FRACTURES OF THE CALCANEUS WITH DISPLACEMENT OF
THE THALAMIC PORTION

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The thalamus is the part of the calcaneus that supports the posterior articular facet and continues forward,
becoming thinner towards the groove of the sinus tarsi. The main displacements after fracture depend on
1) a primary fracture line dividing the bone into anterior and posterior fragments, and 2) a semilunar fragment
in the thalamic region. In the operation advised the sinus tarsi is exposed and the semilunar fragment is
reduced by rotation in the opposite direction and is fixed to the medial fragment (the sustenaculum tali not
being displaced) by a transverse Kirschner wire. The two main fragments are fixed by an antero-posterior
wire. Plaster is applied and is retained for twelve weeks. Weight-bearing is not permitted for the first four
weeks. There were no major complications in fifty-eight operations. The anatomical results were good:
restoration of the tuber-joint angle by reduction of the semilunar fragment was maintained. The functional
results were very satisfactory: permanent disability was slight or mild.

The distribution of the compact bone and lamellae in the calcaneus is a significant factor in the mechanism
and management of fractures of the calcaneus. The thalamic portion of the calcaneus is that part of the bone,
formed of a layer of compact bone tissue, which supports the posterior articular facet and continues forward,
becoming thinner towards the groove of the sinus tarsi. This feature, to which reference has often been made in
the continental literature (Lenormant, Wilmoth and Lecoeur 1928, 1929; Leriche 1929; Paire and Boppe
1935; Stulz 1956; Soeur 1972), has received attention in only one English publication (Warrick and Brenner
1953). The purpose of this paper is to discuss the mechanism and management of fractures involving this
important part of the calcaneus.

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Non-thalamic fracture</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Anterior end</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial tubercle</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Lateral tubercle</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Body of the calcaneus</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Sustenaculum tali</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Plantar spur</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Posterior beak fracture</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>II. Thalamic fractures</td>
<td>93</td>
<td>83</td>
</tr>
<tr>
<td>By vertical compression</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>By shearing and compression</td>
<td>91</td>
<td>98</td>
</tr>
</tbody>
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Seven patients had bilateral fractures of the calcaneus. Associated injuries in the same part of the limb
included a fracture of the lateral malleolus with a chip fracture of the talus, a fracture of the talus with tibio-
fibular diastasis, a subluxation of the ankle and a fracture of the lateral tibercle of the talus. More distant lesions
included a fracture of the femur and three fractures of the spine—a compression fracture of the body of the
second lumbar vertebra, compression fractures of the bodies of the eleventh and twelfth thoracic vertebrae and
a fracture of the transverse process of the third lumbar vertebra.

MECHANISM AND RADIOLOGICAL FEATURES

Fractures involving the thalamic portion of the calcaneus may occur in one of two ways.

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By direct vertical compression—In this mechanism there is a pure vertical depression of the posterior articular facet of the calcaneus by the corresponding surface of the talus (Fig. 1). This mechanism is rare and only two instances were seen.

By shearing or a combination of shearing and compression—Ninety-one fractures were produced by this mechanism (Table II). With the foot in equinus or in valgus, the lateral process of the talus is forced into the base of the sinus tarsi. The damage to the calcaneus is proportional to the violence of the impact and can be classified into three degrees.

**Table II**

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>First degree—shearing alone</td>
<td>33</td>
<td>36</td>
</tr>
<tr>
<td>Second degree—shearing plus compression</td>
<td>56</td>
<td>62</td>
</tr>
<tr>
<td>Third degree—comminuted</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>91</td>
<td>100</td>
</tr>
</tbody>
</table>

First degree: simple shearing (the primary fracture line)—The talus acting as a wedge shears the calcaneus and divides it into two fragments, an antero-medial consisting of the anterior part of the bone and the anterior end of the sustentaculum tali, and the other consisting of the thalamic portion and the remainder of the bone. There is minimal or no displacement. The radiograph shows a line, the primary fracture line described by other authors (Warrick and Bremner 1953). In the lateral view, this line starts at the bottom of the sinus tarsi and, passing vertically or slightly backwards, ends on the plantar aspect of the calcaneus (Fig. 2). In the antero-posterior view it appears as a line perpendicular to the articular surface separating the sustentaculum tali from the rest of the bone. The line is also visible in Anthonsen’s oblique projection.

There were thirty-three fractures in this group.

Second degree: shearing and compression (secondary fracture lines with semilunar or comet fragments)—The fracture is more complex, with secondary fracture lines in both main fragments (Fig. 3).

In the anterior main fragment there are longitudinal cracks due to splitting of the lateral wall of the calcaneus. These secondary fracture lines delimit a number of fragments, of which two types are found frequently. One
Fig. 3
Drawing of the most common fragments: The semilunar fragment of the thalamus (1). The triangular plate (2) and the rod-shaped cortical fragments (3) both issue from the splitting of the lateral wall. The longitudinal split (4) of the anterior end of the bone.

Fig. 4
Second degree thalamic fracture. There is a semilunar fragment rotated to 90 degrees, so that its articular surface faces forwards. With the foot in equinus, the lateral process of the talus acting as a wedge has been driven into the base of the sinus tarsi. There are crack fractures in the anterior part of the calcaneus.

Fig. 5
Second degree thalamic fracture. There is a large comet-shaped fragment which is rotated by the same mechanism as in Figure 4 but with separation of a much larger slice of the superior surface of the calcaneus.

is a triangular plate with its base on the plantar surface. The other is a small rod-shaped cortical fragment detached from the edge of the base of the sinus tarsi. In addition, the anterior end of the calcaneus may be split longitudinally by one or more fracture lines extending into the calcaneo-cuboid joint.

In the posterior main fragment, the characteristic lesions are situated in relation to the thalamic portion of the bone and in the subjacent cancellous bone. A new fracture line separates from the primary fracture line slightly in front of the anterior border of the posterior articular surface, passes in a semicircle round the thalamic portion of the bone and ends on the superior surface of the calcaneus behind the articular surface. This line delimits a characteristic semilunar piece of bone (Fig. 4). Less often, in one in five cases, the secondary line passes posteriorly to cut off a much larger comet-shaped fragment from the superior aspect of the bone (Fig. 5).

The displacement of the semilunar or comet-shaped
fragments represents a well defined pathological lesion. Under pressure from the lateral process of the talus it sinks more and more into the gap of the primary fracture line, and the anterior border of the posterior articular facet of the calcaneus penetrates into subjacent cancellous bone. The fragment rotates to a degree that may sometimes reach 90 degrees on a transverse axis passing through the posterior part of the thalamus. With increasing rotational displacement, the articular surface of the fragment progressively loses its relationship with the corresponding surface of the talus.

In two out of three cases, the displaced fragment occupies the whole width of the bone as seen in the antero-posterior view. In other cases, only the lateral half or third displaces, being separated from the rest of the bone by a sagittal split and, in nine patients, the thalamus was split into three pieces each rotated to a different degree and showing various displacements in the transverse plane.

Second degree fractures were the commonest and occurred in fifty-six cases.

Third degree: comminuted—These are fractures with very extensive displacement. The semilunar fragment can be recognised but it is buried near to the plantar cortex, surrounded by a large number of crushed fragments defying description (Fig. 6). There were only two such cases in this series.

CLINICAL AND RADIOLOGICAL ASSESSMENT

The study that follows is concerned especially with second degree fractures involving the thalamic portion of the calcaneus. Clinical examination shows the typical features of pain, bruising, swelling of the hindfoot, and flattening and valgus of the heel which, by themselves, do not permit sufficient accuracy of diagnosis.

Only radiographs give a complete picture of the
extent of the lesions. Four views are taken. 1) A lateral view, which shows the primary fracture line, the fragments related to the lateral cortex, and the degree of rotation of the semilunar or comet-shaped fragment (Figs. 1 to 6). 2) An antero-posterior view as described by Böhler (1929). This view is not always easy to achieve when the patient is in pain, but it gives information about the degree of displacement and number of fragments of the thalamic portion (Figs. 7 to 9). 3) Anthonsen’s oblique projection which allows confirmation of information found in the previous views. 4) An antero-posterior view of the midtarsal joint to define fracture lines running into the calcaneo-cuboid joint through the anterior part of the calcaneus.

Tomography has been attempted in a number of cases but has not proved helpful; its use is not recommended. Comparison with radiographs of the normal side is often very helpful.

**TREATMENT**

Whereas first degree, undisplaced fractures have been treated by a walking plaster, all fractures of second or third degree have been treated by operation (Figs. 10 to 24). Immediately after arrival, as soon as radiographs have been taken, the foot and leg are bandaged to prevent blistering and the limb is elevated on a Braun’s frame.

**OPERATION**

**Position**—A tourniquet is applied. The patient lies on the uninjured side with the fractured limb resting on a sandbag, presenting its lateral aspect to the operator. **Exposure**—The skin incision passes from the calcaneo-cuboid joint to a point a little below the lateral malleolus. It runs above the peroneal tendons along the line of the sinus tarsi. The branches of the sural nerve are defined by blunt dissection and retracted gently to avoid damage to them, which might otherwise give rise to a painful neuroma. The peroneal tendons are retracted downwards, avoiding, if possible, opening their sheaths. The main calcaneo-fibular portion of the lateral ligament of the ankle is preserved and may not even be exposed.

The sinus tarsi is then exposed. Blood clot, fat, ligamental debris and small pieces of bone are removed to obtain a clear view of the operative field. Sometimes visibility may be aided by slight retraction of bone of the lateral wall of the calcaneus.

It is then possible to assess the condition of the fracture. The lateral process of the talus appears first and may show evidence of its impact with the calcaneus. Below it, the semilunar fragment is inspected in the cancellous bone and only shows the posterior part of its articular surface. This surface is either intact or divided into two or three fragments displaced to varying degree.

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**FIG. 10**

Figure 10—Second degree thalamic fracture in a North African aged 48 years who sustained a fall of 3 metres (10 feet). The semilunar fragment has rotated 80 degrees. **FIG. 11**—A metal spatula is introduced into the primary fracture line and engages the semilunar fragment. **FIG. 12**—The spatula rotates the semilunar fragment to reduce it. The tuber-joint angle is restored.

**FIG. 13**

The same case as in Figures 10 to 12. **FIG. 14**—A transverse Kirschner wire fixes the semilunar fragment in place and a longitudinal wire fixes the posterior main fragment to the anterior main fragment. There is a space in the cancellous bone beneath the semilunar fragment. **FIG. 15**—Twenty-eight days later. The cancellous space has filled spontaneously without the need for bone grafting. **FIG. 15**—Six months later. The wires have been removed. The subtalar joint is well restored.

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and partially covered by bony fragments derived from crushing of the lateral wall. In the distal part of the wound damage to the anterior part of the calcaneus and the calcaneo-cuboid joint can be observed.

Reduction—This is performed carefully and without haste. A metal spatula introduced into the primary fracture line engages the semilunar fragment and reduces it by rotating it in the opposite direction (Figs. 10 to 12). On its deep lateral surface it should be properly aligned with the medial fragment or an intermediate fragment if this is present, which should itself have been correctly reduced. At this point the subtalar joint should have been reduced and the tuber-joint angle restored to normal. If not, the manoeuvre is repeated and correction obtained.

Fixation—The semilunar fragment is fixed to the medial fragment by a transverse Kirschner wire of 2 millimetres.

Fig. 16
The same case as in Figures 10 to 15—antero-posterior views. Figure 16—Before treatment. Figure 17—After fixation. Figure 18—At the end of treatment. The patient resumed work at the ninth month; five years later he was still doing his normal work as a chimney sweeper.
(\(\frac{1}{2}\) inch) diameter. It should enter the fragment 5 millimetres (\(\frac{1}{2}\) inch) from its articular border and 10 millimetres (\(\frac{3}{4}\) inch) from its anterior border. The shape of the posterior part of the calcaneus having been restored, it is now possible to reduce the anterior main fragment on the posterior with restoration, as far as is possible, of the lateral wall. The small cortical fragment which forms the lateral edge of the floor of the sinus tarsi can be fixed as a wedge between the anterior part of the calcaneus and the thalamic portion. An antero-posterior wire passing slightly obliquely from the lateral to the medial side completes the fixation. A third wire is rarely necessary. In the first ten cases it was thought that it might be useful to fill the space resulting from the elevation of the thalamic fragment with bone chips from the tibial metaphysis. This was later abandoned as unnecessary because the cancellous bone reconstitutes itself so rapidly (Figs. 10 to 15).

Radiographs are taken to confirm reduction, the skin is sutured with interrupted steel sutures and a plaster cast is applied.

The limb is elevated on a Braun’s frame for four weeks. The plaster is then changed, sutures are removed and a walking plaster is applied. The last is retained for a further eight weeks. Walking ability is restored rapidly and sticks need not be used. When the plaster is removed, oedema is prevented by an Unna’s paste bandage.

The wires were removed, on average, seven months after operation, the longest period being four years and the shortest three months. In six patients, union was sound with the wires in situ and they were not seen again. Removal of the wires presents no difficulty provided that the branches of the sural nerve are avoided.

**COMPLICATIONS**

No bone sepsis was encountered. In fifty-eight operations there were six minor complications. Failure of superficial skin healing required skin grafting in five cases, and in one case a neuroma in the scar was relieved by infiltration with local anaesthetic.
RESULTS

Duration of incapacity—For industrial cases, complete incapacity averaged six months. Three patients did not resume work after six months because of other complications such as multiple fractures or other causes. Five patients were only partially employed at the time of completion of management. In non-industrial cases, the duration of incapacity was considerably less, usually three to three and a half months.

Anatomical results—The articular surfaces of the subtalar joint were restored in every case and the semilunar or comet-shaped fragments, which had rotated, on average, 58 degrees, were restored to their normal position (Figs. 13 to 15 and 23 and 24). The reduction was maintained: in only two cases was there a minor degree of secondary displacement. The tuber-joint angle before operation measured between −25 and +22 degrees with a mean of ±10 degrees. After operation, normal values up to +38 degrees were obtained, with a mean of +27 degrees. Valgus deformity of the calcaneus was absent or slight. Studies of footprints did not show the characteristic image associated with traumatic flat foot (Fig. 25). There was no instance of severe osteoporosis, such as is sometimes seen after other methods of treatment.

Functional results—Some patients complained of fatigue at the end of a working day, of swelling behind the malleoli, of pain along the outer border of the foot or of discomfort related to change in the weather. Movement of the ankle was full and there was no shortening of the tendo calcaneus. Movements of the subtalar joint were normal in twenty cases, diminished in thirteen and absent in twelve, one having had an arthrodesis. Joint movement was painless except in one case. The midtarsal joint was normal in twenty-three cases, limited in movements in nine, and completely ankylosed in four cases, one of which had been fused by operation. (This was the patient mentioned previously who had had a subtalar arthrodesis.)

Permanent disability—Two patients have no permanent disability at all. Except for those with concomitant injuries, the degree of permanent disability was slight or mild. All except eight patients have resumed their normal work. Most have to climb ladders or scaffolding, to work on trucks or lifts and to stand on beams.

DISCUSSION

Previous authors have described the displaced fragment of the thalamic portion of the calcaneus (J Judet, Judet and La Grange 1954; Sanchis Olmos 1963), but have failed
to appreciate that it should be reduced by rotating it into position and not simply by elevating it. It had previously been thought that the displacement of the fragments was due to the upward pull of the tendo calcaneus and of the muscles of the sole (Böhler 1929; Soeur 1935). A more precise knowledge of the role of the thalamic fragment led to a rejection of this mechanism and, consequently, a modification in the approach to treatment. Previous attempts at reduction had concentrated on depressing the posterior end of the calcaneus and lateral compression by means of a Böhler clamp, followed by an attempt to correct the displacement of the thalamic fragment by means of a punch (Belenger, Vander Elst and Lorthioir 1951; Gosset 1949, 1953; Decoulx, Razemon and Ducloix 1956). The method described here aims, as in other articular fractures, to reduce the fragment by open operation. Reduction of the displaced fragment re-establishes the tuber-joint angle, and it only remains to restore the alignment of the main posterior and anterior fragments. The gap in the cancellous bone that is formed when the fragment is reduced fills in in a few weeks; packing with bone chips is unnecessary and may endanger a good reduction.

Fixation with heavy materials such as screws, bolts or staples is inappropriate in such fragile fragments; it can only be achieved by thin wire and a well applied plaster cast.

CONCLUSIONS

Fractures involving the thalamic portion of the calcaneus are rarely due to direct vertical compression. They are more usually due to a shearing stress combined with compression in a rotary direction. The first stress divides the bone into two main fragments, anterior and posterior. The second stress causes further fragmentation, especially at the posterior articular surface where a semilunar or comet-shaped piece of bone is rotated downwards and backwards. By rotation of the fragment in the opposite direction, the fundamental deformity is corrected and the tuber-joint angle restored. Fixation of the thalamic fragment is maintained by a transverse Kirschner wire and of the two main fragments by a longitudinal wire, with plaster casts, not bearing weight for four weeks and weight-bearing for eight weeks. The results have been satisfactory in fifty-six cases.

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REFERENCES


