AVULSION FRACTURES OF THE CALCANEUS

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Fractures of the calcaneus [os calcis] have received much attention because a large number involve the subtalar joint and frequently lead to chronic pain and osteoarthritic changes. Fractures not involving the subtalar joint are well recognised, but little attention has been directed to avulsion fractures except to differentiate them from the beak fracture, which is regarded as a separate entity having different significance.

Five cases are reported of avulsion fractures of the upper part of the tuberosity of the calcaneus.

CASE REPORTS

Case 1—A woman aged fifty-five fell from a chair suffering severe pain in the right heel sufficient to prevent her from walking. On admission there were swelling and discoloration of the heel with marked tenderness over the back of calcaneus, weakness of plantar-flexion of the ankle and loss of function of the calcaneal tendon as demonstrated on calf compression. Radiographs showed an avulsion fracture of the upper part of the tuberosity of the calcaneus, with wide separation at the fracture site and only a minor degree of comminution of the avulsed fragment (Fig. 1).

Operation—At open reduction the calcaneal tendon was found to be densely adherent to the avulsed fragment over two-thirds of its posterior aspect. There was a ragged transverse tear of the periosteum of the distal fragment below the level of fracture. Only minor comminution of the avulsed fragment had occurred and it was possible to effect reduction of the avulsed fragment and secure it with a lag screw (Fig. 2). The periosteal tear was repaired with catgut sutures. The limb was immobilised in a below-knee plaster with the foot in full equinus.

Progress—There was full functional recovery at review six months later.

Case 2—A woman aged fifty-six tripped while descending stairs in darkness and suffered severe pain in the left heel which prevented her walking. On admission there was marked swelling and bruising of the heel with tenderness over the back of the calcaneus at its proximal border, weakness of plantar-flexion of the ankle, and loss of function of the calcaneal tendon demonstrable on calf compression. Radiographs showed fragments of bone avulsed from the proximal part of the tuberosity of the calcaneus (Fig. 3). The wide separation of the fragments could not be reduced by placing the foot in equinus (Fig. 4).

Operation—The tendo calcaneus was found to have ruptured at the level of its insertion into the crest midway along the posterior surface of the calcaneus. The avulsed fragments of bone were densely adherent to the calcaneal tendon proximal to the rupture. The bony fragments were too comminuted and friable to permit any form of metallic fixation to the calcaneus, but reduction was secured by means of a nylon suture passed through the tendon and brought out and tied over a button on the plantar aspect of the heel. Further repair of the torn end of the tendon to the periosteum of the calcaneus was then possible. A plaster-of-Paris cast was applied with the foot in full equinus (Fig. 5).

Progress—The securing button was removed and the nylon suture withdrawn at four and a half weeks and the equinus was gradually reduced. At eight weeks the plaster was removed and shortly thereafter unprotected weight-bearing was resumed. At review six months after the injury the patient was symptom-free, with a full range of movement at the ankle joint and
Case 1. Figure 1—Radiograph of the original injury. Figure 2—Radiograph of the heel after operation.

Case 2. Figure 3—Showing the original injury. Figure 4—Showing no change in position of the fragments when the foot was placed in equinus. Figure 5—Position of the fragments after operation.
normal power of plantar-flexion. Calf compression produced the normal plantar-flexion response and she was easily able to stand on her toes and to climb stairs normally.

**Case 3**—A woman aged seventy-seven tripped on stairs and felt a "tearing" pain in the right heel which made walking painful and difficult. She rested at home for a week before reporting to hospital, where she was found to have a grossly swollen and discoloured right heel, with tenderness over the upper part of the tuberosity of the calcaneus, weakness of plantar-flexion and loss of passive plantar-flexion on calf compression. Radiographs showed an avulsion fracture of the calcaneus.

*Treatment and progress*—She was treated with supportive bandaging and active physiotherapy. Four and a half weeks later she was free from pain and walking reasonably well. Ten months after injury she had no complaints regarding the right foot but lacked "thrust off" power on the right side, especially when climbing stairs. Examination showed a thickened bony prominence at the upper part of the calcaneus. She was unable to stand on the toes of the right foot alone, and calf compression produced markedly reduced plantar-flexion of the right foot.

**Case 4**—A woman aged sixty-seven was knocked down by a motor vehicle. She sustained an impacted fracture of the neck of the right humerus and an avulsion fracture of the right calcaneus. She had been hemiplegic on the right side for fourteen years following a cerebrovascular incident. There were pain, swelling and discoloration of the right heel. Loss of plantar-flexion on calf compression and no active plantar-flexion of the right foot. Radiographs showed an avulsion fracture of the insertion of the calcaneal tendon into the calcaneus.

*Treatment and progress*—She was treated in a below-knee walking plaster with the foot and ankle at a right angle for two and a half weeks and thereafter supportive bandaging was applied. A month after injury she was managing well. At review seven months after injury she was only moderately active, seldom going out of doors, though this restriction in her activities was largely due to her residual hemiplegia. There was little active plantar-flexion power in the right ankle, and calf compression produced only a slight plantar-flexion response.

**Case 5**—A man aged thirty-nine was working as a caulker in a shipyard when a falling sheet of metal struck him on the back of the legs and knocked him forwards to the deck, injuring both feet. In the right foot he sustained metatarsal fractures. In the left foot he sustained a comminuted fracture of the calcaneus probably partly from direct violence and partly from forcible extension of the ankle. The upper part of the calcaneal fracture was of the nature of a "beak" fracture (Fig. 6) and the subtalar joint was not involved.

*Treatment and progress*—He was treated initially by elevation and compression bandaging, but within a week necrosis of the skin overlying the "beak" fragment was apparent. The

![Fig. 6](image1)

*Fig. 6*  
Case 5. Figure 6—Radiograph of the original injury.  
*Fig. 7*—Radiograph of the heel after internal fixation with Steinmann's pin.

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devitalised skin was excised and the displaced fragment reduced by inserting a Steinmann pin into it and levering it back into position, the reduction being maintained by a below-knee plaster incorporating the pin (Fig. 7). The pin and plaster were removed at two months. A sinus persisted for a further two months before healing spontaneously. Three years after the injury the patient was readmitted for trimming of a troublesome prominence of the posterior aspect of the calcaneus. At review four years after injury he had no complaints regarding the left heel. He was unaware of any weakness and had full function and power. There was a puckered scar overlying the heel where there had originally been skin loss, but this was soundly healed and gave no trouble. He had long since returned to his former employment and was able to climb ladders without difficulty.

**DISCUSSION**

In the classification of calcaneal fractures (Böhler 1931 and 1935, Essex-Lopresti 1952, Watson-Jones 1955) little attention is directed to avulsion fractures. The beak fracture has been regarded as a distinct entity and not a variant of the avulsion fracture. This belief largely stems from the different extent of bony involvement, for a beak fracture involves less than the upper half of the tuberosity of the calcaneus whereas the avulsion fracture involves never less than half the tuberosity. This concept is based on the teachings of the standard textbooks of anatomy (Cunningham 1951) that the calcaneal tendon is inserted into the transverse crest at the mid-point of the posterior surface of the calcaneus where it then becomes continuous with the periosteum over the distal half of the bone and thus with the plantar fascia. The calcaneal tendon is separated from the proximal half of the posterior surface of the bone by an intervening bursa. That this is generally true is the experience of any surgeon who operates in this region.

Yet in the two cases (Cases 1 and 2) in which operation was undertaken the avulsed fragment was densely adherent to the calcaneal tendon over the greater part of its posterior aspect. In other words the tendon was inserted considerably proximal to the classically described anatomical insertion. Under such circumstances it is not surprising to find that avulsion fragments may involve only the proximal half of the tuberosity of the calcaneus. One of these cases showed a fragment radiologically identical with a beak fracture and was at operation demonstrated to be a true avulsion fracture associated with the extensive proximal tendon insertion described. It is suggested that the beak fracture is an avulsion fracture and not a distinct injury due to some other obscure mechanism.

The cause of the additional tendon attachment is not known. In neither case was there any history of previous disease or injury that might account for the adherence, and it is suggested that this is likely to be a normal variation in insertion of the calcaneal tendon. Similar extensive tendon attachment is a relatively common finding when the calcaneus is deliberately freed from its tendinous attachment during a Syme amputation (Whitefield 1968), but the exact incidence is not known.

The most important effect of avulsion fractures of the tuberosity of the calcaneus is impairment of heel-cord function and, as a general rule, the greater the displacement of the avulsed fragments the greater the likely functional loss and the more the need for surgical repair.

An elderly patient with impaired function or reduced physical demands (Cases 3 and 4) who has only a mildly displaced avulsion fracture is satisfactorily treated by non-operative means—initial rest and support followed by early physiotherapy. Reasonable functional recovery occurs and the only residual symptoms are those of occasional discomfort and weakness of plantar-flexion as demonstrated by difficulty in climbing stairs and standing on tiptoe. On the other hand, in a younger patient with severe displacement, satisfactory functional return can only follow operative replacement and fixation of the avulsed fragment.
The technique of fixation is the surgeon's personal choice as determined by circumstances: suture, screw fixation, stapling or spike, and plaster-of-Paris.

A displaced fragment of the calcaneus may cause impairment of overlying skin circulation (Case 5) and this may necessitate operative reduction and fixation even in the most elderly and inactive patient.

**SUMMARY**

1. Five cases of avulsion fracture of the calcaneus are reported.
2. The "beak" fracture of the calcaneus is thought to be a variant of the avulsion fracture and not a separate entity.
3. The variable attachment of the calcaneal tendon to the calcaneus is described, and its relationship to the different forms of avulsion fractures discussed.
4. Operative reduction and fixation are appropriate for young and active patients in order to restore full heel-cord function.
5. Attention is drawn to the risk of pressure necrosis of skin overlying a displaced fragment. Early operative correction may be required to prevent skin damage.

**REFERENCES**


WHITEFIELD, G. (1968): *Personal communication*.