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Case Report

Osteosynthesis with a muscle advancement for a severely retracted greater tuberosity avulsion fracture: a case report

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ABSTRACT

Greater tuberosity fractures with severe retraction are surgically challenging, with no universally accepted surgical procedure. This case report presents a case in which a muscle advancement technique was successfully applied to facilitate the reduction and fixation of a severely retracted greater tuberosity fracture. A 75-year-old female presented with persistent left shoulder pain for more than 3 weeks following a fall. Radiographs revealed a displaced greater tuberosity fracture. During surgery, via a deltoid-split approach, initial attempts to reduce the fragments using sutures placed in the rotator cuff tendons were unsuccessful due to strong traction from the rotator cuff muscles. To overcome this, the supraspinatus and infraspinatus were elevated from the scapular body, allowing the greater tuberosity fragments to slide laterally and achieve anatomical reduction. The fracture was then stabilized using the suture-bridge technique. Postoperative recovery resulted in satisfactory shoulder functional outcomes and complete bone union. To the best of knowledge, this is the first reported case of utilizing a muscle advancement technique in the treatment of a greater tuberosity fracture, providing an effective method to reduce rotator cuff traction and enable stable anatomical fixation.

Introduction

Surgical management of chronic greater tuberosity fractures with large displacements remains challenging due to the difficulty in achieving adequate anatomical reduction due to soft tissue contracture.[1] Medial retraction of the rotator cuff muscles may cause postoperative fixation failure due to the high tension in the rotator cuff.[2,3] However, due to their rarity, there is limited research on surgery for greater tuberosity fractures with severe retraction.[3]

Advancement of the rotator cuff muscles is an established surgical technique for treating irreparable rotator cuff tears. The original muscle advancement was proposed by Debeyre et al,[4] in which the supraspinatus was dissected from the supraspinatus fossa and advanced laterally to suture the torn rotator cuff tendon on the greater tuberosity with acromial osteotomy. Later, Kurokawa et al. modified the Debeyre-Patte procedure and proposed a procedure to maintain deep fascial continuity between these rotator cuff muscles and the rhomboid muscles at the medial border of the scapula instead of detaching the supraspinatus and infraspinatus muscles.[5] Recent studies reported satisfactory functional outcomes with arthroscopy-assisted or all-arthroscopic muscle advancement techniques for irreparable massive rotator cuff tears.[6-9] However, there are no reports on muscle advancement being applied to surgery for greater tuberosity fractures.

This report describes a case of a greater tuberosity fracture with severe retraction that was treated with osteosynthesis using the modified Debeyre-Patte procedure.

Case presentation

A 75-year-old female presented to the hospital with left shoulder pain that had persisted since her fall more than 3 weeks earlier and difficulty moving her shoulder because of the severe pain. She had undergone a pacemaker insertion for the atrioventricular block 5 years ago. There were no findings suggestive of neurovascular injury. Radiography revealed a left avulsion fracture of the greater tuberosity (Figure 1A). Computed tomography revealed superior and posterior displacement of the comminuted fracture fragments (Figure 1B). Based on these findings, it was concluded that the greater tuberosity fracture with severe displacement was the cause of shoulder pain and dysfunction. Therefore, osteosynthesis was scheduled. Written informed consent was obtained from the patient for the publication of this case report and any accompanying images.

Surgery was performed in the beach chair position under general anesthesia. In addition to the skin incision on the lateral aspect of the acromion, a skin incision was planned on the medial scapular spine in case the muscle advancement procedure was performed (Figure 2A). The fracture site was exposed using a

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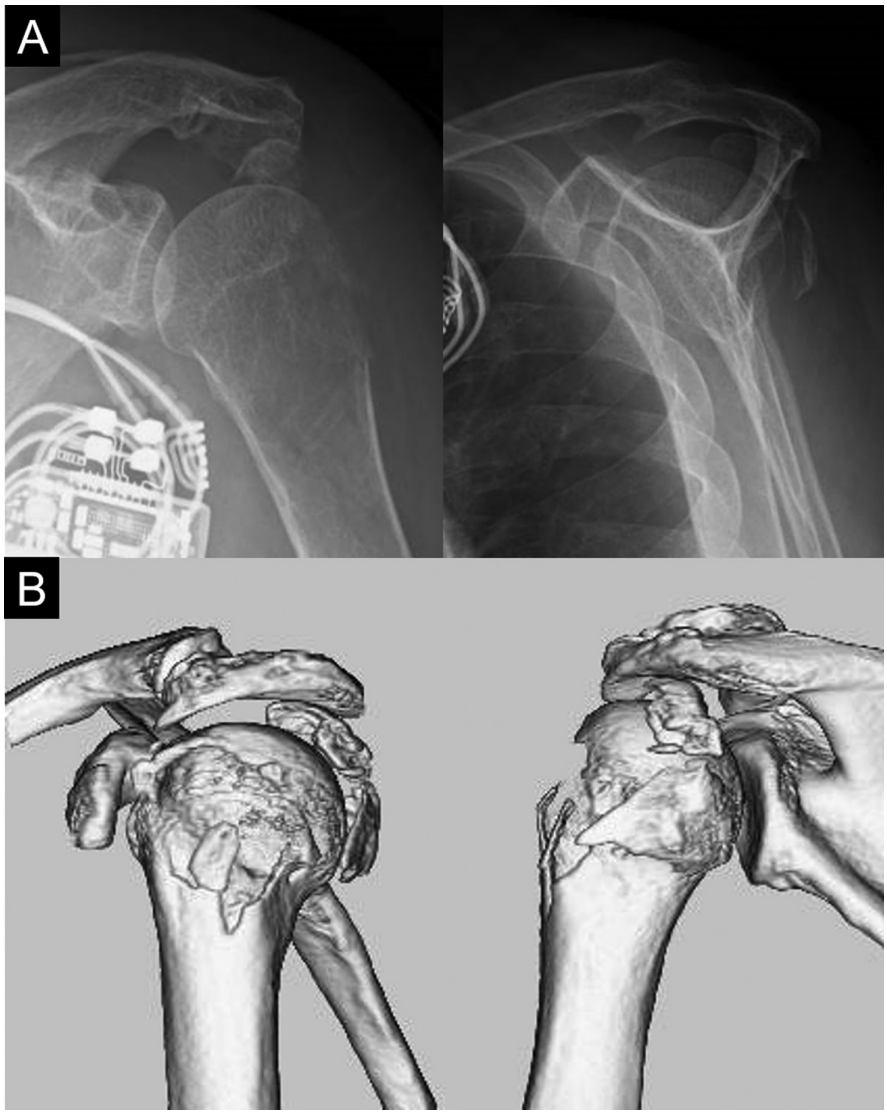

Figure 1. Radiographs and computed tomography (CT) of the left shoulder. Radiographs showed the greater tuberosity avulsion fracture with large displacement (A). CT revealed that the fracture fragments were comminuted and displaced superiorly and posteriorly (B).

deltoid-split approach. The greater tuberosity fragment was divided into 2 segments: one with the supraspinatus and infraspinatus tendons attached and the other with the infraspinatus tendon and teres minor attached. Supraglenoid release was attempted; however, it was difficult to perform under direct visualization due to the humeral head and fracture fragments. Therefore, the rotator cuff muscles were blindly released from the supraglenoid area as much as possible. One FiberWire® (Arthrex, Naples, FL) was applied to the supraspinatus tendon, 2 to the infraspinatus tendon, and 1 to the teres minor muscle to attempt reduction of the greater tuberosity fragments by pulling on the FiberWires. However, anatomical reduction of the greater tuberosity fragment could not be achieved due to the strong traction of the retracted rotator cuff muscles (Figure 2B). Therefore, muscle advancement was performed according to a procedure described in previous reports.[5-7] A 4-cm skin incision was made along the medial spine of the scapula. After detaching the trapezius from the scapular spine, the supraspinatus and infraspinatus muscles were exposed (Figure 2C). The supraspinatus and infraspinatus muscles were lifted from the scapular body using an elevator while maintaining continuity with the rhomboids (Figure 2D and E). After this procedure, the retracted rotator cuff tendons could slide laterally by approximately 2-3 cm, and the greater tuberosity fragments were easily reduced by pulling on the FiberWires (Figure 2F). Four JuggerKnot® anchors (Zimmer Biomet, Warsaw, IN) was inserted medially into the greater tuberosity, and 2 Quattro® Link knotless anchors (Zimmer Biomet) were inserted laterally to the greater tuberosity. The greater tuberosity fragments were fixed using the suture-bridge technique (Figure 2G).

The affected arm was kept in a sling for 4 weeks. Outpatient rehabilitation was performed for 10 months after surgery. Passive shoulder range of motion exercises were initiated at 1 week postoperatively, and

HIGHLIGHTS

- Surgery for greater tuberosity fractures with severe retraction remains challenging.
- The retracted greater tuberosity fracture fragments were successfully reduced and fixed using rotator cuff muscle advancement.
- Muscle advancement may reduce the traction force of the rotator cuffs on the greater tuberosity fragments and prevent the loss of reduction.
- This is the first case in which the rotator cuff muscle advancement was applied to a greater tuberosity fracture with severe retraction.

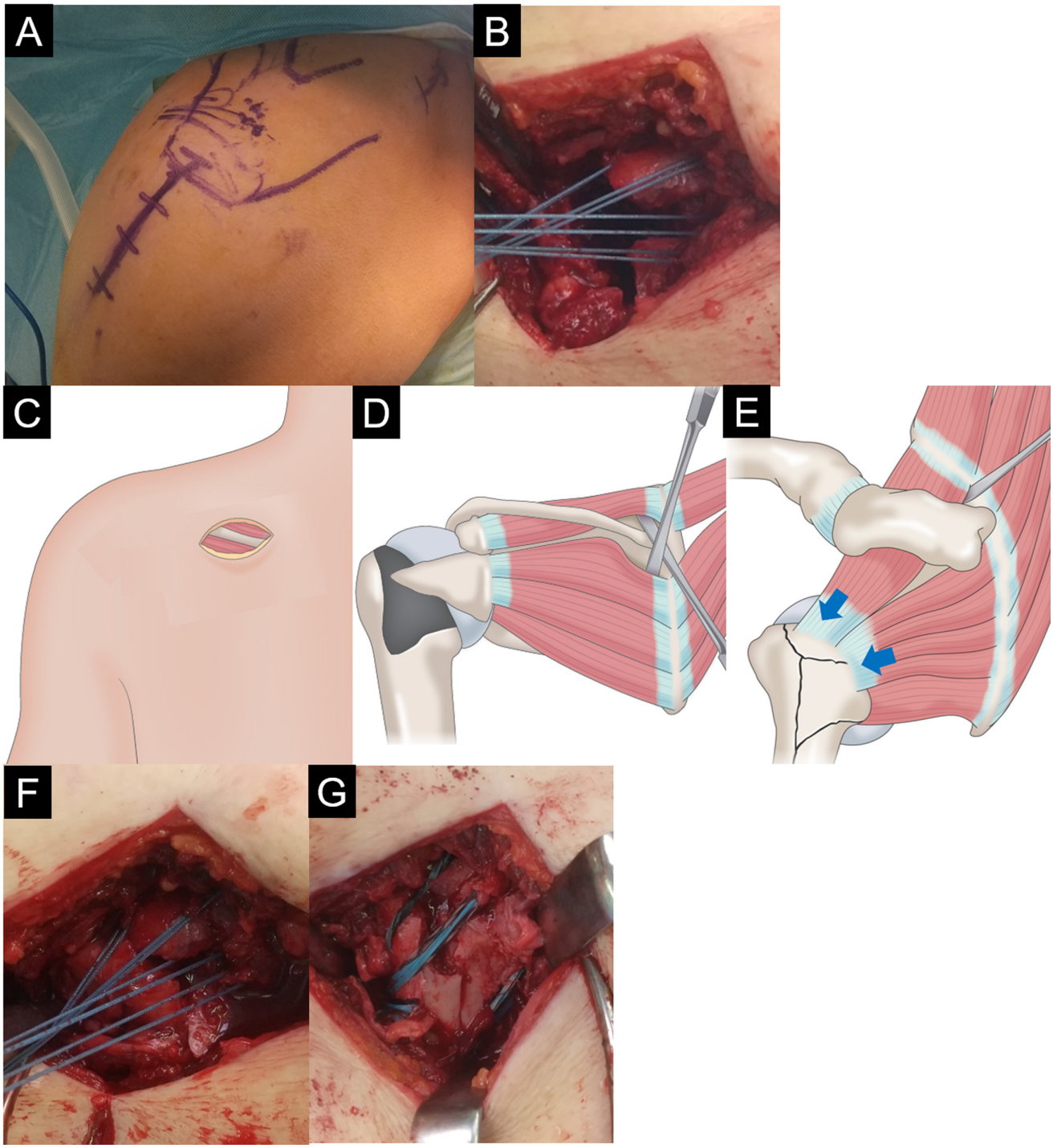

Figure 2. Intraoperative findings of the left shoulder. A skin incision was performed on the medial scapular spine for the muscle advancement procedure in addition to that on the lateral aspect of the acromion (A). With 4 non-absorbable sutures applied to the rotator cuff tendons, an attempt was made to reduce the greater tuberosity fragment. However, anatomical reduction could not be obtained due to the strong traction of the retracted rotator cuff muscles (B). Under a 4-cm skin incision made along the medial spine of the scapula, the supraspinatus and infraspinatus muscles were exposed (C). After the supraspinatus and infraspinatus were lifted from the scapular body using an elevator (D and E), the greater tuberosity fragments were easily reduced (F). The greater tuberosity fragments were then fixed using the suture-bridge technique (G).

active shoulder range of motion exercises were initiated at 4 weeks postoperatively. Isometric strength exercises of the rotator cuff muscles were started at 8 weeks postoperatively, while isotonic strength exercises were started at 12 weeks postoperatively. Patients were permitted to resume heavy labor activities at 12 weeks postoperatively.

Postoperative radiography confirmed bone union without secondary displacement (Figure 3). The shoulder range of motion (right/left) was 150/130° for anterior elevation, 45/30° for external rotation, and Th9/Th12 for internal rotation at 1 year postoperatively. The Constant score was 84 and the VAS score was 0 cm at 1 year postoperatively.

Discussion

In this case, osteosynthesis with muscle advancement of the supraspinatus and infraspinatus muscles for a greater tuberosity fracture

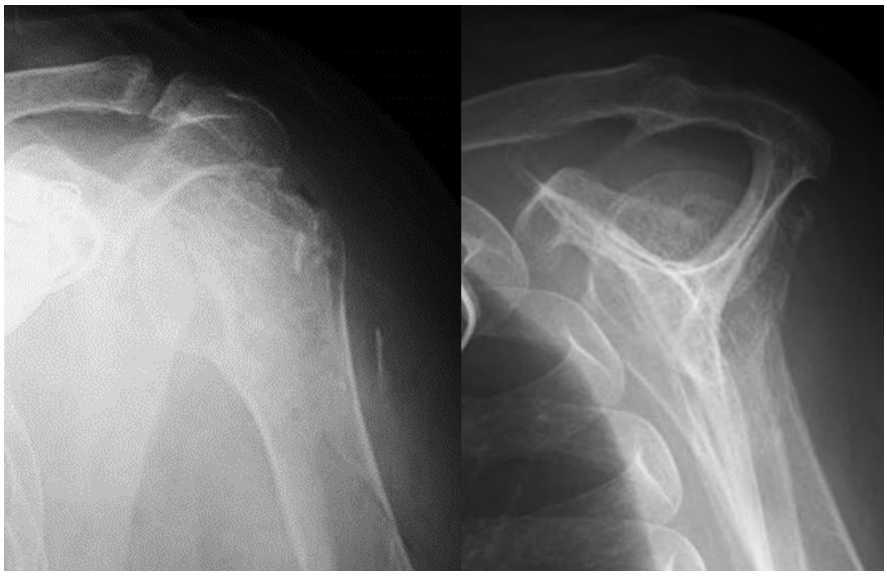

Figure 3. Postoperative radiographs of the left shoulder.

with severe retraction resulted in an anatomical reduction and satisfactory shoulder functional outcomes without postoperative complications.

To date, there has been only 1 report of arthroscopic techniques as a surgical procedure for greater tuberosity avulsion fractures with severe displacement.[3] In this technique, a "mid-scapular portal" was created at the center of the scapular spine, and several traction sutures were applied to the rotator cuff muscle from this portal to assist in the reduction and extensively release the tendon adhesion.[3] However, this procedure requires advanced shoulder arthroscopy. In open surgery, such as in this case, release of the rotator cuff muscles may result in blind and insufficient release due to the humeral head or fracture fragments.

In this case, the surgical procedure had 2 major advantages. First, muscle advancement allows for the retracted rotator cuff muscles to be pulled out, facilitating fracture reduction. Previous studies have reported that muscle advancement enables a 2-5 cm lateral sliding of the rotator cuff muscles for irreparable rotator cuff tears.[7-9] This finding raises the possibility that muscle advancement enables sliding of the greater tuberosity fragments, to which the rotator cuff is attached laterally, during surgery for greater tuberosity fractures. Intraoperative findings in this case showed that the retracted greater tuberosity fragments slid approximately 2-3 cm laterally after muscle advancement, contributing to anatomical reduction. Second, muscle advancement can reduce the tension exerted by the rotator cuff muscles on the greater tuberosity, thereby preventing postoperative fixation failure. Postoperative loss of reduction or malreduction is a common complication of greater tuberosity fractures and is thought to be caused by traction of the rotator cuff muscles.[10] Morihara et al[6] reported that muscle advancement for irreparable rotator cuff tears reduced the average tension of the rotator cuff muscles at the insertion from 30 to 20 N. This suggests that osteosynthesis with muscle advancement reduces the traction force on the greater tuberosity fragments postoperatively, which may be one of the factors preventing the loss of reduction.

However, this technique has the disadvantages of requiring an additional skin incision on the scapular spine and the risk of injury to the suprascapular and spinal accessory nerves. Additionally, since this case involved comminuted greater tuberosity fragments, suture anchor fixation was used, benefiting from the strong tendon-bone junction; however, this procedure carries a risk of anchor pullout in osteoporotic bone.[11] Therefore, plate fixation may provide more rigid fixation in elderly patients with split-type fractures such as in the present case.[12]

This surgical procedure is indicated for chronic cases with a high risk of difficulty in anatomical reduction during surgery. Specifically, given that the muscle advancement procedure is usually indicated for irreparable rotator cuff tears with a retraction of more than 3 cm from the footprint or to the glenoid level,[6-8] this procedure can be applied in cases with a displacement of more than 3 cm or to the glenoid level. Among these fracture types, chronic displacement of greater tuberosity fragments can make intraoperative reduction difficult due to adhesion and soft tissue contraction;[1] therefore, it is desirable to prepare for muscle advancement procedures in advance for chronic, severely retracted greater tuberosity fractures. Additionally, in cases with a high risk of postoperative secondary displacement, such as comminuted fractures, poor bone mineral density, or shoulder dislocation,[13] muscle advancement procedures may reduce the postoperative tension of the rotator cuff muscles and potentially prevent fixation failure; however, further studies are needed to verify this hypothesis.

In summary, this case report provides new information regarding surgery for greater tuberosity fractures with severe retraction. Osteosynthesis using muscle advancement may reduce the traction force of the rotator cuff on the greater tuberosity, allowing anatomical reduction and firm fixation of greater tuberosity fragments.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Informed Consent: Written informed consent was obtained from the patient who agreed to take part in the study.

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Declaration of Interests: The authors have no conflict of interest to declare.

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