

# INTRA-ARTICULAR FRACTURES OF THE CALCANEUM TREATED OPERATIVELY OR CONSERVATIVELY

## A PROSPECTIVE STUDY

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**We report a prospective trial of 66 patients with intra-articular fractures of the calcaneum. All fractures were assessed by CT. Patients with displaced fractures were randomised to receive either conservative (n = 31) or operative treatment (n = 25). Undisplaced fractures (n = 10) were treated conservatively. Operation involved open reduction of the posterior subtalar joint, and fixation with Kirschner wires.**

**All 66 patients were reviewed at a minimum of one year (mean 23 months). After conservative treatment the undisplaced fractures had slightly better results than the displaced fractures. There was no significant difference in outcome between the operatively and the conservatively treated displaced fractures.**

**We have also documented prospectively the natural history of the injury, which is of use in assessing prognosis for both clinical and medicolegal purposes.**

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The treatment of intra-articular fractures of the calcaneum remains controversial. Most published work has been retrospective and uncontrolled, and many different methods of treatment have been described with little consistency in fracture classification or evaluation of results. There have been no prospective randomised controlled trials. The lack of reliable information and the supposed inevitability of a poor outcome (Cotton and Henderson 1916; Bankart 1942) have led many surgeons to advise conservative treatment almost exclusively, regardless of fracture type.

Open reduction, although it had been used for many years, became a recognised method of treatment only after the work of Palmer (1948). He advocated elevation of the depressed lateral facet fragment from the lateral

side, and filling of the cavity below it with bone graft. Others have shown that grafting is unnecessary if early internal fixation is provided by wires or cancellous screws (Soeur and Remy 1975; Stephenson 1983, 1987).

Most of the described techniques of open reduction are based on the assumption that the chronic symptoms following this fracture arise from disruption of the posterior subtalar joint; 80% of injuries which involve this joint are seen to be displaced on plain radiography (Essex-Lopresti 1952; Warrick and Bremner 1953). CT provides a clearer picture and allows more accurate classification of fracture types (Lowrie et al 1988) and its use is now considered to be essential for the evaluation of fracture morphology in trials which compare different methods of treatment (Giachino and Uthoff 1989).

We report a prospective study in which all patients with calcaneal fractures had CT to identify involvement of the subtalar joint and any displacement. Patients with displaced intra-articular fractures were then randomised to receive one of two methods of treatment as follows: 1) closed mobilisation of the hindfoot, which is advised by many surgeons; or 2) open reduction and internal fixation of the posterior subtalar joint. We used the method of Soeur and Remy (1975), since, at the time of planning our trial, these were the only authors to have reported favourable results in a prospective, although not randomised study.

In addition to comparing operative and conservative treatments, our study aimed to provide information on the natural history of the symptoms and disability after this injury, with their important medicolegal implications.

## PATIENTS AND METHODS

Since 1985 all patients (179) who have attended the Leicester Royal Infirmary with fractures of the calcaneum diagnosed by plain radiography have been admitted for treatment and investigation. Initial treatment was by elevation of the leg and the application of ice packs. Inclined coronal CT scans (Lowrie et al 1988) were obtained on all patients who had CT, except those with isolated fractures of the medial or anterior processes.

The fractures were classified and assigned to

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treatment groups on the basis of the CT scans and the lateral radiographs. Undisplaced fractures of the posterior facet of the subtalar joint and extra-articular fractures were treated conservatively. Patients with displaced intra-articular fractures were entered into a randomised trial, to receive either conservative or operative treatment.

**Conservative treatment.** The injured leg was elevated for five to seven days. Ice packs were applied to control swelling, and movements of the foot were encouraged as pain allowed. The patients were randomised by year of birth, the odd years entering the operative group and the even years the conservative group.

**Operative treatment** (Soeur and Remy 1975). A lateral approach was made through the bed of the peroneal tendons or above them. The lateral fragment of the posterior subtalar facet was approximated to the antero-medial fragment under direct vision and held in position by Kirschner wires which passed through the subchondral bone. If the anterior process of the calcaneum was displaced it was also reduced and fixed by a further wire. No attempt was made to reduce the main fragments of the tuberosity of the calcaneum. Postoperatively, the foot was immobilised in a plaster cast for six weeks.

**Rehabilitation.** All patients in both groups remained non-weight-bearing for six to eight weeks, after which graduated weight-bearing started. After the fracture had healed (at approximately three months), and after removal of the wires in those treated operatively, repeat CT scans were obtained in 21 patients. These showed that the position of the fragments did not change in those treated by the closed method, and that there was no satisfactory method of grading the reduction in the operated group. The practice of postoperative CT scanning was therefore discontinued.

**Assessment.** The patients were followed up in a special clinic which most attended for 24 months. At 12 and 24 months after injury they were assessed clinically (Tables I and II). After 1990 we included records of pain pattern, sural nerve symptoms and signs, and compensation status. Data on pain level, heel width and time periods were treated as continuous: all other data were discontinuous (mostly 'yes' or 'no'). Patients with bilateral fractures were excluded from the analysis except when an extra-articular fracture on one side was of no clinical significance and allowed full weight-bearing after the initial period of bed rest. We also excluded patients who could not be randomised, for example because they refused operation.

Continuous data were analysed by the Wilcoxon rank-sum test, and the discontinuous data by the chi-squared test or by Fisher's exact test.

**RESULTS**

Of the 179 patients referred for inclusion in the trial and who had CT scans, 163 had sustained unilateral fractures.

**Table I.** Assessment of outcome from history

Criteria	
Pain	
Level	Analogue scale 0 to 4 Use of analgesia
Site	-
Pattern	Increasing with use Worse with initial use after rest Weather change Other
Sural nerve symptoms	Dysaesthesia or hypoaesthesia
Walking ability	Up slopes Down slopes Uneven ground Running Climbing ladder Use of stick Maximum distance on flat
Occupation	Return to previous or lighter job
Recreation	Return to previous or lighter recreation
Shoe wear	Return to previous shoe wear
Recovery plateau	No further improvement
Compensation	None Pending Settled
Problems	None Mild Moderate Severe

**Table II.** Assessment of outcome by clinical examination

Criteria	
Deformity	Broad heel Valgus heel Lateral bossing Flat longitudinal arch Calf wasting
Heel width	Ratio to normal side by caliper measurement below tip of lateral malleolus
Joint movement	
Ankle	Normal or not when compared with normal side
Subtalar	Nil < 50% > 50% of normal side Normal
Function	Walk without a limp Hop on affected side Stand on tiptoes with even weight
Sural nerve	Hypoaesthesia

There were 37 extra-articular fractures (EA), 17 undisplaced intra-articular fractures (UIA), and 105 displaced intra-articular fractures (DIA). Four were not classified because their scans had been mislaid. Five patients with bilateral fractures had sustained a minor extra-articular fracture on one side, which did not interfere with the management of the contralateral intra-articular fracture. These were included as unilateral injuries, two in the UIA group and three in the DIA group. The 16 patients with bilateral fractures which would have prevented

**Table III.** Fracture types in the 66 intra-articular fractures (numbers and percentage)

	Displaced		
	Undisplaced (n = 10)	Conservative (n = 31)	Operative (n = 25)
CT			
Inverted-Y	3 30	25 81	17 68
Large fragment	5 50	3 10	3 12
Longitudinal split	2 20	2 7	2 8
Comminuted	0	0	2 8
Unknown	0	1 3	1 4
Essex-Lopresti type			
Central depressed	5 50	19 61	18 72
Tongue	3 30	11 36	5 20
Neither	1 10	1 3	1 4
Unknown	1 10	0	1 4
Calcaneocuboid involvement			
Present	4 40	17 55	11 44
Absent	5 50	13 42	12 48
Unknown	1 10	1 3	2 8

**Table V.** Results of clinical examination at least one year after conservative treatment of unilateral intra-articular fracture (percentage of group or ratio)

	Displaced (n = 31)	Undisplaced (n = 10)
Deformity		(n = 9)*
Valgus	10	0
Lateral bossing (p < 0.03)	73	30
Flat longitudinal arch	3	0
Calf wasting	37	30
Heel width ratio (mean)	1.25	1.16
Ankle movement normal	67	80
Subtalar movement		(n = 9)*
Nil	0	11
< 50°	39	44
> 50° of normal side	48	11
Normal	13	33
Function		(n = 9)*
No limp	73	89
Hop on affected leg	42	67
Stand on tiptoes	71	78
Sural nerve hypoaesthesia	0	0

\* data not available on all undisplaced fractures

weight-bearing mobilisation were excluded. Twenty-five patients from the DIA group could not be randomised, leaving 80 patients in the randomised trial.

We reviewed 92 patients after at least one year, and 51 after at least two years. Patients with extra-articular, bilateral or incorrectly randomised fractures, or with a follow-up of less than one year, were excluded from further analysis. Details of the 66 intra-articular fractures studied in detail are shown in Table III. Not all the patients were seen on the date requested. The 'one-year' group was reviewed at from 12 to 14 months; the 'two-year' group at from 24 to 27 months. The overall mean follow-up was 23 months.

Supplementary treatment during rehabilitation included injection of local anaesthetic and steroid around the peroneal tendons in six patients for relief of local

**Table IV.** Results from history at least one year after conservative treatment of unilateral intra-articular fractures (percentage of group)

	Displaced (n = 31)	Undisplaced (n = 10)
Pain level 0 or 1	55	90
Use of analgesia	27	10
Site of principal pain		(n = 6)*
Lateral	44	66
Medial	4	0
Tendo Achillis	4	0
Instep	4	17
Other	8	17
Two or more sites	36	0
Pattern of pain		(n = 3)*
Activity	38	33
After rest	29	33
Weather change	10	0
Other	24	33
Sural nerve symptoms	20	0
No walking difficulty		
Up slopes	81	100
Down slopes	81	100
Uneven ground	45	78 (n = 9)*
Running (p < 0.03)	46	100
Climbing ladder	78	100
All surfaces (p < 0.05)	19	60
Using stick	10	10
Unlimited distance	52	80
Employment (if employed before injury)		
Same work	68	100
Lighter job	5	0
Unemployed	26	0
At previous recreation level	73	89 (n = 9)*
Normal shoes	70	78 (n = 9)*
Recovery plateau reached	63	80
Compensation pending	5	0
No or mild problems (p < 0.04)	65	100

\* data not available on all undisplaced fractures

pain, and Gallie subtalar arthrodesis in five patients for severe pain which had persisted for more than one year.

**Closed treatment** (Tables IV and V). Ten undisplaced and 31 displaced fractures were reviewed at least one year after conservative management. Significantly more patients with undisplaced fractures had no or minimal problems in the injured foot, and more of them were able to run. These patients also experienced less pain than the displaced group but this trend reached statistical significance only on one-tailed testing by Fisher's exact test. Between the one- and two-year follow-ups there was improvement in the ability to run, in walking distance, patient satisfaction, and relief from limp and tenderness in both groups, but not to a statistically significant level in either of them.

The differences in outcome might be related to the different patient populations, since they are not strictly comparable (Table VI). The displaced group included significantly more working men, and more inverted-Y

**Table VI.** Details after at least one year, of groups of patients with undisplaced fractures, or with displaced fractures randomised between conservative and operative treatment

	Undisplaced (n = 10)	Displaced	
		Conservative (n = 31)	Operative (n = 25)
Mean age (range) yrs	50.9 (16 to 64)	48.8 (20 to 79)	48.3 (20 to 72)
Male:female	2.3:1	6.8:1	5.3:1
Working men ( <i>per cent</i> )	30 (p < 0.04)*	70	74
CT type ( <i>per cent</i> )			
Inverted-Y	30 (p < 0.01)*	83	71
Large fragment	50	10	13
Longitudinal split	20	7	8
Comminuted	0	0	8
Essex-Lopresti type ( <i>per cent</i> )	(n = 9)†		
Central depressed	56	61	74
Tongue	33	36	22
Both or unclear	11	4	4
Calcaneocuboid involvement ( <i>per cent</i> )	(n = 9)†		
	44	59	48
Mean follow-up (mth)	25.8	21.6	25.3

\* difference between displaced and undisplaced fractures treated conservatively  
 † data not available on all undisplaced fractures

fractures. The small numbers of undisplaced fractures precluded any further analysis of this group.

There was an even distribution of involvement of the calcaneocuboid joint and the fracture types of Essex-Lopresti (1952) between the groups, and among the different fracture types seen on CT scanning (Lowrie et al 1988). Involvement of the calcaneocuboid joint did not have a significant effect on any of the variables tested, but the tongue-type fracture of Essex-Lopresti was associated with a significant reduction in the ability to hop on the affected foot (p < 0.05), and an increase in the number of peroneal injections (p < 0.03) for persistent pain.

After closed treatment, most patients had a normal range of movement at the ankle, and no limp. The range of movement in the subtalar joint was assessed as 50% or more of that on the uninjured side in 61% and 44% respectively of patients with displaced and undisplaced fractures.

**Displaced intra-articular fractures.** Of the randomised patients, 25 were treated operatively and 31 were treated closed. There were no significant differences between the patient populations (Table VI) and their outcomes are compared in Tables VII and VIII.

We found no statistically significant differences between the two groups, or between subsets of men of working age. From one to two years of follow-up there were tendencies to improvement in pain level, running ability, walking distance, gait (loss of limp), and ability to hop, but the only significant change was an increase in the level of patient satisfaction. Subtalar movement did not improve after one year.

Involvement of the calcaneocuboid joint signifi-

cantly reduced the likelihood of regaining 50% or more of subtalar movement (p < 0.04). The tongue type of fracture was associated with a significant reduction in hopping ability, but the increased incidence of the need for peroneal injections noted in the conservatively treated group was not seen in the operated group.

An inverted-Y fracture pattern tended to be associated with less satisfactory results in most parameters tested, but this was not statistically significant except in men of working age in whom it was associated with a significantly lower level of patient satisfaction.

## DISCUSSION

As for all displaced intra-articular fractures, the treatment of displaced fractures involving the subtalar joint has largely been based on the assumption that late symptoms mostly arise as a result of damage to the joint itself. Operative methods of treatment have included attempts at closed or percutaneous manipulation (Cotton and Wilson 1908; Böhler 1931), open reduction with either internal fixation (Soeur and Remy 1975; Stephenson 1983, 1987) or bone grafting (Palmer 1948) or both, and primary arthrodesis (Wilson 1927; Harris 1946; Dick 1953; Hall and Pennal 1960). We found only small differences between the outcome of undisplaced and displaced fractures treated closed; this suggests that operative treatment of this joint is not likely to improve outcome, and this was confirmed by our study.

These findings may have two explanations. First, the symptoms after fracture may not arise from the posterior subtalar joint. Secondly, it may require only minimal derangement of the joint to give significant

**Table VII.** Result from history at least one year after operative or conservative treatment of displaced unilateral intra-articular fractures (*percentage of group*)

	Operative (n = 25)	Conservative (n = 31)
Pain level 0 or 1	56	55
Use of analgesia	14	27
Site of pain		
Lateral	53	44
Medial	6	4
Tendo Achillis	6	4
Instep	0	4
Other	12	8
Two or more sites	24	36
Pattern of pain		
Activity	43	38
After rest	29	29
Weather change	7	10
Other	21	24
Sural nerve symptoms	30	20
No walking difficulty		
Up slopes	88	81
Down slopes	83	81
Uneven ground	50	45
Running	63	46
Climbing ladder	76	78
All surfaces	28	19
Using stick	4	10
Unlimited distance	44	52
Employment		
Same work	78	68
Lighter job	11	5
Unemployed	11	26
At previous recreation level	63	73
Normal shoes	71	70
Recovery plateau reached	71	63
Compensation pending	7	5
No or mild problems	64	65

symptoms. The small irregularities which persist after open reduction of the facet, and are present in apparently 'undisplaced' fractures, may be sufficient to cause continued disability. These two hypotheses give opposite weight to the importance of the subtalar joint. Our study of the effect of a procedure limited to the subtalar joint suggests that it is not as important as is generally accepted.

The common finding that pain is worse after rest is compatible with the view that it is due to venous engorgement, which is diminished by activation of the venous foot pump. Further research into the timing of weight-bearing, or the use of artificial foot pumps, seems likely to be rewarding (Erdmann, Richardson and Templeton 1992). It has also been suggested that soft-tissue damage is responsible for much of the long-term pain and disability (Lindsay and Dewar 1958). Since the disabling pain after calcaneal fracture dates from the time of injury, it is clear that it does not arise from secondary osteoarthritis.

Our findings show that operative treatment of these

**Table VIII.** Results of clinical examination at least one year after randomised operative or conservative treatment of displaced unilateral intra-articular fractures (*percentage of group*)

	Operative (n = 25)	Conservative (n = 31)
Deformity		
Valgus	13	10
Lateral bossing	58	73
Flat longitudinal arch	13	3
Calf wasting	54	37
Heel width ratio (mean)	1.25	1.25
Ankle movement normal	75	67
Subtalar movement		
Nil	8	0
< 50%	42	39
> 50% of normal side	29	48
Normal	21	13
Function		
No limp	71	73
Hop on affected leg	61	42
Stand on tiptoes	83	71
Sural nerve hypoaesthesia	0	0

fractures by the technique of subtalar joint restoration, as described by Soeur and Remy (1975), does not confer a significant advantage over conservative treatment: other techniques should be considered. An alternative method of operative treatment such as that described by Eastwood, Langkamer and Atkins (1993) may have a place in the management of these fractures; we await with interest the scientific evaluation of that technique in a randomised controlled trial.

Our postoperative treatment included the use of a plaster cast, which delayed mobilisation of the foot for six weeks. There is no evidence in the literature that early mobilisation improves results, and we found that early mobilisation of the undisplaced fractures failed to preserve subtalar movement (only 44% had half or more of the normal range of movement at review). This makes it unlikely that delayed mobilisation was an adverse factor in this group.

We used CT to classify the fractures. It is not yet possible to obtain absolute measurements of the displacement of fragments or of the accuracy of reduction, because the planes of the CT scanning cuts vary between different patients and between repeated scans in the same patient. It is also important to note that the plain lateral radiograph is important in assessing the degree of rotation of the fracture fragments.

Even after one year, about half the patients with displaced fractures treated conservatively still had pain, a limited walking distance, and difficulty in walking on uneven ground and in running. Nevertheless, 78% were able to climb ladders, and 73% of the men of working age had returned to work. A similar proportion was free from any limp and had resumed all recreational activities. By comparison, all patients with undisplaced fractures could run, about 80% had no limitation of walking distance or

any difficulty with walking on uneven ground, and 90% had little pain. We believe that these results are the first from a prospective assessment of intra-articular fractures of the calcaneum treated conservatively. At present most patients are treated in this way and our findings are useful in forecasting the prognosis, both for clinical management and for medicolegal reporting.

We used no overall scoring system because the clinical outcome is almost wholly dependent on one factor, the level of pain. After displaced intra-articular fractures the more severe pain levels (3 and 4) were associated with significant delays in return to employment by working men ( $p < 0.002$ ) and in return to full recreational activities ( $p < 0.01$ ) and with reduced patient satisfaction ( $p < 0.000002$ ). It seems that other factors such as loss of subtalar movement, have much less effect on return to work or patient satisfaction. Many patients experience improvement in their symptoms after the first year, but these changes are small. This implies that in general a decision may be made concerning salvage procedures such as subtalar fusion at one year after injury.

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