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Decreased radial bone mass in Colles' fracture

Computed tomography measurements on the radii of 18 women with Colles' fracture of the radius have shown that compared to normal women of the same age they tended to have a smaller bone cross-sectional area in the radius midshaft, a small deficit of cortical bone, and a substantial deficit of trabecular bone in the distal radius.

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The incidence of Colles' fracture of the distal radius increases significantly in women after the age of 50 years, and above the age of 60 years it is about seven times more prevalent in women than in men (Buhr & Cooke 1959, Alffram & Bauer 1962, Knowelden et al. 1964). It has been suggested that Colles' fracture, fracture of the femoral neck, and spinal fracture in elderly women may all be associated with a deficit in trabecular bone (Crilly et al. 1979). This has not been demonstrated clearly in Colles' fracture, where measurements of bone mineral content have generally been made on the radius using techniques which are not able to discriminate between trabecular and cortical bone (Nilsson & Westlin 1974, Horsman 1976, Krølner et al. 1982). However, it is possible to measure quantities related to trabecular and cortical bone separately by computed tomography (CT). We have used a special-purpose CT system (Ruegsegger et al. 1976) to measure trabecular and cortical bone in the radii of 18 women with Colles' fracture, and have compared the results with values for normal women.

Patients and methods

Quantities related to trabecular and cortical bone in the unfractured wrist were measured on 18 female patients (mean age 67, SD ± 10 years, mean weight 62, SD ± 7 kg, mean height 1.6 SD ± 0.06 m) who had suffered a Colles' fracture during the 2 weeks prior to measurement. Measurements are normally made on the dominant wrist, but eight of these patients had fractured this wrist, so in those cases the CT measurements were made on the non-dominant wrist and a correction was applied. No patient had sustained a previous Colles' fracture to either wrist, or a fracture at any other skeletal site. The CT measurements, which had been approved by the Hospital Ethical Committee, were carried out with the informed consent of each patient.

Measurements were made using a special-purpose CT system (ISOTOM) which incorporated a source of ^{125}I (29 KeV photons, 0.2 to 0.5 Ci 7.4 to 18.5 GBq) (Exner et al. 1979). The sites of measurement were at the distal end and mid-shaft of the radius, approximately 8–10 per cent and 33 per cent of the distance from the ulnar styloid process to the olecranon, respectively.

The following quantities were measured:

Distal radius:

TBD (cm^{-1}) The mean linear attenuation coefficient of the central 50 per cent of the bone cross-sectional area at a site containing trabecular bone.

Radius mid-shaft:

BD (cm^{-1}) The mean linear attenuation coefficient of the complete bone cross-sectional area at a cortical bone site.

CA (cm^2) Bone cross-sectional area.

TA (cm) Total absorption (TA = BD × CA) which is highly correlated with BMC ($g \cdot cm^{-1}$) determined by conventional absorptiometry (Elsasser & Reeve 1980).

The standard error on each of these quantities is approximately 2 per cent and the radiation dose 2 mrem (0.02 mSv) per measurement at the measurement site.

Values obtained from measurements on the non-dominant wrist were converted to equivalent values for the dominant wrist, using the following corrections derived from measurements on normal healthy adults:

BD (dominant = 1.02 × BD (non-dominant)

TA (dominant)= 1.03 × TA (non-dominant).

No corrections were required for TBD and CA because the correction factors were not significantly different from 1.0.

Each quantity, for each patient, was then compared with the corresponding estimated normal value for that patient. Normal values were derived from equations relating each of the quantities to age, and to age, weight and height, based on measurements on the dominant radii of 96 normal healthy females aged 40 to 89 years (unpublished data). The significance of paired differences was obtained using a two-tailed *t*-test (Bailey 1974).

Results

TBD was 12 per cent lower in Colles' fracture patients than in age-matched normals (Table 1 and Figure 1). A similar deficit was also obtained after correction for age, weight and height. At the radius mid-shaft, BD did not differ between the two groups, and CA was different when age was taken into account, but not when allowances were also made for weight and height. However, TA was different between the two groups, with a deficit of 8.5 per cent allowing for age, and 6.4 per cent allowing for age, weight and height.

Table 1. Bone density in Colles' fracture patients compared to normal values. (See text for explanation of abbreviations.)

		Mean values in 18 patients	Comparison of fracture patients with age-matched controls	
			Mean difference	Mean ratio
Distal radius	TBD cm^{-1}	0.58 ±0.023	−0.078 ±0.024 $P<0.01$	0.88 ±0.035 $P<0.01$
Radius mid-shaft	BD cm^{-1}	2.17 ±0.06	−0.07 ±0.04 N.S.	0.97 ±0.02 N.S.
	CA cm^2	0.977 ±0.030	−0.066 ±0.030 $P<0.05$	0.937 ±0.029 $P<0.05$
	TA cm	2.13 ±0.086	−0.193 ±0.069 $P<0.02$	0.915 ±0.030 $P<0.02$

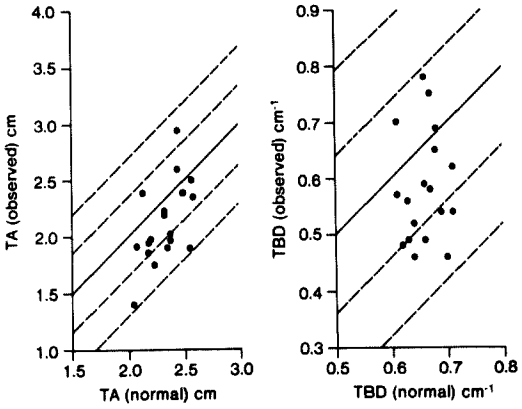

Figure 1. Relationship between observed values and age-matched normal values of TA at the radius mid-shaft and of TBD in the distal radius (line of identity is shown, with 67 per cent and 95 per cent confidence limits). (See text for explanation of abbreviations.)

Discussion

The method used to correct the results of measurements on the non-dominant wrist of Colles' fracture patients to equivalent values for the dominant wrist has been used before by Krølner et al. (1982), except that their results were obtained by dual photon absorptiometry, which does not discriminate between trabecular and cortical bone, and our results were obtained by CT, which does discriminate. Krølner et al. (1982) did point out that there could be a distinct advantage in using CT to study patients with Colles' fracture, as we have found. Our value for the correction of TA (1.03) to equivalent values for the dominant wrist was similar to that reported (1.04) by Exner et al. (1979) using the same CT technique on normal

subjects. Like us, they did not find a significant difference in TBD and CA between non-dominant and dominant wrists in normal adults.

The age, weight and height of each Colles' fracture patient were taken into account in the final analysis of results. In one evaluation, the values for each patient were compared to values estimated for a normal woman of the same age. In the second evaluation, estimated values were derived for a normal woman of the same age, weight and height.

Cross-sectional area is an important factor since BD (BD = TA/CA) was not significantly different between patients and normal women. Although the deficit in TA is an indicator of the true deficit in cortical bone, the deficit in TBD underestimates the true deficit in trabecular bone, because TBD incorporates a significant contribution from marrow (mean linear attenuation coefficient at 29 KeV approximately 0.326 cm^{-1} (Hangartner & Overton 1982)). Estimates of the mean density of trabecular bone in the distal radius were obtained from mean values of TBD, using the methods of Hangartner & Overton (1982) and Ruegsegger et al. (1981). The mean value of TBD (0.58 cm^{-1}) for Colles' fracture patients is equivalent to a trabecular bone density of 0.211 $g \cdot cm^{-3}$, and the corresponding mean value for normals (TBD = 0.658 cm^{-1}) is equivalent to 0.275 $g \cdot cm^{-3}$. Thus the true mean deficit in trabecular bone density (0.064 $g \cdot cm^{-3}$) was probably about 23 per cent.

This study has shown that female patients with Colles' fracture tended to have a smaller bone cross-sectional area of the radius mid-shaft (93.7 per cent of normal), a deficit in the amount of cortical bone in the radius mid-shaft (91.5 per cent of normal) and a larger deficit of trabecular bone density in the distal radius (about 77 per cent of normal) when compared to normal women of the same age. If this situation is typical of the remainder of the skeleton, it is not surprising that in elderly women with Colles' fracture there is an increased incidence of subsequent fracture of the femoral neck (Owen et al. 1982). The possibility exists that the measurement of trabecular bone density in the distal radius, or measurements on the femoral neck by dual photon absorptiometry, could help to identify individuals at increased risk of femoral neck fracture in whom prophylactic treatment would be justified.

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