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Original Article

Opportunistic Identification of Vertebral Fractures

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Abstract

Vertebral fractures are powerful predictors of future fracture, so, their identification is important to ensure that patients are commenced on appropriate bone protective or bone-enhancing therapy. Risk factors (e.g., low bone mineral density and increasing age) and symptoms (back pain, loss of height) may herald the presence of vertebral fractures, which are usually confirmed by performing spinal radiographs or, increasingly, using vertebral fracture assessment with dual-energy X-ray absorptiometry scanners. However, a large number (30% or more) of vertebral fractures are asymptomatic and do not come to clinical attention. There is, therefore, scope for opportunistic (fortuitous) identification of vertebral fractures from various imaging modalities (radiographs, computed tomography, magnetic resonance imaging, and radionuclide scans) performed for other clinical indications and which include the spine in the field of view, with midline sagittal reformatted images from computed tomography having the greatest potential for such opportunistic detection. Numerous studies confirm this potential for identification but consistently find underreporting of vertebral fractures. So, a valuable opportunity to improve the management of patients at increased risk of future fracture is being squandered. Educational training programs for all clinicians and constant reiteration, stressing the importance of the accurate and clear reporting of vertebral fractures ("you only see what you look for"), can improve the situation, and automated computer-aided diagnostic tools also show promise to solve the problem of this underreporting of vertebral fractures.

Key Words: Computed tomography; DXA vertebral fracture assessment; Magnetic resonance imaging; Opportunistic identification; Vertebral fracture.

Introduction

Vertebral fractures are the most common osteoporotic fractures and occur at an earlier age than other such fractures in the humerus and hip *(1)*. They are powerful predictors of future fracture; if a vertebral fracture is present after the age of 50 yr, the patient is at 5 times the risk of a future vertebral fracture and double the risk of a hip fracture *(2–4)*. There are now effective bone protective and bone-enhancing therapies, which for quite modest increases in bone mineral density (BMD) of 4%–12% reduce future vertebral fracture risk by between 30% and 70% *(5,6)*. Identification of vertebral fractures is therefore relevant to the appropriate management of patients with osteoporosis and so at risk of further low trauma insufficiency fractures, which are associated with significant reduction in quality of life, morbidity, and mortality *(7)*. Vertebral fractures are also relevant to the calculation of the World Health Organization 10-yr fracture risk assessment tool (http://www.shef.ac.uk/FRAX/; *8)*. In addition, vertebral fractures may be asymptomatic in 30% or more of subjects *(9)*, depending on the method used to define vertebral fracture, so, imaging techniques provide the opportunity to identify the presence of vertebral fractures incidentally (fortuitously, opportunistically) when images are being performed for other and various clinical indications. These imaging methods include radiographs (lateral chest, abdominal, barium studies, intravenous urography), dual-energy X-ray absorptiometry (DXA) and subsequent vertebral fracture assessment (VFA), computed

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tomography (CT; to include lateral scout views and particularly midline sagittal reformations (SR), which involve no additional scanning or ionizing radiation exposure of the patient), magnetic resonance imaging (MRI; localizer views and direct sagittal images), and radionuclide scans (RNS; both bone and positron emission tomography CT scans). There is considerable evidence in the literature that there is underreporting by radiologists generally *(10,11)*, as well as missing such opportunistic identification of vertebral fractures from this variety of imaging techniques *(12−14)*. This stimulated the vertebral fracture initiatives of the International Osteoporosis Foundation, initially in collaboration with the European Society of Skeletal Radiology in 2002, and subsequently updated in 2010 to include a new section on DXA VFA. An educational resource based on this initiative is available at: http://www.iofbonehealth.org/vertebral-fracture-teaching-program and includes slides, which can be downloaded for those who wish to ''spread the gospel'' of the importance to patients of the accurate identification and clear reporting of the presence of vertebral fractures *(15)*.

The clear and accurate reporting of vertebral fractures is essential. The most widely used method in the assessment and grading of vertebral fractures advocated in clinical reporting is the semiquantitative (SQ) method *(16)* in which changes in vertebral shape are judged subjectively, rather than using objective 6-point morphometry measurements *(17)*. In the SQ method, 4 grades are differentiated: grade 0 = no fracture; grade 1 = mild fracture (reduction in vertebral height 20%−25%, compared to adjacent normal vertebrae); grade 2 = moderate fracture (reduction in height 26%−40%); and grade 3 = severe fracture (reduction in height more than 40%) with shape defined as predominantly wedge, end plate, or crush, but these shape abnormalities may be combined. The authors also stressed the importance of ''aside from morphometric features, most vertebral fractures are readily distinguished by the presence of end plate deformities and buckling of the cortices, by the lack of parallelism of end plates, and by the loss of vertical continuity of vertebral morphology''. They advocated ''the use of a combined approach incorporating both visual and morphometric methods'' in defining vertebral fractures in drug trials in osteoporosis. Consequently, when defining vertebral fractures in clinical practice scrutiny of the vertebral end plate, as stressed by the algorithm-based qualitative method *(18)*, in addition to describing morphometric change in shape of the vertebral body, is essential to differentiate vertebral fractures from deformities, which may be caused by developmental short vertebral height and cupid's bow deformity, Scheuermann disease, and spondylotic modeling *(19)*. In a radiology report, it would improve clarity if vertebrae were regarded only as ''normal,'' ''deformed,'' or ''fractured,'' and if for the latter the grading be given, as the higher the grade and the more vertebral fractures that are present the higher the risk of future fracture. If the vertebral fractures are considered to be osteoporotic in etiology, it would also be useful to add that the appearances are those of ''clinical spinal osteoporosis,'' irrespective of what the lumbar spine DXA BMD might be, as this alerts the referring clinician to consider appropriate management strategies. DXA bone densitometry should be suggested and performed if the results will influence management. Low BMD is a risk factor for prevalent and incident vertebral fractures *(20)*, but in a considerable number of patients with vertebral fracture, BMD may not be reduced. The terms such as ''collapse,'' ''loss of height,'' and ''wedging'' should be avoided as they do not convey to the referring clinician the significance and relevance of the features, in whatever imaging technique is being reviewed for the presence of vertebral fractures.

Imaging Techniques

Radiographs

Spinal radiographs, and increasingly DXA VFA, are the most widely used methods for specific imaging of clinically suspected vertebral fractures. However, the spine is included in radiographs performed for other clinical reasons. Examples include abdominal radiographs (Fig. 1A), barium studies, and intravenous urograms. The images should be scrutinized for vertebral fractures and if they are present, they should be clearly reported and anterior/posterior (AP) and lateral thoracic and lumbar spinal radiographs should be advocated to confirm their presence and grade of severity (Fig. 1B). However, it is lateral chest radiographs that have been most studied for the presence of vertebral fractures and found to be underreported *(10,21−23*; Fig. 1C). In a study of 934 women aged 60 yr and older and in whom a lateral chest radiograph had been performed, these were reviewed for the presence of vertebral fractures *(10)*. Moderate or severe vertebral fractures were present in 132 (14.1%) subjects. Of these, only 50% were stated to be fractures in the radiology report and 23% in the summary, 17% had the fracture noted in the medical record or discharge summary, and in only 18% was appropriate treatment prescribed. The study indicated a need for improving recognition of opportunistic vertebral fracture identification on such imaging *(10)*. Another study examined 10,291 women who had lateral chest radiographs and in whom 142 (1.4%) had vertebral fractures reported *(22)*. However, in only 58 (41%) did the presence of a vertebral fracture appear in the final conclusion, in only 23 (16%) was the presence of a vertebral fracture documented in the discharge summary, and only 36% of the patients were using any osteoporosis medications at discharge. The authors concluded that vertebral fractures from lateral chest radiographs represented a missed opportunity for osteoporosis management *(22)*. In a smaller number of women (106) of various ethnicities with a mean age of 65 (range 55−89) yr, the lateral chest radiographs were reviewed with a 1−2-yr follow-up *(23)*. Twenty-six of 106 patients (25%) had vertebral fractures; the fracture prevalence increased with age (in 17 of 54 [13%] women under the age of 65 yr; in 19 of 52 [37%] women older than 65 yr), and 3 of 16 (19%) developed interval fractures. In only 4 of 26 (15%) patients was the fracture included in the report; and although 31 of 106 (29%) were scheduled for bone densitometry, this was performed in only 6 of 106 (6%)