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CASE SERIES

Novel Techniques in Treating Calcaneal Tuberosity Fractures

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ABSTRACT

Calcaneal tuberosity fractures comprise only 1 to 2% of all calcaneal fractures. Treatment of these injuries has traditionally included open reduction and internal fixation with various means including lag screws, suture anchors and K-wires. We report on a series of cases treated with excision of the tuberosity fragment with repair of the Achilles tendon supplemented by a flexor hallucis longus tendon transfer.

Keywords: Calcaneus, Tuberosity, Fracture, Achilles, Flexor hallucis longus.

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INTRODUCTION

Calcaneal tuberosity fractures account for approximately 1 to 2% of all calcaneal fractures.[1,2] These fractures usually occur from a strong concentric contraction of the gastrocsoleus complex on the calcaneal tuberosity. The peak incidence in women occurs in the seventh decade.[2,3]

Three types of calcaneal tuberosity fractures have been described. Type I fractures describe an avulsion of a small shell of cortical bone off the calcaneal tuberosity with the Achilles tendon attached. Type II fractures describe a larger fragment that extends to the posterior facet. Type III fractures are a small avulsion from the middle of the tuberosity.[2,4]

Because the skin of the posterior heel can be compromised and the function of the gastroc-soleus complex is usually limited after these injuries, operative treatment is recommended. The purpose of the present study is to describe a novel technique for treatment of posterior calcaneal tuberosity fractures by excision of the tuberosity fragment with repair of the Achilles tendon using an anchoring system and supplemented by a flexor hallucis longus (FHL) tendon transfer.

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SURGICAL TECHNIQUE

A direct posterior incision is made over the Achilles tendon and carried down to the epitenon, which is incised. After removal of the hematoma at the fracture site, the tuberosity fragment is identified. The Achilles tendon is split lengthwise and carefully released subperiosteally from the tuberosity fragment (Fig. 1).

The fractured tuberosity fragment is then removed (Fig. 2).

The deep fascia of the posterior compartment is incised with a 15-blade and opened proximally and distally. The FHL muscle belly is identified and traced distally to the tendon. Traction is placed allowing for the tendon to retract into the surgical wound. The ankle and great toe are maximally plantarflexed and the FHL tendon is released at its most distal aspect through the fibro-osseous canal. A tag suture is placed on the end of the tendon, and it is appropriately sized.

A guide pin for the biotenodesis reamer is placed approximately just anterior to the Achilles tendon insertion site. The pin is driven through the inferior aspect of the calcaneus. An appropriately sized reamer is drilled over the guide pin, throughout the entire height of the calcaneus. The FHL tendon stump is brought through the prior drill hole exiting through the inferior aspect of the calcaneus (Fig. 3). With the foot held in maximum plantar flexion, the FHL tendon is tensioned and held in place with a biotenodesis screw.

Arthrex (Naples, FL) suture bridge anchors are placed between the tunnel and the lateral and medial calcaneal walls, respectively. The sutures are brought through the Achilles approximately 1 to 1.5 cm proximal to the level of the anchors and are tied. This allows for the Achilles to brought distally by a few millimeters. A nonabsorbable suture is used repair the split in the Achilles tendon. While throwing these sutures, the FHL tendon is tied to the Achilles tendon.

The remaining two anchors of the suture bridge system are placed distally in the calcaneus. One limb of each stitch from the anchors used in the prior step is used to tie into the peg, thereby reapproximating the Achilles insertion site on the calcaneus (Fig. 4).

Fig. 1: A 69-year-old female with a calcaneal tuberosity avulsion fracture. The Achilles tendon epitenon is incised revealing the tuberosity fragment

The epitenon and subcutaneous tissues are closed with #2-0 absorbable sutures and the skin is closed with staples. The patient is placed into a well-padded Bulky Jones splint in resting plantar flexion.

CASE REPORTS

Case 1

A 57-year-old male with past medical history significant for noninsulin dependent diabetes mellitus sustained an injury to his left heel resulting in a calcaneal tuberosity fracture (Fig. 5A). He presented to the office 10 days after his injury.

At that time, he had a 3 × 4 cm necrotic eschar at the midportion of wound. Plastic surgery was consulted and felt that orthopaedic surgical intervention could progress as planned and that the soft tissue needed to demarcate prior to plastic surgery intervention. The patient underwent excision of the calcaneal tuberosity fracture with repair of the Achilles tendon, augmented with a FHL transfer.

Eight weeks postoperatively, he continued to have a necrotic eschar. At this time, he underwent a fasciocutaneous sural island flap and a split thickness skin graft. Twelve weeks after his index procedure he was allowed to weight bear as tolerated in a CAM boot with eventual transition to normal shoe at 16 weeks. At last follow-up at 1 year, his motion was 50° of active plantar flexion and 0° dorsiflexion. He was back to work, full-duties with no limitations.

At the final follow-up at 1 year, the physical and mental scores of the SF-12 survey of the patient are 56 and 57 which stands well above the national average.[5]

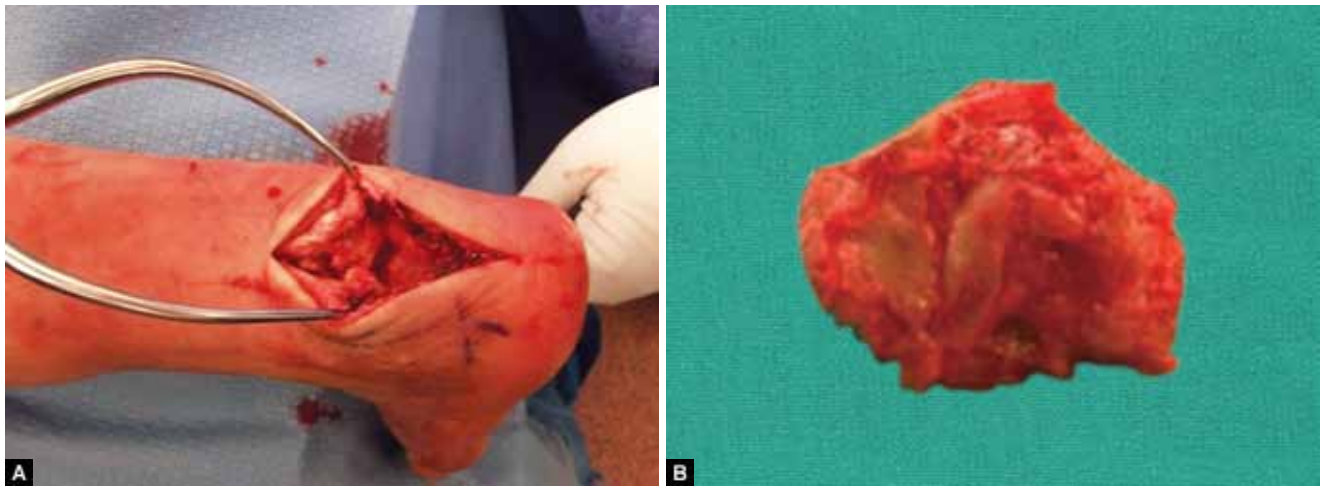
Case 2

A 69-year-old female with past medical history significant for insulin-dependent type II diabetes mellitus and tobacco abuse injured her left ankle in a same level fall. Radiographs confirmed the presence of an avulsion fracture of her calcaneal tuberosity (Fig. 5B).

Given the nature of her injury she underwent a left posterior calcaneal tuberosity excision along with Achilles tendon repair supplemented with a FHL transfer.

Postoperatively, she was placed into a short leg non-weight bearing cast. At 6 weeks, she was placed in a CAM boot and start physical therapy. Twenty-four weeks after surgery, she was back to her normal activities with equal range of motion compared to her uninjured side. At 1 year follow-up, the patient reported no limitation in her daily activities and had only mild limitation in performing stairs.

At the final follow-up at 13 months, the physical and mental scores of the SF-12 survey of the patient are 50 and 50 which stands at the national average scores of PCS and MCS.[5]



Figs 2A and B: A 69-year-old female with a calcaneal tuberosity avulsion fracture: (A) The Achilles tendon is split longitudinally and released subperiosteally from the remaining bone and (B) the tuberosity fragment is excised

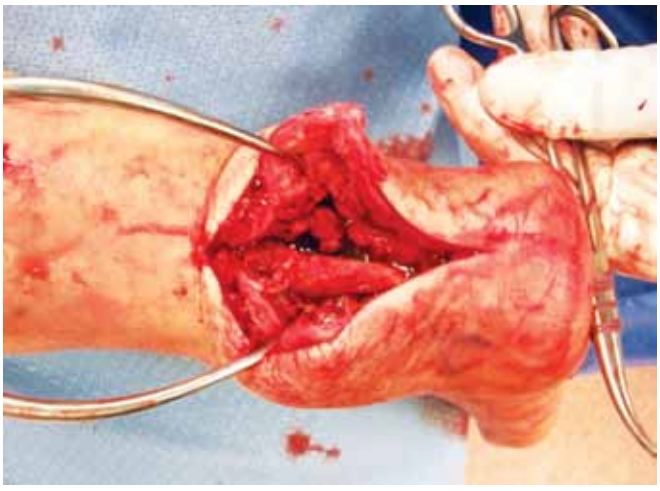


Fig. 3: The flexor hallucis longus (FHL) tendon is released from its fibro-osseous canal and brought through a drill hole in the inferior aspect of the calcaneus

Fig. 4: The FHL tendon is tensioned appropriately and reapproximated to the Achilles insertion site

Figs 5A to C: Lateral radiographs of left foot showing avulsion of the calcaneal tuberosity

Case 3

A 43-year-old male, with no significant past medical history, presented to the emergency department after he was ejected from his motorcycle. Plain radiography showed a large, displaced calcaneal tuberosity avulsion fracture (Fig. 5C).

Given the nature of the injury, he underwent a left calcaneal tuberosity excision along with Achilles tendon repair supplemented with a FHL transfer as detailed above.

Postoperatively, he was made nonweightbearing and placed into a plantarflexion splint. At 6 weeks postoperative, he was allowed to weight bear as tolerated in a CAM boot with a gradual return to normal activities by 12 weeks. At 18 weeks postoperatively he was doing very well and was noted to have equal active dorsiflexion and plantarflexion bilaterally.

Despite the clinical improvement however, at the final follow-up at 2 years, the physical and mental scores of the

SF-12 survey of the patient are 39 and 32 which are below the national average.[5] This patient has a very strenuous job which requires high impact on his feet. It is felt that his outcomes reflect the high demand that he places on his limb.

DISCUSSION

We present a series of patients who were successfully treated with excision of a calcaneal tuberosity fragment and repair of the Achilles tendon supplemented by flexor hallucis longus tendon transfer. To our knowledge this has not been reported in the current orthopaedic literature.

Most extra-articular fractures of the calcaneus are managed nonoperatively, provided that the injury does not change the weight-bearing surface of the foot or alter hindfoot biomechanics. However, calcaneal tuberosity fractures have been traditionally treated with operative intervention.

Squires et al reported on 24 calcaneal tuberosity fractures treated with a lateral oblique tension-band technique. Loss of reduction or wound healing problems was not observed. It was the conclusion that nonoperative treatment of displaced tuberosity fractures resulted in a poor outcome and that open reduction and internal fixation with a lateral tension-band technique should be used.[6]

Banarjee, et al described in 5 patients a suture fixation technique through transosseous drill holes in the calcaneal body for smaller tuberosity fragments and supplemented with screw fixation for larger fragments. Patients were followed to a maximum of 12 months. No difficulties in fracture healing were reported and a minimum of 4/5 plantarflexion strength was regained.[2]

It has been shown previously that suture anchor fixation of the Achilles tendon in calcaneal tuberosity avulsion fractures adds to the strength of the repair. Khazen et al looked at 12 cadaveric specimens and compared lag screw fixation alone of the fracture *vs* the addition of suture anchors for fixation of the Achilles tendon. The specimens treated with lag screws alone failed at an average of 200 N less than the comparative suture anchor group.[7]

Wound healing issues are a known complication of calcaneal tuberosity fractures. Hess et al reported on a case series of 3 patients with calcaneal tuberosity fractures who went on to have skin necrosis secondary to a delay in treatment.[8] In a large series of 139 tongue-type calcaneal fractures, Gardner et al reported that 21% had some degree of posterior soft tissue compromise with a higher incidence occurring in those patients who had greater fracture displacement, a delay in seeking appropriate medical care or smoked tobacco.[9,10]

Because of potential for wound healing complications with these fractures, minimally invasive techniques have been developed. Tornetta treated 41 intra-articular calcaneal fractures with a percutaneous technique involving K-wire reduction and fixation with cannulated screws. No major wound complications were reported; however 5 of the 41 patients had superficial pin site infections treated with oral antibiotics.[11]

Nonunion of calcaneal fractures after open reduction and internal fixation (ORIF) is a rare complication but has been reported. In a series of 157 intra-articular calcaneal fractures treated by ORIF, Zwipp reported a nonunion rate of 1.3%.[12] Molloy prospectively evaluated 14 calcaneal nonunions after ORIF, with 1 being a tongue-type fracture, and found 3 (21%) overt cases of osteomyelitis. There was a 60% reoperation rate after the initial nonunion takedown and a high rate (20%) of wound dehiscence, which was attributed to repeat surgery through the delicate soft tissues around the heel. They identified the most significant risk factors for a nonunion to be quality of reduction and appropriateness of fixation.[13]

Immobilization after open reduction and internal fixation is not uniformly agreed upon in the literature. After ORIF of a purely extra-articular fracture, most authors advocate a short period of immobilization in a below-the-knee splint followed by early subtalar range of motion. If the fracture line extends to involve an intra-articular component, restricted weight bearing and immobilization is recommended for 6 weeks.[5] Tuberosity fractures treated nonoperatively require cast or splint immobilization for 6 to 8 weeks with the possibility of fracture malunion causing a misshapen heel and difficulty with shoe wear.[6]

Our described technique allows for excision of the tuberosity fragment with primary repair of the Achilles tendon using suture anchors supplemented by an FHL tendon transfer. Follow-up out to a minimum of 1 year for 2 of our 3 patients showed excellent return to normal daily activities with minimal to no limitations. By not using internal fixation, we avoid the potential for nonunion, complications associated with malunion such as weakness in plantar flexion or difficulty with shoe wear, and device failure.[10]

In our reported patients, 1 did have wound healing problems necessitating soft tissue coverage by plastic surgery; however, soft tissue compromise in the tenuous posterior calcaneal soft tissues is a well described complication of these types of fractures as noted by both Hess[8] and Gardner[9] and we do not consider this to be specific to our method of treatment. In addition, this patient was delayed in seeking definitive orthopaedic care, which is a known risk factor for posterior soft tissue compromise.[9]

We acknowledge the limitation of our report of the limited case numbers as well as lack of long-term follow-up.

Even still, we do believe that there are some distinct advantages to this technique that warrant its consideration in the calcaneal avulsion fracture.

CONCLUSION

Posterior calcaneal tuberosity fractures treated with excision of the fractured tuberosity fragment along with primary repair of the Achilles tendon supplemented with a FHL tendon transfer appears to be a safe and effective method of treatment for this injury.

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