Chapter 3

The relation between AO-classification of distal radial fractures and bone mineral density

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Introduction

Osteoporosis is a major health problem of which the clinical manifestation is a fragility fracture. Fragility fractures do have a significant impact on quality of life, morbidity and mortality[1-4]. In elderly patients, there is a strong association between distal radial fractures and osteoporosis[5,6]. Osteoporosis in distal radial fractures is associated with malunion, early instability and late carpal malalignment, which makes early screening for osteoporosis perhaps worthwhile as it might have implications for the initial treatment choice: operative versus conservative. Another advantage of early screening is that anti-osteoporotic therapy can be initiated as soon as possible, which is important because most subsequent fragility fractures occur within the first year after the initial fracture and it takes at least 3 months before anti-osteoporotic medication results in its maximum effect[7-9].

The golden standard in screening for osteoporosis is measurement of BMD with dual energy X-ray Absorptiometry (DXA). In most hospitals it is, because of logistic reasons, not possible to perform DXA measurements within the first week after a distal radial fracture. Other ways to be informed about the osteoporotic status of patients would thus be worthwhile. The AO-fracture classification system might be helpful in this. Theoretically, with an increasing loss of BMD the same force applied to the distal radius would result in a more comminutive fracture pattern. This would imply that the BMD in an AO grade C fracture is lower than in an AO grade A fracture. However, there is some controversy about this in literature as previous clinical research showed no correlation between the AO-classification and BMD, which was in contrast to an in vitro study showing the opposite[7,10].

The aim of this study was to establish the relation between the AO-classification and BMD. Moreover, we calculated the prevalence of subsequent fragility fractures and the time interval between the initial and subsequent fracture. This information could be used to improve the timing of osteoporosis screening after a distal radial fracture.

Patient and Methods

Study design

This is a retrospective, descriptive study, conducted from April 2009 till April 2011 in our non-academic teaching hospital.

Study population

All patients older than 50 years, admitted with a distal radial fracture, were invited through mailing for the screening for osteoporosis at our Fracture Liaison Service (FLS). During the study period 562 patients with a distal radial fracture were admitted to our hospital, of which 214 patients were actually screened at the FLS. From the 214 patients, 2 were excluded from further analysis because they were first admitted to another hospital and the trauma radiograph of their distal radius was missing. Four patients did not show up for their DXA scan and therefore had to be excluded from further analysis. Thus, the final study population comprised 208 patients. Table 1 shows the basic characteristics of our study population.
Bone Mineral Density Measurements

Bone mineral density was measured in a standardized fashion at the left hip and lumbar spine (L1-4) using DXA (Hologic Discovery A; Hologic, Bedford, Massachusetts), and expressed as a T-score. The T-score is the number of standard deviations above or below the mean for a young adult white woman[11-13]. Scanning time on the DXA took about 20 minutes and the machine was calibrated automatically on a daily basis using a phantom. In this study the lowest of the two T-scores was used for further analysis and comparison. We used the World Health Organization’s definitions of osteoporosis (a T-score ≤-2.5SD), osteopenia (a T-score in between -1SD and -2.5SD), and normal BMD (a T-score >-1SD)[11].

Distal radial fractures

All distal radial fractures were confirmed on the radiographs at the time of admission and classified by group and subgroup according to the AO-fracture classification system by the first author, who is a trauma surgeon[14]. Because the sample sizes in the different subgroups of AO-classification were small, subgroup analysis was not performed. For a better overview the number of patients in the different subgroups are not expressed in the results.

Subsequent fragility fractures

To identify patients with a subsequent fragility fracture we checked the hospital registration system. All fractures recorded till October 2011 were included in our analysis as long as these fractures occurred after a distal radial fracture in patients over 50 years. The follow up for subsequent fractures in patients with a distal radial fracture was therefore in between 6 and 30 months, depending on the time of inclusion of the patient. In 176 patients the follow up was at least 12 months.
Statistical analysis

Statistical analysis was performed using SPSS software. Descriptive evaluation was carried out using number and percentages for categorical variables, mean values and standard deviations for normally distributed variables and median and inter quartile range (IQR) for not normally distributed values. For comparison of BMD with the different groups of patients in the AO-classification system cross tabulation were performed with Chi-square test and Fisher’s exact test as appropriate. The level of significance was set at P<0.05.

Results

Correlation between the AO-classification and BMD

Of all patients with a distal radial fracture 80% had a low BMD, of which 34% suffered from osteoporosis. Based on the AO-classification for distal radial fractures, 96 (46%) fractures were classified type A, 26 (13%) type B and 86 (41%) type C. As can be seen in table 2, there was no significant correlation between the AO-classification and BMD (p=0.394).

<table>
<thead>
<tr>
<th></th>
<th>Osteoporosis</th>
<th>Osteopenia</th>
<th>Normal BMD</th>
<th>Conservative treatment</th>
<th>Operative treatment</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>AO type A</td>
<td>29</td>
<td>53</td>
<td>14</td>
<td>89</td>
<td>7</td>
<td>96</td>
</tr>
<tr>
<td>AO type B</td>
<td>8</td>
<td>11</td>
<td>7</td>
<td>25</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>AO type C</td>
<td>20</td>
<td>46</td>
<td>20</td>
<td>58</td>
<td>28*</td>
<td>86</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>110</td>
<td>41</td>
<td>172</td>
<td>36</td>
<td>208</td>
</tr>
</tbody>
</table>

Table 2. Distribution of BMD and kind of treatment among the different categories of AO-classification

1 BMD, Bone Mineral Density
* Patients with a type C distal radial fracture were significantly more often treated operatively (p<0.01)

Subsequent fragility fracture

A subsequent fragility fracture occurred in 11 of the 208 patients (5.3%). There was no significant correlation between the AO-classification and the occurrence of a subsequent fragility fracture. In respectively 8.3%, 3.8% and 2.3% of the patients with an AO type A, B or C fracture a subsequent fragility fracture occurred (p=0.154). Subsequent fragility fractures occurred significantly more often in osteoporotic patients compared to non osteoporotic patients, respectively 14% of osteoporotic patients, 1.8% of osteopenic patients, and 2.4% of patients with a normal BMD suffered from a subsequent fragility fracture (p<0.01). The median time interval after which a subsequent fragility fracture occurred was 138 days (IQR: 52-529). This was close to the median time interval after which osteoporosis screening was performed, being 83 days (IQR 63-121).
Operative versus non-operative treatment

In this study 36 of the 208 (17.3%) patients were treated operatively. Table 3 shows the distribution of type of treatment among the different categories of BMD. In all categories of BMD patients were significantly more often treated non-operatively (p=0.035). Table 2 shows that patients with a type C fracture were significantly more often treated operatively than patients with a type B or A fracture (p<0.01). Of the 57 osteoporotic patients 5 (8.8%) patients were treated operatively.

<table>
<thead>
<tr>
<th></th>
<th>Conservative treatment*</th>
<th>Operative treatment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoporosis</td>
<td>52 (91%)</td>
<td>5 (9%)</td>
<td>57</td>
</tr>
<tr>
<td>Osteopenia</td>
<td>84 (76%)</td>
<td>26 (24%)</td>
<td>110</td>
</tr>
<tr>
<td>Normal BMD¹</td>
<td>36 (88%)</td>
<td>5 (12%)</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>172 (83%)</td>
<td>36 (17%)</td>
<td>208</td>
</tr>
</tbody>
</table>

Table 3. Distribution of type of treatment among the different categories of BMD

¹ BMD, Bone Mineral Density

* Patients were significantly more often treated conservatively than operatively: p=0.035

Discussion

This study shows that the AO-classification of distal radial fractures is of no value in the screening for osteoporosis as there is no correlation between the AO-classification and BMD. This finding is supported by another clinical study[7]. On the other hand, the in vitro study by Lill showed a positive correlation between different classification systems and BMD[10]. But, in analyzing this study, a good correlation (r=-0.70) is only proven for the Melone classification and BMD[10]. The correlation between the other classification systems (AO, Cooney, Fernandez and Frykman) and BMD was weak (r≤-0.25)[10]. The Melone classification is only applicable to intra-articular fractures of the distal radius and therefore less useful as a general classification system[15]. There might be several reasons why BMD is not correlated to the AO-classification system. First: there is a known variability in classification of groups with the use of the AO-classification system[16]. Second: the severity of a fracture pattern is complex and influenced by many factors including BMD. There is for example a great variability in the amount of energy transmitted to the distal radius in each patient during a fall[17]. Third: DXA measures thickness of cortical bone, which is thicker in the metaphyseal area than in the epiphyseal area. A more severe osteoporotic fracture would therefore be a metaphyseal fracture instead of an intra-articular fracture.
We found a prevalence of subsequent fragility fractures of 5.3%, which is comparable to the literature[9]. Another important conclusion from this study is that the median time interval after which a subsequent fragility fracture occurred was only 138 days, which is shorter than the previously reported interval of 10.8 months[9]. This is an interesting result as the median time interval after which patients are screened at the FLS was 83 days and the maximum effect in risk reduction of anti-osteoporotic medication will take at least 90 days[8]. Add to this that subsequent fragility fractures occurred significantly more often in osteoporotic patients, the timing of screening for osteoporosis in patients with a distal radial fracture is important. As the goal of this screening is preventing subsequent fractures, patients with a distal radial fracture might benefit most when the screening for osteoporosis is done as soon as possible. Another reason for early screening for osteoporosis might be the higher risk of malunion in osteoporotic patients[7]. In this context, it is interesting that this study showed that only 8.8% of the osteoporotic patients were treated operatively. On the other hand we should realize that in low-demand patients malunion has less adverse impact on the patient’s satisfaction[7,18].

This study has some limitations. The first limitation is the possible selection bias, which could have been introduced because only 208 of the 562 patients with a distal radial fracture were screened at the FLS. Another limitation is that all radiographic measurements were performed by a single trauma surgeon. Although he is experienced in interpreting these radiographs a risk of inter- and intraobserver error in the measurements remains.
**Letter to the Editor**

**The relation between AO-classification of distal radial fractures and bone mineral density**

*Sir,*

Distal radial fractures in elderly patients are associated with osteoporosis and osteoporosis is related to malunion, early instability and late carpal malalignment[5,7,19]. Early diagnosed osteoporosis might have implications for the initial choice of treatment: operative *versus* conservative. Measurement of bone mineral density (BMD) in patients with a distal radial fracture can therefore be important. However, instant measurement of BMD with Dual Energy X-ray Absorptiometry (DXA) is not feasible in most hospitals and other ways to be informed about the osteoporotic status of patients would be worthwhile. Theoretically, a more severe fracture pattern can be expected with an increasing loss of BMD. This suggests that fracture classification systems might be helpful in diagnosing osteoporosis. Previous *clinical* research showed no correlation between fracture-classification (AO) and BMD, which was in contrast to an in *vitro* study showing the opposite[7,10]. This study was performed to solve this controversy. The aim was to establish the relation between the AO-classification and BMD.

From April 2009 till April 2011, all 212 patients of fifty years or older admitted to our emergency room with a distal radial fracture were offered screening on osteoporosis. Four patients were excluded because they refused screening on osteoporosis. Therefore, the final study sample comprised 208 patients, 30 men and 178 women. The BMD was measured in a standardized fashion at the left hip and lumbar spine and expressed as a T-score. The T-score is the number of standard deviations above or below the mean for a young adult white woman[11]. Osteoporosis was defined as a T-score ≤-2.5SD, osteopenia as a T-score of -1 to -2.5SD, and a normal BMD as a T-score >-1SD[11]. All distal radial fractures were classified according to the AO-fracture classification system by the first author (trauma surgeon)[14]. Fractures were classified as AO type A, B or C fractures.

This study showed no correlation between the AO-classification of distal radial fractures and BMD (*p*=0.394). A reason for this might be that DXA measures thickness of cortical bone. Cortical bone is thicker in the metaphyseal area than in the epiphyseal area. A more severe osteoporotic fracture would therefore be a metaphyseal fracture instead of an intra-articular fracture. We concluded that the AO-classification of distal radial fractures *cannot* be used to identify osteoporotic patients.
References
