HOLOGIC®

Vertebral Fracture Assessment

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The current generation of Hologic DXA scanners support low dose single and dual energy x-ray imaging of the AP and lateral spine to allow detection of vertebral fractures, including those that were not recognized clinically at the time of their occurrence. Originally implemented on Hologic fan beam densitometers as the HD Instant Vertebral Fracture™ assessment (IVA HD), in 2006 the International Society of Clinical Densitometry (ISCD) recommended that the term "Vertebral Fracture Assessment" (VFA) be used to refer to this imaging modality.[1]

Vertebral fractures have long been recognized as a cardinal sign of systemic skeletal fragility and predictor of subsequent vertebral and non-vertebral osteoporotic fractures, even after accounting for age and bone mineral density (BMD).[2-5] Recent US population-based data using the US National Health Nutrition Examination and Survey (NHANES) showed the prevalence of vertebral fractures rises sharply with increasing age from 2.1% among those age 40 to 49 to 18.0% among those age 80 and older, with the prevalence for men and women within each age group being nearly the same.[6] However, other studies suggest that the age-adjusted prevalence of vertebral fractures may be higher in older women compared to older men.[5,7-9]

Both the National Osteoporosis Foundation (NOF)[10] and the ISCD[11] have established guidelines for VFA to identify patients with a prevalent vertebral fracture. Over the last 20 years, the scientific evidence supporting use of VFA at the point of care of bone densitometry to identify those with this important fracture risk factor has been well established. First, numerous studies have shown that patients with prevalent vertebral fractures (especially those that are moderate or severe) can be identified accurately on VFA images compared to standard radiography.[12-14] Second, NOF and ISCD guidelines on VFA select a population for imaging with a reasonable probability of a prevalent vertebral fracture. Studies have shown by following NOF or ISCD guidelines, clinicians can capture at least half of those in the overall population who have a prevalent vertebral fracture.[8,10,15,16] Third, cohort studies have shown that those who have a vertebral fracture specifically identified on VFA are at higher risk of: subsequent vertebral,[17,18] hip,[17,19] major osteoporotic,[17] non-vertebral,[17] all clinical fractures,[19] and fracture hospitalizations,[18] even after accounting for BMD, age, and other risk factors.

VFA has several significant advantages compared to standard radiographs. First, VFA exposes patients to only 1/50th of the radiation exposure of standard thoracic and lumbar spine radiographs. Second, the fan beam technology allows visualization of vertebrae with less parallax than standard cone-beam radiography. A disadvantage of VFA is that it can be more difficult to visualize vertebral fractures superior to T7 because of the lower spatial resolution of VFA compared to standard radiography. However, this disadvantage is mitigated by the fact that osteoporotic vertebral fractures occur primarily in the skeletal region of T10 to L2, and that vertebral fractures above T7 are uncommon.[20,21]

The third and perhaps most important advantage of VFA is that it can be seamlessly and cost-effectively[22] incorporated into standard bone densitometry screening routines with minimal additional time and expense. By following NOF and ISCD guidelines, bone density technologists have demonstrated the ability to accurately identify those who meet the criteria to have a VFA as part of their bone density test,[23,24] sparing the physician ordering the bone density test the need to determine *a priori* if a VFA should be performed. Non-radiologist physicians can easily be trained in a half day course (available through both the International Osteoporosis Foundation (IOF) and the ISCD) to accurately read VFA images in a manner similar to radiologists. When criteria very similar to the NOF or ISCD guidelines are applied, studies across four different health care delivery organizations in the US and Canada showed that about 20% of those who have a bone density test will meet the criteria for a VFA and will have the procedure done within the context of actual clinical practice.[17,24] Among these, the prevalence of vertebral fracture has been shown to be in the range of 13% to 21% at these institutions.

In addition, identifying a prevalent vertebral fracture on VFA in clinical practice has been shown to increase appropriate prescription of fracture prevention medication by physicians and use of such medication by patients.[23] The influence of VFA on medication use behavior is particularly impactful among those who have BMD in the osteopenic range, or who have a FRAX® estimated risk of fracture (before vertebral fracture status is known) less than 20%.[23] Even among patients who have osteoporosis by BMD criteria, identification of prevalent vertebral fractures may increase patients' perceived need for fracture prevention medication.[23] Hence, VFA can play a significant role in closing the osteoporosis treatment gap by identifying those at high risk of fracture and motivating patient compliance with medication.[23]

Use of VFA to identify abdominal aortic calcification

Abdominal aortic calcification (AAC) identified on lateral spine x-rays is an indicator of systemic atherosclerosis, and has been shown in the Framingham and Rotterdam studies to be associated with subsequent cardiovascular disease events such as: coronary heart disease,[25] myocardial infarction,[26] stroke,[27,28] congestive heart failure,[29] symptomatic peripheral vascular disease,[28] and cardiovascular disease mortality,[25] even after accounting for clinical cardiovascular disease risk factors and/or Framingham Heart Score. AAC can be accurately scored on the HD Instant Vertebral Fracture™ assessment from Hologic,[30-34] and several studies have shown that AAC scored on these images also predict: incident myocardial infarction and/or stroke,[35,36] incident cardiovascular disease events,[37,38] hospitalizations for cardiovascular disease,[37] and all-cause mortality.[37]

AAC has also been shown to be a risk factor in most[39-43] (but not all)[44,45] studies for hip and non-spine fractures for the subsequent five years after its identification, even after accounting for other fracture risk factors such as age, BMD, and previous fractures. Further studies are planned to better define the association of AAC on VFA images and fracture outcomes.[46]

While routine use of VFA imaging for cardiovascular disease risk assessment cannot be recommended at this time, there is significant potential to identify individuals with asymptomatic atherosclerosis on the HD Instant Vertebral Fracture™ assessment whose high risk for incident cardiovascular disease might otherwise not be recognized.[47] Further studies are needed on the impact of a high level of AAC identified on the HD Instant Vertebral Fracture™ assessment. Such studies should assess how AAC may impact cardiovascular disease risk management by health care providers, their patients, and the subsequent impact on cardiovascular disease outcomes. However, today it is possible to opportunistically identify those with a high level of AAC on the HD Instant Vertebral Fracture™ assessment, thus indicating a higher risk of incident cardiovascular disease and hip fracture.

Summary

VFA imaging at the time of a bone density test is a convenient and efficient way of identifying patients with one or more prevalent vertebral fractures. This aids in identifying those at high risk of subsequent fracture and for whom fracture prevention therapies are indicated. Interpreting these images for vertebral fracture is easy to learn through the Vertebral Fracture Recognition courses of the ISCD and IOF. The HD Instant Vertebral Fracture™ assessment can also be used to identify those with a high level of AAC who are at high risk for cardiovascular disease events.

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