Osteosynthesis for intra-articular calcaneal fractures

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ABSTRACT

Purpose. To correlate treatment results of intra-articular calcaneal fractures with their computed tomographic (CT) classification.

Methods. 36 men and 4 women with 48 intra-articular calcaneal fractures (8 bilateral) underwent open reduction and internal fixation with bone grafting via an extensile lateral approach. Based on 2-dimensional CT scans, the fractures were categorised using the Sanders classification. There were 16 type-II, 20 type-III, and 12 type-IV fractures. Radiographs and Maryland foot scores were used for evaluation of the results at a mean of 38 (range, 26–66) months.

Results. Anatomic reduction of the posterior calcaneal facet was achieved in 38 of 48 fractures. The Bohler and Gissane angles were restored to between 92 and 99% of normal, respectively. Despite this, the mean functional scores were 84 in type-II, 83 in type-III and 67 in type-IV fractures.

Conclusion. Surgical results were superior in type-II and -III fractures. Type-IV fractures fared poorly, despite excellent restoration of calcaneal anatomy; subtalar arthrodesis should have been considered.

Key words: calcaneus; fracture fixation, internal; tomography, X-ray computed

INTRODUCTION

Injury mechanisms and fracture patterns largely determine treatment results of calcaneal fractures. Controversy has existed over closed versus open treatments. A number of treatment classifications have been proposed based on plain radiography. Improvement in imaging technology has allowed a better understanding of fracture pathology and provided the basis for newer classifications. Internal fixation has shown encouraging results in selected patients. However, lack of a consistent classification and absence of a universal protocol for subjective, objective, and radiological evaluation of operative results have hampered comparisons.

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MATERIALS AND METHODS

From April 1999 to August 2001, 36 men and 4 women with 48 intra-articular calcaneal fractures (8 bilateral) underwent open reduction and internal fixation with bone grafting. The most common injury mechanism was a fall from height. The mean patient age was 28 (range, 18–46) years. In 18 (45%) of the patients the left side was involved, in 14 (36%) the right side, and in 8 (20%) the fractures were bilateral. Patients with >3-week-old or compound fractures or those with local or general conditions precluding surgery were excluded. The mean period between injury and surgery was 7 days. The mean follow-up duration was 38 (range, 26–66) months.

Standard lateral, axial, and anteroposterior radiographs of the calcaneum and foot were taken. Broden view radiographs in 10º, 20º, 30º, and 40º of tube tilt were used to detect disruption of the posterior facet. Fractures were categorised based on 2-dimensional computed tomographic (CT) scans (Fig. 1), using the Sanders classification (Table 1). Type-I fractures were treated conservatively with limb elevation and early mobilisation. Types II, III and IV (all intra-articular) fractures were treated surgically.

Patients were placed in a plaster of Paris slab after applying a Jones bandage to resolve soft tissue swelling. They were operated on via a lateral position with a pneumatic tourniquet placed high in the thigh. Ipsilateral iliac crests were routinely prepared to obtain bone grafts. The fracture site was exposed via an extensile lateral approach. A right-angled incision was started 4 cm above the lateral malleolus between the fibula and Achilles tendon and extended downwards till the skin colour between the lateral ankle and sole changed. It was then extended anteriorly to the calcaneocuboid joint. After deep dissection of the wound directly onto the periosteum of the lateral wall of the calcaneum, a full thickness flap was raised until the subtalar joint was reached. The sural nerve (lying approximately 1.5 cm anterior to the insertion of Achilles tendon) was cautiously retracted to avoid injury and reflected along with the flap, as it crossed the line of the incision near its proximal part. Using a curved osteotome, the lateral wall was removed. The displaced posterior facet was then rotated out from within the calcaneal body. The tuberosity was reduced to correct the calcaneal height and heel varus, and was provisionally fixed with Kirschner wires. The posterior facet was fixed using 3.5-mm cortical lag screws directed into the intact medial wall; best purchase was obtained in the sustantacular tali. A tricortical graft taken from the ipsilateral iliac crest was used to fill the defect left after elevation of the depressed posterior fragments. Small pieces of cancellous bone were used to fill any remaining defects. The tuberosity and anterior calcaneum were fixed using either an H plate or a 3.5-mm reconstruction plate contoured to the lateral wall.

The wound was irrigated and closed over a suction drain. The leg was placed in a plaster of Paris slab. Ankle and subtalar movement exercises were started after the first dressing (Fig. 2), provided the condition of the wound was satisfactory. Sutures were removed at 3 weeks and the patients kept non–weight bearing for 8 weeks. Patients were followed up with radiographs taken at discharge, 3 months, and one year after the operation.

The Bohler and Gissane angles as well as calcaneal height and width before and after surgery were compared. Subtalar movement was compared with that of the normal foot and expressed as a percentage. Functional assessment was carried out at the one-year follow-up, using the Maryland Foot Score.14

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>I</td>
<td>Non-displaced fracture irrespective of the number of fracture lines</td>
</tr>
<tr>
<td>II</td>
<td>Two parts fragment or split fracture</td>
</tr>
<tr>
<td>III</td>
<td>Three parts fracture or split depression</td>
</tr>
<tr>
<td>IV</td>
<td>Four parts fracture or highly comminuted</td>
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Figure 1  Computed tomographic scans showing a Sanders type-I calcaneal fracture.
RESULTS

Using the Sanders classification, there were 16 (25%) type-II, 20 (42%) type-III, and 12 (33%) type-IV fractures. The tuber joint angle and the Gissane angle were restored to 92 and 99% of normal, respectively; calcaneal height and width were restored to 82 and 95% of normal, respectively (Table 2). A congruent reduction of the posterior facet was achieved in 38 of the 48 patients, as seen on the Broden view radiographs (Fig. 3).

The mean Maryland foot scores were 84 in type-II, 83 in type-III, and 67 in type-IV fractures. 14 fractures attained excellent, 24 attained good, 8 attained fair, and 2 attained poor results. Except for one patient, they were all able to return to their pre-injury jobs. Subtalar movement was restored to 75% of normal in 10 instances, 50% of normal in 20, and <25% of normal in 18.

The most common complication was superficial wound necrosis (n=4), which resolved after conservative treatment. One patient had paraesthesia due to sural nerve involvement. Another patient developed chronic osteomyelitis, after which the implant was removed (Fig. 4). No patient opted for subtalar fusion for pain relief.

DISCUSSION

Intra-articular fractures account for approximately 75% of calcaneal fractures, usually with poor outcome, and are commonly associated with other axial load injuries giving rise to lumbar, pelvic, and

<table>
<thead>
<tr>
<th>Fracture type</th>
<th>No. of patients</th>
<th>Mean Bohler angle (°)</th>
<th>Mean Gissane angle (°)</th>
<th>Mean heel height (mm)</th>
<th>Mean heel width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-op</td>
<td>Post-op</td>
<td>Pre-op</td>
<td>Post-op</td>
</tr>
<tr>
<td>Type II</td>
<td>16</td>
<td>21°</td>
<td>26°</td>
<td>137°</td>
<td>120°</td>
</tr>
<tr>
<td>Type III</td>
<td>20</td>
<td>7°</td>
<td>27°</td>
<td>132°</td>
<td>120°</td>
</tr>
<tr>
<td>Type IV</td>
<td>12</td>
<td>-2°</td>
<td>21°</td>
<td>135°</td>
<td>117°</td>
</tr>
</tbody>
</table>
tibial plateau fractures.

The treatment goals are: (1) restoration of congruency of the posterior facet of subtalar joint, (2) restoration of the calcaneal height and width, (3) decompression of the subfibular space available for the peroneal tendons, (4) realignment of the tuberosity in a valgus position, and (5) reduction of the calcaneocuboid joint.

Controversy exists over non-operative versus operative treatment. 17 of 27 fractures treated by conservative means attained fair to poor results. Results are worse with increasing degrees of comminution of the posterior facet. 12 of our 13 patients with a non-displaced (type-I) fracture achieved good or excellent results with closed treatment. However, poor results were encountered in type-II (displaced) and type-III (comminuted) fractures. A prospective, randomised, CT-based study comparing operative versus non-operative treatments for type-II and -III fractures, revealed that the former type of treatment followed by early mobilisation produced superior results.4

The results of operative treatment are variable, mostly related to the quality of the posterior facet reduction; 80% of patients with successful reductions had satisfactory results.1 In another series, 76% of patients attained satisfactory results based on CT assessment of the fracture reduction.17 Unsatisfactory results were associated with failure to obtain or maintain a satisfactory reduction.

Lateral, axial, anteroposterior, and Broden view radiographs are used to examine calcaneal fractures. Extension of the fracture into the posterior facet is clearly visualised using the Broden view, but overlap of tarsal bones and articular surfaces makes assessment of the exact fracture anatomy difficult. Two-dimensional CT scans give additional information on (1) the size and number of fracture fragments, (2) the size and displacement of sustantacular tali relative to superomedial fragments, (3) the presence of a step or diastasis of the posterior facet, and (4) impingement of the fibular malleolus on the tuberosity of the calcaneum.18 Such scans also provide information regarding fractures involving the sinus tarsi, calcaneocuboid joint, and anterior calcaneal process, all of which could be relevant while planning the lateral surgical approach.

CT evaluation of calcaneal fractures has allowed classification systems to offer prognostic significance. By circumventing the need for multiple views of the heel, this reduces the radiation dose and discomfort to the patient.

We used the lateral extensile approach5 because it provides wide exposure of the subtalar joint and
allows more accurate exposure of the facet fragments and calcaneocuboid joint, easier decompression of the lateral wall, and sufficient area laterally for plate fixation. After a mean follow-up of 3 years, 77% of the patients undergoing a combined medial and lateral approach were reported to have a good result. With increasing comminution, results were less favourable. Excellent or good results were obtained in 73% of type-II, 70% of type-III, and only 27% of type-IV fractures. In our study, 79% of patients had good or excellent results and 21% had fair or poor results, despite anatomic calcaneal restoration (as measured by the Bohler and Gissane angles). Type-IV fractures fared poorly in functional terms, despite anatomic restoration and congruent reduction of the calcaneum.

Type-I fracture patients should be treated conservatively with limb elevation, splintage, and early mobilisation. Those with type-II and -III fractures yield good results with open reduction and internal fixation. Patients having type-IV fractures experience poor results, even after open reduction (Fig. 5); their pain appears to be due to many causes, including: subtalar arthritis, soft tissue impingement, altered mechanics of the tibiotalar joint, and smashed heel pad syndrome. Some patients with subtalar arthritis may require subtalar or triple arthrodesis, but no patient selected this option. Patients with type-IV fractures may benefit from primary osteosynthesis to correct heel varus and height, so as to decompress the peroneal tendons. Functional results continue to improve, even one year after surgery. To correct calcaneal anatomy, open reduction should be offered to all such patients.

REFERENCES