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RESTORATION OF BONE MASS AFTER FRACTURE OF THE LOWER LIMB IN CHILDREN

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Fracture of the tibial shaft in adult man causes a loss of bone in the knee-region amounting to about 25 per cent; the loss after an injury to the semilunar cartilage is about 10 per cent. Adults seem to have very little ability to restore the bone mass after such local loss (Nilsson 1966, Nilsson & Westlin 1970).

The objective of the present study was to measure post-traumatic osteoporosis in children in order to investigate the ability of the young child to restore the lost bone mass.

MATERIAL AND METHODS

The material consisted of 30 young adults, 18 men and 12 women, 14 of whom had sustained fracture of the shaft of the tibia and 16 fracture of the shaft of the femur. The age at the time of the fracture was 8.8 ± 3.9 years (average ± standard deviation) and the average time elapsed between the injury and the measurement was 11 years. Only cases without history of other injury or disease in the lower limbs were included.

The bone density was measured in the distal end of the femur using a photon absorption method. The attenuation of the radiation from an Americium-241 source was measured with the beam passing through the epicondylar level of the distal end of the femur (Figure 1). The bone density was calculated and expressed in g/cc of bone; the method has previously been described in detail (Nilsson 1966).

The leg length was measured from the anterior iliac spine to the

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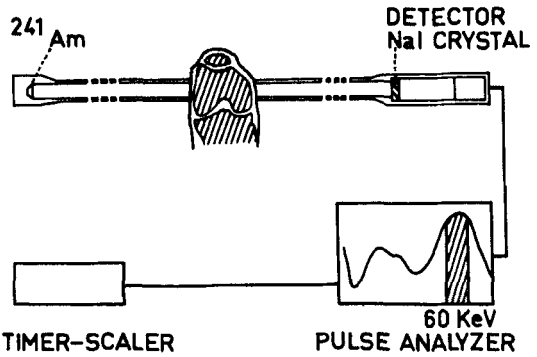

Figure 1. Measuring device.

medial malleolus with a measuring tape; the accuracy of this method is at the best 1 cm.

In the statistical analysis probability levels of 95 per cent or better were considered significant.

RESULTS

In the cases of femoral shaft fracture there was a significantly increased leg length on the injured side as compared to the uninjured; the difference was 0.63 ± 0.22 cm (average $\pm$ standard deviation). There was no measurable difference in the leg length in the cases of tibial shaft fracture.

There was no significant difference at the time of the follow-up in the mineral contents in the distal ends of the femora between the injured and the uninjured legs of the individuals who had sustained *tibia shaft fractures.* In the individuals with *femoral shaft fractures,* however, the uninjured side was significantly denser (Table 1).

Table 1. Changes in bone mass in the distal end of femur after fracture of the femur and the tibia.
(Control minus fracture, g/cc)

	No.	Difference (average $\pm$ S.E.)	
Tibia	14	—0.006 $\pm$ 0.009	Non-significant
Femur	16	0.011 $\pm$ 0.005	Significant

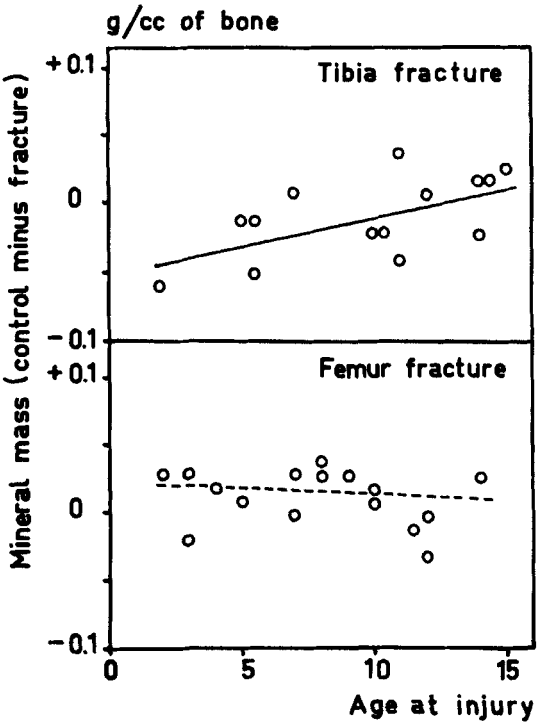

Figure 2. The degree of osteoporosis (control minus fracture) at the time of follow-up as a function of age at the time of injury.

The data were analysed with special reference to the age at which the child had sustained the injury. The differences in bone density between the uninjured and the injured legs against the age at fracture are plotted in Figure 2. After tibial shaft fracture there was a significant positive relationship, so that after fracture in early childhood there was a negative difference: the bone mass had become greater in the injured limb than in the uninjured. However, after fracture in teenagers there was residual osteoporosis in the injured side.

After femoral shaft fracture there was no such age-relationship; in all age-groups there was residual osteoporosis.

DISCUSSION

It has been debated whether an adult with osteoporosis may be able to restore the lost bone under any circumstances. One has failed, however, to demonstrate such restoration even when the causative disease has

been cured. It has been claimed that the young child, unlike the adult, can compensate for lost bone. However, this statement has also been subjected to doubt (Albright & Reifenstein 1948, Moldawer 1958, Skeels 1958).

In the present study it appears that the young child is able to compensate or even overcompensate for lost bone in conjunction with fracture. However, when the fracture was located proximally of the measured area, as was the case in the femoral shaft fractures, there was no evidence that the child was able to replace the bone completely. The trabecular bone located distally of the fracture, which was usually treated in traction for a substantial period of time, may be subjected to such profound changes that not even the growth process will be sufficient to replace the lost bone.

The loss of 0.011 g/cc of bone represents, however, only about 7 per cent of the total bone mineral content which should be compared to the 25 per cent loss found after tibial shaft fractures in adults.

SUMMARY AND CONCLUSIONS

Fourteen children with tibial shaft fractures and 16 with fractures of the shaft of the femur were studied about 11 years after the injury with respect to the bone mass in the epicondylar level of the femora. It was found that children with tibial shaft fractures, if they were young at the time of the injury, had been able to compensate and even overcompensate for the post-traumatic osteoporosis which follows the fracture. In children with fracture of the shaft of the femur, there was a remaining deficit of bone mineral in the injured limb at the time of the follow-up, although less than might be expected when compared to data obtained from adults.

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