

Trabecular osteopenia in Colles' fracture

Bone density was measured in 23 postmenopausal women with Colles' fracture. Trabecular spine density was measured by quantitative computed tomography. The bone mineral density in the distal radius and in the diaphysis of the radius and ulna was measured by the gamma ray attenuation method. Compared with age-matched controls, the patients were found to have reduced trabecular bone mass in the spine and distal radius, but no osteopenia in the diaphysis of the radius and ulna. The mean age-corrected decrease was 0.7 SD in the spine and 0.5 SD in the distal end of the radius. The results suggest that patients with Colles' fracture have trabecular but not cortical osteopenia.

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A relationship between fracture and bone mineral density in the distal end of the radius is suggested by the data of Nilsson & Westlin (1977) and Jensen et al. (1983). However, studies of the overall bone mass in patients with Colles' fracture have been inconclusive (Nilsson & Westlin 1974, Horsman 1976, Lamke et al. 1978, Meema & Meema 1982, Krølner et al. 1982, Nordin 1984, Hesp et al. 1984). It has been suggested that involutional osteoporosis can be divided into two distinct groups (Riggs et al. 1983). In accordance with this hypothesis, the distribution of spinal and peripheral osteoporosis has been found to differ between patients with vertebral fragility and those with hip fracture (Riggs et al. 1982, Krølner & Pors Nielsen 1982, Härmä et al. 1985).

We have compared forearm and vertebral bone mass in women with Colles' fracture.

Patients and methods

Twenty-three postmenopausal women with recent Colles' fracture volunteered for the study. Their mean age was 62 (53-74) years. Nineteen fractures were in the dominant arm. All patients with previous forearm fracture, known metabolic bone disease or using drugs known to interfere with calcium metabolism were excluded. Hemoglobin, sedimentation rate, serum creatinine, albumin, free thyroxin index, calcium, inorganic phosphate and alkaline phosphatase were normal. The patients were studied during the first 5 weeks after the fracture while the fractured arm was still in plaster.

The bone mineral content (BMC) and bone min-

eral density (BMD) in the uninjured arms of the patients were measured by a modification of the gamma ray attenuation method described by Karjalainen (1973). In this method a 45 mCi Am-241 with a gamma energy of 60 keV is used as the radiation source. In the distal end of the radius the measurements were taken 1.5 cm from the distal edge of the radius - in this region approximately 65 per cent of the bone is trabecular (Schlenker & Von Seggen 1976). The measurements of cortical bone were made at the junction of the middle and distal thirds of the radius and the ulna. BMC in the diaphyses (g/cm^2) and BMD in the distal end (g/cm^3) were calculated as described by Karjalainen (1973). Control values for the dominant and nondominant arms were obtained from an age-matched group of healthy women, previously studied (Karjalainen & Alhava 1977).

The trabecular bone density in the spine was measured by computed tomography (CT) with a standard scanner. The first three lumbar vertebrae were scanned by consecutive 4 mm slices with an energy of 96 kV, 300 mAs and 720 projections. The density values were corrected by the water and air standards obtained from a calibration phantom placed under the subjects in all CT measurements. The density of the vertebrae was presented as CT-Hounsfield-numbers (HU). The weighted mean of the values obtained from the trabecular bone area of the measured vertebrae was calculated as described earlier (Härmä et al. 1985). Control values were obtained from healthy postmenopausal women studied previously (Härmä et al. 1985).

Patient and control values were compared by calculating the mean differences from the age regressions of the control subjects, i.e. from the age-adjusted mean of the controls. Comparison of the mean difference values of the patients and control subjects was made by the two-sided *t*-test.

Results

The mean difference between patient and control values (Figure 1) was -5.2 per cent in the distal end of the radius ($p < 0.05$) and -20 per cent in the spine ($p < 0.05$). In the diaphysis of the radius the corresponding difference was $+12$ per cent ($p < 0.05$) and in the ulnar diaphysis $+5.5$ per cent (NS). The age-adjusted mean difference was positive in the diaphysis and negative in trabecular bone (Table 1).

Discussion

In our patients with Colles' fracture we found a decreased mass of trabecular bone in the distal end of the radius, but no osteopenia in the diaphyses of the radius and ulna. Our results agree with the recent report of Hesp et al. (1984). In earlier studies osteopenia was not found in the distal radius of patients with Colles' fracture (Nilsson & Westlin 1974, Horsman

1976, Krølner et al. 1982). A possible reason for this difference is the choice of measuring site. In the site used by us the relative amount of trabecular bone was about 65 per cent, whereas in most of the previous studies the measuring site was more proximal with perhaps less than 20 per cent trabecular bone (Schlenker & Von Seggen 1976).

The status of cortical bone in patients with Colles' fracture did not differ from age-matched controls in studies of radiographic morphometry in the metacarpal bones (Nordin 1984) and the radial diaphysis (Meema &

Table 1. Bone density in patients with Colles' fracture. The values are given as the difference from the age-adjusted mean of the control subjects, using one standard deviation of the controls as a unit (z-score). Mean \pm 1 SD

Bone mineral content in the radial diaphysis	$+0.9 \pm 1.5^a$
Bone mineral content in the ulnar diaphysis	$+0.4 \pm 1.2$
Bone mineral density in the distal radius	-0.5 ± 1.0^a
Trabecular bone density in the spine	-0.7 ± 0.5^a

a. $p < 0.05$, two-sided *t*-test.

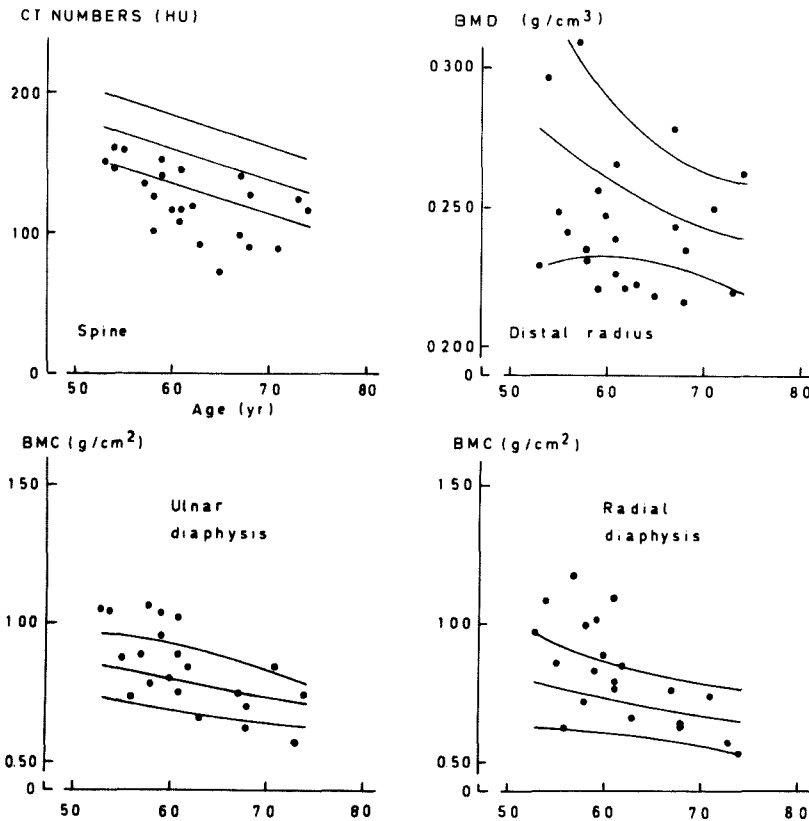


Figure 1. Individual bone density values of the 23 Colles' fracture patients at the four measuring sites. The lines denote the age regression of the controls \pm 1 SD.

Meema 1982) or BMC of the femoral neck and shaft (Lamke et al. 1978). In the only previous investigation using the gamma transmission method in the radius diaphysis of patients with Colles' fracture, Nilsson & Westlin (1974) found a 7 per cent decrease in BMC, but after correction for cortical thickness this difference disappeared.

Lumbar BMC in patients with Colles' fracture has been reported to be reduced to 91 per cent of the mean value for normal women of the same age (Krølner et al. 1982). In our CT study the reduction was about 20 per cent.

The relative amount of trabecular bone at our measuring site in the distal end of the radius was about 65 per cent. The 0.7 SD reduction of trabecular bone mass in the spine of the patients with Colles' fracture was similar to the 0.5 SD reduction in the compound trabecular and cortical bone mass in the distal end of the radius in the same patients. This reduction in spinal and peripheral trabecular bone mass was in the same range as the data reported for patients with hip fracture (Härmä et al. 1985). However, patients with hip fracture had reduced cortical bone mass in the radius as well.

References

- Hesp, R., Klenerman, L. & Page, L. (1984) Decreased radial bone mass in Colles' fracture. *Acta Orthop. Scand.* **55**, 573–575.
- Horsman, A. (1976) Bone mass. In: *Calcium, phosphate and magnesium metabolism*, pp. 382–384. (Ed. Nordin, B. E. C.) Churchill Livingstone, Edinburgh, London.
- Härmä, M., Karjalainen, P. & Hoikka, V. (1985) Bone density in women with spinal and hip fractures. *Acta Orthop. Scand.* 380–385.
- Jensen, G. F., Christiansen, C., Boesen, J., Hegedüs, V. & Transbøl, I. (1983) Relationship between bone mineral content and frequency of postmenopausal fractures. *Acta Med. Scand.* **213**, 61–63.
- Karjalainen, P. (1973) A method for determination of the mineral content and mineral density of the distal radius using gamma ray attenuation. *Ann. Clin. Res.* **5**, 231–237.
- Karjalainen, P. & Alhava, E. M. (1977) Bone mineral content of the forearm in a healthy population. *Acta Radiol. Ther. Phys. Biol.* **16**, 199–207.
- Krølner, B. & Pors Nielsen, S. (1982) Bone mineral content of the lumbar spine in normal and osteoporotic women: cross-sectional and longitudinal studies. *Clin. Sci.* **62**, 329–333.
- Krølner, B., Tøndevold, E., Toft, B., Berthelsen, B. & Pors Nielsen, S. (1982) Bone mass of the axial and the appendicular skeleton in women with Colles' fracture: its relation to physical activity. *Clin. Physiol.* **2**, 147–157.
- Lamke, B., Sjöberg, H-E. & Sylvén, M. (1978) Bone mineral content in women with Colles' fracture: effect of calcium supplementation. *Acta Orthop. Scand.* **49**, 143–146.
- Meema, S. & Meema, H. E. (1982) Evaluation of cortical bone mass, thickness and density by z-scores in osteopenic conditions and relation to menopause and estrogen treatment. *Skeletal Radiol.* **8**, 259–268.
- Nilsson, B. E. & Westlin, N. E. (1974) The bone mineral content in the forearm of women with Colles' fracture. *Acta Orthop. Scand.* **45**, 836–844.
- Nilsson, B. E. & Westlin, N. E. (1977) Bone mineral content and fragility fractures. *Clin. Orthop.* **125**, 196–199.
- Nordin, B. E. C. (1984) Metabolic bone and stone disease, pp. 9–11. Churchill Livingstone, Edinburgh, London, Melbourne, New York.
- Riggs, B. L., Wahner, H. W., Seeman, E., Offord, K. P., Dunn, W. L., Mazess, R. B., Johnson, K. A. & Melton III, L. J. (1982) Changes in bone mineral density of the proximal femur and spine with aging. Differences between the postmenopausal and senile osteoporosis syndromes. *J. clin. Invest.* **70**, 716–723.
- Riggs, B. L., Melton III, L. J. & Wahner, H. W. (1983) Heterogeneity of involutional osteoporosis: evidence for two distinct osteoporosis syndromes. In: *Clinical disorders of bone and mineral metabolism*, pp. 337–342. (Ed. Frame, B., Potts Jr, J. T.) Excerpta Medica, Amsterdam, Oxford, Princeton.
- Schlenker, R. A. & Von Seggen, W. W. (1976) The distribution of cortical and trabecular bone mass along the lengths of the radius and ulna and the implications for *in vivo* bone mass measurements. *Calcif. Tissue Res.* **20**, 41–52.