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Spinal radiographs in those with back pain – when are they appropriate to diagnose vertebral fractures?

EM Clark¹, SR Cummings², JT Schousboe³

¹Musculoskeletal Research Unit, School of Clinical Sciences, University of Bristol, UK; ²California Pacific Medical Centre Research Institute, San Francisco, USA; ³Park Nicollet Osteoporosis Center and HealthPartners Institute, Minneapolis, MN, USA.

Corresponding author: Dr Emma Clark
Musculoskeletal Research Unit
University of Bristol
Learning & Research Building
Southmead Hospital
Bristol
BS10 5NB
Email: emma.clark@bristol.ac.uk
Telephone: +44 117 414 7841

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Abstract

The presence of an osteoporotic vertebral fracture improves fracture risk assessment and may change management, so it is vital for healthcare professionals to assess patients for the presence or absence of these fractures. This may be particularly important in the presence of back pain. However, the correlation between low back symptoms and spinal imaging results is poor and the pathophysiology of most low back pain is not known, leading to a common conclusion that spinal radiographs are not appropriate for the assessment of back pain. For individual patients with back pain, spinal radiographs should be considered if they have certain features in the history and examination. As well as the traditional risk factors for osteoporosis, self-reported descriptives of back pain and novel physical examination findings have been shown to make the presence of vertebral fractures more likely. Systematic approaches have the potential to improve bone health across the population, but need to be targeted to be cost-effective.

Keywords

Vertebral fracture
Back pain
Pain descriptives
Physical examination

Mini Abstract (50 words)

Spinal radiographs should be considered for individual older patients with back pain if they have certain additional features in the history and examination.

Emma Clark, Steve Cummings and John Schousboe have No Disclosures

Introduction

In this article we review evidence about identifying vertebral fractures in patients with back pain and make recommendations on how to assess patients with back pain and when to refer them for spinal imaging. Back pain is one of the most common symptoms managed in primary care[1], but there has been concern about over-use of imaging for *low back pain* in adults[2]. The correlation between symptoms and imaging results is poor and the pathophysiology of most back pain is not known, leading to a common conclusion that spinal radiographs are not appropriate for the assessment of back pain without features of motor impairment or red flags suggestive of metastatic cancer or infection[3]. The UK guidelines[3] recommend that lumbar radiographs should not be undertaken in patients with uncomplicated low back pain. US guidelines[4] recommend considering spine imaging if fracture is suspected, but offer no criteria on which to base suspicion of fracture other than older age, a diagnosis of osteoporosis, or use of systemic glucocorticoid therapy. However, there is increasing evidence that history and focused physical examination can aid identification of older adults with back pain who may have a vertebral fracture. Patients found to have a clinically recognized vertebral fracture have a very high risk of having another, and other types of fracture[5] and would generally benefit from treatments to reduce future fractures with consequent improvement in quality of life.

Estimates suggest anywhere between 35[6]-90%[7] of vertebral fractures do not come to clinical attention. This may be due to several reasons. Older people may not seek healthcare believing that back pain is part of aging perhaps controlling their pain through self-medication with simple analgesia, and healthcare professionals tend to assume that back pain in older adults needs only management of symptoms[8]. Older people often have concerns about travel to radiology departments and difficulties parking the car, limiting access to radiographs. Even if a spinal radiograph is performed, fractures may be described by other terms, such as end plate depression or wedging, that results in lack of understanding of the significance of the radiology report[9]. Evidence suggest that simple features of a history that patients can also recognize, and a very simple physical examination can identify and select patients who have a probability of vertebral fracture that makes spinal imaging, by radiograph or lateral DXA (Vertebral Fracture Assessment, VFA) worthwhile[7, 10-12].

Who to image? Features in the history (see Box 1)

Results from the Study of Osteoporotic Fractures (SOF) and the Osteoporotic Fractures in Men (MrOS) Study show that incident radiographically ascertained vertebral fractures that do not come

to clinical attention are associated with a two- to three-fold increase in back pain and functional limitations[13, 14] compared to those who do not have radiographic vertebral fracture. This suggests that back pain could be used to trigger questions that help identify those who have vertebral fractures. Guidelines already stress the importance of 'red flags' in cases of low back pain to identify the presence of fracture or cancer[3], but these guidelines do not assist in the identification of vertebral fractures that are related to osteoporosis rather than trauma[15, 16]. However, not all studies find that back pain is associated with prevalent vertebral fractures[17-19], and this may be because simply asking about the present of back pain (yes or no) is not useful. There is now an increasing body of evidence that site and description of back pain may be helpful in deciding who could have an osteoporotic vertebral fracture[10, 11].

A cross-sectional study of 504 older women reported that the presence of lateral waist pain was associated with a 4.5 fold increased probability of a vertebral fracture on subsequent radiograph (OR 4.48, 95%CI 2.02 to 9.94)[10]. Conversely, the presence of midline waist pain indicated a lower risk of having a vertebral fracture (OR 0.45, 95%CI 0.21 to 0.98). However, in this study the prevalence of lateral waist pain was 18.1% and some women with vertebral fractures do not have lateral waist pain: the presence of lateral waist pain has a sensitivity of 44.8% and a specificity of 84.6% for the presence of a vertebral fracture. Thus, if spinal radiographs were performed in all women with lateral waist pain aged 65-75 years old, approximately one in four would have a vertebral fracture identified, but half of those with a vertebral fracture would be missed.

A case-control study of 197 older women who had thoracic radiographs for back pain has identified several self-reported features associated with vertebral fracture[11]. The 64 women with vertebral fractures were more likely to describe their pain as brief or momentary, crushing, or improving on lying down. The women without vertebral fractures were more likely to describe pain present for months to years, report a negative effect of damp weather, and describe pain radiating down their legs. Those without vertebral fractures were also more likely to have had other previous severe pain experiences such as excruciating toothache or abdominal pain. Importantly, there was no difference in severity based on a visual analogue scale or bothersomeness (identified by asking 'Overall, how bothersome has your back pain been' with responses ranging from 'not at all' to 'extremely'). This is in agreement with other studies[17]. In this case-control study, independent predictors of vertebral fractures were increasing age, a history of previous fracture, pain described as crushing, pain improving on lying down, and pain not spreading down their legs. Pain described as crushing was used by 12.5% of cases and 4.5% of controls (OR for vertebral fracture in someone using the word

crushing to describe their pain of 3.02, 95%CI 1.01 to 9.12). Pain improving on lying down was described by 83.0% of cases compared to 60.4% of controls (OR for vertebral fracture in someone describing their back pain improving by lying down of 3.19, 95%CI 1.35 to 7.58). Pain radiating down the legs was described by 22.2% of cases compared to 47.7% of controls (OR for vertebral fracture in someone with pain radiating down their legs of 0.31, 95%CI 0.18 to 0.70). Therefore, a simple questionnaire based on self-reported pain descriptives may help identify which older people with back pain should have spinal radiographs.

Some of the 'traditional' risk factors for osteoporosis have associations with the presence of vertebral fractures including increasing age, female gender, low body weight or Body Mass Index, maternal hip fracture [18-23], along with a history of prior fracture[7, 18-21, 24-26]. In women, late menarche defined as 16 years or older is associated with an increased risk of vertebral fracture (RR 1.80, 95%CI 1.24 to 2.63)[27]. In addition, cumulative corticosteroid dosage is associated with vertebral fractures, independent of bone density[24, 25, 28]. More than 4 cm difference between height at age 25 and current height has been associated with vertebral fractures in several studies[19, 29]. Current smoking may be an important risk factor[30], with men and those who have developed Chronic Obstructive Pulmonary Disease (COPD) being at particular risk of vertebral fractures[31]. How strongly these 'traditional' risk factors predict the presence of vertebral fracture in someone with back pain is not fully understood, although there is some evidence that in the presence of back pain increasing age, prior fracture and use of corticosteroids are still associated with the presence of vertebral fracture[11], whereas maternal hip fracture is not[11].

Who to image? Physical examination (see Box 1)

A rib-to-pelvis distance of two finger breadths or less[32] (see Figure 1) has been associated with the presence of vertebral fractures in several studies[7, 33, 34], although in one study adjustment for other anthropometry such as arm span-height differences attenuated the association between rib-to-pelvis distance and vertebral fractures[34]. Gentle percussion over the spinous processes with a closed fist is likely to induce pain in recent vertebral fractures, but not in individuals with degenerative change without fracture[35]. In contrast, kyphosis measured by several techniques, such as wall-to-occiput distance, or wall-to-tragus distance have shown contradictory results [7, 33, 36, 37]. Kyphosis often results from degenerative disc disease rather than vertebral fracture[38].

Systematic approaches to population-level spinal imaging

Data from the European Vertebral Osteoporosis Study and the National Health and Nutrition Examination Survey (NHANES) suggests that 6-21% of postmenopausal women have at least one vertebral deformity [39] [40]. Therefore, should all postmenopausal women undergo spinal imaging to screen for vertebral fractures? This was tested in a randomised controlled trial of such a screening programme[12], based on the results of a population-based cross-sectional study[7] that identified four clinical risk factors: reported height loss, history of previous non-vertebral fracture, the Margolis back pain score (calculated from the number of areas of a mannequin diagram labelled as painful) and the rib-to-pelvis distance. A pre-determined cut-off risk score using these clinical factors was used to pre-select which older women should have spinal radiographs with excellent discriminatory accuracy (Area Under the Receiver Operating Curve (AUC) of 0.88, 95%CI 0.80 to 0.97). 3200 older women were randomised to either receive the face-to-face clinical risk assessment followed by spinal radiograph if identified to be at risk, or to standard methods of screening for vertebral fracture in primary care (healthcare professional discretion after ad-hoc presentation by patient). After 12 months, approximately twice as many women assigned to the screening arm than to standard care reported receiving new prescriptions for osteoporosis medications (OR 2.24, 95%CI 1.16 to 4.33). Cost-effectiveness modelling suggested a cost per quality-adjusted life year of approximately £30,000. This is above most worldwide cost-effectiveness thresholds, but the cost-effectiveness of the intervention could be improved by targeting screening to high risk patients. For example, five independent predictors of vertebral fracture with a combined AUC of 0.85 (95% CI 0.79 to 0.92), with a pre-determined cut-off of 0.39 (see Figure 2) for use in older women with back pain[11], would identify 77% of those with a vertebral fracture, whilst reducing the number of radiographs performed by 60%. This needs further research, but has the potential to be more cost-effective from the societal perspective than screening of all older women.

The use of Vertebral Fracture Assessment (VFA) at the time of DXA scanning is an alternative to spinal radiographs. However, to be cost-effective, this approach also needs to be targeted[41]. For example, in the US, use of VFA in older patients with height loss who has osteopaenia (lowest T-score between -1.5 and -2.4) or in those on current systemic glucocorticoids increased prescription of appropriate fracture prevention medication, because the presence of a vertebral fracture lowered treatment thresholds sufficiently to alter management recommendations[42]. Use of VFA at the time of bone densitometry and selective spine radiography among those presenting to primary care providers with recent back pain can be considered complementary aspects to systematic efforts to identify those with prevalent vertebral fractures who are at high risk of subsequent fractures. With the former, bone mineral density is generally measured simultaneously, and can be easily

incorporated into a decision rule as to whether or not to image the spine. The quality of VFA images produced by older bone density machines may limit usefulness however, but with the newer generation machines VFA image quality is becoming less of a problem.

The appropriate criteria for VFA at the time of bone densitometry may vary by health care delivery system and country. For example, the VFA algorithm described above[42] is specific for the USA and has been incorporated into the National Osteoporosis Foundation guidelines and the 2013 International Society for Clinical Densitometry (ISCD) Position Statement[43]. However, a small recent study presented at the UK's National Osteoporosis Society conference utilises slightly different indications for VFA (VFA is performed on all patients having a DXA scan where treatment is not currently being recommended e.g. osteopaenia with low FRAX score). With use of this approach in the National Health Service (NHS), fracture prevention treatment is recommended in approximately 10% more patients than without the use of VFA[44] because of the identification of vertebral fractures.

Conclusion

The presence of a vertebral fracture improves fracture risk assessment and may change management, so it is vital for healthcare professionals to assess patients for the presence or absence of these fractures. For individual patients with back pain, spinal radiographs should be considered if they have certain features in the history and examination that have been shown to make the presence of vertebral fractures more likely. Currently there is not enough data to identify which combinations of features in the history and examination have discriminative ability for the presence or absence of vertebral fractures, and we therefore propose a research agenda that includes (1) qualitative work with older people with osteoporotic vertebral fractures to evaluate pain to identify if any important descriptors have been missed; (2) cohort studies of older people with back pain to identify the clinical triggers that should be included in a tool to identify which people are likely to have an undiagnosed vertebral fracture and therefore need spinal imaging; and (3) randomised controlled trial data of the clinical tool to address the question of whether it is clinically and cost-effective to implement. In particular primary care providers would clearly benefit from simple decision rules based on combinations of specific characteristics from Box 1 that can be implemented quickly in practice.

Box 1: Features in the history and examination that may indicate the presence of a vertebral fracture

- Older age
- Female gender
- Lateral waist pain
- Back pain described as crushing
- Back pain improving on lying down
- Pain not radiating down the legs
- Current smoking
- Diagnosis of Chronic Obstructive Pulmonary Disease
- Prior fracture
- Late menarche
- Cumulative corticosteroid dosage
- Reported height loss of >4cm
- Low body weight
- Rib to pelvis distance of 2 fingers or less
- Spine tender to gentle percussion (acute vertebral fractures only)

Figure legends

Figure 1: How to measure the rib-to-pelvis (RTP) distance. Reproduced from Siminoski et al, 2003. With the examiner standing behind the subject, the hands of the examiner are held vertically and inserted into the space between the inferior margin of the ribs and the superior edge of the pelvis in the mid-axillary line. The vertical distance is measured in fingerbreadths.

Figure 2: Box plot for risk score in cases with vertebral fractures and controls without vertebral fractures, illustrating discriminatory ability of the independent predictors identified in this study (age, previous fracture, short duration of back pain, pain described as crushing, pain improved by lying down and pain not radiating down legs). Taken from Clark et al 2016

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