ABSTRACT. Low bone mass is a major risk factor for osteoporotic fractures. Thus, bone density evaluation, performed by Dual Energy X-ray Absorptiometry (DXA) is important for diagnosis and monitoring treatment of osteoporosis. The accuracy of DXA, particularly at the lumbar spine, can be affected by several factors such as degenerative diseases. To evaluate the effects of vertebral osteophytosis on densitometric measurements, we examined 198 women, aged 32-81 years, who had undergone lateral X-ray of the lumbar spine. We classified patients according to different grades of osteophytosis, and evaluated bone density at the lumbar spine and the proximal femur by DXA. We also performed quantitative ultrasound at the heel (QUS). Patients with severe osteophytosis were significantly older (p<0.0005), and values were adjusted for this parameter. We observed a significant increase in lumbar bone density with worsening osteophytosis (p<0.02). On the contrary, no significant differences were found at the femur and QUS. According to bone density at the femoral neck, we subdivided patients into two groups: osteoporotic (group A) and non-osteoporotic (group B). Both groups showed increasingly low bone density at the spine with worsening osteophytosis (A: p<0.01; B: p<0.02). No differences were found in all the other evaluations. In conclusion, lumbar spine measurement is dramatically influenced by osteophytosis, particularly in the elderly. Consequently, other strategies should be performed such as evaluation of the hip and also measurement of the heel by ultrasound, which could be an interesting approach in these cases.

INTRODUCTION

In the wake of the increase in the numbers of older persons in developed countries, osteoporosis has become a major health problem. This condition is characterized by low bone mass and microstructural alterations, leading to increased fracture risk. Indeed, fractures are the most serious and costly outcome of this disease particularly in the elderly, in whom morbidity and mortality are largely increased after these events (1). Thus, diagnosing osteoporosis before fractures occur may help to prevent these severe complications; however the accuracy of this diagnosis is a major issue.

Previous studies demonstrated that low bone mass is the most important risk factor for fragility fractures (2, 3). Indeed, bone mass is highly correlated with bone strength, which accounts for 70-85% of the variance in the ultimate strength of bone tissue (4). Consequently, the measurement of bone mineral density (BMD) has become essential for detecting osteoporosis, predicting fracture risk, and monitoring treatment.

Dual Energy X-ray Absorptiometry (DXA) is the most widely used method to quantify bone mass, and is considered the most reliable (5). Moreover, several sites can be evaluated to predict the cumulative fracture risk, although it is generally agreed that measurement at a specific site is more appropriate for predicting the risk of fracture at that site (3). The lumbar spine is the most frequently evaluated site, mostly in relation to the large proportion of trabecular bone tissue in the vertebrae, and the impact of vertebral fractures on the clinical history of osteoporosis (6). Unfortunately, several factors may affect the accuracy of spinal BMD measurement, especially in the elderly; among these, degenerative diseases of the spine such...
as osteoarthritis and mainly osteophytosis are generally considered important sources of BMD overestimation at this site, thus leading to clinical errors (7, 8). Many investigators suggest that systemic osteoarthritis is associated with a decreased incidence of low bone mass (9-12), but it is still debated whether degenerative diseases of the vertebrae per se may be associated with high bone mass at other skeletal sites. However, there is some evidence that subjects with spinal osteoarthritis are not protected against non-vertebral osteoporotic fractures (13).

In the last decade, many studies have addressed the role of quantitative ultrasound (QUS) in detecting osteoporosis and the related fracture risk (14). It is generally believed that QUS provides additional information about bone quality and, in particular, that assessment at the heel can predict the risk of hip fracture in the same way as DXA at the proximal femur (14, 15).

In this study we examined the effects of vertebral osteophytosis on densitometric evaluation of bone density at the lumbar spine; we also assessed whether in this condition the two different techniques of measurement, DXA at the femur and QUS at the heel, were equivalent.

SUBJECTS AND METHODS

We consecutively selected 198 women from a larger sample of patients referred to our Bone Densitometry Center over a 12-month period. Patients were included in the study if they had undergone lateral X-ray of the lumbar spine including L1 to L5 by a standard procedure, with a target to film distance of 105 cm. Women were 32-81 years old (mean±SD; 61±9 years), and 176 were postmenopausal.

Radiographs were read in the blind for the presence and severity of osteophytosis, and scored from 0 to 3, according to the criteria suggested by Orwoll et al. (16). This system takes into account osteophytic calcification involving the L₁₂ through L₄₅ interspaces, as follows: score 0, no osteophytes; score 1, small osteophytes at one or two vertebral interspaces; score 2, large osteophytes at one or two vertebral interspaces, or small osteophytes at three or four interspaces; score 3, large osteophytes at three or four interspaces.

All women with radiographic evidence of vertebral fractures were excluded from the study. Clinical parameters of patients after this subdivision are shown in Table 1.

After clinical examination, all patients underwent the following bone investigations: bone densitometry measured by DXA at the antero-posterior L₂-L₄ lumbar spine, femoral neck and total hip (DXA, Hologic QDR 1000®); quantitative ultrasound evaluation at the heel (QUS, Lunar Achilles+®). Densitometric values were expressed as BMD (g/cm²), T-score, and Z-score (number of standard deviations with respect to young adults, and age-matched normal controls, respectively). Parameters of ultrasound evaluation were expressed as Broadband Ultrasound Attenuation (BUA, dB/mHz), Speed of Sound (SOS, m/sec), Stiffness (calculated strength index), and T-score values.

According to the bone density at the femoral neck, the women were further subdivided into two groups: osteoporotic (T-score ≤ -2.5 SD, Group A) and non-osteoporotic (T-score > -2.5 SD, Group B, Table 2). We referred to bone density at the femoral neck because this site is less affected by degenerative diseases than the other sites, and has good diagnostic accuracy (3).

STATISTICAL ANALYSIS

Results are expressed as mean ± 1SD. Multiple group comparisons were made by ANOVA, and the Newman-Keuls test was used as a post-hoc test for differences between the groups. Multifactorial analysis of variance was then employed to adjust for age. Simple regression analysis was used to evaluate the relation-

<table>
<thead>
<tr>
<th>Score 0</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N=25)</td>
<td>(N=61)</td>
<td>(N=78)</td>
<td>(N=34)</td>
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<tr>
<td>Age (years)</td>
<td>56±8</td>
<td>58±8</td>
<td>64±9*</td>
</tr>
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<td>Time since menopause (years)*</td>
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<td>11±7</td>
<td>16±10**</td>
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<tr>
<td>Weight (kg)</td>
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<td>65±9</td>
<td>65±10</td>
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<tr>
<td>Height (cm)</td>
<td>157±7</td>
<td>159±6</td>
<td>158±6</td>
</tr>
</tbody>
</table>

*176 postmenopausal women.
*p<0.0005 vs score 0 and 1; **p<0.05-0.005 vs score 0 and 1.