Avulsion Fracture of the Calcaneal Tuberosity: A soft tissue complication from delayed treatment

by M. Radzilani MBChB, E. D’Alton MBChB,(Pret), MMed (Orth), R.G Golele, MBChB (Natal), MFGP (SA), MMed (Orth), FCS Orth (SA)

The Foot and Ankle Online Journal 3 (6): 1

Avulsion fractures of the calcaneal tuberosity are rare extra-articular injuries that usually occur indirectly from forced ankle dorsiflexion particularly in elderly females. Direct trauma to the calcaneal tuberosity is an infrequent cause particularly in young adults. Failure to treat these injuries urgently with open reduction and internal fixation may result in soft tissue complications. We review the literature and present a case report in which soft tissue complications occurred after a direct traumatic avulsion fracture of the calcaneal tuberosity occurred due to delayed treatment.

Key words: Calcaneal avulsion fracture, calcaneal tuberosity, heel fracture.

Accepted: May, 2010 Published: June, 2010

Most calcaneal fractures are closed injuries that are treated non-operatively, or if treated operatively, surgery is delayed to allow the soft tissues to recover and lower the incidence of incisional complications. This delayed approach in calcaneal tuberosity avulsion fractures can lead to skin necrosis and severe wound complications.

We present a male patient who presented with avulsion fracture of the calcaneal tuberosity due to direct trauma to the calcaneal tuberosity and subsequently developed severe soft tissue complications due to delayed treatment.

The purpose of this report is to emphasize the comparative rarity of tuberosity avulsion fractures of the calcaneus particularly those that are due to direct trauma and to highlight that this subset of calcaneal fractures should be treated urgently to avoid soft tissue complications.
A 37 year old male patient was assaulted on his left heel with a steel rod 7 weeks before presenting to our center. He had sustained a closed injury, which was initially treated with a plaster of Paris (POP) cast. He then complained of persistent pain inside the plaster cast. Upon removal of the cast, an open wound was identified. The wound was dressed as an outpatient for about 6 weeks before referral. He presented to us with a septic wound, heel boss deformity and a visible bone fragment through the wound. (Fig. 1) He was unable to plantarflex the ankle against resistance. Plain radiograph examination revealed an open beak type fracture or avulsion fracture of the posterior calcaneus as shown in figure 2. Consent was obtained for photographs and documentation.

Wound cultures revealed staphylococcus aureus, which was sensitive to cloxacillin. The sepsis was treated for 2 weeks with suction drainage and intravenous cloxacillin until the wound was healed. During this time, the ankle was immobilized with an ankle orthosis with a limiting upstop. After the wound had healed and blood markers indicated that the infection was eradicated, open reduction and internal fixation of the fracture was performed. Post-operative radiograph is shown in figure 3. After two weeks the surgical wound was healed and a below knee cast was then applied in plantarflexion for 8 weeks.
After 12 weeks, he was allowed to fully weight bear when there were signs of bone union radiographically. He was then referred to physiotherapy for rehabilitation with an emphasis on Achilles tendon stretching.

**Anatomy**

Surgical Anatomy reveals variable insertion of the Achilles into the posterior tuberosity of the calcaneus. (Fig. 4) These anatomical variations have been confirmed surgically by various studies.  

Neonates have a thick, continuous sheet of fibers connecting the Achilles tendon and the plantar fascia. With age, the continuity between these two structures diminishes and the retrocalcaneal bursa adjacent to the tendon Achilles insertion become calcified, altering the actual zone of tendon attachment. These age-related changes to the Achilles tendon, combined with diminished bone density, explain an increased incidence of calcaneal tuberosity avulsion fractures in the elderly, particularly females.
**Mechanism injury** | **Possible Etiology**
---|---
Dorsiflexion violence<sup>1,2</sup> | • A fall from height
Violent triceps surae muscle contraction with simultaneous extension of the knee<sup>3,14,17</sup> | • Sprinting
Direct blunt blow to the hindfoot<sup>2,4,17,18</sup> | • Blunt Trauma
Direct penetrating trauma<sup>4,14,17,18</sup> | • Gunshot
Neuropathic fractures<sup>3,19,20</sup> | • Diabetes Mellitus

**Table 1** Various mechanisms of avulsion fracture injury associated with possible etiologies as described in the literature.

**Risk factors**

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Possible Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Degeneration of tendoAchilles insertion and diminished bone density in the elderly particularly females&lt;sup&gt;2,6,7&lt;/sup&gt;</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>Diminished bone density&lt;sup&gt;2,6,7,8&lt;/sup&gt;</td>
</tr>
<tr>
<td>Neuropathic disorders</td>
<td>Repeated microtrauma. e.g diabetes mellitus&lt;sup&gt;3,4,5,6,7,19,20&lt;/sup&gt;</td>
</tr>
<tr>
<td>Metabolic diseases</td>
<td>Diseases like osteomalacia, hyperparathyroidism, amyloidosis, end stage renal failure, rheumatoid arthritis&lt;sup&gt;7,9,10,21&lt;/sup&gt;</td>
</tr>
<tr>
<td>Drugs</td>
<td>Corticosteroids, alcohol, smoking, fluoride, fluoroquinolones&lt;sup&gt;7,9,10,21&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**Table 2** Risk factors that can contribute to calcaneal avulsion fractures as described in the literature.

**Pathogenesis**

The posterior skin of the heel is thin with precarious blood supply<sup>10</sup>. The ankle initially assumes a position of maximal plantarflexion as in falling from a height. In this position the force from a loaded Achilles tendon is transmitted to the calcaneal tuberosity, and to the plantar fascia by a series of highly oriented trabeculae<sup>6,16</sup>. When the gastrocnemius-soleus complex contracts which occurs after a low impact fall, sudden forced dorsiflexion occurs, pulling the tendon Achilles and causing avulsion of a fragment of bone. The size of the avulsed fragment will depend on the position of the foot during impact. During pronation, the whole tuberosity is involved whereas only a part of the tuberosity is involved during supination.

The superior fragment is displaced upwards, presumably due to the pull of the Achilles tendon, and rotated so that the postero-superior border moves upwards and the postero-inferior edge moves posteriorly, compressing the thin skin at the back of the heel. The fragment hinges on its anterior apex as it displaces so that a fracture, which had minimal displacement anteriorly, is often significantly displaced posteriorly, potentially giving rise to a heel boss, pressure necrosis and formation of an ulcer as in our case.

This phenomenon explains the disability resulting from so-called ‘undiagnosed’ fractures<sup>9</sup>. Mechanisms of injury and possible etiologies has been described as shown in Table 1. The risk factors that may contribute to calcaneal tuberosity fractures are described in Table 2.

© The Foot and Ankle Online Journal, 2010
Table 3 Three types of classifications describing calcaneal avulsion fractures. (with permission granted by Beavis, et al., and Foot & Ankle International Publishers)

<table>
<thead>
<tr>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>True avulsion fracture or ‘sleeve’ type tuberosity fracture described by Rothberg.</td>
<td>This is a ‘Beak’ type of avulsion fracture. In these fractures there is an oblique fracture line running posteriorly from just behind the Bohler’s angle.</td>
<td>Infrafrursal avulsion fracture from the middle third of the posterior tuberosity. This is very rare.</td>
</tr>
</tbody>
</table>

Classification

In older reviews of the literature, two types of tuberosity avulsions were distinguished into those that do not involve the insertion of the Achilles tendon (“beak” fracture) and those that do involve the insertion of the Achilles (avulsion fracture). It is currently thought that these 2 fractures are the same entity and are due to variations in the insertion of Achilles tendon. Beavis, et al., has recently proposed a classification system incorporating these two previously described fractures patterns in the literature and one they described themselves. (Table 3)

Discussion

Avulsion fractures of the calcaneal tuberosity are rare. They have been classically described as occurring from indirect trauma produced by falls in which the patient lands on the foot, causing dorsiflexion, with resulting Achilles tendon tension leading to an avulsion.

Direct trauma to the calcaneal tuberosity, as in our case, is an infrequent cause of this type of fracture. Malgaigne described avulsion fractures of the tuberosity of the calcaneus as early as 1843. Management and treatment is often dictated by the age, health and functional demands of the patient as well as degree of separation of the fracture fragments. With minimal or no displacement (≤1 cm), conservative treatment either in an equinus cast or a functional boot has yielded satisfactory results. This is accomplished by treatment in a short-leg non-weightbearing equinus cast for 6 to 12 weeks until radiographic union is confirmed. The patient is then gradually brought out of equinus and weight bearing is increased.

Complications after non-operative treatment of calcaneal tuberosity fractures include: skin necrosis, Haglund’s deformity and loss of plantarflexion power. In displaced fractures, skin necrosis as a result of pressure from the underlying fragment is significant cause for concern.
It should be remembered that the soft tissue overlying the Achilles tendon and calcaneal tuberosity is thin with a precarious blood supply. For these reasons these fractures should be treated as emergencies with open reduction and internal fixation.\textsuperscript{10}

Methods of fixation include suturing of the avulsed bone fragment, suture anchors, tension band wiring and screw fixation as performed in the present case report.\textsuperscript{6,7,9} The choice of technique depends on the size of the avulsed bone fragment and the degree of osteopenia. Screw fixation has been advocated; however it should be kept in mind that most of these fractures are insufficiency fractures. Screw purchase in the bone is poor and healing takes longer to occur.

A better method of fixation would be tension band wiring as described by Brunner and Weber.\textsuperscript{24} The fracture is then protected in a short-leg equinus cast for six to eight weeks non-weight bearing until there is radiological evidence of bony union. After union, an ankle orthosis with a limiting upstop is issued for up to one year. Union in these fractures has been reported in the literature from ten weeks to a year.\textsuperscript{3,6,7,9}

Neuropathic fractures takes longer to heal compared to traumatic fractures in young adults.\textsuperscript{3,10,20}

Calcaneal fractures have a high incidence of skin and soft tissue injury. Fracture blisters and deep contusion are common and play an important role in decision-making regarding treatment. Most calcaneal fractures are treated non-operatively, or if treated operatively, surgery is delayed for 2 to 3 weeks to allow the soft tissues to recover and lower the incidence of incisional complications. This delayed approach in calcaneal tuberosity avulsion fractures can lead to skin necrosis and severe wound complications.\textsuperscript{10}

Soft tissue problems in avulsion fractures of the calcaneal tuberosity have been known for decades. The case that Rothberg described in 1939 had a superficial infection postoperatively.\textsuperscript{1} Dieterle noted soft tissue impingement by the fracture fragments in his classical description of “open-beak” type of calcaneal tuberosity fracture in 1940.\textsuperscript{25}

Arner, et al., showed associated rupturing of a small medial part of the Achilles tendon proximal to an avulsed bony fragment in all of the three cases of avulsion fractures of the calcaneal tuberosity that they reported.\textsuperscript{17}

Protheroe drew attention to the risk of pressure necrosis of skin overlying displaced fragments and he advocated the need for early operative correction to prevent skin damage.\textsuperscript{12} Lowy also described one of his four cases he reported in 1969 which was marred by a persistent sinus which did not heal for 9 months after surgical intervention.\textsuperscript{11} Lyngstadaas made mention of the fact that the Achilles tendon may be damaged when it runs over the sharp fragments of an avulsed bone in a poorly repositioned beak.\textsuperscript{14} He advocated surgery for this type of soft tissue threatening fractures although necrosis developed on the incision wound of one of the two patients he treated surgically due to what he described as poor circulation.

Cooper, et al., reported on a case of an open fracture of calcaneal tuberosity due to a gunshot injury. The patient was treated with wound debridement, open reduction and internal fixation and intravenous antibiotics as an emergency. The patient went on to unite with no disability.\textsuperscript{4} Recently, Hess, et al., reported on three cases of avulsion fractures of the calcaneal tuberosity, which developed soft tissues complications because of delayed surgical intervention. They concluded that the only way to prevent these complications is to reduce and fix the fracture expeditiously, thus decompressing the skin.\textsuperscript{10}

In 1980, El-Khoury, et al., described neuropathic calcaneal tuberosity fractures in diabetic patients. They coined the name calcaneal insufficiency avulsion fractures for these fractures. Of importance is the fact that calcaneal insufficiency fractures have high incidence of complications including that of soft tissues.\textsuperscript{3,19,20}

Review of this literature supports that a delayed approach in avulsion fractures can lead to skin necrosis and severe wound complications. The initial evaluating physician must therefore recognize these signs to get these injuries treated early.
Signs of skin at risk at presentation are blanching and lack of capillary refill. These are followed by overt skin necrosis, tissue breakdown and infection as in our case. All the complications in our case may have been prevented if more expedient treatment was given on presentation at the referral hospital.

Conclusion

Tuberosity avulsion fractures are rare, particularly those due to direct trauma. They represent a subset of calcaneal fractures that should be addressed urgently to avoid complications, particularly skin breakdown and subsequent sepsis. The initial evaluating physician must recognize the signs of skin at risk so that treatment can be offered urgently. Non-operative treatment has been shown to yield poor results. The golden standard is early surgical intervention when indicated.

References