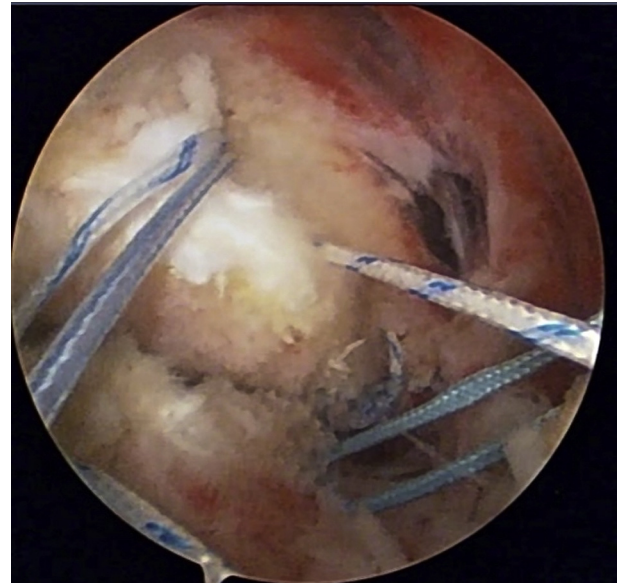


Figure 7 Tension band construct before tensioning the sutures.

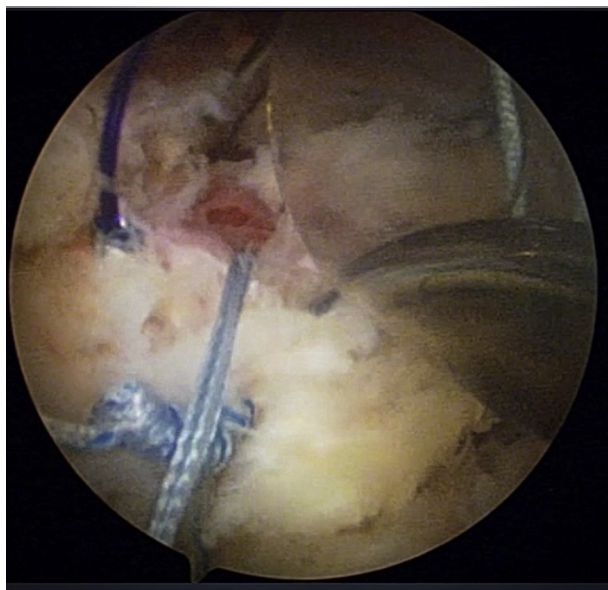


Figure 6 Sutures passed in a “back-pack” configuration through the outer part of the subscapularis tendon.

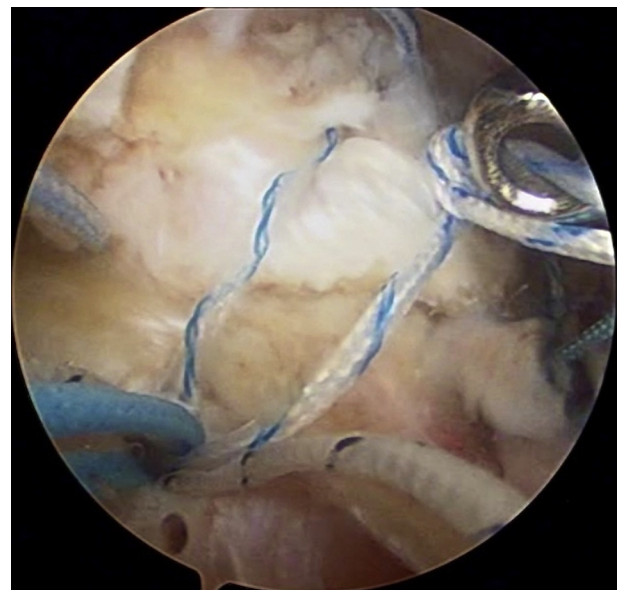


Figure 8 Reduction of the lesser tuberosity after tightening the sutures.

axillary nerve lesion, and instability.^{6,7,9-11} Surgical treatment has been traditionally performed by open reduction and internal fixation using transosseous sutures, cancellous bone screws, or suture anchors, resulting in good outcomes.^{3,14,15,18,19}

Arthroscopic reconstruction of an isolated LT in the adult patient was first reported in 2005, and, although offering the advantages of minimally invasive surgery, to our knowledge, only a few more cases have been published since then.^{2,5,9,12}

The reported arthroscopic technique differs from those previously published, mainly because our case consisted of the avulsion of the entire LT and most of the fracture bed was very soft, thus discouraging the placement of suture anchors in the avulsed zone. In this sense, we could not proceed with a mattress suture reconstruction as described in adults by Scheibel and Nascimento and in adolescents by Heyworth, because the anchors could not be placed at the fracture site.^{5,9,12} We decided to make the repair by applying

the tension band construct (Backpack) described by Gerber⁴ to fix the osteotomy of the LT for shoulder arthroplasty. Different biomechanical studies have confirmed the stability of this biomechanical construct.^{13,16}

Suture anchors were placed in the hard adjacent bone of the bicipital groove, and the sutures were passed through the outer part of the subscapularis tendon, in line for direct reduction traction of the LT. We did not consider piercing the LT to avoid fragmenting the tuberosity.⁹ We also did not grasp the fragment with sutures in the luggage-tag fashion proposed by Cregar² because we believe that the suture material interposed in the fracture interval might interfere with the bone contact between the LT and its avulsion bed. Finally, by tightening the sutures passed in the form of a “back-pack” through the subscapularis tendon, the tension band mechanism reduced and compressed the LT in its fracture bed.

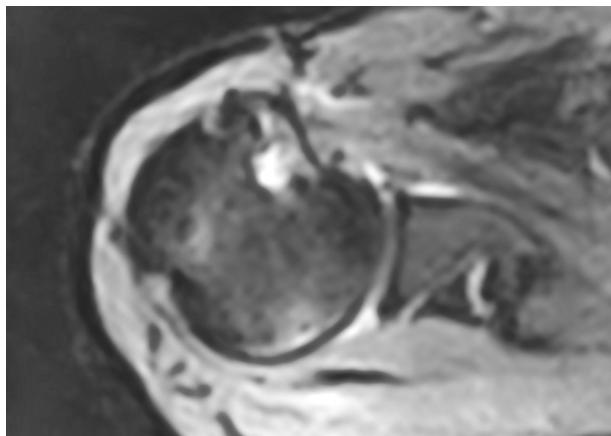


Figure 9 Postoperative GE short-tau inversion-recovery axillary magnetic resonance imaging shows the repaired lesser tuberosity fracture.

To our knowledge, this is the first report of arthroscopic tension band reconstruction of an LT avulsion fracture that is already known to produce satisfactory results in the open fixation of LT osteotomy for shoulder arthroplasty. This arthroscopic technique provides precise and stable fixation and avoids some drawbacks of conventional open surgery, with good functional outcomes and patient satisfaction being achieved.

Conclusion

Isolated avulsion fractures of the LT are rare injuries that are mostly treated by open surgery but may benefit from arthroscopic surgery. The present arthroscopic technique based on the biomechanical principle of the tension band mechanism provides precise and stable fixation and is particularly indicated as in our case when the avulsed bed is osteoporotic to ensure early rehabilitation and a good prognosis.

Disclaimer

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Supplementary Data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jseint.2020.07.002>.

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