BIOCHEMICAL MARKERS OF NUTRITION IN
TYPE-I AND TYPE-II OSTEOPOROSIS

H. RICO, P. RELEA, R. CRESPO, M. REVILLA, L. F. VILLA, I. ARRIBAS, J. USABIAGA

From the University of Alcalá de Henares, Madrid, Spain

We studied nutritional deficits, using as markers the levels of transferrin, retinol-binding protein, and prealbumin, in 20 women with osteoporotic hip fractures (type II), 40 women with vertebral fractures (type I), and two groups of age-matched control subjects. The concentrations of all three nutritional markers were lower in the two groups of patients than in their matched controls, and in type-I as compared with type-II osteoporosis.

In the osteoporotic patients, simple linear regression showed a significant correlation between the variables which we studied (r² ranged from 0.5 to 0.7; p < 0.001), the best correlation being between prealbumin and retinol-binding protein in type-II osteoporosis. Our results suggest that there is a more marked nutritional deficit in type-II than in type-I osteoporosis.

Apart from the age of presentation and the type of fracture, there are other important differences between type-I and type-II osteoporosis (Reginster et al 1992). In type I, we have recently shown the existence of a nutritional deficit by evaluating four body components (water, fat, non-fat, and minerals) (Rico et al 1992) and by measuring biological markers of nutrition (Rico et al 1993b).

Several authors have postulated a nutritional deficit in type-II osteoporosis (Fleisch 1988; Cooper et al 1989; Rudman et al 1989), but this has not been studied in terms of biological markers. We have therefore compared the concentrations of biological markers of nutrition in women with type-II osteoporosis, women with type-I osteoporosis, and two groups of normal women age-matched for each osteoporotic group.

PATIENTS AND METHODS

We studied two groups of patients with type-I and type-II osteoporosis and two separate groups containing the same number of age-matched normal subjects as those in each osteoporotic group. The group with type-I osteoporosis included 40 women, aged 65 ± 8 (s.d.) years. All had sustained more than one vertebral collapse without previous trauma, and were outpatients. We excluded myopathy, muscular weakness and secondary osteoporosis by appropriate clinical and laboratory tests. None had osteomalacia according to the index of McKenna et al (1983). The control group for type I consisted of 40 women, aged 66 ± 7 years, with no radiological evidence of vertebral deformities and with normal laboratory tests. None of the patients or the control groups smoked, and all had only an occasional intake of alcohol. None had received postmenopausal hormone treatment or in the last five years had taken any corticosteroid, diuretic or other medication that might interfere with water-mineral or lipid metabolism. All had normal creatinine clearance and normal hepatic function, and none was diabetic. A similar period had elapsed from the menopause (17.3 ± 1.9 years as against 18.8 ± 1.8 years, respectively) for both groups.

The group with type-II osteoporosis included 20 women of mean age 82 ± 6 years who had been admitted from home to the University Hospital of San Sebastian with hip fractures caused by minimal trauma. All had been independent and able to walk normally. They were selected because they had no other disease that might influence calcium metabolism; all had normal creatinine clearance.

Received 22 March 1994; Accepted 20 June 1994.

Two types of osteoporosis are distinguished on the basis of age of presentation (Gallagher 1990) and differing rates of loss of cortical or trabecular bone (Riggs et al 1981). Type I is characterised by vertebral fractures in postmenopausal women at about the age of 65 years; type II may occur in both sexes at about 75 years of age and produces mainly osteoporotic hip fractures (Riggs et al 1981). This classification, although debated by some authors (Gotfredsen et al 1989; Stevenson et al 1989), does fit the different rates of bone loss with age in trabecular and cortical compartments, in the axial or peripheral skeleton or both (Rico et al 1993a, 1994).

©1995 British Editorial Society of Bone and Joint Surgery
0301-620X/95/1917 S2.00
and we excluded secondary osteoporosis and osteomalacia by appropriate clinical and laboratory tests, as in group I. The control group of 20 age-matched women (mean age 81 ± 7 years) had a similar period from the menopause. 32 ± 6 years as against 31 ± 4 years, as the group-II osteoporotic patients. The inclusion criteria for both groups were the same as those detailed above for the type-I osteoporosis group and their control group.

None of the women had clinical or laboratory evidence of infection or inflammation, and all had a normal ESR, C-reactive protein levels, and haemoglobin concentration. There were no significant differences between the groups for intake of calcium, protein, phosphorus, sodium or total calories as calculated from a seven-day diet questionnaire (Payette and Gray-Donald 1991). We did not consider retrospective differences in diet, but all the women were from the same social class of urban immigrant workers, and were housewives with a sedentary life-style. A similar percentage of both groups had lived in rural locations during childhood and youth. Each subject gave written consent.

We obtained blood samples under fasting conditions, and measured transferrin (TF), prealbumin (PAb), and retinol-binding protein (RBP) levels, using a nephelometer 100 (Behringwerke AG Diagnostica, Marburg, Germany). In our laboratory, all these measurements have intra-assay and interassay coefficients of variation of less than 6%. We have made similar previous studies of type-I osteoporosis, but the measurements were repeated in all patients and control groups so that blood samples could be processed simultaneously to eliminate interassay variations. Blood samples were stored and frozen at -20°C and then analysed as one batch. From the patients with type-II osteoporosis, blood samples were obtained within 24 hours of their hip fracture, before the patient had received any medication. The type of fracture was not considered separately, but 12 were of the femoral neck and 8 were trochanteric. Vitamin K levels, although a factor in osteoporosis, were not determined, but the prothrombin time was measured routinely in fracture patients and was normal in both groups.

We used the Mann-Whitney U test to compare the groups, and a simple linear regression of the correlation between TF, RBP and PAb levels in each group.

RESULTS

Table 1 shows the characteristics of the groups. The age range of the group with type-I osteoporosis was, of course, different from that of the group with type-II (p < 0.001). Both groups were less tall than the corresponding control groups (p < 0.005), and had significantly lower TF, PAb and RBP concentrations (p < 0.001 for TF and PAb; p < 0.05 for RBP) than their respective control groups. Comparison between type-I and type-II osteoporosis showed the same levels of decrease for all three biological markers of nutrition.

In the patient groups there was a significant correlation by simple linear regression between the parameters studied, with r² ranging from 0.5 to 0.7 (p < 0.001). The best correlation was between PAb and RBP (Fig. 1) in the group of patients with type-II osteoporosis. In the control subjects, r² ranged from 0.1 to 0.5 and the best correlation was, again, between PAb and RBP (r² = 0.528, p < 0.001). There was a significant negative correlation between age and the weight of the osteoporotic women (r² = −0.562; p < 0.001), but no correlation between height and age.

DISCUSSION

The classic markers of nutrition such as albumin (Mattox and Teasley-Strausburg 1991), PAb, TF, and RBP (Sachs and Bernstein 1986; Uderzo et al 1991) are well recognised and most frequently used (Benjamin 1989; Mohan et al 1991). We found that the best correlation in both normal subjects and patients was between PAb and RBP, agreeing with Sachs and Bernstein (1986) that these are useful biochemical markers of nutrition.

Nutritional deficiencies of calcium (Avioli 1991), minerals (Reginster et al 1989; Rico 1991) and of proteins (Callaway 1987; Santora 1987) have been reported in osteoporotic patients. We have shown significantly lower concentrations of PAb, TF and RBP in type-II than in type-I osteoporosis, and in both types as compared with normal individuals. This suggests that there is a more marked nutritional deficit in type-II than in type-I osteoporosis, and corroborates the results of our earlier studies of type-I osteoporosis (Rico et al 1993b). Regardless of the cause these findings are of interest because of the importance of nutritional status on the recuperation of surgical and orthopaedic patients (Teasley 1989). Several studies have shown that nutritional supplements for patients with hip fracture can help to produce significant reductions in complications, duration of hospital stay, and mortality rate (Delmi et al 1990; Tkatch et al 1992).

As regards anthropometric variables, we found that low-
er height was the only significant difference between the patients and their respective control groups. This is probably related to vertebral collapse.

Hip fractures have become an orthopaedic epidemic (Royal College of Physicians of London 1989), with large socioeconomic costs and a high rate of mortality (Riggs and Melton 1986). Many factors have been cited for both women and men, including decreased bone mass, visual defects, diminished reflexes, and various medications (Cooper et al 1987; Melton and Cummings 1987). Nutritional status has been mentioned repeatedly (Callaway 1987; Santora 1987; Reginster et al 1989; Avioli 1991; Rico 1991), but there have been no specific studies.

Heaney (1992) emphasised the importance of nutrition, noting that the presence of a good muscular mass may help to lessen possible injuries, and Vellas et al (1990) reported a decrease in PAb, TF, and RBP levels in elderly subjects with a tendency to falls. Both these factors imply that nutritional deficit could be an important factor, even apart from bone mass.

We conclude that the nutritional status of elderly adult subjects may be an important factor in the incidence and prevention of hip fractures, and of the considerable problems that they cause.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

---

### Table I. Details of patients with type-I and type-II osteoporosis and age-matched control groups and concentrations of nutritional markers (see text) (mean ± so)

<table>
<thead>
<tr>
<th></th>
<th>Osteoporosis</th>
<th>Control</th>
<th>p value of difference type I vs type II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type I (n = 40)</td>
<td>Control (n = 40)</td>
<td>Type II (n = 20)</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>65.0 ± 8.0</td>
<td>66.0 ± 7.0</td>
<td>82.0 ± 6.0</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>56.0 ± 9.0</td>
<td>57.0 ± 6.0</td>
<td>53.0 ± 6.0</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>159.0 ± 8.0</td>
<td>163.0 ± 7.0*</td>
<td>155.0 ± 6.0</td>
</tr>
<tr>
<td>Body mass index (k/m²)</td>
<td>22.5 ± 3.7</td>
<td>21.5 ± 2.2</td>
<td>22.3 ± 2.5</td>
</tr>
<tr>
<td>TF (mg/dl)</td>
<td>267.0 ± 33.0</td>
<td>297.0 ± 52.0†</td>
<td>221.0 ± 56.0</td>
</tr>
<tr>
<td>PAb (mg/dl)</td>
<td>26.0 ± 3.9</td>
<td>28.9 ± 4.6†</td>
<td>17.7 ± 8.3</td>
</tr>
<tr>
<td>RBP (g/l)</td>
<td>0.038 ± 0.008</td>
<td>0.042 ± 0.010‡</td>
<td>0.034 ± 0.014</td>
</tr>
</tbody>
</table>

difference from control: * p < 0.005
† p < 0.001
‡ p < 0.05

---

### REFERENCES


---

THE JOURNAL OF BONE AND JOINT SURGERY


