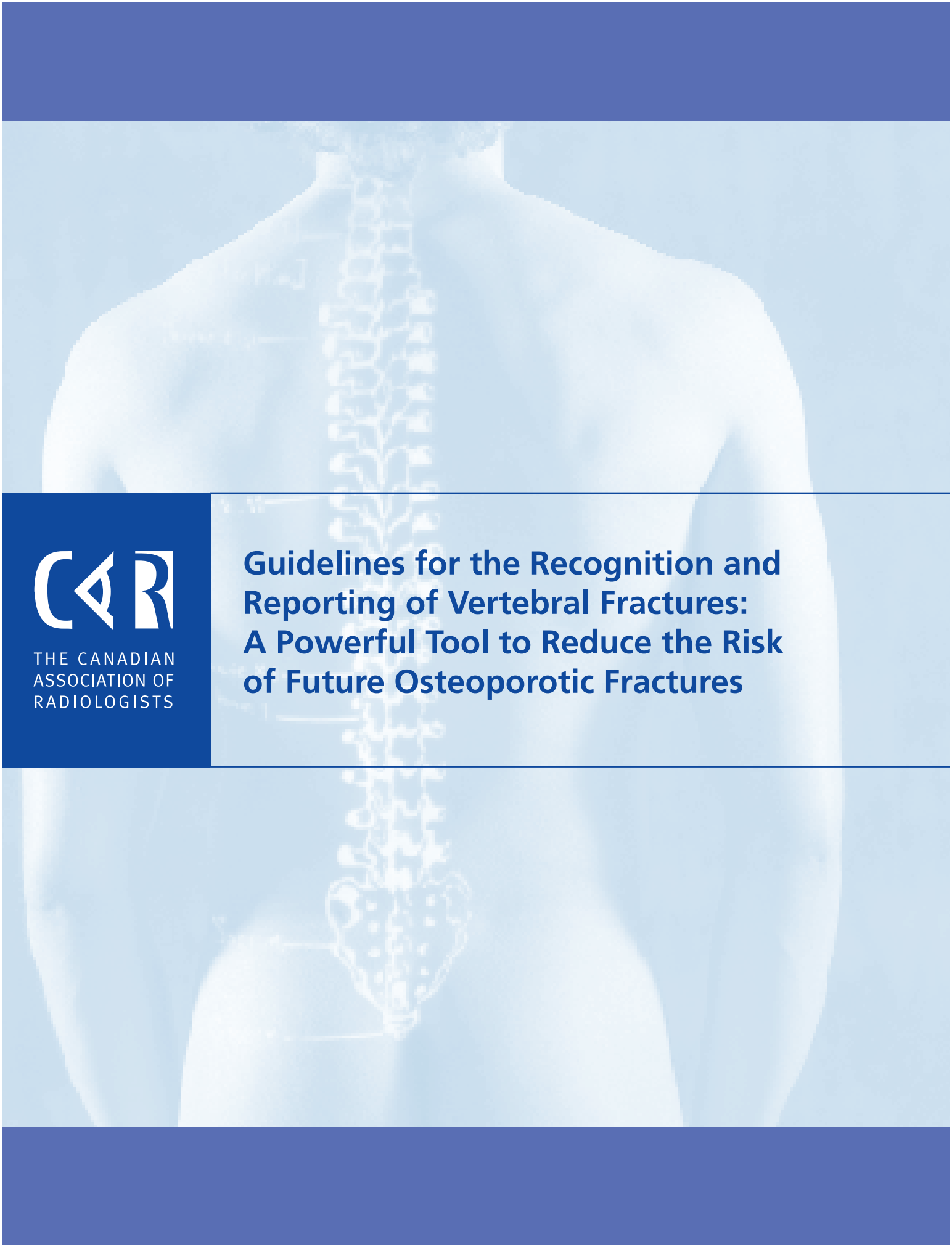

THE CANADIAN ASSOCIATION OF RADIOLOGISTS

Guidelines for the Recognition and Reporting of Vertebral Fractures: A Powerful Tool to Reduce the Risk of Future Osteoporotic Fractures

Guidelines for the Recognition and Reporting of Vertebral Fractures: A Powerful Tool to Reduce the Risk of Future Osteoporotic Fractures

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Abbreviated title:

Guidelines for the Recognition and Reporting of Vertebral Fractures

Funding from the following companies in Canada facilitated the guideline development process: Eli Lilly, Merck Frosst, Procter and Gamble Pharmaceuticals and Sanofi-Aventis Pharma. None of the funding sources had a role in the development of these recommendations.

MeSH headings:

vertebral fracture, osteoporosis, vertebral deformity, compression fracture

Abstract:

Objective: Given the increasing evidence that vertebral fractures are under-diagnosed and not acted upon, Osteoporosis Canada and the Canadian Association of Radiologists initiated a project to develop and publish a set of recommendations to promote and facilitate the diagnosis and reporting of vertebral fractures.

Options: The recognition of spinal fracturing is not uniform. On the one hand, more than 65% of vertebral fractures cause no symptoms. On the other hand, it is apparent that there is inadequate recognition of vertebral fractures when the opportunity for diagnosis arises fortuitously. It is to the patient's benefit that radiologists report vertebral fractures evident on a chest or other radiograph, no matter how incidental to the immediate clinical indication for the examination.

Outcomes: The present recommendations can help to close the care gap in recognition and treatment of vertebral fractures, prevent future fractures and thus reduce the burden of osteoporosis-related morbidity and mortality, as well as fracture-related costs to the healthcare system.

Evidence: Several studies indicate that a care gap exists in regards to the diagnosis of vertebral fractures and the clinical response following vertebral fracture diagnosis. All recommendations presented here are based on consensus.

Values: These recommendations were developed by a multi-disciplinary working group under the auspices of the Scientific Advisory Council of Osteoporosis Canada and the Canadian Association of Radiologists.

Benefits, harm, and costs: Prevalent vertebral fractures have important clinical implications in terms of future fracture risk. The recognition and reporting of fractures incidental to radiological examinations done for other reasons has the potential to reduce health care costs by initiating further steps in osteoporosis diagnosis and appropriate therapy.

Recommendations:

a) Physicians should be aware of the importance of vertebral fracture diagnosis in assessing future osteoporotic fracture risk.

b) Vertebral fractures incidental to radiological examinations done for other reasons should be recognized and reported.

c) Vertebral fractures should be assessed from lateral spinal or chest radiographs according to the semi-quantitative method of Genant et al.

d) Grade II and grade III fractures as classified by this method should be given the greatest emphasis.

e) Semi-quantitative fracture recognition should include the recognition of changes such as loss of vertebral end-plate parallelism, cortical interruptions, etc., as well as quantitative changes in the anterior, midbody and posterior heights of vertebral bodies.

f) When spine radiographs are performed to assess the presence of vertebral fractures, AP examinations may assist in the initial evaluation. The standard follow-up need only consist of single lateral views of the thoracic and lumbar spine that include T4 to L4 vertebrae.

g) The radiographic technique described in this paper should be used, or a technique of comparable efficacy.

h) DXA examinations that include lateral spinal morphological assessments (Vertebral Fracture Assessment, or VFA) may contribute to fracture recognition and this technology should be monitored to determine if and when it can be regarded as effective.

i) Educational material about the clinical importance of vertebral fracture recognition as a potential indicator of future osteoporotic fracture risk with its associated morbidity and mortality should be directed to all physicians

Validation: Recommendations were based on consensus opinion.

Guidelines for the Recognition and Reporting of Vertebral Fractures: A Powerful Tool to Reduce the Risk of Future Osteoporotic Fractures

Introduction

The early detection of a vertebral fracture, which is the most common type of osteoporotic fracture, can lead to further investigation and appropriate therapy that decreases the risk of future fractures. Unfortunately these clinical markers of established osteoporosis often go undiagnosed.[1-6]

Although it is impractical, for reasons of cost and radiation exposure, to advocate widespread population radiographic screening, the benefit of utilizing chest radiographs done for other reasons as a tool for vertebral fracture assessment has been demonstrated.[2,3,7] No matter how incidental to the immediate clinical indication for the examination, it is to a patient's benefit that radiologists report vertebral fractures evident on chest or other radiographs. In appropriate situations, a report should also include recommendations for further evaluation (e.g. thoracic and lumbar spine radiographs) to guide clinicians.

Importance of Vertebral Fracture Reporting

There is an international growth of interest in vertebral fractures resulting from osteoporosis and their importance in future fracture risk estimation.[8-11] Incident or prevalent vertebral fractures are a major risk factor for further fracturing [8] and they are an indicator of excess morbidity and mortality.[9,10] It is also increasingly recognized that spinal fracturing is associated with a morbidity and mortality comparable to that of proximal femoral fracturing 5 years after the fracture[12] occurs. The early detection of a vertebral fracture can therefore lead to appropriate therapy that decreases the risk of future fractures.

Symbolic of the increased awareness of this issue is the creation of working groups in Europe and by the International Osteoporosis Foundation (IOF) to heighten interest in the diagnosis of vertebral fractures. The European Society of Musculoskeletal Radiology (ESSR) and the IOF have jointly produced an interactive educational CD to this end and have published their material on the IOF web site.[11] Moreover, Link et al have recently produced a guide to the radiological assessment of vertebral fractures.[13]

Impact of Vertebral Fractures

Both clinical and occult vertebral fractures are associated with important health consequences. Clinical vertebral fractures, which are those detected when patients present with back pain, account for about one-third of osteoporotic vertebral fractures.[2,14-16] The remaining fractures are occult, meaning that they do not cause severe pain and go undetected during subsequent medical evaluations unless these include radiography.

Direct effects of vertebral fracture include chronic back pain,[2,16-22] reduced range of motion,[17,21-22] slower gait,[8] and impaired pulmonary function.[23-24] This deterioration in physical function leads to impaired ability to perform activities of daily living ,[2,8,9,19-21] a higher likelihood of disability,[8,16,19,22] loss of independence,[8] social isolation,[20] and impaired quality of life.[18-20,25-26]

Vertebral deformities are associated with a markedly increased risk of additional fractures, including hip fracture,[1] and are associated with higher rates of death, with five year mortality rates following vertebral fracture being comparable to the five year mortality rates following a hip fracture.[12,27-29] Therefore, we have reason to promote heightened awareness of spinal fractures among physicians and health care providers who deal with affected patients but may not always appreciate the future implications of vertebral fractures.

Under-reporting of Vertebral Fractures

The recognition of spinal fracturing is not uniform since more than 65% of vertebral fractures cause no symptoms. At the same time, it is apparent that there is inadequate recognition of vertebral fractures when the opportunity for diagnosis arises fortuitously:

a) Gehlbach et al. looked at the thoracic spines of 934 women aged 60 or more having chest radiographs.[2] They found that 132 women had one or more spinal fractures when diagnosed using the semi-quantitative criteria of Genant.[30] However, only 65 cases (49% of 132 women with fractures) had been reported by the radiologist. Worse yet, in only 23 (17%) patients did the physicician enter the diagnosis into the medical record, and in only 25 (19%) patients was any treatment of the underlying osteoporosis initiated.

b) A similar Canadian study of emergency room radiographs reported the following findings: mean age of the population was 75 years, 47% were women, and 46% were admitted to the hospital.[31] According to the reference radiologist, prevalence of moderate to severe vertebral fractures (Genant grades II and III) was 22%. Simple agreement was 87-88% among radiograph reviewers; kappa values were moderate (0.56-0.58). The greatest agreement was between the reference standard radiologist and quantitative digital morphometry (89% agreement; kappa = 0.67). Only 55% (12/22) of vertebral fractures were mentioned in the official radiology reports.

c) The IMPACT study has recently led Delmas et al. to identify the underdiagnosis of vertebral fractures as a worldwide problem.[32] False negative rates of vertebral fracture reporting in women aged 65 to 80 were found to range from 29.5% to 46.2% in different parts of the world, using a central reading centre that employed the method of Genant to define fracture. False positives were not a significant issue, occurring in only 5%, likely reflecting inter-observer disagreement.

Lack of Subsequent Clinical Care

It is anticipated that clinicians including radiologists will recognize from these data the considerable opportunity afforded them to contribute to the management of their patients. This is particularly true since fractures have implications for preventing disease and disability.[33]

It is to the patient's benefit that radiologists report vertebral fractures evident on a chest and other radiographs, no matter how incidental to the immediate clinical indication for the examination. Furthermore, BMD testing should be considered if a vertebral fracture is found without the diagnosis of osteoporosis having already been confirmed. The clinician will, moreover, be helped by precise statements as to the grade of fracture and the segmental level or levels involved.[30]

Types of Radiological Examinations of the Spine

Radiographic examinations of the spine can be classified as:

- Plain radiographs – complete: These will usually amount to multiple views with orthogonal and sometimes oblique films. These are done to investigate symptoms such as back pain or after trauma. These may be done supine or erect, and it is often not appreciated that acute fracturing may only be evident on erect radiographs.
- Plain radiographs – limited: Single lateral views of the thoracic and lumbar spine done specifically to look for osteoporotic fracturing.
- Plain radiographs – incidental: The spine may be seen incidentally on a variety of radiographs undertaken for other purposes, e.g. lateral chest films.
- Vertebral Fracture Assessments (VFA) – T4 to L4: Usually lateral imaging, incidental to DXA. VFA examinations are variously described by the manufacturers as Instant Vertebral Assessment, IVA (Hologic) or Lateral Vertebral Assessment, LVA and Dual Energy Vertebral Assessment, DVA (Lunar). The International Society for Clinical Densitometry supports the use of the generic term Vertebral Fracture Assessment, VFA.[34] Such examinations provide lower resolution images of the spine which are, however, not subject to projection distortion since the x-ray beam is operated in scanning mode consistently orthogonal to the spine. However, the true value of such examinations remains to be established.
- Computerised Tomography (CT) of the spine: Done to clarify subtle or uncertain findings on radiographs. With the multiplanar imaging and image reconstruction techniques now available on modern CT scanners the presence of vertebral fractures can be easily assessed both on routine studies of the chest and abdomen as well as on dedicated studies of the thoracic and lumbar spine.
- Magnetic Resonance Imaging (MRI) of the spine: Done to examine soft tissues or clarify the acuteness of spinal fracturing since recent fractures have a characteristic signal pattern of signal loss on T1 images and signal enhancement on T2 images.
- Radionuclide bone scanning: Undertaken to look for disease activity or distribution and may be helpful in diagnosing such conditions as metastatic disease and acuteness of injury, for example.

Radiographic Protocol

Vertebral radiographs remain the best simple method for assessing the presence of vertebral fractures; there is currently no satisfactory alternative in the absence of localized pain to indicate the need to proceed to more sophisticated examinations such as CT or MRI.[5]

For the initial assessment of spinal osteoporotic fractures, both the anteroposterior (AP) and lateral projections of both the thoracic and lumbar spines are advised. For follow-up, only the lateral radiographs of the thoracic and lumbar spines are required, as these are the most effective in the detection of osteoporotic fractures.

On the initial exam, the AP view of the thoracic spine should demonstrate C7 to L1 levels and the AP of the lumbar spine should include T12 to S1. The AP radiographs allow for the identification of the correct vertebral levels, and also contribute to the detection of vertebral deformity and incidental findings that may mimic fracture when only a lateral image is available.

The lateral thoracic spine should clearly demonstrate T4 to L1 levels. Isolated osteoporotic fractures above the level of T4 are uncommon and even in patients with osteoporosis should raise the suspicion of another underlying disease process. A “spot-view” to demonstrate the upper thoracic spine is not required.

The lateral lumbar spine view should demonstrate T12 to S1. A coned view of L5/S1 is not required for the assessment of vertebral osteoporotic fracture.

A concerted effort must be made to avoid the common pitfalls that can limit interpretation of the spine films. Proper centering of the beam at T7 with a 100 cm tube-to-film distance will decrease distortion due to parallax. With the subject in the lateral position, the spine must be aligned as closely as possible to the horizontal plane of the table. Padding between the elbows, knees and even ankles can help avoid spinal rotation in the long axis.

Establishing a written protocol specifically for these specialized radiographic examinations will aid in quality assurance and will allow for reproducible images necessary for accurate comparisons on follow-up. (Please refer to the appendix for a checklist of the recommended technique for spinal radiographs.) (Insert Figures 2-6 showing Spinal radiographs - to come)

Vertebral Fracture Analysis

As recently reiterated, BMD measurements do not represent all of the determinants of bone strength.[35] With tools to assess bone quality, fracture risk assessment and follow-up could be much improved.

At present, osteoporosis may be diagnosed on the basis of bone density measurements or the existence of a low-trauma fracture. The history of such a fracture is today the nearest we can come to a simple measure of bone quality. As noted above, there is a growing realization of the importance of diagnosing asymptomatic vertebral fractures – most other fractures being more readily identified because they cause obvious symptoms. It was, therefore, a small step for the makers of some central x-ray based densitometers to add to their machines a capacity to image the relevant segments of the spine.

Such images have been variously styled but it has been suggested that a manufacturer-neutral description be used and "vertebral fracture assessment" (VFA) has been proposed as a generic description of DXA-based lateral spine images obtained from T4 to L4.[34,36] These images are obtained from fan-beam densitometers operated as supine lateral (cross-table) or lateral decubitus devices, depending upon the ability of the imaging C-arm to be rotated through 90 degrees. A low-photon flux is used (the radiation dose is only 2 – 8 microSv effective dose) and the images are printed on paper or examined on a monitor. Quality is modest although since the gantry that translates the beam is consistently orthogonal to the spine and the limited image quality is offset to some degree by the absence of the off-axis distortion (sometimes described as parallax) that is seen on conventional radiographs.[37]

The technique of VFA cannot at present be entirely endorsed. Some initial published data concerning the usefulness of this technology reported sensitivities comparable to conventional radiography for moderate to severe fractures.[36-39]

Original reports of sensitivity (when using plain radiographs as the reference examination) ranged in the literature from 54% to 92%, with specificity of 94.2% to 99%.[39] Sensitivities range from 90 to 94% for Genant grade II and III fractures. A recent report from the Technology Evaluation Center found the sensitivity to be only 60 – 70% using the same yardstick and suggested that the examination provides no added value over and above densitometry.[40] A further limitation of VFA is the inadequate assessment of vertebrae above T7 (only some 40% of T4 and 70% of T6 segments are assessable).[41-42] Another problem is inferior detection of mild fractures (Genant grade I), where sensitivity is less.[41-42]

Fracture Assessment

There is no consensus on the definition of vertebral fracture.[43] This is mainly due to a lack of evidentiary data in the form of longitudinal studies of vertebral morphology from youth to old age. The most widely accepted and used criteria are provided by the semi-quantitative method of Genant (Figure 1).[30] This method has been prospectively validated in the data from the pivotal trials of osteoporosis drug therapies. Its crucial elements are altered vertebral form with loss of parallelism of vertebral end plates, cortical breaks and interruptions and, usually, decreased vertebral height in the anterior, mid or posterior vertical dimension (Figures 2 – 9).

Semiquantitative Visual Grading of Vertebral

Deformities: Graphic Representation (Need to get permission)

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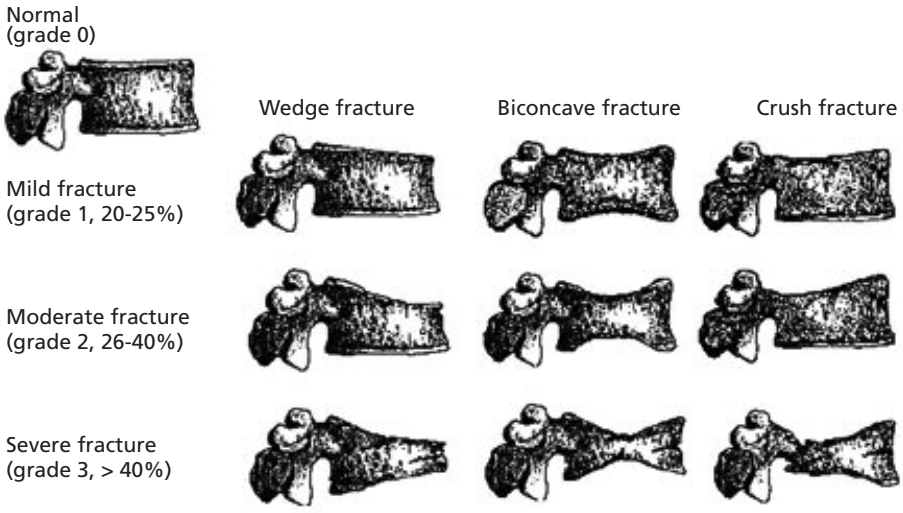

Sources: Am J Roentgenol© 2004 American Roentgen Ray Society

Difficulties in Diagnosis

It is an imperfect truism to state that "all vertebral fractures cause vertebral deformities but not all vertebral deformities are due to fracturing". There are a number of congenital and acquired deformities which are not fractural or in which the fracturing is not due to osteoporosis **(Table 1).**

TABLE 1:

Examples of Congenital and Acquired Deformities which are not Fractural or in which the fracturing is not due to Osteoporosis

Congenital causes of non-fractural vertebral deformities	■ ? Normal variation ■ Hemi-vertebra (Figure 11) ■ So-called notochordal or cupid-bow defects (L2 – 4) (Figure 12)
Acquired causes of non-fractural vertebral deformities	■ Old or traumatic fractures ■ Osteolytic metastases including bone marrow tumours such as multiple myeloma ■ Scheuermann's disease ■ Intervertebral disc disease including limbus vertebrae (Figure 10) ■ Schmorl's nodes
Spinal deformity associated with other diseases causing reduced bone density	■ Hemangioma ■ Lytic phase of Paget's disease of bone ■ Osteogenesis imperfecta ■ Gaucher's disease
Spurious appearances that may mislead	■ Lower pole of scapula projected over spine (Figure 13)

The CaMos study

The Canadian Multicentre Osteoporosis Study (CaMos) is a population-based study of osteoporosis in Canada.[44] CaMos has reported that the average vertebral fracture rates in Canadians over age 50 were 23.5% for women and 21.5% for men.[45] The prevalence rate in women rises from about 10% in the decade of 50 to 59 years old to 45% among those over age 80. In men, the prevalence is about 15% in the 50 to 59 year age range, increasing to 35% over age 80 years.[45]

It is important to note that most epidemiological studies, including CaMos, do not use the semi-quantitative method of defining vertebral fracture recommended by this committee. Instead, they use purely quantitative morphometry, usually automated or semi-automated protocols, and the designation of fracture is internally determined for each vertebrae by

comparison with normal vertebral shape within the study population.[45-48] Consequently, vertebral fracture prevalence rates determined by CaMos will differ from the rates that would be found using the semi-quantitative method. In women, for example, CaMos defines an anterior (wedge) compression fracture at T11 as having occurred only when the height ratio is reduced by 26%. Posterior (crush) fracturing requires only a 7% deformity for diagnosis. In contrast, the recommended semi-quantitative method in all cases defines a grade I fracture as a 20% change in height ratios along with changes in the vertebral contour. Comparative studies on the same population using the two approaches indicate that the purely quantitative morphometric approach approximately doubles the apparent fracture prevalence.[45,49-51]

Conclusion

There is a care gap in respect to osteoporotic vertebral fracturing as exemplified by the following:

a) More than 65% of spinal fractures do not cause recognizable symptoms and may be undiagnosed.
b) Fractures that might be diagnosed incidental to other examinations are often not reported by radiologists.
c) If recognized, fractures may not get adequately investigated.
d) If detected and investigated, the treatment may not be appropriate to the scale of future risk for the patient involved.

The early detection of vertebral fracture, which is the most common type of osteoporotic fracture, can lead to appropriate therapy that decreases the risk of future fractures.

Although it is not justifiable to advocate widespread screening by spinal radiography, the benefit of utilizing chest radiographs as a case-finding tool for vertebral fracture assessment has been demonstrated. No matter how incidental to the immediate clinical indication for the exam, it is to patients' benefit that radiologists report and clinicians act upon vertebral fractures evident on chest radiographs. In appropriate situations, the report should also include recommendations for further evaluation (e.g. thoracic and lumbar spine radiographs and DXA testing), which will promote action on the part of the clinician.

Endorsements

These recommendations were developed by a multidisciplinary working group under the auspices of the Scientific Advisory Council of Osteoporosis Canada and the Canadian Association of Radiologists.

They were reviewed and endorsed by the following organizations:

Canadian Association of Nuclear Medicine

Canadian Association of Radiologists Canadian College of Family Physicians

Canadian Orthopaedic Association

Canadian Panel of the International Society for Clinical Densitometry

Canadian Rheumatology Association

Canadian Society of Endocrinology and Metabolism Osteoporosis

Canada Society of Obstetricians and Gynaecologists of Canada

Acknowledgements

We gratefully acknowledge the contributions of Donna Spafford, Clinical Consultant, Osteoporosis Canada, Maria Kalivas, R.T., Technical Director, Canadian Association of Radiologists, and Elke Henneberg, Communications Message & More Inc.

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Appendix

Technique for Lateral Spinal Radiographs

Lateral thoracic spine (T2 or 3 to T12 inclusive)

- System: Bucky film-screen technique
- Focal spot: < 1.3 mm
- Total filtering: > 2.5 mm Al-equivalent (HVL)
- Grid: r = 12 to 1 at 100 cm
- Film-focus distance: 100 cm
- Peak voltage: 60 – 70 kVp
- Exposure: "Breathing technique", circa 2s
- Film size: 35 x 42 or 27 x 35 cm (14 x 17 or 11 x 14 inches)
- Central ray: T7 or 2.5 cm. Below the lower pole of the scapula when the arms are elevated
- Instruct patient to breathe quietly

Lateral lumbar spine (T12 to S1 inclusive)

- System: Bucky film-screen technique
- Focal spot: < 1.3 mm
- Total filtering: > 2.5 mm Al-equivalent (HVL)
- Grid: r = 12 to 1 at 100 cm
- Film-focus distance: 100 cm
- Peak voltage: 80 – 90 kVp
- Exposure: 1 s or using a central photocell
- Film size: 35 x 42 or 27 x 35 cm (14 x 17 or 11 x 14 inches)
- Central ray: L3 or approximately 2.5 cm above the iliac crest
- Instruct patient to hold breath

Note:

- The two films should provide a clear view of T4 through L4
- T12 should be visible on both films
- The left lateral position is preferred to reduce magnification distortion of the heart; legs flexed for comfort and support
- Patient's head supported by a pillow
- Place both arms at right angles to the trunk (if the arms are raised higher the scapulae may be projected over the thoracic vertebral bodies
- Elbows flexed for comfort
- Place supports between knees and ankles and under the knee nearest to the table both for support and as an aid in maintaining the true lateral position
- Place support under the mid-lumbar region to position the long-axis of the spine parallel to the table (check by palpation)
- Adjust collimation to minimize radiation exposure

Technique for Antero-Posterior (A-P) Spinal Radiographs

A-P thoracic spine (T2 to T12 inclusive)

- System: Bucky film-screen technique
- Focal spot: < 1.3 mm
- Total filtering: > 2.5 mm Al-equivalent (HVL)
- Grid: r = 12 to 1 at 100 cm
- Film-focus distance: 100 cm
- Peak voltage: 60 – 70 kVp
- Exposure: Central photocell
- Film size: 35 x 42 or 27 x 35 cm (14 x 17 or 11 x 14 inches)
- Central ray: T7
- Instruct patient to hold breath on inspiration

A-P lumbar spine (T12 to S1 inclusive)

- System: Bucky film-screen technique
- Focal spot: < 1.3 mm
- Total filtering: > 2.5 mm Al-equivalent (HVL)
- Grid: r = 12 to 1 at 100 cm
- Film-focus distance 100 cm
- Peak voltage 70 – 80 kVp
- Exposure: Central photocell
- Film size: 35 x 42 or 27 x 35 cm (14 x 17 or 11 x 14 inches)
- Central ray: L3 or approximately 2.5 cm above the iliac crest
- Instruct patient to hold breath on expiration
- Place patient on the examination table supine with the spine parallel to the plane of the table and along its long axis
- Place support under the patient's head and under the knees to maximize comfort.
- Adjust collimation to minimize radiation exposure to tissues lateral to the spine