COMPUTERISED TOMOGRAPHIC ASSESSMENT OF THE SUBTALAR JOINT IN CALCANEAL FRACTURES
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Thirty-six patients with 39 fresh fractures of the calcaneus were investigated by standard radiography and by computerised tomography. It was found that the size and disposition of the fracture fragments and the degree of involvement of the posterior facet of the subtalar joint were more clearly shown by CT scanning. We recommend this technique for assessment and particularly for pre-operative planning.

The treatment of calcaneal fractures remains controversial and operative management is more prevalent in continental and North American centres than in Britain. Because the nature and extent of these fractures has been difficult to determine, many surgeons have been reluctant to embark upon operative reconstruction.

Several attempts have been made to classify calcaneal fractures (Böhler 1931; Essex-Lopresti 1952; Warwick and BRENNER 1953; SOEUR AND REMY 1975): Böhler's classification, based on increasing degrees of severity, was later modified by Essex-Lopresti who emphasised the importance of distinguishing intra-articular from extra-articular fractures. A classification based on involvement of the thalamic portion of the calcaneus was proposed by Soeur and Remy (1975). None of these authors, however, commented on the difficulty of obtaining satisfactory radiographs of the acutely injured hindfoot. Recent reports have described the advantages of computer tomography (CT) for fractures not easily visualised by radiography, for example, tibial plateau fractures (Dias et al. 1987), and acetabular fractures (Adam et al. 1985). This led us to try CT with calcaneal fractures.

PATIENTS AND METHODS
From July 1985 to December 1986, patients presenting at Leicester Royal Infirmary with fresh fractures of the calcaneus were admitted to hospital. Standard radiographs were taken using lateral, axial and oblique views (Anthonisen 1943), and CT scans were obtained within three days of admission. There were 39 fractures in 36 patients whose ages ranged from 18 to 79 years (average 42 years). All but three were male, and most had been injured while falling from a height.

The CT scans were performed using a GEC 8080 Scanner with the patient's foot placed at an angle of 30° to the horizontal and with the ankle positioned in approximately 20° of plantarflexion; the gantry was angled at 15° to the vertical (Fig. 1). This method was selected after a trial with the foot in other positions which produced less satisfactory views of the calcaneus and its articulations. Scout views of preliminary lateral projections were used by the radiologist to pre-select optimum scans. Although a scan of the opposite foot was performed in every case, it proved extremely difficult to obtain identical views and this procedure was abandoned after experience in interpreting the scans had been gained.

Fig. 1
Diagram of the position of the ankle and foot in the CT scanner: A, 30°; B, 50°; C, 15°.
RESULTS

Lateral view. All the fractures involving the subtalar joint were classified from the appearance of the lateral radiographs (Essex-Lopresti 1952). The centrally depressed fracture was the most common, occurring in 24 of 39 fractures (Fig. 2). There were seven tongue fractures (Fig. 3). In two patients it was not possible to distinguish between the two types of fracture from the radiographs, and these were termed mixed. Six fractures were minimally displaced or undisplaced, and it was difficult to determine whether the subtalar joint was involved. The degree of comminution also was assessed from the lateral radiograph.

Axial view. This was the most difficult to obtain, and an average of two attempts to obtain this view were necessary. Even when a supposedly satisfactory view was obtained, definition of the fracture was often poor, and radiography was uncomfortable if not painful for the patient who had to dorsiflex a recently injured foot. However, fractures confined to the tuberosity were usually best seen in this view; additionally, in one patient the fracture was seen only in this view and was poorly visualised even on the CT scan. We found that, in most cases, the additional information provided by the axial view was not helpful.

Oblique views. These results were disappointing and provided very little information not already seen in the lateral view.

CT scans. In comparison with the axial radiograph, patients found this to be a much more comfortable procedure as there was no need to dorsiflex the foot. The ability of the radiologist to pre-select the views was another advantage, reducing the time required for the investigation, nor was there any need to repeat the scans since consistent results were regularly obtained with ease.

The normal appearance of a scan through the posterior facet of the subtalar joint is shown in Figure 4. We identified three basic fracture patterns on the CT scan; the most common, occurring in 19 of 39 fractures, was an inverted "Y" pattern in which the posterior facet was split into two approximately equal fragments diverging from each other and a large fragment of tuberosity was seen posteriorly (Fig. 5). The next most common, occurring in 10 out of 39 fractures, was the large-fragment type in which the posterior facet was complete or there was a small fragment medially or laterally (Fig. 6). A longitudinal-split pattern, in which a vertical fracture line produced approximately equal-sized fragments, was the third type (Fig. 7) but occurred in only two cases. Four of the fractures could not be classified into these groups because of the degree of comminution; these were simply termed comminuted (Fig. 8).

CT scans of the six fractures which had been classified from the lateral radiograph as either undisplaced or minimally displaced revealed that the fracture was confined to the tuberosity in four. Of the other two, one was a longitudinal-split fracture involving the articular surface of the posterior facet (not seen on the plain radiographs) and the other was a large-fragment fracture with minimal displacement. The relationship between the CT scan types and the radiological classification is shown in Table 1. In all the CT scans, the middle facet of the subtalar joint remained undisplaced; the sustentaculum tali, whether as part of a major fragment or as an isolated fragment, maintained its relationship to the talus (Fig. 8). In two cases, loose fragments within the subtalar joint could also be clearly seen (Fig. 9).

DISCUSSION

As in previously published reports, we found that the centrally depressed fracture was the most common. The two most frequent fracture patterns seen on the CT scan were the inverted "Y" and the large-fragment type, and their distribution was the same for both centrally depressed and tongue fractures; this is noteworthy.
CT scans. Figure 4 – A normal subtalar joint. Figure 5 – An inverted “Y” fracture (same patient as in Fig. 2). Figure 6 – A large-fragment fracture. Figure 7 – A longitudinal-split fracture. Figure 8 – A comminuted fracture showing the sustentaculum tali in the normal position. Figure 9 – An inverted “Y” fracture with a loose fragment within the joint (arrow).
because one would expect the large-fragment type to be more common in centrally depressed fractures. We believe this demonstrates that disruption of the articular surface occurs more often than previously recognised. Another finding not previously reported is that the sustentaculum tali maintains its normal relationship with the talus.

Others have suggested that improved diagnosis of calcaneal intra-articular pathology may be achieved using CT scans (Segal, Marsh and Leiter 1985) and we confirm this. In our study we found that classification of the fractures from the plain radiographs was not easy, since it was difficult to obtain views of the fracture lines which were both accurate and consistently reproducible. In all but one case, a fracture confined to the tuberosity, the CT scan gave useful additional information. In two fractures, which on the radiographs appeared to be confined to the tuberosity, involvement of the articular surface of the posterior facet was demonstrated by CT scan.

Although the ideal method of treating these fractures has not yet been established, clear delineation of fracture morphology is essential in order to plan open reduction and internal fixation. We found that CT scans gave a clearer indication of the true extent of the fracture and the displacement of fragments than radiographs.

**REFERENCES**


