Topics to be covered:
- What is vertebral fracture assessment?
- How does VFA compare to standard lateral spine radiography?
- Who should have VFA testing?
- How should VFA images be obtained?
- How should VFA images be interpreted?
- Incorporating VFA results into fracture risk assessment
- Characteristics of good VFA reports
- Illustrative cases

Relevant reference:

Relevant reference:
How does VFA compare?

- Not only are prevalent vertebral and non-vertebral fractures a strong risk factor for incident vertebral fractures independent of BMD, but their presence may alter the association between bone mineral density and incident vertebral fractures.

**Relevant reference:**
- Siris et al. (2007) Enhanced prediction of fracture risk combining vertebral fracture status and BMD. Osteoporos Int 18: 761-770

- While VFA has definite practical advantages (point of service location, lower radiation exposure and lower cost) the radiograph remains the gold standard for detection of vertebral fractures.
- Image quality and resolution are superior with the radiograph, particularly at the upper thoracic regions (above T6 or T7) where the VFA image can suffer from interference by ribs, scapula and soft tissues. However, since the majority of vertebral fractures occur in the lower regions, VFA is useful for detection of most fractures.
- VFA provides a single image of both thoracic and lumbar spine and does not suffer from parallax distortion which may complicate interpretation of the lumbar spine radiographs.

- Lower resolution of VFA makes it harder to recognize vertebral deformities that are not fractures.
- Also, VFA has poor visualization above T7. But remember – most fractures at T7 or below and 97% vertebra at T7 and below are evaluable.

**Relevant references:**

This slide shows the presence of a grade 3 crush fracture of T12 on both VFA and standard radiography.
- Note how the vertebral endplates and cortices are sharper on the standard radiographs compared to the VFA image.
- VFA is very accurate at identifying SQ grade 2 and grade 3 fractures, but is much less accurate at identifying SQ grade 1 fractures.

**Relevant reference:**

- These studies may underestimate the performance of VFA with the latest technologies compared to standard.
- Manufacturers of densitometers have changed their technologies to improve image quality and VFA technology.

**Relevant references:**

- This study shows the improvement in VFA image quality with a newer compared to an older scanner.

**Relevant reference:**

- This shows the maintenance or improvement in image quality with a newer system with faster image acquisition time.
Indications for VFA

Slide 22

ISCD recommended indications for VFA are those for which there is evidence that the pre-test probability of one or more prevalent vertebral fractures being present is 10% or higher.

Slide 23

This shows data from the largest study done to date on risk factors that influence the pre-test probability of one or more prevalent vertebral fractures being present.

Relevant reference:

Slide 24, 25, 26, 27

Since VFA is done at the point of service of a bone density test, the indications are tethered to some degree by category of BMD.

The first set of criteria is for those who do not have osteoporosis by bone density criteria, where documenting a vertebral fracture likely will provide an indication for pharmacologic fracture prevention therapy.

By the same rationale, VFA is indicated for osteopenic women with two or more of the following criteria: Age 60-69, historical height loss of 2-4cm, self-reported prior non-vertebral fracture or chronic systemic diseases with increased risk of vertebral fractures.

VFA is indicated for osteopenic men age 80 or older, with historical height loss > 6 cm, prospective height loss > 3 cm, or men with a self-reported history of vertebral fracture.

By the same rationale, VFA is indicated in osteopenic men with two or more of the following criteria: age 70-79, historical height loss of 3-6 cm, self-reported prior non-vertebral fracture, chronic systemic diseases with increased risk of vertebral fractures or on pharmacologic androgen deprivation therapy or following orchietomy.

All indications for VFA are available from the ISCD website.

Relevant reference:
- 2007 ISCD Official Positions
In the case of those who have osteoporosis by BMD criteria, it becomes harder to delineate those situations where documentation of a prevalence deformity will influence therapy. The following scenarios were rated as situations where a VFA would be indicated in those with osteoporosis by BMD criteria.

**Relevant reference:**
- 2007 ISCD Official Positions

If recent and adequate spine imaging has been done, VFA will add no new information that could affect patient management.

**Relevant reference:**
- 2007 ISCD Official Positions

Reverse lateral positioning can sometimes improve the visualisation of fractures for assessment. Note: AP spine imaging is not essential for vertebral fracture assessment but can aid identification and labelling of vertebra, can aid evaluation of scoliosis severity if present and/or can aid detection of lateral cortex / endplate compression fractures.

**Relevant reference:**

Advantages of Genant semi-quantitative criteria:
- Excellent inter-rater and intra-rater reliability
- Concurrent validity (SQ vertebral fractures are associated with low BMD)
- Predictive validity (SQ vertebral fractures predict incident fractures independent of BMD)
- Easy to implement in clinical practice
- May be more accurate than clinical morphometry

**Relevant reference:**
- Obviously, not all vertebral bodies are able to be adequately visualized to allow interpretation.
- Evaluable vertebral bodies are either normal or abnormal.
- Equivocal fractures are typically grade 1 and commonly confused with normal variations of vertebral shape characteristically observed as anterior wedging in the thoracic spine.
- Remember that there is no universal agreement for radiological or densitometric diagnosis of vertebral fractures – refer to ISCD official position for current recommendations for VFA.

Relevant reference:
- 2007 ISCD Official Positions

- Endplate depression is central to definition of a vertebral fracture
- ABQ is a qualitative method developed to avoid labeling vertebral bodies with short vertebral height as fractured
- Reliable, reproducible on both standard radiographs and VFA images
- Predictive validity (eg prospective fracture prediction) has yet to be demonstrated and compared to the SQ method

Relevant reference:

- Although it is difficult to visualize T4-T6 on VFA, this is not a common site for isolated fractures.
- Note bimodal distribution of prevalent fractures with highest incidence at thoraco-lumbar junction (T11-L2), but also a significant peak at T7-T9.

Relevant reference:

- Note these are incident fractures – minimizes false positives from anatomical or congenital variants.

Relevant reference:
- It is important to recognize normal morphology of vertebra.
- Note that lumbar vertebrae have a slightly biconcave shape, thoracic vertebrae slightly wedged. Therefore, caution is required interpreting mid-thoracic vertebrae with a slightly wedged shape, and interpreting lumbar vertebrae with a slightly biconcave shape.

- It is important to remember that not all vertebral deformities represent vertebral compression fractures.
- Paget’s disease often causes bony enlargement.
- Malignancy and multiple myeloma often cause a pancake deformity. It is important to especially consider these possibilities with vertebral fracture and normal BMD.
- There remains controversy as to whether or not vertebrae with short anterior height without any endplate depression or cortical break (such as buckling of the anterior cortex) are truly fractured.

- This slide shows how degenerative remodeling without fracture can result in both wedging (with short anterior vertebral height) and elongation.
- It is always helpful to compare adjacent vertebra – not the uniformity of the elongation seen at multiple contiguous levels.

- Another cause of “abnormal” vertebrae is Schmorl's nodes, usually a developmental abnormality but can be seen in situations of endplate weakness including hyperparathyroidism, infection, neoplasms and trauma. Additionally, these nucleus pulposis herniations are common in adolescent males, especially those who participate in contact sports.
- May be associated with vertebral “wedging,” sclerosis of the vertebral margins and the formation of a “limbus vertebra.”
- Often associated with Scheuermann’s disease.
- This statement is obvious, but worthy of emphasis for those of us who focus on osteoporosis diagnosis and treatment.
- Note that there is also an upper T-spine fracture which could be metastatic or osteoporotic.
- Note T6 difficult to assess on VFA but clearly fractured on X-ray.