Long-term results of conservative treatment of Sanders type 4 fractures of the calcaneum

A SERIES OF 64 CASES

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TRAUMA

A high rate of complications is associated with open reduction and internal fixation of Sanders type 4 fractures of the calcaneum. We assessed the long-term outcome of 83 Sanders type 4 comminuted intra-articular fractures of the calcaneum in 84 patients who underwent non-operative treatment between 1999 and 2005. Each fracture was treated by closed reduction and immobilisation in a long leg cast. Patients were reviewed every three months in the first year, and every six months thereafter. At each visit, the involved ankles were assessed by the American Orthopaedic Foot and Ankle Society (AOFAS) criteria. The degree of fracture healing and the presence of osteoarthrosis were assessed.

At a mean follow-up of 51 months (24 to 70) the mean AOFAS score was 72 (52 to 92). Osteoarthrosis was scored radiologically using Graves’ classification and was evident in the subtalar joints of 75 ankles (90%) on x-ray and in all ankles on CT scans, of which 20 were grade 0 or 1, 39 grade 2, and 24 grade 3.

A non-operative approach to treating these fractures may be simpler, less expensive, easier to administer with fewer complications, and may be better tolerated than surgery, by many patients.

Fractures of the calcaneum are usually caused by an accident or by a fall from a height. They may also be seen in cases of high-impact trauma associated with life-threatening, multi-organ injuries and spinal and pelvic fractures.1 The mechanism of injury for this fracture is most commonly axial loading.1

These fractures can differ widely in shape, the number of fragments and the status of the surrounding soft tissues, reflecting the energy of the trauma. After a low-impact injury an extra-articular fracture occurs with mild or moderate swelling and bruising of the soft tissues. By contrast, a high-impact injury usually results in a displaced and fragmented intra-articular fracture accompanied by serious injury to the soft tissues. The injured region is very painful and the foot may swell rapidly.2

Although these fractures are common, their treatment by open reduction and internal fixation or primary arthrodesis is complicated. However, non-operative approaches are also available,2-4 and may be preferred for the treatment of undisplaced fractures. They may also, however, be used to treat comminuted intra-articular fractures of the calcaneum, as reduction and internal fixation do not always produce satisfactory results.1,3-6

Until 2005, we did not have enough experience to treat these fractures surgically and therefore, out of necessity, treated them conservatively. However, based on our success before 2005, we continue to treat some conservatively.

In this study we evaluated the long-term clinical and radiological outcomes of conservatively treated Sanders type 4 comminuted intra-articular fractures of the calcaneum over a seven-year period. We used the Sanders classification as it is the most useful for assessing fractures of the calcaneum on CT.3

Patients and Methods

We retrospectively identified by CT all patients with a Sanders type 4 comminuted intra-articular fracture of the calcaneum who had been treated non-operatively at our centre between January 1999 and December 2005. This produced an initial cohort of 89 patients with 117 comminuted intra-articular fractures, of whom 25 were excluded due to lack of follow-up, which left a study group of 64 patients with 83 fractures. Their mean follow-up was 51 months (24 to 70).

After initial anteroposterior (AP) and lateral ankle radiographs all had been treated by closed reduction using the technique described by Omoto et al9 which involves manually compressing the medial and lateral aspects of the calcaneum with the patient prone and sedated, with the knee flexed at 70° and the ankle in the...
equinus position. For patients with a spinal injury, we performed an as-yet unpublished modification of Omoto’s technique with the patient supine.

After reduction a long-leg plaster-of-Paris cast was applied and CT scans were undertaken allowing the fracture to be graded according to the Sanders classification. During the period of the study grade 1, 2 and 3 fractures were treated by open reduction and internal fixation. Patients with grade 4 comminuted fractures with four or more posterior articular facets were treated non-operatively.

After reduction and immobilisation all patients were admitted in order to monitor for swelling of the leg. If serious oedema, assessed by swelling of the toes, did not occur within five days, we repeated the reduction manoeuvre with the patient sedated and applied a further long leg cast with the ankle in 20° of equinus. Oedema was treated by elevation, cold compression and intramuscular injections of diclofenac twice daily. When the oedema had resolved, usually after a week or so, the fracture was reduced as described and a long leg cast applied. After four weeks, the cast was changed to a below-knee cast to allow movement of the knee and after eight weeks, it was removed. Active movements of the ankle were started and the patients were instructed to wear silicone socks supported by metatarsal and medial longitudinal arches. Partial and full weight-bearing were encouraged at the end of the 12th and 16th weeks, respectively. All patients were subsequently reviewed every three months for the first year and every six months thereafter.

At each visit, the ankle was assessed with the American Orthopaedic Foot and Ankle Society (AOFAS) criteria, by which pain, function and alignment of the foot are evaluated out of 40, 50 and 10 points, respectively. Union of the fracture was evaluated with conventional non-weight-bearing AP and lateral radiographs. In addition, axial CT scans were undertaken at presentation, at three months, and at the most recent visit. A single independent radiologist also evaluated degenerative changes in the foot and the condition of the posterior facet on the x-rays and CT scans. We found that clinical evaluation and AP and lateral radiographs were adequate for managing care so did not take special radiographs such as axial or Broden’s views.

We defined a satisfactory result as a final AOFAS score > 70 points and a return to daily activities, with the ability to wear shoes and to walk more than 200 metres.

Arthritis was scored on the CT scans using Graves classification. According to this classification, stage 0 joints show no arthritic changes. Stage 1 joints have only a narrowed joint space; stage 2 joints have intermediate sclerosis and osteophyte formation; stage 3 joints have serious sclerosis, joint space narrowing and osteophyte formation; and stage 4 joints are ankylosed. The tibiotalar, talonavicular, subtalar and calcaneocuboid joints were examined separately.

**Results**

Of the 64 patients, there were 54 men and ten women with a mean age of 34 years (18 to 54). There were five open fractures, four of which were type 2 and one was type 3, according to Gustilo and Anderson’s grading system. All wounds were debrided and closed primarily. None of them became infected and there were no serious wound problems. A total of 19 patients had bilateral fractures; all were men. Trauma was high-energy in all cases, and due to a fall from height in 31 patients, a road traffic accident in 23 and by a direct blow in ten. Serious oedema occurred in 12 patients but resolved after a mean of five days (2 to 12). At the end of the first month, 12 cast-associated skin lesions were identified in 12 patients. These were bullous lesions of
the dorsal or lateral parts of the foot and were aspirated and dressed daily. No patients had a compartment syndrome or required a subtalar arthrodesis.

Two patients required special silicone socks to accommodate a wider sole. At three months CT scans showed complete union of all fractures. The mean time to return to work was six months (3 to 13), and 12 patients had to change jobs because they were unable to stand for long periods. Of the 64 patients, 34 returned to full-time work, 18 to part-time work, and 12 were unable to work. However, the time required off work following a calcaneal fracture remains unclear. At their last examination, the mean AOFAS score was 72 (52 to 92).

At the most recent examination, the mean movements of the ankle joint, as measured by a goniometer, were: dorsiflexion 6° (0° to 12°), plantar flexion 18° (5° to 30°), inversion 12° (6° to 30°) and eversion 6° (0° to 12°). Of the 83 ankles involved, 16 (19%) had a normal range of movement and 75 (90%) had evidence of osteoarthritis in the subtalar joints on plain radiographs, and these were mutually exclusive findings. Degenerative changes according to Graves’ classifications were grade 3 in 24 ankles, grade 2 in 39, and grade 1 or 0 in 20. All 64 patients had subtalar degenerative changes, such as sclerosis, joint narrowing and subchondral cyst formation on CT scans. The CT findings were associated with AOFAS classification scores. The mean AOFAS score for patients with grade 3 and 2 arthritis was 62 (52 to 70), compared with 82 (60 to 92) for those with grade 1 or 0. However, we did not investigate this association further.

In summary, 83 Sanders type 4 comminuted intra-articular fractures of the calcaneum in 64 patients were successfully treated by closed reduction and immobilisation in a plaster-of-Paris cast. Every patient had a final AOFAS score > 50 and returned to daily activities such as standing and walking at a mean follow-up of 51 months. An example case is shown in Figures 1 to 4.

Discussion
Several methods of treatment have been proposed for fractures of the calcaneum. CT and new surgical techniques have focused attention on operative treatments, but for Sanders type 1 fractures a conservative approach gives satisfactory results and is preferred. Surgery has been recommended for Sanders type 2 and 3 fractures,
in which the aim is to restore continuity of the displaced articular surfaces and to achieve a normal weight-bearing position of the calcaneum by stabilising the bone and allowing movement of the subtalar joint. This method is believed to prevent osteoarthritis of the subtalar joint by maintaining the normal height of the heel, and presumes that walking can be restored to normal by preserving heel length and that subtalar joint stiffness and pain can be avoided by restoring continuity of the articular surfaces. Nevertheless, open reduction and internal fixation may not always give satisfactory results in Sanders type 4 cases where there are comminuted fractures of the posterior facet.18,21

Sanders7 carried out open reduction and internal fixation using a plate and screws through a lateral approach in 132 patients with a displaced intra-articular fracture. Both feet were compared using coronal and transverse pre-operative CT scans. Of the 132 cases, 120 were followed for a minimum of one year. Although joint reduction was successful in 86% of type 2 fractures and 60% of type 3 fractures, it was mostly unsuccessful in the 11 type 4 fractures, only one of which achieved a good result. Increasing surgical experience was associated with higher success rates in type 2 and type 3 fractures, but not in type 4 fractures.20

In a type 4 fracture, primary fusion may be an alternative.18,21 However, this brings with it a higher morbidity than closed reduction and a risk of complications, such as infection, wound problems and iatrogenic sural nerve injury, which do not occur with closed reduction.

Several studies have found that closed reduction can be as successful as open reduction for treating these fractures (Table I);2,5,22,23 however, other recent studies suggest that operative methods are superior to non-operative ones.16,24,25 These studies report that, in general, surgery reduced the time to return to work, greatly reduced the progression to subtalar fusion, and was less expensive. In addition, the experience of the surgeon was important in achieving a good result. Most of these studies evaluated patients with gait analysis, which ours did not. We hope to undertake further research including gait analysis.

Limitations of the study. Our study was not a randomised trial and was subject to selection bias: we tended to treat patients with relatively sedentary lifestyles conservatively and those with active lifestyles surgically. Since 2005 we have treated most type 4 fractures of the calcaneum surgically. Unfortunately, we do not have the outcome and functional data that would allow us to compare operative with non-operative treatment.

Another limitation is the fact that of the 89 eligible patients, 25 (28%) were lost to follow-up. We cannot speculate on whether their loss was related to satisfactory results that did not bring them back for check-ups, or to unsatisfactory results that took them to another centre for treatment.

We assessed the clinical outcome according to AOFAS criteria. In the original report of the AOFAS grading system there is no definition of a poor, fair, good or excellent result. However, higher scores are better than lower scores, so we arbitrarily defined a satisfactory result as a final score > 70 points and included three other criteria as well: return to daily activities, the ability to wear shoes, and the ability to walk long distances.

In conclusion surgical management of Sanders type 4 comminuted intra-articular calcaneal fractures is complicated and does not always give satisfactory results. A non-operative approach may therefore be more appropriate and can produce satisfactory long-term outcomes in selected cases. In addition, evidence of subtalar osteoarthritis is not necessarily associated with a poorer clinical outcome.

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References

Table I. Studies reporting good results for the treatment of Sanders type 4 fractures

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of ankles</th>
<th>Mean follow-up (yrs)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pozo et al22</td>
<td>21</td>
<td>14.6</td>
<td>16 (78%) good</td>
</tr>
<tr>
<td>Kitaoka et al2</td>
<td>27</td>
<td>6</td>
<td>10 (37%) good or excellent</td>
</tr>
<tr>
<td>Buckley et al24</td>
<td>424</td>
<td>&gt; 2</td>
<td>No functional differences between 206 operative and 218 non-operative cases</td>
</tr>
<tr>
<td>Ibrahim et al23</td>
<td>26</td>
<td>15</td>
<td>No clinical or radiological differences between randomly allocated operative and non-operative cases</td>
</tr>
</tbody>
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