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Changes in bone-mass after tibial shaft fracture

Vilhjalmur Finsen and Øystein Haave[1]

We studied 20 patients who had suffered tibial shaft fractures 30 months previously. The bone-mineral content in diaphyseal and metaphyseal bone of the femur and tibia was determined by photon absorptiometry. There was a moderate, but significant, deficit of bone-mineral in metaphyseal bone at the knee and distal tibia. This loss was, however, far smaller than that previously reported. Persisting bone-mineral changes in diaphyseal bone were insignificant except in the fracture area where there was a 28 per cent increase. This may indicate that bone may, under some circumstances, locally increase in strength after remodelling of the fracture.

Nilsson & Westlin (1977) found a persisting 15 per cent loss of bone mineral at the distal radius in patients who had suffered previous diaphyseal radius fractures. Westlin (1974) demonstrated an 18 per cent reduction of bone mineral of the radius and the ulnar shaft 1 year after a Colles' fracture. Nilsson (1966) studied patients with past tibial fractures and found a deficit of bone mass of 25 per cent in the ipsilateral distal femur, even many years after the fracture. Similarly, Andersson & Nilsson (1979a) found a 25 per cent loss in the proximal tibia 1 year after a tibial fracture. This loss was uninfluenced by early weight bearing (Andersson & Nilsson 1979b). Persisting loss of bone mineral has also been reported after amputation (Bjørk & Lempberg 1967) and meniscectomy (Nilsson & Westlin 1969).

In studies of bone-mineral changes persisting after femoral fractures (Finsen et al. 1987) and tibial osteotomies (Finsen 1987), we found far less change than previously reported after tibial fractures. We report the changes of bone-mineral content in diaphyseal and metaphyseal bone after nonoperatively treated tibial shaft fractures.

Patients and methods

Twenty patients, 11 women and 9 men, who had sustained tibial shaft fractures a median of 30 (16–68) months previously gave informed consent to participate in the study. None had at any time had other fractures of the lower extremities, nor been operated primarily or because of delayed union.

The median age at the time of fracture was 34 (14–61) years. Low- to-moderate energy trauma had been the cause of fracture in 13 cases. The dominant leg was fractured in 11 cases, and in 2 cases the fracture was open (Grade 1). There were five fractures of the middle and 15 fractures of the lower third of the tibia. The fibula was fractured in 15 cases.

The fractures were reduced and immobilized with a cast from the midthigh to the toes; in 3 cases transfixion with Kirscher pins was also performed. Weight bearing was allowed after changing to a patellar tendon-bearing type walking plaster after 7 (5–11) weeks. This was used for another 10 (3–22) weeks. The median time from fracture to removal of all external support was 18 (11–28) weeks. All the fractures healed.

Measurements of bone-mineral content (BMC) were performed on both lower extremities with a Gambro single-energy photon absorptiometer

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Departments of Orthopedics and [1]Trauma, Trondheim University Hospital, N-7006 Trondheim, Norway

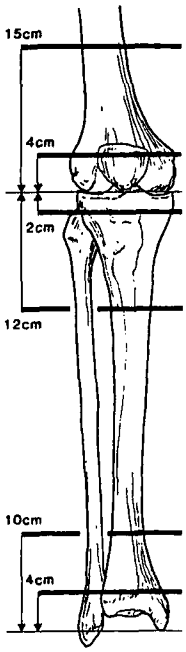

Figure 1. Levels at which bone-mineral content were determined. Reference points: the tibial plateaus and tip of medial malleolus.

(Naucler et al. 1974) that had been modified so as to admit the lower limb. The radiation from the Americium 241 source was collimated to a 7-mm beam. A fixed distance was kept between source and detector at each measuring level.

The tibial plateaus were located with an image intensifier. Scans of the femur were performed across the diaphysis and at the distal metaphysis (including the patella) (Figure 1). The tibia was scanned at the proximal metaphysis, mid-diaphysis, distal diaphysis, and distal metaphysis. The fibula was only included at the lowest level. The measurement in the distal tibial diaphysis included the fracture area in all 15 patients with fractures of the lower third of the tibia. In 1 patient, however, the scan at this level was unsuccessful for technical reasons.

Repeated measurements on 14 volunteers showed that the precision of the measuring procedure used was 2 percentage points at all the diaphyseal measuring levels, 3 at the proximal tibial metaphysis, 4 at the distal tibial metaphysis, and 5 at the distal femoral metaphysis.

Table 1. Median percentage change (95 per cent confidence range) in bone mineral content after tibial shaft fractures

Femoral diaphysis	-3	(-10— 0)	NS
Distal femoral metaphysis	-8	(-19— -3)	*P*<0.01
Proximal tibial metaphysis	-8	(-13— -4)	*P*<0.05
Mid tibial diaphysis	-3	(- 9— 2)	NS
Distal tibial diaphysis	+20	(7— 31)	*P*<0.001
Distal tibial metaphysis	-7	(-16— -6)	*P*<0.001

Persisting BMC changes were found by expressing the difference in BMC values on the two sides as a percentage of the value on the unfractured side. This percentage was considered negative when the BMC was lower in the fractured limb.

For statistical evaluation, we used Wilcoxon's nonparametric tests.

Results

Moderate falls in bone-mineral content were found at all the metaphyseal measuring levels (Table 1). In the distal tibial diaphysis the BMC was higher on the fractured than on the contralateral side. The changes in the mid-tibial and the femoral diaphysis were in significant.

All but 1 of the patients where the fracture area was included in the distal diaphyseal scan showed a gain in BMC; the median gain was 28 per cent. Among the 5 patients where the fracture had been at a higher level, however, a median loss of 1 per cent was found.

Discussion

The persisting bone-mineral changes that we have found are far smaller than the mean loss of 25 per cent reported by Nilsson (1966) in the distal femoral metaphysis and by Andersson & Nilsson (1979a) in the proximal tibial metaphysis. Nilsson (1966) used a prototype of our absorptiometer, and this difference in methods is probably of importance. Andersson & Nilsson (1979a) used the same equipment as we did. Their patients were slightly older, and there were more transfixions and open reductions. The immobilization time was similar, however, and it seems unlikely that these differences in treatment and age can explain the discrepancies in BMC values. It may be of importance that we performed our scans of the metaphysis more proximally.

A study of bone-mineral changes after osteotomy of the tibia (Finsen 1987) showed differences in bone-mineral content between the two sides in the distal tibial metaphysis, mid-tibial diaphysis, and distal femoral metaphysis after 2 years, almost identical to this investigation. It thus seems that persisting BMC changes after osteotomy and fracture are much the same in spite of much less energy absorbed by tissues during an osteotomy, and in spite of very early weight bearing in the osteotomy patients.

We found (Finsen et al. 1987) that patients who have sustained tibial fractures are more likely to have subsequent fractures of the tibia or femur on the same side. This may partly be due to behavioral patterns and to reduced coordination and muscle function, but it is possible that posttraumatic osteopenia is of some importance: there were considerable individual variations in the reduction of bone-mineral changes in our present study. Furthermore, in patients with senile osteopenia, a posttraumatic reduction of up to 19 per cent, as observed in our present study, is probably enough to increase the risk of ipsilateral fracture.

It is interesting to note the increase in BMC in the fracture area. We have previously found a 39 per cent increase in bone mineral in the fracture area after a Colles' fracture (Finsen & Benum 1986a) and have documented a marked reduction in the incidence of ipsilateral refracture after both previous Colles' (Finsen & Benum 1987) and hip fractures (Finsen & Benum 1986b). It thus seems possible that the fracture area in both metaphyseal and diaphyseal bone may have increased strength after healing and remodeling of the fracture.

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