THE MEASUREMENT OF OSTEOPOROSIS IN CLINICAL PRACTICE

COMPARISON OF HISTOLOGICAL AND RADIOLOGICAL METHODS

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In a prospective study of the measurement of osteoporosis in patients with fracture of the femoral neck, we compared a histological with a radiological method.

We found no significant correlation between histological planimetry and the radiological six metacarpal hand index in patients with either cervical or trochanteric fractures. This demonstrates that metacarpal morphometry cannot predict histological osteoporosis of the iliac crest.

Osteoporosis may be assessed quantitatively by radiography, by densitometry studies or by histological methods (Ralston 1983), and is associated with progressive weakening of bone (Stevenson and Whitehead 1982) and an increased incidence of fractures (Lane and Vigorita 1983). Aitken (1984) has shown that 84% of patients with a femoral neck fracture had either mild or severe osteoporosis; this emphasises the need for techniques to identify the condition and to monitor its progress. Only then can different treatments be accurately assessed.

The measurement of trabecular bone volume in iliac crest biopsies permits the early diagnosis of osteoporosis (Stevenson and Whitehead 1982), but it is known that this can vary from site to site within the skeleton. Metacarpal morphometry, which relates cortical thickness to the total width of the metacarpal at its midpoint, was first described by Barnett and Nordin in 1960. It has been refined by Horsman and Simpson (1975), who measured the combined cortical thicknesses of the middle three metacarpals of both hands and expressed the result as a percentage of the combined metacarpal diameters. They termed it the 'six metacarpal hand index'.

If metacarpal morphometry is a reliable method of measuring osteoporosis then it should compare well with measurements made by a histological method. We have made such a comparison.

PATIENTS AND METHODS

Over a four-month period every patient admitted to the University Hospital, Nottingham with a cervical or trochanteric fracture of the femoral neck was considered for study. Patients were excluded if they had biochemical or histological evidence of osteomalacia, a recent previous fracture or a pathological or sub-trochanteric fracture, or were not treated by operation. After these exclusions and review of biopsies, we selected 50 patients aged from 45 to 94 years (mean 77.9 years), 24 with a cervical and 26 with a trochanteric fracture.

Histology. Trephine biopsy of the ipsilateral iliac crest was carried out at the time of operation on the hip fracture, using the vertical biopsy technique described by Sacker and Nordin (1954) in the manner recommended by Williams and Nicholson (1963). The specimen was a cylinder of bone approximately 5 mm in diameter and 12 mm long. Sections were prepared and stained by the von Kossa method, using a standard technique. Cases were excluded from the series if a significant amount of unmineralised osteoid was present, if there was any evidence of metastatic tumour or metabolic bone disease, or if the biopsy specimen was inadequate or unduly damaged. After such exclusions had been made, 50 cases had histomorphometry. The level of osteoporosis was
Cervical Fractures

Trochanteric Fractures

Fig. 1a

Fig. 1b

Scattergrams comparing the results of histological planimetry and the six metacarpal hand index in 50 patients with fractures of the neck of the femur.

objectively evaluated by a semi-automatic method, the amount of bone present being measured using a digiplan microprocessor and the percentage area of bone calculated. The cortical plate was not included in the morphometric analysis, nor were the extreme edges of the biopsy sample where the trabecular pattern was less clear. Sections were also assessed at a magnification of 100 on an average of 18 fields per specimen for the percentage of calcified trabecular bone.

Radiology. A standardised radiograph of both hands was taken at the time of postoperative hip radiography. In all cases, both hands were placed flat on the radiographic plate and a postero-anterior view taken, using CEA Singul-X RP exposed to 50 kVP radiation with a tube current of 32 mA/sec and a film-focus distance of 100 cm. The film was processed on a M6AN-Kodak machine with Kodak chemistry for 90 seconds. Poor quality radiographs were not accepted and patients with regional osteoporosis, such as those with rheumatoid arthritis were excluded.

Metacarpal morphometry on the second, third and fourth metacarpals of both hands used the technique described by Horsman and Simpson (1975) and by Aitken (1984). Electronically-digitalised micrometer calipers (NSK Max-Cal digital readout calipers) gave an accuracy of 0.01 mm.

To minimise errors one observer carried out all radiological measurements and another performed the histological measurements. Observer bias was excluded by isolating the results from each technique.

Statistical evaluation. Mean bone density, measured histologically, in patients with cervical fracture was compared with that in trochanteric fracture, using the Mann-Whitney U test. The results of metacarpal morphometry were also compared in the two groups of patients.

To compare the results of histological and radiological methods the planimetric percentage of bone was plotted against the six metacarpal hand index, separately for cervical and trochanteric fracture cases. Linear regression analysis of the results was also performed, calculating the Pearson correlation coefficient (R) for the comparison.

RESULTS

There was no statistical difference in bone density between patients with cervical fractures and those with trochanteric fractures as measured histologically (Mann-Whitney U-239.0) or by the six metacarpal hand index (U-286.0).

The results of the semi-automatic histological method and the radiological six metacarpal hand index are compared in Figure 1a for patients with cervical fractures and in Figure 1b for patients with trochanteric fractures. These scattergrams clearly show that there is little correlation between the histological and the radiological measurements in either group, and this is confirmed by statistical calculation: the Pearson correlation coefficient (R) was 0.1333 for cervical fractures and 0.2713 for trochanteric fractures. These results show that
there is no significant correlation between the histological and radiological methods of assessment of osteoporosis as used in our study.

DISCUSSION
The measurement of bone density is essential for the assessment of osteoporosis and for the evaluation of drug and dietary treatment in its management. Assessment of the severity of osteoporosis has always proved difficult. It is known that changes in bone density are not uniform throughout the skeleton and that certain sites are selectively affected (Stevenson et al 1986). However, the iliac crest has always been regarded as a representative site, and is favoured for histological biopsy, although this is probably because of its accessibility. Whether cortical narrowing in the metacarpal bones is representative of general changes is critical if metacarpal morphometry is to be used as a measure of osteoporosis.

Another problem in the histological assessment of osteoporosis is the definition of the cut-off point between normal and osteoporotic bone. Different authors use different values (Garner and Ball 1966; Meunier et al 1976).

Our study has shown that metacarpal morphometry is not comparable to histological measurement in the assessment of osteoporosis in patients with cervical or trochanteric hip fractures. Both groups of patients were well matched as regards histological bone density and cortical thickness as measured by the six metacarpal hand index: neither bone density nor cortical thickness seemed to have influenced the type of fracture.

Recently, dual photon absorptiometry has become popular in the assessment of osteoporosis (Riggs et al 1982), but this requires expensive equipment which is not available for most studies. We feel that when absorptiometry is not available, quantitative assessment of osteoporosis in a hip fracture patient is best undertaken by analysis of bone biopsy samples, especially when attempting to evaluate the efficiency of various drugs and diets.

Serial biopsies of the iliac crest by trephine can be performed on out-patients under local anaesthesia to monitor treatment regimes in patients with Paget's disease or osteomalacia. Such serial histological assessments are proving extremely valuable in improving the management of these diseases and may be of value in the monitoring of patients with osteoporosis.

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REFERENCES