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Fractures of the calcaneum

A REVIEW OF 70 PATIENTS

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We have assessed the long-term results after operative and non-operative treatment of undisplaced and displaced calcaneal fractures.

At a mean of 6.5 years, we reviewed 70 patients with a calcaneal fracture who were divided into four groups: group 1, 18 patients with undisplaced fractures and a normal Böhler's angle (BA) who had been treated non-operatively; group 2, 23 with intra-articular fractures and a BA <10° who had been treated non-operatively; group 3, 13 with intra-articular fractures and a BA >10° who had been treated surgically; and group 4, 16 with intra-articular fractures and a BA <10° who had been treated surgically.

The results were assessed by a clinical score considering pain, return to work, return to physical activity, change in shoe-wear and the requirement for subtalar arthrodesis.

Patients with undisplaced calcaneal fractures had a good outcome. Those with displaced fractures treated surgically who presented at follow-up with a BA >10° had a satisfactory functional outcome and those with displaced fractures who had non-operative treatment had a poor outcome. The poorest outcome was consistently seen in patients who were treated operatively without restoration of BA. Open reduction and internal fixation of intra-articular calcaneal fractures can only be expected to benefit those patients in whom nearly anatomical reconstruction is obtained.

The treatment of intra-articular fractures of the calcaneum remains controversial. Previous cohort studies¹⁻³ have suggested that operative and non-operative treatment provide comparable results. Few prospective, randomised trials have been performed analysing the benefit of either form of treatment. Parmar, Triffitt and Gregg⁴ showed that there was no difference between operative and non-operative treatment at follow-up at one year. Thordarson and Krieger⁵ randomised 30 patients to either operative or non-operative treatment and noted that those managed by surgery had higher functional scores one year after treatment. In a meta-analysis published in 2000, Randle et al⁶ stated that "there is a trend for surgically treated patients to have better outcomes; however, the strength of evidence for recommending operative treatment is weak". Buckley et al⁷ presented a multicentre, prospective, randomised controlled trial without unmasking of the data by removal of the patients who were receiving workers' compensation and noted satisfactory results after non-operative treatment of intra-articular calcaneal fractures which were similar to those after operative treatment.

We wished to determine whether undisplaced fractures consistently have good results, whether the results after open reduction and internal fixation depend on restoration of the anatomy of Böhler's angle (BA) and whether secondary subtalar arthrodesis may be avoided by restoring BA.

Patients and Methods

Between 1991 and 1998, we treated 193 fractures of the calcaneum in 163 patients of whom 70 were followed up. Of the latter, there were 18 patients with undisplaced fractures and 52 with displaced intra-articular fractures. The intra-articular fractures were classified according to Essex-Lopresti⁸ as the 'joint-depression type' in 36 and as the 'tongue-type' in 16 patients.

The mean age of the patients was 53 years (27 to 88) and 70% of the fractures occurred in men. The mechanism of injury was a fall from a height in 83% of patients (attempted suicide in 33%) and a motorcycle accident in the remaining 17%. The 18 undisplaced fractures were treated non-operatively as were 23 of the 52 displaced intra-articular fractures. The remaining 29 were treated operatively.

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Table I. Details of the scoring system for subjective criteria

Pain	None/minimal or constant/severe
Return to work	Yes or no
Return to physical activity	Yes or no
Change in shoe wear	Yes or no
Subtalar arthrodesis	Yes or no
Böhler's angle	>10° or <10°

Surgery was performed using the lateral extensile approach, as described by Benirschke and Sangeorzan.⁹

The fracture was elevated and an attempt made to restore the shape of the calcaneum. The fracture was fixed with a plate; no bone graft was used.

The mean follow-up was for 6.5 years (4 to 14). The assessment was performed by one examiner (MP) who had not participated in the treatment of any of the patients. A clinical scoring system was used to evaluate each patient with regard to the subjective criteria (Table I). Objective parameters included whether a subtalar arthrodesis had been performed and whether BA was <10° or >10° (Fig. 1).

There were four groups of patients: group 1, 18 patients with undisplaced fractures and a normal BA (25 to 40°) who had been treated conservatively; group 2, 23 with displaced intra-articular fractures and a BA <10° who had been treated conservatively; group 3, 13 with displaced intra-articular fractures and a BA >10° who had been treated surgically; and group 4, 16 with displaced intra-articular fractures and a BA <10° who had been treated surgically.

Statistical analysis. Fisher's exact test was used in the statistical analysis.

Results

All the 18 patients with undisplaced fractures (group 1) had good results. Only four (22%) complained of constant pain, but each had returned to work and all except one had returned to physical activity. The BA was normal in all cases. No patient had undergone subtalar arthrodesis (Table II).

In the 23 patients with intra-articular fractures, who had non-operative treatment (group 2), all had a BA <10°. Eleven (48%) presented with constant pain but 17 (74%) patients in this group had returned to work and 15 (65%) to physical activities. Secondary subtalar arthrodesis was carried out in five (22%) within two years of their injury.

The 13 patients with intra-articular fractures treated operatively with restoration of BA (>10°, group 3) had satisfactory results. Five (38%) had constant pain, but 11 (85%) had returned to work and nine (69%) to physical activities. None had undergone subtalar arthrodesis (Fig. 2).

In comparison with group 3, the 16 patients with intra-articular fractures treated operatively with a BA <10° (group 4) had a statistically significant difference with regard to pain, return to work, change in shoe-wear and

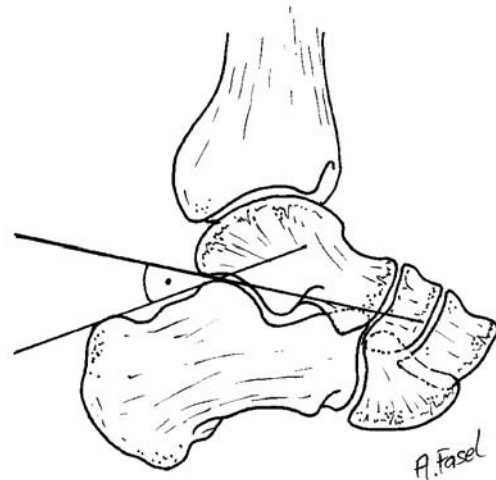
**Fig. 1**

Diagram showing the measurement of the Tuber joint or Böhler's angle. The normal is 25° to 40°.

**Fig. 2**

Radiographs showing a) the original fracture and b) with Böhler's angle restored.

subtalar arthrodesis ($p = 0.0001$). All complained of constant, severe pain, and only four (25%) had returned to work; 13 (81%) required adapted shoe-wear and ten (62%) had undergone secondary subtalar arthrodesis within two years of their injury (Table II; Fig. 3).



Fig. 3

Radiographs showing failure to restore Böhler's angle.

Table II. Details of the results in the four groups, by percentage

Group	Fracture/treatment	Number	Pain	Work	Physical activity	Shoes	Fusion	BA (°)
1	Undisplaced	18	22	100	94	17	0	Normal
2	Displaced <10° conservatively	23	48	74	65	30	22	<10
3	Displaced >10° operative	13	38	85	69	15	0	>10
4	Displaced <10° operative	16	100	25	31	81	62	<10

Discussion

There is no consensus in the current literature regarding the optimal treatment of intra-articular fractures of the calcaneum. Operative methods of treatment have included attempts at closed reduction or percutaneous manipulation,^{10,11} open reduction with either internal fixation^{12,13} or bone grafting¹⁴ or both, and primary arthrodesis of the subtalar joint.¹⁵⁻¹⁸

A meta-analysis published in 2000⁶ showed no sound evidence which allowed a surgeon to decide upon optimal treatment for a displaced intra-articular fracture of the calcaneum. In our study, criteria for the evaluation of outcome were chosen which represented function and included variables such as pain, working ability, physical activity and footwear. These are more difficult to measure than anatomical or radiological values. Imaging techniques^{19,20} and measurements of foot pressure²¹ may yield more objective and detailed results with higher validity and reliability.²² While these measurements correlate more or less with the clinical evaluation, they cannot replace it.

Clearly, the aim of treatment is unlimited pain-free walking in everyday shoes, and not the normalisation of any technical values. In our study, CT scans were not available for all the patients and we were thus not able to evaluate the classification according to Sanders et al²³ and Sanders.²⁴ Only plain films were available and for this reason only the Essex-Lopresti classification⁸ was used. The determination of the BA was possible in all cases.

We found good results in undisplaced fractures of the calcaneum with a normal BA which had been treated non-operatively, satisfactory results in intra-articular fractures treated operatively with restoration of the BA, poor results in intra-articular fractures treated conservatively, and the poorest outcome in intra-articular fractures treated operatively without restoration of the BA. This suggests that BA is of prognostic relevance.^{3,4,7,25,26} Thus, open reduction and internal fixation of fractures of the calcaneum can only be expected to benefit those patients with nearly anatomical reconstruction.^{3,4,7,17} No operatively-treated patient with restoration of the BA underwent secondary subtalar arthrodesis. On the other hand, 62% of patients treated operatively without restoration of the BA required arthrodesis ($p = 0.0001$) for severe persistent pain within two years of injury.

We did not directly compare the results of operative with non-operative treatment because patients were not randomised before treatment. However, we are of the opinion that operative treatment which does not result in approximate anatomical reconstruction has more disadvantages than non-operative management of these injuries.

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