Chapter 3

Prevalence of vertebral fractures and risk factors

3.1 Why do geriatric outpatients have so many moderate and severe vertebral fractures? Exploring prevalence and risk factors

3.2 High prevalence of moderate and severe vertebral fractures in male geriatric outpatients
3.1

Why do geriatric outpatients have so many moderate and severe vertebral fractures? Exploring prevalence and risk factors

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Abstract

Objectives: to determine the prevalence of vertebral fractures and their risk factors in geriatric patients.

Design: prospective cohort study.

Setting: teaching hospital in Amsterdam, The Netherlands.

Subjects: three hundred and three geriatric patients, who had their first visit at a diagnostic day hospital between April and August 2007.

Measurements: lateral X-rays of the lumbar spine and chest were performed; vertebral fractures were scored according to the semi-quantitative method of Genant by trained observers and compared to the official report of radiologists. Co morbidity, reported falls, mobility and cognitive function were scored.

Results: Vertebral fractures were observed in 51% (156/303) of geriatric patients. Sixty-nine per cent (107/156) of these fractures were moderate to severe. In 21% (33/156) of the patients with a fracture, vertebral fractures were diagnosed on the lumbar spine X-ray alone. Patients with vertebral fractures had more previous non-vertebral fractures (Odds Ratio 2.40 95%CI 1.40–4.10), had lower serum albumin levels (OR 0.92 95%CI 0.87–0.97) and more current prednisone use (OR 8.94 95%CI 1.12–71.45). Co morbidity and cognitive decline were not identified as risk factors. Radiologists reported vertebral fractures in 53% (82/156) of the cases.

Conclusion: this study showed a very high prevalence of vertebral fractures in geriatric patients; particularly the high prevalence of moderate and severe fractures is remarkable. Because of this high prevalence, the routinely performed lateral X-ray of the chest should be used to look for vertebral fractures. An additional X-ray of the lumbar spine might be useful in patients without vertebral fractures on the chest X-ray.
Introduction

Vertebral fractures are the most common fractures, and are usually due to severe osteoporosis [1,2]. The prevalence of vertebral fractures increases with age, with a prevalence of 50% in a geriatric population [3-5]. The lifetime risk for 50-year-old white women is 32% for suffering a vertebral fracture [6]. Vertebral fractures are associated with increased morbidity such as restrictive pulmonary disease, chronic back pain, loss of independence and reduced quality of life. Moreover, patients with vertebral fractures have an increased mortality rate after adjusting for age, and the mortality rate increases with the number of vertebral fractures [7].

The diagnosis of a vertebral fracture is easily made with radiography. Still, despite the high prevalence of vertebral fractures, there is major underdiagnosis due to several reasons [8]. First, only one third of the patients have acute complaints for which they visit the doctor [1]. Secondly, the clinical presentation is not very specific, so the doctor easily makes a different diagnosis [1]. A third reason is that vertebral fractures are often overlooked in radiographs. In large studies the false negative rates vary between 27% and 50% [2,9]. Additionally, the use of ambiguous terminology in radiology reports makes it difficult to read the diagnosis for the physician [10], which is a fourth reason. The fifth reason is that the diagnosis can be overruled by another diagnosis. The doctor is aware of the vertebral fracture on the x-ray, but at time of presentation another diagnosis seems more important such as pneumonia or malignancy. Sixth reason is missing the clinical relevance of vertebral fractures by individual doctors and therefore they do not consider the start of medication.

Missing the diagnosis or not starting treatment has negative consequences for the patients due to a high risk of a new fracture. Females with a vertebral fracture have a doubled risk for hip fracture and approximately four times greater risk for a new vertebral fracture [11,12]. Nineteen per cent of women with a new vertebral fracture have an incident vertebral fracture in the next year [13]. Several risk factors for vertebral fractures have been identified: osteoporosis, high age, low BMI, family history of osteoporosis, current smoking and the use of a walking aid [14,15]. Specific risk factors in the geriatric population are not yet identified. According to the literature vertebral fractures originate most often from minimal trauma, such as sudden bending, lifting or while making a false step [2]. Because patients with cognitive decline have a tendency to walk too fast and fall more often [16], the hypothesis arises that these patients might have more vertebral fractures.

The aims of this study is to investigate first the prevalence of vertebral fractures in the total spine in a geriatric population; second, to find out whether the X-ray of the lumbar spine has additional value next to the lateral chest x-ray in this evaluation; finally, to identify any additional risk factors for vertebral fractures in this geriatric population.
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Methods
Participants
From April 2007 until August 2007, we included consecutive patients in the Slotervaart hospital, a large teaching hospital, in Amsterdam, the Netherlands. These were all geriatric out clinic patients visiting our diagnostic day hospital for the first time. Patients were referred by their general practitioner for different reasons such as memory complaints, weight loss, falls and polyfarmacy. Every patient who was seen on our day hospital in the specific period was included. The patients gave informed consent, or if they were not able to judge, their substitute decision-makers did. Exclusion criteria were no informed consent and if the patient was not able to undergo radiographs. The study was approved by the regional research ethical committee of the Slotervaart Hospital.

Measurements
Medical history, medication use and the final diagnoses at the end of the diagnostic work up were assessed from the patient’s chart. The Charlson Index score was assessed as a measure for co-morbidity based on the information at the end of the diagnostic day. The Charlson Index score is the most extensively studied co-morbidity index for predicting mortality [17,18]. Patients and caregivers were asked about falls in the last year. Mobility was measured by the Timed get Up and Go test ‘TUG’ [19]. If the test is completed in less than 10 s, mobility is considered normal. Tests completed in 10-20 s implicate impaired mobility and over 20 s abnormal mobility. The cognitive function of the participants was assessed through the minimal mental state examination ‘MMSE’ [20] and by using the criteria for dementia from the Diagnostic and Statistical manual of Mental disorders ‘DSM IV’. Three groups were formed: with dementia, no dementia or with Mild Cognitive Impairment ‘MCI’. Blood samples for albumin and vitamin D were taken. All patients on the geriatric day clinic had a chest X-ray (posterior-anterior and lateral) and a lateral lumbar spine X-ray.

Diagnosis of vertebral fractures
Two investigators (HJ,MV) were trained to find vertebral fractures with the semi-quantitative method of Genant [21]. This method is validated in comparison to quantitative morphometry in different studies [22,23]. Fractures were categorized by severity (grade 1- mild 20-25% loss of height, grade 2- moderate 25-40% loss of height and grade 3-severe > 40% loss of height) and fracture type (wedge, biconcave or crush-fracture). In patients with more than one fracture, we categorized the most severe fracture. The two observers scored separately every X-ray for vertebral fractures. Their conclusions were compared. In cases where the conclusion did not match, consensus was reached by discussion between the observers. This diagnosis was considered as gold standard. Geriatricians working at the day hospital were teached in an educational program to score vertebral fractures with the semi-quantitative method of Genant. The radiologists were asked to look specifically for vertebral fractures. The results of the two
observers were compared with the outcome of the geriatricians and the official report of the radiologists.

**Statistics**

The Statistical Package for the Social Sciences (version 15.0 for Windows, SPSS, Inc., Chicago IL.) was used. Included and excluded patients were compared for age, sex, co-morbidity and cognitive decline. We compared patients who had vertebral fractures on the X-rays with patients without vertebral fractures. We used Chi square test for categorical variables and independent t-tests or Mann-Whitney test for continuous variables. A two-sided probability of p<0.05 was considered statistically significant. We used logistic regression for univariate analysis. A vertebral fracture on the x-rays was the dependent variable. Variables in this analysis with a p<0.1 were included in the multivariate analysis. Age and sex were included as confounders. A backward and forward selection procedure was applied for the multivariate regression analysis.

**Results**

During the inclusion period, 338 patients were screened for inclusion. A total of 35 patients were excluded. Eight patients refused and twenty five patients were not able to undergo a lateral lumbar spine X-ray because of severe illness. In two cases the quality of the X-rays was too poor to score.

<table>
<thead>
<tr>
<th>Variable</th>
<th>without VF*</th>
<th>with VF *</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients (%)</td>
<td>147 (49%)</td>
<td>156 (51%)</td>
<td></td>
</tr>
<tr>
<td>Age, y, mean ± SD</td>
<td>81 ± 8</td>
<td>82 ± 6</td>
<td>0.2</td>
</tr>
<tr>
<td>Females, n (%)</td>
<td>93 (63%)</td>
<td>97 (62%)</td>
<td>0.9</td>
</tr>
<tr>
<td>Non -VF* in history, n (%)</td>
<td>22 (15%)</td>
<td>38 (24%)</td>
<td>0.04</td>
</tr>
<tr>
<td>Current Smoking, n (%)</td>
<td>28 (19%)</td>
<td>26 (17%)</td>
<td>0.3</td>
</tr>
<tr>
<td>Charlson Index score, mean ± SD</td>
<td>2.1 ± 1.8</td>
<td>2.3 ± 1.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Body Mass Index, mean ± SD</td>
<td>25.8 ± 4.8</td>
<td>25.6 ± 5.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Prescriptions, median (range)</td>
<td>5 (0-14)</td>
<td>6 (0-19)</td>
<td>0.14</td>
</tr>
<tr>
<td>Prednison use, n (%)</td>
<td>1 (0.7%)</td>
<td>8 (5%)</td>
<td>0.06</td>
</tr>
<tr>
<td>25(OH)Vitamin D, nmol/L, mean ± SD</td>
<td>39 ± 25</td>
<td>41 ± 20</td>
<td>0.7</td>
</tr>
<tr>
<td>25(OH)Vitamin D below 50 nmol/L</td>
<td>76%</td>
<td>74%</td>
<td></td>
</tr>
<tr>
<td>25(OH)Vitamin D below 30 nmol/L</td>
<td>44%</td>
<td>32%</td>
<td></td>
</tr>
<tr>
<td>Serum Albumin, g/L mean ± SD</td>
<td>38 ± 3.7</td>
<td>36 ± 5.1</td>
<td>0.02</td>
</tr>
<tr>
<td>Reported falls, at least one in the last year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two or more falls the last year, n (%)</td>
<td>67 (46%)</td>
<td>87 (56%)</td>
<td>0.05</td>
</tr>
<tr>
<td>No falls the last year, n (%)</td>
<td>36 (24%)</td>
<td>36 (23%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>54 (37%)</td>
<td>42 (27%)</td>
<td></td>
</tr>
<tr>
<td>Timed get up and go test</td>
<td>106 (72%)</td>
<td>107 (69%)</td>
<td>0.5</td>
</tr>
<tr>
<td>patients who completed the test, n (%)</td>
<td>16 ± 10</td>
<td>17 ± 15</td>
<td></td>
</tr>
<tr>
<td>mean in seconds ± SD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive function, MMSE, mean ± SD</td>
<td>22 ± 6</td>
<td>22 ± 5</td>
<td>0.4</td>
</tr>
<tr>
<td>No dementia, n (%)</td>
<td>45 (31%)</td>
<td>47 (30%)</td>
<td></td>
</tr>
<tr>
<td>Mild Cognitive Impairment, n (%)</td>
<td>34 (23%)</td>
<td>28 (18%)</td>
<td></td>
</tr>
<tr>
<td>Dementia, n (%)</td>
<td>53 (36%)</td>
<td>59 (38%)</td>
<td></td>
</tr>
<tr>
<td>Unknown cognitive function, n (%)</td>
<td>15 (10%)</td>
<td>17 (11%)</td>
<td></td>
</tr>
</tbody>
</table>

* VF: vertebral fractures
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There were no statistical significant differences between included and excluded patients (data not shown). In 21 cases (7%) discussion between the two observers was needed. Patient characteristics of the two groups with and without vertebral fractures are shown in Table 1. Mean age was 82 years, 63% was female. The mean co morbidity-score was more than 2 chronic diseases per patient. Only sixteen percent had no chronic disease. Twenty-six percent had fractures of any kind in history. In 18% of the cases the diagnosis osteoporosis was already known at the time the patient was presented at the hospital, but only 3% of these patients received treatment at that time. Mobility was poor, only 9% performed the TUG-test in less than 10 s and 51% of the patients reported a fall in the last year. Cognition was impaired in 47% of the patients.

Vertebral fractures, overall prevalence and risk factors

Table 1 shows the prevalence of vertebral fractures in our study group of 51% (156/303). The mean number of vertebral fractures per patient was 2.1(SD 1.6). Figure 1 shows the number of fractures per patient and the severity of the fractures. Patients with vertebral fractures had more reported falls (56% vs 46%) (p=0.05). Nine patients used prednisone at day of presentation, of whom eight had a vertebral fracture (p=0.06). Patients with an earlier non-vertebral fracture more often (24% vs 15%) had a vertebral fracture (p=0.04). The albumin level was lower (36g/L vs 38g/L) in the group with vertebral fractures (p=0.02).

We identified the following risk factors for vertebral fractures in this geriatric population (Table 2): earlier non-vertebral fractures (OR 2.40, 95%CI 1.40 – 4.10), prednisone use (OR 8.94, 95%CI 1.12 – 71.45) and low serum albumin (OR 0.92 95%CI 0.87 – 0.97), reported falls in the last year (OR 1.74 95%CI 1.04 – 2.90). In the multivariable regression analysis only the first three factors were independent risk factors. Co-morbidity through the Charlson Index score and cognitive decline were not identified as risk factors.

Figure 1A: Number of fractures per patient, N=156

![Number of fractures per patient, N=156](image)
Prevalence of vertebral fractures and risk factors

Figure 1B: Severity of the fractures, N=156

Table 2: Risk factors for vertebral fractures

<table>
<thead>
<tr>
<th></th>
<th>Univariate analysis*</th>
<th>Multivariate analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds ratio</td>
<td>95% CI</td>
</tr>
<tr>
<td>Age</td>
<td>1.02</td>
<td>0.99 - 1.06</td>
</tr>
<tr>
<td>Females</td>
<td>1.05</td>
<td>0.66 - 1.67</td>
</tr>
<tr>
<td>Non-VF in history</td>
<td>2.40</td>
<td>1.40 - 4.10</td>
</tr>
<tr>
<td>Current Smoking</td>
<td>1.28</td>
<td>0.70 - 2.32</td>
</tr>
<tr>
<td>Charlson Index score</td>
<td>1.05</td>
<td>0.92 - 1.19</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>0.99</td>
<td>0.94 - 1.05</td>
</tr>
<tr>
<td>Prescriptions</td>
<td>1.06</td>
<td>0.99 - 1.13</td>
</tr>
<tr>
<td>Prednison use</td>
<td>8.94</td>
<td>1.12 - 71.5</td>
</tr>
<tr>
<td>25(OH)Vitamin D</td>
<td>1.00</td>
<td>0.99 - 1.02</td>
</tr>
<tr>
<td>Serum Albumin</td>
<td>0.92</td>
<td>0.87 - 0.97</td>
</tr>
<tr>
<td>Reported falls</td>
<td>1.74</td>
<td>1.04 - 2.90</td>
</tr>
<tr>
<td>Timed up and go test</td>
<td>1.00</td>
<td>0.99 - 1.03</td>
</tr>
<tr>
<td>MMSE</td>
<td>0.99</td>
<td>0.95 - 1.02</td>
</tr>
</tbody>
</table>

CI, confidence interval.
*Variables with a p-value <0.20 in the univariate analysis were included in the multivariate analysis; these variables are marked in bold in the p-value column. Age and sex were included as potential confounders. A backward selection procedure was applied; a forward analysis selected the same variables.

Lumbar spine fractures
Thirty-three cases (11%) had a vertebral fracture only in the lumbar spine on vertebrae L2 or lower. For these patients without a vertebral fracture on the chest X-ray, the chance that they might have a vertebral fracture in the lumbar spine is 18% (33/180). There were no significant differences between the group of patients with only a lumbar fracture and those with no fractures at all. Logistic regression analysis showed no significant factors.

Diagnosis by radiologist and geriatrician
The geriatricians correctly diagnosed a vertebral fracture in 70% of the cases with a fracture. Although every suggestion of a vertebral fracture in the official reports of the
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radiologists was taken into account, only 82 reports mentioned a fracture of any kind (82/156=53%). The detection by radiologists of moderate and severe fractures was 69%.

Discussion
This study shows the very high prevalence of vertebral fractures and the high rate of moderate and severe fractures among geriatric patients visiting a diagnostic-day clinic. The additional value of a lumbar spine x-ray is not very high, but might be relevant for the patients without a fracture on the lateral chest X-ray. Risk factors identified in this study for this specific population are previous non-vertebral fractures, current prednisone use and low serum albumin. The underdiagnosis by radiologists is 47%.

The high rate of moderate and severe fractures is remarkable, other studies showed a lower percentage of moderate and severe vertebral fractures [24]. In population-based studies of white women with a comparable high age, prevalence rates of vertebral fractures vary between 25%-40% [4,5]. The possible explanation for the high prevalence and the high rate of moderate to severe fractures is the high prevalence of risk factors for severe osteoporosis in this geriatric population. Geriatric patients (referred to a diagnostic day hospital) have, by definition, a high age and often present with immobility due to several acute and chronic medical conditions; they have a high rate of poor nutritional status including a low vitamin D level, which are all confirmed in this study. The high rate of moderate and severe fractures is clinically relevant, because patients with severe incident vertebral fractures more often have chronic back pain than patients with mild vertebral fractures [25], and have a substantially increased risk of a new or subsequent vertebral fracture [26] and severe fractures are associated with increased mortality [7].

Risk factors
Our hypothesis that patients with vertebral fractures would have a higher co-morbidity score was not confirmed. Apparently, the Charlson Index score is not discriminative for vertebral fractures in this cohort. This co-morbidity score does not reflect the severity or complications of the chronic disease nor the duration of the illness.

Normal levels of albumin are identified as a protective factor in this population. Low serum albumin levels in the fracture group might be a sign of overall worse condition, but this was not shown in other measures such as BMI or Charlson Index score. Low serum albumin levels are not very specific [27]. There are a number of acute or chronic conditions with low serum albumin levels, such as poor nutritional state, acute inflammatory response and end-stage renal disease. Low serum albumin levels are therefore not discriminative for having a vertebral fracture in geriatric patients who visit a diagnostic day hospital.

A reported fall in the last year gives a higher risk of a vertebral fracture, although in the multivariate analysis adjusted for age and sex it was not significant anymore. The reliability of reported falls is low in every population, and in our group with a high prevalence of cognitive disorders even more unreliable [28]. It is not known whether
these reported falls are the origin of the fractures, or that vertebral fractures itself give rise to instability and falls. Increased thoracic kyphosis due to vertebral fractures can shift the center of mass, which can result in more instability and falls [29]. Further research with more tests on mobility could reveal answers on this matter. Our hypothesis that patients with cognitive decline would have more vertebral fractures is negative. Cognitive decline and vertebral fractures were not related in this cohort.

**Lumbar spine fractures**
The additional value of a lumbar spine x-ray is debatable. Eighteen per cent may not be high enough to include an extra X-ray of the lumbar spine as a routine screening method for osteoporosis in this kind of population. In our hospital we take routine chest X-rays and as shown in this study, the detection of vertebral fractures by radiologists and geriatricians is suboptimal, as confirmed in literature [2,9,10]. In our opinion, the detection, especially of moderate and severe vertebral fractures, seems not very difficult after little training. In conclusion of the earlier-mentioned accounts, geriatric patients would benefit more from a better detection of vertebral fractures on the routinely performed chest X-ray, than that they would benefit by performing an extra lumbar spine X-ray.

**Limitations**
A limitation of this study is that the risk factors, we wanted to identify were not measured directly in this study. Falls were measured by self-report, immobility was partly measured by the timed get up and go test, but most patients with immobility were not able to perform the test and only 71% finished the test. Poor nutrition was not reflected otherwise than through the body mass index and the serum albumin level. Duration of chronic disease was not measured at all, and disability was not explored enough. It is for further investigation whether the frailty-syndrome would be more predicting for vertebral fractures than co-morbidity. Fried et al. showed that co-morbidity, disability and frailty are overlapping, but are distinct clinical entities [30].

**Conclusion**
Moderate and severe vertebral fractures have a high prevalence among geriatric outpatients, and frequently stay underdiagnosed on radiographs. Because of the high prevalence, the routine X-ray of the chest should be used carefully to look for vertebral fractures, especially in the geriatric population. An additional lumbar spine X-ray might be recommended for patients without a vertebral fracture on the chest X-ray, since patients with a lumbar spine fracture cannot be diagnosed through clinical characteristics.
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References

3. Van Hengel M, Van der Jagt H, Vis M, Tulner CR, Lems WF. High prevalence and under-diagnosis of vertebral fractures in elderly patients in the elderly outpatient day clinic (submitted).