Bone mineral content in the calcaneus after ankle fracture

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The bone mineral content across the calcaneus was measured by gamma absorptiometry in 82 patients with operated on ankle fractures. A mean deviation in bone mineral content between the injured and the uninjured leg of 6 percent was found. Early weight bearing in a walking cast or brace did not influence the process of postfractural osteopenia.

Compared with the patients with isolated lateral malleolar fractures, the patients with bimalleolar and trimalleolar fractures were older and had a lower bone mineral content in the calcaneus of their uninjured leg. The percentage of deviation in bone mineral content between the injured and uninjured leg was also greater in patients with more severe fractures.

We have measured the bone mineral content of the calcaneus after ankle fracture with early or late weight bearing.

Patients and methods

Included in this study were 42 patients with a dislocated fracture of the lateral malleolus and 40 patients with dislocated bimalleolar or trimalleolar fractures. Twenty-two males with a mean age of 48 years and 60 females with a mean age of 53 years were examined (Table 1).

For the lateral malleolar fractures the mean age was 46 years and for the bimalleolar and trimalleolar fractures 58 years, and the male/female ratio was 12/30 and 10/30, respectively.

All the ankles were operated on using cerclage wires, staples, and pins (Cedell 1967), and all had a rupture of the anterior tibiofibular ligament. At the end of the operation the patients were, by instruction in a sealed envelope, randomly allocated either to early or late weight bearing.

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In the *early* weight-bearing group (n 41), 28 patients were randomized to weight bearing in a walking cast from the first postoperative day and 13 patients to weight bearing in an orthosis from

Table 1. Patient material. Absolute numbers or mean values (SD) are given

		Early weight bearing n 41	Late weight bearing n 41
Age (years)		54 (17)	50 (16)
Male/female		13/28	9/32
Deviation in bone mineral content (percent)			
Lateral mall. fractures		2 (6)	5 (7)
Bimall. or trimall. fractures		9 (10)	7 (8)
Time from fracture to bone mineral measurement (months)		17 (10)	18 (11)
Fracture classification according to Lauge-Hansen			
Supination-eversion	II	8	9
	III	7	1
	IV	13	16
Pronation-abduction	III	5	6
Pronation-eversion	III	2	1
	IV	6	8

the second postoperative week. The patients using the orthosis were allowed daily unloaded active ankle movements.

In the *late* weight-bearing group (n 41), 32 patients were randomized not to bear weight in a walking cast until the fourth or fifth postoperative week, and 9 patients using a dorsal plaster splint were randomized to no weight bearing at all. Active ankle movements were allowed in the latter group from the second postoperative week. For all the patients the period of external support was 7 weeks.

The 82 patients included in this study were selected as follows: Fifteen males and 35 females with lateral malleolar fractures and 15 males and 35 females with bimalleolar or trimalleolar fractures were randomly selected from 180 consecutive ankle fractures operated on at the Department of Orthopedics at Danderyd Hospital. Excluded from the study were 8 patients who preferred not to participate, 1 patient with postoperative residual fracture displacement, and 9 patients with earlier injuries to either of their legs.

When comparing the patients investigated before 18 months with those measured 18 to 36 months after fracture, the number of the lateral malleolar fractures was 25 before and 17 after 18 months. The corresponding numbers for the bimalleolar and trimalleolar fractures were 21 and 19.

At follow-up 6 months postoperatively, the range of loaded dorsal flexion was recorded (Lindsjö 1981). For subjective evaluation an ankle score and a linear analog scale were used (Olerud and Molander 1984).

The bone mineral content was measured by a single photon absorptiometry rectilinear scanning device (ND 1100A Bone Density Scanner, Christiansen and Rödbro 1977) across the calcaneus (Figure 1). The ND 1100A apparatus was modified by us for measurements of the calcaneus. A Plexiglass cage suitable for the foot was designed where the hind part of the foot could be kept in a firm and reproducible position during the measuring procedure. To correct for body size, the bone mineral content values were automatically divided by the outer dimensions of the calcaneus. The deviation in bone mineral content in the calcaneus of the injured leg was expressed as a percentage of the corresponding value of the uninjured leg. By replicate measurements in 16 volunteers, the precision of the measuring procedure was found to be 1.9 percent (1 SD); no difference was found between the right and the left leg.

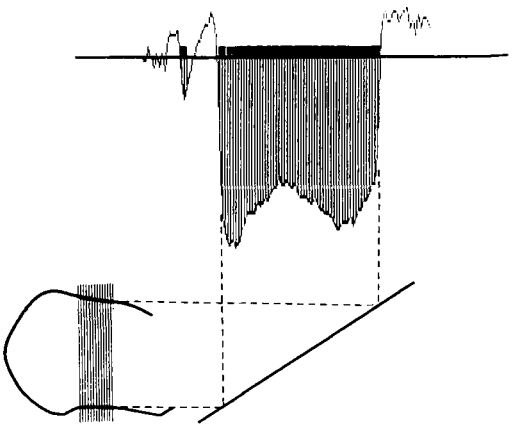

Figure 1. Graphic presentation of absorptiometry across the calcaneus.

The Student's *t*-test, the chi-square test, and analysis of variance by regression (Wonnacott and Wonnacott 1985) were used. $P < 0.05$ was considered significant.

Results

The mean bone mineral loss in the calcaneus of the injured compared with the uninjured leg was 6 percent ($P < 0.001$, Figure 2). Patients with

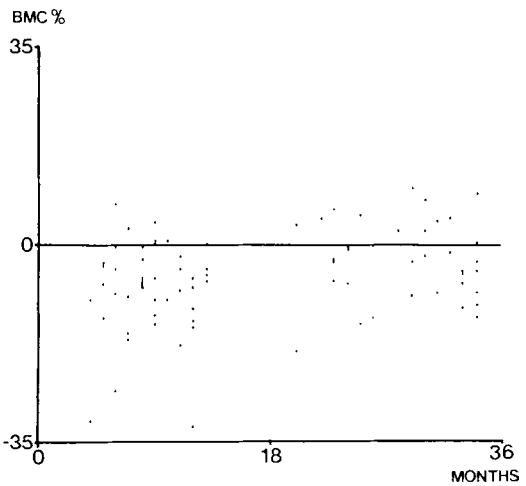

Figure 2. Bone mineral content (BMC) in the calcaneus of the injured leg, expressed as a percentage of the corresponding value of the uninjured leg in relation to time in months.

bimalleolar and trimalleolar fractures had 15 percent less bone mineral in the calcaneus of the uninjured side compared with patients with lateral malleolar fractures ($P < 0.001$). They also had greater loss in bone mineral ($P < 0.01$) in the calcaneus of the injured side (8 compared with 4 percent). Women as compared with men had less bone mineral in the calcaneus of their uninjured heel, and they also had greater mineral loss (7 compared with 3 percent, $P < 0.05$).

No differences in bone mineral values were found between early and late weight bearing or between active ankle movements and no ankle exercise. Further, we could not find any correlation between the deviation in bone mineral content and objective or subjective parameters at the 6-month follow-up.

Discussion

There was no evidence that early weight bearing in a walking cast or brace influenced the process of postfracture osteopenia triggered by the injury. This is in agreement with an earlier report on tibial shaft fractures treated with a weight-bearing brace (Andersson and Nilsson 1979).

We have expressed the bone mineral content of the injured side as a percentage deviation from the corresponding value of the uninjured leg as previously done by others (Nilsson 1966, Nilsson and Westlin 1975). We found no systematic differences between the right and left calcaneus in our healthy volunteers; and in a recent study including 240 volunteers, no difference between the left and the right leg was found (Margulies et al. 1986).

A tendency to lose bone mineral in the contralateral uninjured extremity has been reported (Mattsson 1972, Westlin 1974); it is possible that our values slightly underestimate the actual bone mineral loss.

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