The prevalence of osteoporosis in patients with severe hip and knee osteoarthritis awaiting joint arthroplasty

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Abstract

Background: the presence of osteoporosis in patients with hip and knee osteoarthritis (OA) has important implications for understanding disease progression and providing optimal surgical and medical management.
Objective: to determine the prevalence of osteoporosis among patients with osteoarthritis awaiting total knee arthroplasty or total hip arthroplasty aged between 65 and 80 years.
Design: cross-sectional observational study.
Setting: tertiary referral centre in Newcastle upon Tyne, UK.
Subjects: patients with osteoarthritis awaiting total knee hip arthroplasty aged between 65 and 80 years.
Methods: lumbar spine, bilateral femoral and forearm bone mineral density (BMD) measurements were obtained using dual-energy X-ray absorptiometry.
Results: the cohort consisted of 199 patients with a mean age of 72 years (SD 4), and 113 (57%) were women. The overall rate of osteoporosis at any site was 23% (46/199) and a further 43% (85/199) of patients would have been classified as osteopaenic according to World Health Organization criteria. Osteoporosis was more commonly detected in the forearm (14%) than the lumbar spine (8.5%) and proximal femur of the index side (8.2%).
Conclusions: in summary, a significant proportion of patients with end-stage OA have osteoporosis but this diagnosis may be missed unless BMD measurements are performed at sites distant from joints affected by OA.

Keywords: osteoporosis, osteoarthritis, hip, knee, bone mineral density, elderly

Introduction

The relationship between osteoarthritis (OA) and osteoporosis (OP) has been examined in both community studies and case series, which have frequently documented that the presence of OA is associated with higher bone mineral density (BMD) [3–5] or that there is an inverse relationship between these two diseases [9–11]. In contrast to these publications, a study of postmenopausal women with hip OA demonstrated that 25% (17/68 patients) of these patients had occult OP [12]. In addition, data from a longitudinal cohort study suggest that although both high BMD and BMD gain are associated with an increased risk of incident knee OA, these factors decrease the risk of progression of radiographic knee OA [13]. Their results have given new insights into how the structure of bone may affect the course of OA and could have potential therapeutic implications.

Sandini et al. [14] add another side to the debate in their study of a cohort of female patients surgically treated for hip or knee OA compared to healthy controls measured twice over 5 years. They reported no significant difference in BMD between these groups but at 5-year follow-up they found that OA can be associated with a faster loss in BMD as well as changes in bone geometry. There have been relatively few
studies of the association of OP and OA performed in men, but in contrast to studies involving women, these have not suggested a significant inverse association [15–17]. Studies have also tended to focus on patients with hip OA. OA of the hip and knee can be associated with different risk factors, implying that the two should be regarded as different diseases [18]. This underscores the importance of studying the association with OP in patients with knee and hip OA.

Whereas OA may protect against the development of OP, the evidence base for this is inconsistent implying that management of some OA patients has been incomplete [19]. The clinical relevance of OP existing with osteoarthritis concerns the progression of the osteoarthritis and from a surgical perspective the outcome of a joint replacement procedure (i.e. joint loosening or peri-prosthetic fracture). To understand the size of this potential problem, we recruited patients with severe primary knee and hip OA who were to receive a total knee arthroplasty (TKA) or total hip arthroplasty (THA). The objectives were to (i) compare areal bone density with the previously obtained well-validated normative data for subjects of a comparable age; (ii) determine the prevalence of OP in patients awaiting TKA or THA at the hip, lumbar spine and forearm sites; and (iii) examine the association between OP at these sites with each other and other potential risk factors for low BMD.

Patients

Participants were taken from the waiting list for primary TKA and THA at a tertiary referral centre in Newcastle upon Tyne, UK and were included if they had a diagnosis of primary OA and were aged between 65 and 80 years. Exclusion criteria were diagnosis other than primary OA, previous TKA or THA of the contralateral knee (if awaiting TKA) or hip (if awaiting THA), or comorbid medical conditions that resulted in gross lower limb asymmetry (e.g., stroke, amputation, severe leg length discrepancy). After initial screening of the waiting list, we mailed information letters inviting eligible patients to participate and then contacted them by telephone for final screening.

Methods

The Local Research Ethical Committee (LREC) approved this study and written informed consent was obtained from all participants (LREC reference number 2002/340, January 2003). Patients completed a questionnaire, which included self-reported comorbid medical conditions and current medications. The questionnaire also included the Western Ontario and McMaster University OA Index (WOMAC) [20, 21] disease-specific health status measure where scores were transformed to a 0–100 scale for pain, stiffness and function (100 best). Participants had their height and weight measured and body mass index calculated. The Timed Up and Go (TUG) [22] walk test was carried out using their usual walking aid as required.

Areal BMD (measured in grammes per square centimetre) of the proximal femora, lumbar spine (from L1 to L4) and forearm was measured by dual-energy X-ray absorptiometry (DEXA) using a Hologic QDR-4500A scanner. All operators were trained and experienced and had been accredited in the performance and analysis of DEXA scans in a research context. The precision of the BMD measurements for the proximal femur is 1.32% [23] and for the lumbar spine is between 1.2 and 2.7% [24]. In the lumbar spine scans, where there was evidence of severe degenerative changes, the affected vertebrae were removed from the overall analyses of lumbar spine BMD. The BMD results were obtained as absolute measurements (g/cm²) but have also been expressed as T- and Z-scores for total lumbar spine, total hip and total forearm, and World Health Organization (WHO) classifications of osteopenia and OP based on T-scores have been used (Figure 1). Biochemical investigations were also performed as part of this study as detailed in the online Appendix A found at Age and Ageing online.

Analysis

Statistical analyses were performed using the SAS version 8.1 statistical software. Pearson correlation coefficients were used to assess the strength of the relationship between absolute bone density measures from the different sites. Comparisons between osteoporotic and non-osteoporotic patients’ demographic, clinical characteristics, BMD measurements and health status measures were made using chi-square, two-sample t-test and Wilcoxon rank-sum test analyses where appropriate. Analyses were stratified by gender prior to univariate analyses. Logistic regression models were used to identify risk factors associated with OP using a stepwise selection process that entered variables with a P-value <0.1, and these variables remained in the model if their P-value was <0.05. All tests were two-tailed and a P-value of <0.05 was regarded as significant throughout.

Results

A total of 442 information letters were mailed and 278 (63%) of these recipients met the inclusion criteria. Of these, 199 patients (72%) were recruited and there was no statistically significant difference in age, gender or index joint (hip or knee) between participant and non-participant groups. The recruited patients comprised 115 (58%) who were on the waiting list for TKA and 84 (42%) who were awaiting THA. Mean age was 72.2 years (SD 4.0) and 113 (57%) were female. Thirty-eight patients (19%) were listed for bilateral procedures, 96 (48%) for right and 65 (33%) for left procedures.

The median Z-scores (interquartile range) for the total group at the different anatomical sites were lumbar spine = 1.32 (0.34–2.43), index (that is, side of hip or knee to be re-
place) proximal femur = 0.50 (−0.27 to 1.34), contralateral proximal femur = 0.55 (0.02−1.54) and forearm = 0.79 (−0.15 to 1.52). The prevalence of osteopenia and OP (WHO criteria) at each site is presented in Table 1 for the whole group and by gender. The overall rate of OP at any site was 23% (46/199) and most commonly occurred at the forearm (27 patients, 14%). A further 43% (85/199) of patients had evidence of osteopenia at one of the sites and only 68 (7%) of the men had OP. The osteoporotic female group was significantly older (P = 0.036) and had a significantly lower body mass index (BMI; P = 0.0018) than the non-osteoporotic female patients. BMD (g/cm²) measures were lowest at the forearm and Z-scores also demonstrated that these measures were lower in the osteoporotic group after adjusting for age and gender (Table 3).

The WOMAC scores confirmed that, on average, patients had moderate to severe responses of pain, functional limitation and stiffness, which is characteristic of patients with end-stage knee or hip OA awaiting arthroplasty. Comparisons of WOMAC Pain, Function and Stiffness scores and the TUG test demonstrated no significant difference between osteoporotic and non-osteoporotic groups of patients.

Multivariate logistic regression analysis using stepwise elimination entered age, gender and BMI (dichotomised as <25 or ≥25 kg/m²) into the analysis to determine the significant predictors of OP in this cohort of patients. This analysis revealed that female gender (odds ratio 7.8, 95% confidence interval 3.1, 20.0) and low BMI (<25 kg/m², odds ratio 3.6, 95% confidence interval 1.5, 8.6) were the only predictors of OP.

Details of the biochemical results are provided in the online Appendix A found at Age and Ageing online. Overall, there were no clinically meaningful or statistically

**Table 1.** Number (%) of subjects with osteoporosis and osteopenia at different sites by total group and by gender

<table>
<thead>
<tr>
<th></th>
<th>Osteopenia&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Osteoporosis&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Osteopenia&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Osteoporosis&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All N = 199</td>
<td>All N = 199</td>
<td>Males N = 86</td>
<td>Males N = 86</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Females N = 113</td>
<td>Females N = 113</td>
</tr>
<tr>
<td>Lumbar spine (N = 199)</td>
<td>48/199 (24)</td>
<td>17/199 (9)</td>
<td>14/86 (16)</td>
<td>34/113 (30)</td>
</tr>
<tr>
<td>Forearm (N = 199)</td>
<td>82/199 (42)</td>
<td>27/199 (14)</td>
<td>33/86 (39)</td>
<td>49/113 (44)</td>
</tr>
<tr>
<td>Index proximal femur&lt;sup&gt;b&lt;/sup&gt; (N = 162)</td>
<td>58/162 (36)</td>
<td>13/162 (8)</td>
<td>11/67 (16)</td>
<td>47/95 (50)</td>
</tr>
<tr>
<td>Contralateral proximal femur&lt;sup&gt;a&lt;/sup&gt; (N = 154)</td>
<td>48/154 (31)</td>
<td>9/154 (6)</td>
<td>8/65 (12)</td>
<td>40/89 (45)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Excludes patients awaiting bilateral arthroplasty or patients with previous total hip arthroplasty.

<sup>b</sup>Osteoporosis defined as a T-score of <-2.5 and osteopenia defined as a T-score between -1.0 and -2.5 (WHO).
**Table 2.** Comparison of patients with and without osteoporosis by gender. Scores reported are the medians with 5th and 95th percentiles. Z-scores are reported for the total BMD measurements from each site.

<table>
<thead>
<tr>
<th></th>
<th>OPb women N = 40</th>
<th>Non-OPb women N = 73</th>
<th>OPb men N = 6</th>
<th>Non-OPb men N = 80</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>73 (67, 80)</td>
<td>71 (66, 79)</td>
<td>73 (66, 78)</td>
<td>72 (65, 79)</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>27 (22, 39)</td>
<td>32 (23, 41)</td>
<td>27 (24, 32)</td>
<td>29 (24, 38)</td>
</tr>
<tr>
<td><strong>BMD (g/cm²)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lumbar spine</td>
<td>0.811 (0.626, 1.243)</td>
<td>1.048 (0.813, 1.436)</td>
<td>0.978 (0.755, 1.264)</td>
<td>1.110 (0.899, 1.449)</td>
</tr>
<tr>
<td>• Index proximal femur(^b)</td>
<td>0.687 (0.564, 0.810)</td>
<td>0.880 (0.679, 1.148)</td>
<td>0.757 (0.674, 0.795)</td>
<td>1.037 (0.821, 1.193)</td>
</tr>
<tr>
<td>• Contralateral proximal femur(^b)</td>
<td>0.686 (0.545, 0.869)</td>
<td>0.912 (0.713, 1.132)</td>
<td>0.825 (0.726, 0.828)</td>
<td>1.036 (0.845, 1.281)</td>
</tr>
<tr>
<td>• Forearm</td>
<td>0.435 (0.356, 0.536)</td>
<td>0.512 (0.445, 0.615)</td>
<td>0.492 (0.440, 0.560)</td>
<td>0.639 (0.561, 0.760)</td>
</tr>
<tr>
<td><strong>WOMAC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pain</td>
<td>35 (13, 75)</td>
<td>40 (15, 80)</td>
<td>38 (15, 80)</td>
<td>40 (20, 80)</td>
</tr>
<tr>
<td>• Function</td>
<td>35 (9, 71)</td>
<td>37 (12, 63)</td>
<td>40 (35, 63)</td>
<td>39 (10, 72)</td>
</tr>
<tr>
<td>• Stiffness</td>
<td>38 (13, 75)</td>
<td>38 (13, 75)</td>
<td>63 (38, 100)</td>
<td>50 (13, 75)</td>
</tr>
<tr>
<td>Timed Up and Go (s)</td>
<td>17 (11, 38)</td>
<td>16 (10, 32)</td>
<td>14 (10, 17)</td>
<td>14 (9, 32)</td>
</tr>
</tbody>
</table>

\(^a\)Excludes bilateral patients and patients with previous total hip arthroplasty.

\(^b\)Osteoporosis defined as a T-score of < -2.5 and non-osteoporotic as a T-score of at least -2.5 at any site (WHO).

\(^c\)OP women were significantly older (P = 0.0036) and had significantly lower BMI (P = 0.0018).

**Table 3.** Comparison of patients with and without osteoporosis by gender. Scores reported are the medians with 5th and 95th percentiles. Z-scores are reported for the total BMD measurements from each site.

<table>
<thead>
<tr>
<th></th>
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<th>Non-OPb women N = 73</th>
<th>OPb men N = 6</th>
<th>Non-OPb men N = 80</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Z-scores</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lumbar spine</td>
<td>0.1 (~1.2, 4.2)</td>
<td>2.0 (0.04, 5.8)</td>
<td>0.03 (~2.2, 2.6)</td>
<td>1.3 (~0.8, 4.2)</td>
</tr>
<tr>
<td>• Index proximal femur(^b)</td>
<td>~0.5 (~1.6, 0.8)</td>
<td>1.0 (~0.4, 3.1)</td>
<td>~1.2 (~1.8, ~0.8)</td>
<td>0.9 (~0.4, 1.8)</td>
</tr>
<tr>
<td>• Contralateral proximal femur(^b)</td>
<td>~0.5 (~1.2, 0.9)</td>
<td>1.4 (~0.2, 3.2)</td>
<td>~0.7 (~1.5, ~0.6)</td>
<td>0.8 (~0.4, 2.2)</td>
</tr>
<tr>
<td>• Forearm</td>
<td>~0.2 (~1.9, 1.3)</td>
<td>1.5 (~0.2, 3.2)</td>
<td>~2.3 (~3.1, ~1.3)</td>
<td>0.7 (~0.9, 2.8)</td>
</tr>
</tbody>
</table>

\(^a\)Excludes bilateral patients and patients with previous total hip arthroplasty.

\(^b\)Osteoporosis defined as a T-score of < -2.5 and non-osteoporotic as a T-score of at least -2.5 at any site (WHO).

There were significant differences between the patients with and without osteoporosis.

**Discussion**

The findings from this study demonstrate that a significant proportion of patients with end-stage OA have OP. We found that 23% of patients had evidence of OP at one or more sites and a further 43% of patients had osteopaenia at one or more of the sites measured. The highest prevalence of OP and osteopaenia was at the forearm. This indicates that the diagnosis of OP may be missed unless BMD measurements are performed at sites distant from joints affected by OA. Patients who were listed for unilateral procedures had significantly lower BMD of the proximal femur on the index side compared to the contralateral proximal femur.

OA is generally assumed to be associated with an increase in BMD but there is evidence that there is no linear relationship between increasing severity of radiographic knee OA and increasing BMD. The inclusion of a forearm measurement demonstrated the highest prevalence of OP and osteopaenia at a non-weight-bearing site distant from the index joint. This is an important finding as it has been shown that the presence of osteophytes, especially in the lumbar spine and to a lesser extent in the hip, elevates bone density measurements of these sites [16]. Given that a high proportion of patients with knee or hip OA have associated lumbar spine and hip OA, forearm BMD may be a more accurate measure of true bone loss in these patients. Weight-bearing status has been shown to have a significant impact on bone loss [25]. In patients who were listed for unilateral procedures, we found that they had significantly lower BMD in the affected proximal femur compared with the opposite side.

This study was limited to a convenience sample of patients from the waiting list of a busy orthopaedic unit in a National Health Service (NHS) hospital. Despite this, we were able to recruit 74% of all eligible patients and have complete BMD and questionnaire data on all patients, suggesting it is representative of this centre, although generalizability cannot be assumed. This study is one of the few studies to include female and male patients in equal proportion and was able to identify OP, and osteopaenia oc-
occurs in a remarkable proportion of female patients with severe knee or hip OA as well as in a small proportion of male patients. However, the size of the sample limited the power of some of the subgroup analyses. This study was limited as it did not collect data on a control group of patients, but previously reported measurements on a normal population of patients from our institution has demonstrated that our data are similar to previously published normative data that were used to calculate T-scores and Z-scores for our analyses [7, 8].

In summary, osteopenia and OP do occur in patients with severe knee and hip OA. The highest prevalence of OP was observed at the forearm, a site distant from the index joint. This study raises many clinical questions for further work. Firstly, does early detection and treatment of OP in patients with knee or hip OA have an effect on the progression of OA? Secondly, does early detection and treatment of OP in patients with knee or hip OA have an effect on the outcome of joint replacement, particularly loosening and fracture? Additionally, is the presence of OP at the forearm associated with a different outcome of joint replacement? The present study is important because it demonstrates the complex relationship between OA and OP in both men and women. It is timely to study the association of OP and osteoarthritis, the implications for treatment and the impact on joint replacement, as the demographic and epidemiological trends predict an increasing burden on health care resources due to these diseases.

Key points

- Prevalence of OP in OA.
- Importance of including forearm BMD for detection of OP in OA.
- Consideration for treatment of OP in OA patients.

Acknowledgements

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Supplementary data

Supplementary data mentioned in the text is available to subscribers in Age and Ageing online.

References

The association between various visual function tests and low fragility hip fractures among the elderly: a Malaysian experience

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Abstract

Background: Hip fractures are an increasing source of morbidity and mortality in older people. The role of visual function tests such as visual impairment, stereopsis, contrast sensitivity and visual field defects in low fragility hip fractures in Asian populations is not well understood.

Objective: To determine the association between various visual function tests and low fragility hip fractures in an Asian population.

Design: Case–control study.

Setting: University Malaya Medical Centre, Kuala Lumpur, Malaysia.

Subjects: 108 cases aged ≥55 years admitted with low fragility fractures and 108 controls (matched for age, gender and race).

Methods: Both cases and controls underwent a detailed ophthalmological examination, which included visual acuity, stereopsis, contrast sensitivity and visual field testing.

Results: Poorer visual acuity (odds ratio, OR = 4.08; 95% confidence interval, CI: 1.44, 11.51), stereopsis (OR = 3.60, 95% CI: 1.55, 8.38), contrast sensitivity (OR = 3.34, 95% CI: 1.48, 7.57) and visual field defects (OR = 11.60, 95% CI: 5.21, 25.81) increased the risk of fracture. Increased falls were associated with poorer visual acuity (OR = 2.30, 95% CI: 1.04, 5.13), stereopsis (OR = 2.11, 95% CI: 1.03, 4.32), contrast sensitivity (OR = 2.12, 95% CI: 1.05, 4.30) and visual field defects (OR = 3.40, 95% CI: 1.69, 6.86).

Conclusion: Impaired visual acuity, stereopsis, contrast sensitivity and visual field defects are associated with an increased risk of low fragility hip fractures. We recommend that all patients aged ≥55 should have an annual ophthalmological examination.