SCREENING FOR OSTEOMALACIA IN ELDERLY PATIENTS WITH FEMORAL NECK FRACTURES

T. J. WILTON, D. J. HOSKING, E. PAWLEY, A. STEVENS, L. HARVEY

From the University Hospital, Nottingham

In this study 201 elderly patients with femoral neck fractures were compared with 30 osteomalacic patients with the same injury. Hypocalcaemia and a raised alkaline phosphatase level are common biochemical abnormalities in elderly patients with femoral neck fractures. In only a minority of patients, however, were they associated with histologically proven osteomalacia. By using the combination of hypocalcaemia and a raised alkaline phosphatase it is possible to identify a subgroup (approximately 10% of all admissions) in whom osteomalacia is relatively likely.

Although an association between osteomalacia and femoral neck fracture in the elderly has previously been reported (Jenkins et al. 1973; Aaron et al. 1974), a recent survey of over 1000 consecutive femoral neck fractures showed that it was present in only 2% of cases (Wilton et al. 1987). Nonetheless, the detection of osteomalacia is important since it may influence subsequent management of the femoral fracture.

Ideally diagnosis should be based on a combination of clinical, biochemical, radiological and histological features. Unfortunately, no single parameter has been found to be entirely reliable (Dent 1974) and ultimately osteomalacia must be defined in histological terms (Aaron, Gallagher and Nordin 1974). The screening of a population with a low incidence of osteomalacia would be more efficacious if a high-risk group could be identified; this would avoid performing unnecessary bone biopsies. Measurement of serum calcium, phosphate and alkaline phosphatase are obvious screening tests but previous studies have shown no strong correlation with bone histology in elderly patients with fracture (Jenkins et al. 1973). Our own experience suggested that these tests were of value (Campbell et al. 1984) and we have therefore re-examined the association between biochemical and histological abnormalities in elderly patients with femoral neck fractures.

PATIENTS AND METHODS

From August 1984 to January 1985, 286 patients were operated on for a femoral neck fracture at Queen’s Medical Centre in Nottingham; 248 of these (86.7%) had an iliac crest bone biopsy performed during the operation. Measurements of serum calcium, phosphate, creatinine and liver function were available in 210 (84.6%) of those biopsied. Blood was taken either on arrival or on the following morning. In either case the patient was likely to have fasted for several hours; no attempt was made to ensure standardised fasting and our results therefore reflect the normal (pre-operative) circumstances under which blood would be taken.

Five patients were excluded from analysis: three had Paget’s disease, one had hyperparathyroidism and one had carcinomatosis. Since the serum alkaline phosphatase rises in the second week after a fracture (Hosking 1978), four patients who had suffered a fracture more than a week before admission were also excluded from analysis. This left 201 patients for study and we have called these the control group; there were 41 men and 160 women whose ages ranged from 59 to 99 years (mean 80 years), and approximately equal numbers with intertrochanteric and subcapital fractures.

The data from this group were compared with those from a consecutive series of 30 elderly patients, seen over the last three years, with femoral neck fractures and known to have osteomalacia. Differences between these groups were used to identify those biochemical tests which would be of value in the detection of subclinical osteomalacia.

For the purposes of this study osteomalacia was defined as an osteoid area comprising more than 5% of the total trabecular area; all but two patients also had a surface extent of osteoid greater than 25% of the total trabecular surface.
RESULTS

Serum alkaline phosphatase was raised in 47 of the 201 patients (23%), most of whom had osteoporosis; high values were found in 31 of 161 who had normal liver function tests (19%) and in 16 of 40 (40%) in which these were abnormal (Fig. 1). Measurements of serum alkaline phosphatase in the 30 patients with osteomalacia are shown in relation to osteoid parameters (Fig. 2). There was a reasonable correlation with osteoid area (r = 0.54; p < 0.01) but in 12 patients with values below 17% the serum alkaline phosphatase was normal on admission. There was no significant relationship between serum alkaline phosphatase and osteoid surface. Serum calcium was corrected to an albumin concentration of 40 g/l (Br Med J 1977) by using the following formula:

\[
\text{corrected calcium} = \frac{\text{measured calcium} + 0.02 (40 - \text{serum albumin})}{280}
\]

The results for the control group are shown in Figure 3. Hypocalcaemia was present on admission in 35% of the 201 control patients: stratification on the basis of serum creatinine did not improve the discriminatory value of this test.

The relationship between serum calcium and the osteoid measurements is shown for the 30 osteomalacic patients in Figure 4. There was an inverse relationship between calcium and these two variables, the correlation being slightly better for osteoid area (r = 0.51; p < 0.01) than for surface (r = 0.48; p < 0.02). Ten patients with a less severe abnormality (an osteoid area of less than 18% of the total trabecular area) had normal serum calcium levels.

Serum phosphate concentrations for controls and for those patients with osteomalacia are shown in
Figure 5 where it can be seen that phosphate is a poor discriminator for the presence of osteomalacia. Stratification on the basis of serum creatinine did not improve the discriminatory power of phosphate measurements.

The value of combining serum calcium and alkaline phosphatase as a screening test for osteomalacia is shown in Figure 6. In the bottom half of the figure are shown the data from those patients with osteomalacia, while at the top the relative distribution of the various combinations of biochemical values in the control group are shown. In order to detect every case of osteomalacia, however slight, every patient would require a bone biopsy. If biopsies were restricted to those with either hypocalcaemia or a raised alkaline phosphatase, then 49% of all admissions would require a biopsy and this would detect 83% of the cases of osteomalacia. Only two mild and three borderline cases of osteomalacia in our study would have been missed by this approach. Restricting a bone biopsy to those patients with both an abnormal alkaline phosphatase level and hypocalcaemia would detect 13 of 30 cases of osteomalacia (43.4%), including all those with the most severe abnormality. In order to detect these cases only 9.5% of the control population would need to be biopsied.

DISCUSSION

The present study shows that hypocalcaemia and a raised alkaline phosphatase level are common abnormalities in elderly patients admitted to hospital with femoral neck fractures. Acutely ill hospitalised patients of similar age and sex without fractures show comparable changes (Campbell et al. 1984) except that hypocalcaemia is approximately half as common. The main problem with using these tests for screening is that in only a minority of cases are abnormal results associated with the presence of osteomalacia (Jenkins et al. 1973; Peach et al. 1982; Campbell et al. 1984).

The logistic problems of using biochemical screening in order to identify a high-risk group in whom iliac crest biopsy has a reasonable probability of detecting abnormality is well illustrated by the present study. In order to detect every case of osteomalacia, however mild, every patient with a femoral neck fracture would need a bone biopsy. Since our previous study showed that the incidence of subclinical osteomalacia in this population

![Figure 4](image-url)

The relationship between serum calcium levels and osteoid parameters in the 30 patients with a femoral neck fracture complicated by osteomalacia. O Serum creatinine < 120 µmol/l; ● Serum creatinine > 120 µmol/l.

![Figure 5](image-url)

Serum phosphate values in patients with normal or osteoporotic bone histology and osteomalacia. O Serum creatinine < 120 µmol/l; ● Serum creatinine > 120 µmol/l.
is only 2% (Wilton et al. 1987), this approach is clearly neither clinically justifiable nor cost-effective.

Using the criteria of both hypocalcaemia and a raised alkaline phosphatase level (irrespective of whether liver function tests are abnormal) would detect all the severe cases of osteomalacia (that is, those with an osteomalacic area comprising more than 18% of the total trabecular area). This would involve performing an iliac crest bone biopsy, usually at the time of operation, in only 9.5% of the total fracture population. In our previous two-year survey (Wilton et al. 1987) nine of 21 cases of osteomalacia had both hypocalcaemia and a raised alkaline phosphatase level, detected in a biopsy population of 955. If the above criteria had been used, the same cases could have been detected by taking specimens from only 91 cases over two years, which is clearly manageable within routine clinical practice.

Detection of lesser degrees of osteomalacia would involve an increasing number of biopsies for a proportionately lower yield of abnormality. Until the benefits to be obtained from treating mild osteomalacia accompanying femoral neck fractures are established, this approach cannot be recommended, even though the biopsy procedure itself is generally uncomplicated (Johnson, Kelly and Jowsey 1977).

Although there is no evidence to show that treating severe degrees of osteomalacia complicating femoral neck fracture is beneficial, it seems sensible to do so. Moreover, it is known that, in a non-fracture population, treatment with either vitamin D or alfalcacidol is safe and effective in correcting the osteomalacia (Hosking et al. 1983). The ability to process bone biopsies rapidly using frozen sections (Stevens and Palmer 1985) is of considerable practical advantage in that treatment can be instituted in the immediate postoperative period.

Since our unit takes all femoral neck fractures from the city of Nottingham and the majority were entered into the study, there should be no selection bias, and our experience should be representative of that of most other large orthopaedic centres. The significance of the present study is that it shows the relationship between the need for a biopsy and the severity of osteomalacia. It therefore allows other units to decide what degree of histological abnormality they wish to detect and treat. Only by routinely screening femoral neck fractures for associated osteomalacia will sufficient material be accumulated to assess the benefits of early treatment.

REFERENCES


