Original Article

Bone Mineral Density, Hip Axis Length and Risk of Hip Fracture in Men: Results from the Cornwall Hip Fracture Study

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Abstract. Bone mineral density (BMD) and hip axis length (HAL) are important determinants of fracture risk in women. There are, however, few data concerning their predictive risk in men. The aim of this study was to determine the relationship between BMD, HAL and the risk of hip fracture in men. A case–control design was used. Cases were men aged 50 years and over with a minimal-trauma hip fracture admitted to the Royal Cornwall Hospital, Truro, during 1995–1997. Controls were recruited from a large general practice within the catchment area of the hospital. Subjects were invited for assessment of BMD at the lumbar spine and proximal femur, using dual-energy X-ray absorptiometry. HAL was assessed using machine software. Data concerning BMD were available in 62 fracture cases and 100 controls. After adjusting for age, height and weight, a reduction in BMD was associated with a significant increase in the risk of hip fracture [odds ratio (OR) 1.8–4.0 per standard deviation (SD) reduction, depending on site]. HAL was similar in both fracture and control groups (12.0 cm vs 12.0 cm). After adjusting for height, there was no association between HAL and the risk of hip fracture (OR per 1 SD increase in HAL = 0.9; 95% confidence interval 0.6, 1.3). Compared with those with a cervical fracture (n = 31), those with an intertrochanteric fracture (n = 31) had lower BMD at all skeletal sites, though this was significant for the trochanteric site only. It is concluded that BMD though not hip axis length is a risk factor for low-trauma hip fracture in Caucasian men.

Keywords: Bone mineral density; Hip axis length; Hip fracture; Men; Osteoporosis; Risk factors

Introduction

Hip fractures are an important health burden [1]. The majority of fractures occur in women, though at least one-third occur in men [2]. A knowledge of the risk factors for hip fracture may help target preventive therapy, with the aim of reducing the attendant morbidity and mortality.

Bone mineral density (BMD) is one of the most important determinants of skeletal strength. Studies in women indicate that for each standard deviation (SD) reduction in bone mass the risk of hip fracture increases by a factor of 1.5–3 [3]. Less is known, however, about the influence of BMD in determining fracture risk in men. Several observational studies suggest that BMD is lower among men who have sustained a hip fracture than those without, though in most of these the number of individuals studied has been relatively small [4–11].

Recent studies have suggested that geometric parameters of the proximal femur may be additional determinants of fracture risk [12–16]. In women, a 1 SD increase in hip axis length (HAL) – the distance from the base of the greater trochanter to the inner pelvic rim along the femoral axis – is associated with a 1.8-fold increase in hip fracture risk [12], the effect being independent of bone mass. There are, however, no data concerning the influence of HAL on risk of hip fracture in men.

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The aim of this study was to determine the relationship between BMD, HAL and the risk of hip fracture in men.

Materials and Methods

A case–control design was used. The study was undertaken at the Royal Cornwall Hospital in Truro; this is the only referral center for acute orthopedic care to a geographically defined population of 384,000 which includes 65,858 men aged over 50 years. One hundred consecutive male admissions with a ‘low-trauma’ hip fracture aged 50 years and over were recruited during a 14 month period between 1995 and 1997. ‘Low trauma’ was defined as a fall from standing height or less. The fracture cases were identified by daily review of the admissions unit and the orthopedic wards. Fractures were classified as ‘cervical’ or ‘intertrochanteric’ according to their radiographic appearance. One hundred controls were recruited from a large general practice within the catchment area of the hospital. Control subjects were recruited concurrently with the cases, and were selected to broadly match their age distribution. Subjects who agreed to take part completed an interviewer-administered questionnaire, which in the fracture cases was within 48 h of admission. The questionnaire included questions concerning lifestyle, comorbid factors and aspects of health. Height (cm) was recorded in 74 of the fracture cases, and weight (kg) in 85 cases at the time of admission (or within the subsequent 3 months). Both height and weight were recorded in 97 of the controls. The study was approved by the local ethics committee of the hospital.

Bone Mass Assessment

BMD measurements were performed at the lumbar spine and the proximal femur on all subjects capable of lying still in a specified position on the scanner for at least 10 minute BMD was measured by dual-energy X-ray absorptiometry (DXA) using a Hologic QDR 1000 (Hologic, Waltham, MA). In the fracture cases, measurements were performed within 7 days of admission. The controls had proximal femur measurements made at the right hip, while in the fracture cases the non-fractured side was assessed. HAL was recorded using automated software provided with the scanner. The coefficient of variation in assessment of HAL and BMD at the lumbar spine and femur in our unit is 0.4%, BMD was measured in all the controls and 62 cases. The reasons for non-scanning among the cases include early death, extreme frailty and concurrent comorbid conditions (36) and refusal (2). In a further 4 cases measurements were not made at the proximal femur because of prosthesis (2), frailty (1) or extreme obesity (1).

Statistical Analysis

Descriptive statistics were used to characterize the distribution of age, height, weight, body mass index, HAL and BMD in the cases and controls. Logistic regression was used to determine the association between both BMD, HAL and the risk of hip fracture. Adjustments were made for age, and subsequently height and weight. The results were expressed as the odds ratio (OR) and 95% confidence interval (CI). Logistic regression was used also to assess, among individuals with fracture, the influence of BMD and HAL in predicting fracture type (intertrochanteric vs cervical).

Results

Subject Characteristics

The descriptive characteristics of the 62 cases and 100 controls with data concerning BMD and HAL are presented in Table 1. Compared with the controls, men with hip fractures had significantly lower body mass index (BMI) and weight (<0.01); they were slightly older but not significantly. Among the fracture cases, those not scanned (n = 38), compared with those scanned (n = 62), were slightly older (mean age 82.6 years vs 78.0 years; p<0.01) and a greater proportion had concurrent comorbid diseases (79% vs 64%; p=0.02), though there was no significant difference in height, weight or BMI (data not shown).

Bone Mineral Density

BMD at all sites was strongly correlated, Spearman’s correlation (rs) ranging between 0.50 and 0.83. Using the World Health Organization (WHO) definition of osteoporosis (T-score ≤ −2.5 SD), and using the manufacturer’s normal values, 83% of fracture cases were osteoporotic at the femoral neck, and 36% at the lumbar spine (the corresponding figures for the controls were 39% and 5% respectively). BMD was significantly lower in those with a hip fracture at the proximal femur (all four sites) and at the lumbar spine compared with the controls (Table 2). After adjusting for age, height and weight, the risk of hip fracture increased for each 1 SD

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fracture cases (n = 62)</th>
<th>Controls (n = 100)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>78.4 (10.1)</td>
<td>75.1 (9.6)</td>
<td>NS</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.2 (8.7)</td>
<td>170.6 (7.7)</td>
<td>NS</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.6 (10.7)</td>
<td>77.7 (16.3)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>23.4 (3.3)</td>
<td>26.7 (5.5)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

*a After adjusting for age.