Radial head fracture: a potentially complex injury
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Chapter 4

Osteoporosis and radial head fractures in female patients: a case-control study

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ABSTRACT

Introduction: Identifying radial head fractures as fragility fractures may improve case-finding for osteoporosis and thus be an indicator of other fragility fractures. Methods: 35 female patients of ≥50 years of age with a radial head fracture and 57 controls were retrospectively selected and matched for age in strata of 5 years. Peripheral bone density measurement (BMD) was performed at the calcaneus. A T-score of < -2.7 was considered osteoporosis. In case of a T-value between -1.4 and -2.7, an additional dual energy X-ray (DXA) scan was performed. Results: The median age of the patients was 60 years, compared to 58 years of the control patients (P = 0.33). The mean T-score of the patients was -1.8 (range: -2.2 to -0.3, SD: 1.0), compared to -1.2 (range: -4.0 to 1.3, SD: 1.2) for the control patients (P = 0.04). 11 patients and 5 control patients were diagnosed with osteoporosis. The patients had an increased risk of osteoporosis compared to the control patients, with an odds ratio (OR) of 3.4, with a P-value of 0.027. Conclusions: This study confirms that radial head fractures in female patients ≥50 years are potential osteoporotic fractures. Offering these patients a BMD measurement may prevent future osteoporotic fractures, such as hip and spine fractures. Level of evidence: Level III.
INTRODUCTION

Radial head fractures are common, with an incidence of 2.5-2.9 per 10,000 inhabitants per year and account for up to one third of all elbow fractures.\(^1\)\(^,\)\(^2\) The patients mean age is 45-48 years old, with a male to female ratio ranging from 1:1 to 2:3.\(^2\)\(^,\)\(^3\) Women are significantly older (53-57 years) compared to men (34 to 41 years) when suffering a radial head fracture. Peak incidence in male patients is between the age of 30 to 40 and in females between 50 to 60 years.\(^2\)\(^,\)\(^4\) The number of female patients with a radial head fracture is significantly larger than males as the age rises above 50 years. Gebauer et al. studied 60 radial heads from cadavers and found osteoporotic changes in the micro-architecture, in both males and females, which can imply that radial head fractures are at least partial osteoporotic fractures.\(^2\)\(^,\)\(^5\) These observations suggest a possible correlation between radial head fractures and osteoporosis. Identifying radial head fractures as fragility fractures may improve case-finding for osteoporosis and thus be an indicator of other fragility fractures, as radial head fractures occur earlier in life, compared to hip and vertebral fractures.\(^6\) The hypothesis of this retrospective case-control study is that there is an increased incidence of osteoporosis in female patients ≥50 years of age with a radial head fracture compared to control patients without a radial head fracture.

PATIENTS AND METHODS

Patients
The study cases in this retrospective non-randomized case-control study were female patients of ≥50 years of age, who visited the emergency department of the Amphia hospital (Breda, the Netherlands) with a radiographically visible radial head fracture in the period between January 1\(^{st}\) and December 31\(^{st}\) 2009 were retrospectively reviewed. According to the current protocol for screening on osteoporosis by the Dutch Orthopaedic Federation, these patients were offered a standard osteoporosis screening with a bone mineral density (BMD) measurement at our fracture and osteoporosis (FO) clinic after initial fracture treatment.\(^7\) Control subjects were selected from the medical records of female patients, ≥50 years, who underwent a BMD measurement, which was offered to visitors of the open door day of our hospital for the general public. Patients with recent fractures (<12 months), immobility, dementia and bone disorders other than osteoporosis were excluded. Control patients were matched for gender (all female) and age (within 5 years) with the cases. At least one control patients was matched to each case and some cases had two controls. All control patients underwent a BMD assessment. A specialized nurse practitioner at the FO clinic collected all patient’s data, such as length, weight, BMI and period between menopause and radial head fracture. Additional risk factors for os-
teoporosis, such as smoking behaviour, corticosteroid use, previous osteoporotic fractures and a body weight of >60 kg, were collected.

**BMD measurement**

The BMD was measured using dual energy X-ray (DXA) and laser absorptiometry of the non-dominant calcaneus with the DXL Calscan (Demetech AB, Solna, Sweden). This peripheral BMD measuring device combines dual energy X-ray absorptiometry with laser absorptiometry. The laser absorptiometry corrects for the soft tissue component of the heel, which results in 10-20% more accuracy compared to other peripheral DXA technology. Several studies have shown that this method can be used in the measurement of BMD.\(^8\)\(^-\)\(^10\) A T-score of >-1.4 measured with the DXL Calscan was considered as normal, indicating normal bone density. A T-score with the DXL Calscan of < -2.7 was considered as abnormal and proof of osteoporosis. A T-score between -1.4 and -2.7 was considered as indication of osteopenia. In these cases an additional DXA scan of the femoral neck was performed, which is regarded as the gold standard.\(^11\) The T-score of the DXA scan was considered as the final result for these patients. Reference values of the DXA scan interpreted were according to the World Health Organisation (WHO): A patient was classified as being osteoporotic if the T-score was below –2.5.\(^12\)

**Statistical analysis**

Due to skewed distributions data are presented as medians with accompanying ranges. The Mann-Whitney test was used to compare baseline characteristics such as age, Length, weight and time interval between menopause and BMD assessment. The Cox regression model was used to perform a matched logistic regression analysis to determine the effect of osteoporosis on radial head fractures. Cases and controls were stratified in age groups of 5 years and odds ratios with 95% confidence intervals were calculated. A p-value of 0.05 was considered as statistically significant. Analysis was performed using SPSS for Windows version 16 (SPSS Inc., Chicago, IL, USA).

**RESULTS**

In the selected period, patients with a radial head fracture who met the inclusion criteria were identified. They were offered a standard osteoporosis screening with a BMD measurement at our FO clinic after initial fracture treatment. Of these 47 patients, 35 accepted the protocol and were screened, with a median age of 60 (50-84) years. The mean time between the radial head fracture and the BMD measurement was 6.8 (2-12) months. A total number of 57 controls were included, with a median age of 60 (50-84) years. All cases and controls were Caucasian. Except for the period between menopause and BMD assessment
Radial head fractures and osteoporosis

(a median of 11 years of the cases vs. a median of 8 years in the control group), there were no significant differences between the case- and control-groups. Patient characteristics are summarized in table I. A total of 23 patients (14 cases and 9 controls), had a t-score of between -1.4 and -2.7 with the DXL Calscan and underwent an additional DXA scan to determine a final T-score. The mean T-score of the fracture cases was -1.8 (range: -2.2 to -0.3, SD: 1.0), compared to -1.2 (range: -4.0 to 1.3, SD: 1.2) for the control group (p = 0.04). 11 fracture cases and 5 controls were diagnosed with osteoporosis (p = 0.01). The cases had an increased risk of osteoporosis compared to the controls, with an Odds Ratio (OR) of 3.4 (95% Confidence Interval (CI); 1.1-10.1), with a p-value of 0.03.

**DISCUSSION**

The results of this study support the hypothesis that radial head fractures in women ≥50 years old are to be considered as osteoporotic fractures. This could also explain the typical age distribution of patients with a radial head fracture. This hypothesis is also supported by the osteoporotic anatomical changes found in 30 cadaveric radial heads of elderly human specimens by Gebauer et al.: histomorphometry revealed a significant reduction of cortical thickness, bone volume per tissue volume, and trabecular thickness in male and female specimens. A significant decrease of total and cortical bone mineral density was also observed. Identifying and treating female patients ≥50 years with a radial head fracture as patients with a high risk of osteoporosis, may prevent future fragility fractures such as hip and vertebral fractures, as they occur later in life compared to radial head fractures. However, the OR for osteoporosis is lower compared to distal radial fractures: 7.1 vs. 3.4 in this study. This difference can be explained by the anatomy of the proximal and distal radius. The process of demineralization in osteoporosis is more manifest in the

<table>
<thead>
<tr>
<th></th>
<th>Cases (n=35)</th>
<th>Controls (n=58)</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>Median 60</td>
<td>58</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Range 51-84</td>
<td>50-84</td>
<td></td>
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<tr>
<td>Period menopause-scan (years)</td>
<td>Median 11</td>
<td>8</td>
<td>0.05</td>
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<td></td>
<td>Range 0-40</td>
<td>0-36</td>
<td></td>
</tr>
<tr>
<td>Length (m)</td>
<td>Median 1.66</td>
<td>1.65</td>
<td>0.97</td>
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<tr>
<td></td>
<td>Range 1.48-1.80</td>
<td>1.53-1.80</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>Median 69</td>
<td>68</td>
<td>0.54</td>
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<td></td>
<td>Range 49-100</td>
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<tr>
<td>BMI (kg/cm²)</td>
<td>Median 25.2</td>
<td>24.1</td>
<td>0.39</td>
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<td></td>
<td>Range 19.1-36.4</td>
<td>18.5-38.7</td>
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*Table I: Baseline data of cases and controls.*
cancellous bone and compared to the proximal radius, the distal radius consists of more cancellous bone in relationship to the amount of cortical bone.\textsuperscript{14}

The DXL Calscan has been introduced as a novel (screening) method to assess BMD. The main advantages are that the device is patient-friendly, easy to use, with a relatively short examination time.\textsuperscript{15, 16} The DXL Calscan sensitivity (80\% for osteoporosis and 82\% for osteopenia) and specificity (82\% for osteoporosis and 89\% for osteopenia) is reported to be reasonably high and reproducibility is good.\textsuperscript{17} To increase sensitivity and specificity of the DXL Calscan, the thresholds were set at T-score of $>-1.4$ for manifest non-osteoporotic and $<-2.7$ for manifest osteoporosis, according to guideline of the United Kingdom National Osteoporosis Society.\textsuperscript{18} These thresholds are defined so that patients with osteoporosis at the hip or spine are identified with 90\% sensitivity and 90\% specificity. Patients with a DXL Calscan result below the lower threshold are likely to have osteoporosis at the hip or spine, patients with a result above the upper threshold are unlikely to have osteoporosis, while those between the two thresholds require a hip and spine BMD examination for a definitive diagnosis. A weakness of this study is the possible bias of a significant difference in the mean period between start of the menopause and BMD: 15.5 years in patients with a radial head fracture, compared to 10.5 years in the control patients. This bias might underestimate the incidence of osteoporosis in the control group.

**CONCLUSIONS**

In conclusion we can state that this is, to our knowledge, the first case-control study that links radial head fractures to an increased risk for osteoporosis in female patients of $\geq$50 years of age. Identifying radial head fractures in these patients as potential osteoporotic fractures and offering a BMD measurement improves the early diagnosis of osteoporosis. Subsequent and adequate treatment of osteoporosis may then prevent future osteoporotic fractures, such as hip and spine fractures.
REFERENCE LIST


