Influence of vertebral fracture assessment by dual-energy X-ray absorptiometry on decision-making in osteoporosis: a structured vignette survey

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Abstract

Objective. Vertebral fracture assessment (VFA) is a radiographic method using DXA to diagnose vertebral fractures, validated for reproducibility, sensitivity and specificity as compared with spine radiographs. This study was designed to assess the impact of VFA results on decision-making in osteoporosis, using a clinical vignette-based approach.

Methods. Twenty-nine rheumatologists provided data on post-menopausal women consulting for BMD measurement: clinical risk factors for osteoporosis, clinical characteristics of patients, BMD, T-score and VFA images. Standardized clinical vignettes were generated from these patients, and each rheumatologist assessed five vignettes assigned at random, in two distinct steps: first step without and second step with VFA data. At each step, they had to answer questions about the prescription of radiographs and treatments, using a yes/no format.

Results. A total of 117 vignettes were available [117 patients: mean age 65.1 (10.1) years, lumbar spine T-score: −1.64 (0.92)], 36.7% with a personal history of fracture. Rheumatologists intended to prescribe radiographs in 62.4 and 46.2% cases (P = 0.0206) before and after VFA results, respectively; a change occurred in 36.8% of patients, i.e. a de novo prescription of radiographs in 12 patients, and a deleted prescription in 31 patients. VFA data induced a therapeutic change for 30.8% of patients.

Conclusion. This study shows that VFA results influence patient management, both for radiographs and treatment prescriptions.

Key words: Osteoporosis, Vertebral fracture, Vertebral fracture assessment, Dual-energy X-ray absorptiometry, Clinical vignettes.

Introduction

Vertebral fracture assessment (VFA), is a radiographic method using DXA to assess vertebral fractures [1–5]. It uses lateral spine images, and is considered to be a reliable method for detecting vertebral fractures, with the advantage of delivering a lower dose of radiation to the patient as compared with standard spine radiographs.

The clinical consequences of vertebral fractures are well recognized [6–10], and prevalent vertebral fractures are a strong risk factor for sustaining a vertebral or non-vertebral fracture, including hip [11, 12]. Both the severity and the number of prevalent fractures are
determinants of the risk of future fractures [13–15]. Moreover, at any given bone density, the risk of incident vertebral and non-vertebral fractures depends heavily on the presence of vertebral fractures [16]. Thus, the appropriate diagnosis of vertebral fractures for both the thoracic and the lumbar spine is mandatory for optimal identification of high-risk patients who should receive the highest priority for treatment. However, in post-menopausal women, only one out of three vertebral fractures comes to clinical attention because they may occur without typical clinical symptoms [16]. Spine radiographs are the gold standard for the diagnosis of vertebral fractures, but they cannot be used routinely to screen all women because of both radiation concerns and costs. In clinical studies, the prescription of spine radiographs can be optimized considering age, height loss and history of fracture [17–19], but this approach is far from the day-to-day care of women with osteoporosis [20]. For physicians the dilemma is to detect vertebral fractures while avoiding unnecessary radiation and cost associated with radiographs.

The VFA technology has been validated for reproducibility, and sensitivity and specificity as compared with spine radiographs. The effective radiation dose for VFA is \( \mu \text{Sv} \) vs 600 \( \mu \text{Sv} \) for one lateral lumbar spine X-ray [21]. VFA compares favourably with standard spine radiographs in detecting vertebral fractures, with sensitivities and specificities >80 and 90%, respectively, when moderate or severe vertebral fractures are assessed [31]. Lower results have been reported for diagnosis of mild fractures, or for fractures located at the upper part of the thoracic spine, because legibility problems may occur at this site. VFA is also convenient for patients, as it is performed at the same time as BMD measurement. However, it remains uncertain whether the use of this technique can modify patient management. Thus, we conducted this study to assess the impact of VFA results on the prescription of spine radiographs and anti-osteoporotic treatment in post-menopausal women using a clinical vignette-based approach.

**Methods**

**Selection of participants and procedures**

We invited rheumatologists, identified according to their clinical experience in the osteoporosis field, to participate. They were selected based upon their steady use of a bone densitometry device equipped with an optimal version of VFA software (according to the manufacturer). They were asked to provide data from post-menopausal women aged \( \geq 50 \) years consulting for BMD measurement, without spine radiographs in the year before inclusion, and without artefact, which may preclude assessment of BMD data (such as scoliosis and/or degenerative changes of the lumbar spine). Clinical risk factors for osteoporotic fractures and BMD were collected for these patients. Images and results of BMD and \( T \)-scores were obtained at the lumbar spine (L1–L4), and proximal femur (including results of femoral neck and total hip). Acquisition of VFA was performed according to the manufacturer’s recommendations. VFA lateral and posteroanterior views of the thoracic and the lumbar spine were collected; one or more relevant localized views could be selected on the screen according to the rheumatologist’s opinion. The study was approved by the Comité Consultatif sur le Traitement de l’Information en matière de Recherche dans le domaine de la Santé.

**Elaboration of clinical vignettes**

Clinical vignettes were generated from these patients’ data according to the following process (Fig. 1). Scan data were anonymized. A rheumatologist, unrelated to the material, elaborated a standardized vignette for each patient; all vignettes used similar wording and the following information was described, in this order: age; age of menopause and years since menopause; past or current use of HRT (including age at the end of treatment if applicable); personal history of drugs or treatments that may affect bone metabolism; prevalent fragility fractures; parental history of fragility fractures; current height and weight; estimated height at the age of 20 years; back pain and duration of pain if any; spinal radiological data if any X-rays performed \( >1 \) year before were available; BMD and \( T \)-score results at spine, hip and femoral neck; VFA images of thoracic and lumbar spine (i.e. four views);

**Fig. 1 Flow chart illustrating the study survey.**
and additional focal view if given by the rheumatologist based on his own opinion of relevance.

**Assessment**

All clinical vignettes were on a file server and rheumatologists received a login and a password to access the data. Each rheumatologist received five clinical vignettes assigned at random. None of these vignettes was from their own patients. To determine whether rheumatologists would change their decision according to the results of VFA images, we followed two distinct steps for each vignette. In the first step, only the clinical, BMD and T-score data were available; the rheumatologist was asked to evaluate the probability of a patient having a vertebral fracture (in the case of absence of radiological data) or a new vertebral fracture (in the case of prevalent vertebral fracture) with a probability expressed as a percentage (0–100%). Then the following questions were presented: ‘Do you prescribe spine radiographs for this patient?’ and ‘Do you prescribe an anti-osteoporotic treatment for this patient?’ using a yes/no format. All answers were recorded at the end of the first step and could not be subsequently modified. In the second step, the VFA images were provided, and the rheumatologists had to answer the two following questions: ‘Having these VFA data, do you prescribe spine radiographs for this patient?’ and ‘Do you change the treatment prescribed?’ using again a yes/no format.

**Statistical analysis**

Descriptive analysis was used for the probability of vertebral fractures before and after VFA data, and the proportion of patients for whom the prescriptions of spine radiographs and treatments were changed after VFA results. Wilcoxon’s test was used to compare the absolute difference in probabilities of fractures with 0. An extension of the McNemar test for clustered data was used to compare the proportions of prescription for spine radiographs, before and after VFA assessment, respectively [22]. This test was used in order to take into account the cluster created by rheumatologists. All tests were two-tailed, with $P<0.05$ considered statistically significant. All statistical analyses were performed using SAS version 9.1 (SAS Institute, Inc., Cary, NC, USA). The SAS macro CLUSTPRO was used for the McNemar test for clustered data (Lieber ML and Ashley C, Cleveland Clinic Foundation, Cleveland, OH, USA). The number of clinical vignettes was estimated to be 120, in order to expect a 20% change in prescription of spine radiographs with a precision of 7.2%.

**Results**

Twenty-nine rheumatologists participated in the study, and 117 clinical vignettes were available. The characteristics of the population are presented in Table 1. Based on T-scores, 52 patients had osteoporosis and 65 had osteopenia. Out of the 117 included women, 15 (12.8%) had spine radiographs available (performed >1 year before inclusion) and 13 (11%) had prevalent vertebral fractures. In all, 71 (60.7%) women had a history of prior or current anti-osteoporotic treatment including HRT (35.9%), bisphosphonates (23.1%) and raloxifene (5.1%).

**Before VFA assessment**

Based on clinical, BMD and T-score data, the estimated mean probability of existing vertebral fracture was 47.4 (29.5%) (median 40, minimum 10, maximum 100). Rheumatologists intended to prescribe spine radiographs in 73 (62.4%) patients, calcium and vitamin D in 60 (51.3%) patients and a bisphosphonate, raloxifene, teriparatide and HRT in 27 (23.1%), 9 (7.7%), 1 (0.8%) and 1 (0.8%) patients, respectively.

**After VFA assessment**

For the whole population, the mean probability of vertebral fracture was estimated to be 46.2 (36.7%) (median 30, minimum 10, maximum 100). However, the mean absolute difference between the two probabilities (before–after VFA for each vignette) was 22.6 (21.7%) (median 20%) ($P<10^{-8}$). The difference was greater or equal to 10, 20, 30, 40, and 50% in 77.8, 51.3, 35.9, 26.5 and 16.2% of patients, respectively.

Rheumatologists intended to prescribe spine radiographs in 54 (46.2%) patients (compared with 62.4% before VFA assessment: $P=0.0206$), and they answered ‘yes’ to the question on therapeutic change for 36 (30.8%) patients. VFA did not change intentions to prescribe spine radiographs in 74 patients (32 without, and 42 with a prescription). In contrast, a *de novo* prescription of radiographs was stated in 12 patients, and the prescription was deleted in 31 patients, i.e. a change in 43 patients (36.8%, 95% CI 28.1, 45.1%).

The same analyses were conducted in osteoporotic patients (defined by having at least a T-score less than or equal to −2.5, $n=52$) and non-osteoporotic patients ($n=65$), patients aged ≥65 ($n=47$) and younger ($n=70$).

### Table 1 Characteristics of patients

<table>
<thead>
<tr>
<th></th>
<th>Mean (s.d.)</th>
<th>Range</th>
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<tbody>
<tr>
<td>Age, years</td>
<td>65.1 (10.1)</td>
<td>57–94</td>
</tr>
<tr>
<td>Height, cm</td>
<td>157.6 (6.7)</td>
<td>142–173</td>
</tr>
<tr>
<td>Estimated height at age 20 years</td>
<td>160.6 (5.9)</td>
<td>156–175</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>60.4 (11.4)</td>
<td>53–91</td>
</tr>
<tr>
<td>Years since menopause</td>
<td>17.3 (12.8)</td>
<td>1–55</td>
</tr>
<tr>
<td>Lumbar spine T-score</td>
<td>−1.89 (1.43)</td>
<td>−4.70–3.40</td>
</tr>
<tr>
<td>Hip T-score</td>
<td>−1.64 (0.92)</td>
<td>−3.60–0.80</td>
</tr>
<tr>
<td>Femoral neck T-score</td>
<td>−1.89 (0.88)</td>
<td>−4.00–0.60</td>
</tr>
<tr>
<td>Personal history of fracture, %</td>
<td>36.7</td>
<td></td>
</tr>
<tr>
<td>Familial history of fracture, %</td>
<td>27.3</td>
<td></td>
</tr>
<tr>
<td>Back pain, %</td>
<td>37.6</td>
<td></td>
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<tr>
<td>Thoracic spine pain, %</td>
<td>12.0</td>
<td></td>
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<tr>
<td>Lumbar spine pain, %</td>
<td>38.5</td>
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The proportion of intention to prescribe X-rays decreased from 78.8 to 50.0% (\(P = 0.0063\)) in osteoporotic patients and did not change in non-osteoporotic patients (49.2 to 43.1%, \(P = 0.42\)). These intentions of prescription decreased in both patients aged >65 years (from 72.3 to 55.3%, \(P = 0.036\)) and in younger patients (from 55.7 to 40.0%, \(P = 0.068\)).

**Discussion**

This study shows that VFA results influence patient management, inducing changes in prescription of spine radiographs in 36% of patients, and changes in treatment in 31%. The difficulties of making a diagnosis of vertebral fracture are well documented [23–25]. Back pain is very common and spine X-rays are often not performed in patients with such symptoms. Vertebral fracture may occur without pain, or with pain of insufficient magnitude to arouse the concern of the physician. Moreover, as the fracture may occur without recognizable trauma, symptoms are commonly related to degenerative changes of the spine. Height loss may help to recognize patients with structural damage of the spine, but height measurement is not performed routinely in adults by physicians; moreover, the main cause of height loss in post-menopausal women is degenerative changes in intervertebral discs. Even vertebral fractures detected on radiographs may not be reported by radiologists, especially when the radiographs are not performed in the context of osteoporosis diagnosis: in a review of chest radiographs done on women >65 years for diverse medical reasons, only one out of four visible vertebral fractures was listed in the conclusions of the radiological reports [24]. In a cross-sectional study of 824 post-menopausal women with osteoporosis, we observed an unexpectedly high level of discrepancies among specialists [23]; the explanation was that the presence of at least one vertebral fracture was considered enough for diagnosis, and that a full-spine assessment was not systematically performed, although the number of fractures must be considered in an appropriate estimate of risk [15]. Thus, a safe and quickly performed diagnostic test would be useful to improve the identification and care of patients with vertebral fractures.

The gold standard for vertebral fracture diagnosis is the spine radiograph. However, radiation and costs are limiting factors for the systematic use of radiographs in the general population of post-menopausal women. The prevalence of vertebral fracture is high, increasing from 6 to 10% in patients in their fifties up to 30% in their eighties [26, 27]. It is now recognized that vertebral fractures can be found in a large proportion of patients with risk factors for osteoporosis, but with a T-score higher than –2.5 [28, 29], i.e. in patients for whom physicians would be reluctant to prescribe radiographs. VFA has reduced sensitivity compared with radiographs because of problems of visualization of the upper thoracic spine vertebrae, and because of difficulties in assessing mild vertebral fractures (i.e. a decrease in at least one vertebral body height of 20–25%), which are a risk factor for incident vertebral fractures in osteoporotic women [14]. However, performance of VFA is good enough to detect prevalent and incident [30] fractures in most patients and recommendations have been published regarding subjects who should have VFA [31]. As it can be done at the same visit as for BMD measurement, it is very convenient and may have large indications. The efficiency of VFA in detecting women with vertebral fractures has been shown previously, and VFA can be used routinely according to BMD [32, 33]. How this procedure can change patient management has not been evaluated so far. Our study shows that rheumatologists change their opinion about spine radiographs and treatment prescriptions on the basis of VFA data. An intriguing observation is that the proportion of intention to prescribe X-rays did not change in non-osteoporotic patients, which may indicate that the rheumatologist’s decision is based mainly on BMD. If the clinical and BMD data had been the determinants of the spine radiographs prescription, 31 (26.5%) patients would have had unnecessary irradiation. This also suggests that this procedure is cost saving.

Our study has strengths and limitations. It is the first study assessing the utility of VFA in a naturalistic setting, on clinical vignettes generated from real patients. The validity of clinical vignettes in assessing physicians’ practice performance could be debated. However, a substantial body of research supports the use of the clinical vignette method and its validity in measuring clinician’s performance [34, 35]. The rheumatologists involved were experienced in VFA assessment and bone diseases, and results cannot be applied directly to less-experienced physicians or general practitioners. Moreover, we selected the devices using optimal VFA technology. As rheumatologists selected the cases, patients with illegible spine were not studied. Moreover, we assessed the changes in management, but we did not estimate whether these changes were correct and appropriate as we did not confirm vertebral fracture diagnosis by radiographs or central reading. Finally, vignettes were based on data from patients with indications for BMD measurement, and this cannot apply to the general population. Recognition of vertebral fractures changes estimation of fracture risk and the threshold for pharmacological intervention, independently of BMD. VFA can reliably diagnose these fractures and, according to rheumatologists’ opinions, VFA results induce a change in the management of patients.

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**Rheumatology key message**

- VFA results influence rheumatologists’ prescriptions for X-ray imaging.

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References
