

# How reliable is a radiological report in osteoporosis in diagnosing low bone density?

C D McCullagh, K McCoy, V L S Crawford, H Taggart

Accepted May 2003

---

## SUMMARY

**Patients are often referred to osteoporosis clinics with a radiological diagnosis of osteoporosis. Previous studies attempting to ascertain risk of osteoporosis from radiographs have been conflicting. The aim of our study was to determine how reliable spinal radiographs were at detecting low bone density compared with Dual Energy X ray Absorptiometry (DXA). We retrospectively measured the Bone Mineral Density (BMD) at the spine in 130 patients with a radiological diagnosis of osteopenia or osteoporosis in the absence of vertebral fractures. They were compared with a group of 119 age and sex matched patients with one or more low trauma vertebral fractures. There was a statistically significant difference in the mean BMD between these two groups. 12.7% of the x-ray group with osteopenia reported, had a normal bone density, 49.2% had osteopenia (T-score -1 to -2.5) and 38.1% had osteoporosis (T-score <-2.5). Of those with a radiological report of osteoporosis, 12.8% had a normal bone density, 44.7% had osteopenia and 42.6% had osteoporosis. We conclude that a radiological report of low bone density is a strong predictor of osteopenia or osteoporosis by BMD measurement.**

---

## INTRODUCTION

It has been a generally held view that bone loss of less than 30% cannot be detected radiologically.<sup>1,2</sup> However, these conclusions were drawn from in vitro experiments carried out over 40 years ago.

Previous studies have attempted to ascertain the reliability of X-rays in estimating low bone density, although the results have been conflicting. Some were underpowered,<sup>3-5</sup> and one of these used the femoral condyle and ankle as the preferred region.

The aim of our study was to determine how reliable spinal radiographs are at detecting low BMD compared with DXA at the spine.

## METHODS

### Patients

We retrospectively studied the BMD of 130 patients (118 female, 12 male) who had been consecutively referred to the Osteoporosis Clinic at the Belfast City Hospital by their General Practitioner or other specialist from hospitals throughout Northern Ireland. These patients had x-rays of dorsal or lumbar spine, or both, which

commented on the presence of osteopenia or osteoporosis in the absence of any vertebral fracture. We included a subgroup of patients in whom an additional report of degenerative osteoarthritic changes had been made.

Results were compared with a group of 119 age and sex matched patients (108 female, 11 male), attending our osteoporosis clinics with one or more low trauma vertebral fractures (defined as a loss in vertebral height of 20% or more). The X-rays were reported by a radiologist in the referring

---

The Queen's University of Belfast, Department of Geriatric Medicine, Whitla Medical Building, 97 Lisburn Road, Belfast BT9 7BL.

Dr C D McCullagh, MB, MRCPI, Specialist Registrar.

Dr V L S Crawford, PhD, Senior Lecturer.

Osteoporosis Unit, Belfast City Hospital, Lisburn Road, Belfast BT9 7AB.

K McCoy, RGN, Research Nurse.

Dr H Taggart, MD, FRCP, Consultant Physician.

Correspondence to Dr Taggart.

hospital and as this was an observational study of clinical practice, no attempt was made to standardize radiographs. They used the classification of either osteopenia or osteoporosis. The latter is regarded as demonstrating more bone loss but there is no objective way of making this distinction.

#### MEASUREMENT OF BONE MINERAL DENSITY

BMD was measured by DXA using the Hologic 4500 A bone densitometer. Measurements were made in the L1-L4 region and the results expressed as gm/cm<sup>2</sup>. Osteoporosis was defined as a value for BMD that is 2.5 standard deviations (SD's) or more below the young adult mean value (T-Score less than -2.5). Osteopenia denotes a T-score that lies between -1 and -2.5 and normal was taken as a T-score >-1, according to the WHO criteria.<sup>6</sup>

#### Data Analysis

Data were analyzed using SPSS. Descriptive statistics are reported and an independent samples 't' test was used to compare BMD levels between x-ray patients and fracture patients.

#### RESULTS

Tables 1 and 2 show the characteristics of the study groups. The two groups were well matched for age (mean 63.8 yrs in the x-ray group and 63.9 in the fracture group). There was a statistically significant difference in the mean BMD between the two groups (0.8 gm/cm<sup>2</sup> vs 0.68 gm/cm<sup>2</sup>,  $p < 0.0001$ ) 84% of patients in the fracture group were classified as having osteoporosis, 13.4% osteopenia and 2.5% had normal bone density. 49.2% of patients with a radiological diagnosis of osteopenia had this confirmed by DXA while 38.1% had osteoporosis and 12.7%, a normal BMD. 42.6% of patients with a radiological diagnosis of osteoporosis had this confirmed by DXA. However a higher proportion actually had osteopenia, (44.7%) and 12.8% had a normal BMD.

#### DISCUSSION

A large proportion of patients in the fracture group had evidence of osteoporosis. These were people in whom there was evidence of low trauma vertebral fracture, which is an important risk factor for osteoporosis. BMD is not a perfect measurement to diagnose osteoporosis particularly in older patients when the lumbar spine is employed. For example, spinal osteoarthritis may affect the measurement.<sup>7</sup>

Our study has shown that a radiological report of osteoporosis is very useful in diagnosing low bone density, but could not accurately differentiate between osteopenia and osteoporosis as measured quantitatively by DXA. Of the 110 patients referred with low bone density by radiology, 87.2% had this confirmed by DXA. This is in contrast to the study of Scane et al,<sup>3</sup> which showed that only 66.7% of women with apparent osteopenia on spine x-ray without vertebral deformation had a bone density below the normal range for young women. However, this was a very small study. In a review of 269 referrals for bone density measurements on the basis of an x-ray report of osteopenia by Ahmed et al,<sup>8</sup> the highest proportion of women in any one group (out of nine) referred for BMD measurement as having osteoporosis was in the radiographic osteopenia group (n=268; 24% at the spine, 11% at the femur and 29% at the spine, femur or both). This was despite the finding that the mean Z scores for BMD were lower in secondary amenorrhoea and premature menopause groups. Michael et al<sup>7</sup> reported on 80 individuals in whom radiographs and BMD, as measured by quantitative CT, were performed. They concluded that radiographs were reliable in detecting low bone density in osteoporotic individuals without fracture Masud et al,<sup>9</sup> who assessed osteopenia in spine radiographs and BMD as measured by DXA in a large sample of 818 patients concluded that 'high grade' osteopenia should be an indication for bone densitometry and that a 'normal' x-ray is unlikely to have a significantly low BMD.

This finding was supported by Garton et al,<sup>10</sup> who assessed the BMD and spinal radiographs of patients randomly selected from the community. Their sample comprised more men than women (107 vs 93), which does not correspond to the true referral patterns for osteoporosis. However, if the diagnosis of osteoporosis depended on radiological features alone, then 38.1% of patients with osteoporosis would have been missed. Conversely, 44.7% of the patients with a radiological diagnosis of osteoporosis would have possibly received treatment for osteoporosis when they had osteopenia or a normal bone density.

The interpretation of radiographs depends on film penetration, patient positioning and inter/intra observer variability. In the study of Epstein et al,<sup>11</sup> the authors concluded that there was poor agreement between radiologists and within the

TABLE I  
*Patient Characteristics*

	<i>X-Ray Patients N(%)</i>	<i>Fracture Patients N(%)</i>
Total No. of Patients (n)	130 (M=12, F=118)	119 (M=11, F=108)
Age Range (y)	28-88	25-81
Mean Age (y0	63.8	63.9
Mean BMD (gm/cm <sup>2</sup> )	0.80	0.68

TABLE II  
*Radiological Diagnosis vs Bone Mineral Density*

	<i>Osteopenia N=63</i>	<i>Osteoporosis N=47</i>	<i>Low Bone Density and Degenerative changes N=20</i>	<i>Fracture Patients N=119</i>
T-Score>-1.0 Normal	12.7%	12.8%	20%	2.5%
T-Score -1 to -2.5 Osteopenia	49.2%	44.7%	35%	13.4%
T Score <-2.5 Osteoporosis	38.1%	42.6%	45%	84%

same radiologist on reviewing the same film at a different time. However, only 15 pairs of films were reviewed, chest radiographs were employed and DXA was not used to measure BMD, as the design of the study was primarily to establish concordance and reproducibility of observations. This is in contrast to the study by Jergas et al,<sup>12</sup> in which a larger sample of 100 patients was used. DXA was used for quantitative assessment of BMD. There was considerable agreement between the observers but only when a substantial amount of bone was lost.

Garton et al<sup>10</sup> concluded that in an assessment of 200 patients that interobserver agreement was fair to moderate and intraobserver agreement was moderate to good. They also concluded that although the overlap between the different gradings of osteopenia was considerable, BMD was significantly related to visually estimated

osteopenia. Epseland et al<sup>13</sup> showed fair to excellent overall interobserver and intraobserver agreement.

These studies support our conclusion that a spinal radiograph is very useful in the diagnosis of low bone density. The usual indication for spinal x-ray is to establish a cause for back pain. If there is no evidence of fracture, low bone density is reported by the radiologist, then the patient should be referred for a DXA scan. Radiologists should be encouraged to report any loss of vertebral height more than 20% as a vertebral fracture in these patients should be treated. Our study would suggest that there is no value in attempting to differentiate between osteopenia and osteoporosis on x-ray. A radiological report of low bone density on thoraco-lumbar x-ray is a strong predictor of osteopenia and osteoporosis by bone mineral density measurement.

## REFERENCES

1. Lachman E, Whelan E Th. Röntgen diagnosis of osteoporosis and its limitations. *Radiology* 1936; **26**:165.
2. Johnston C C, Epstein S. Clinical, biochemical, radiographic, epidemiologic and economic features of osteoporosis. *Orthop Clin North Am* 1981; **12**(3): 559-69.
3. Scane A C, Masud T, Johnson F J, Francis R M. The reliability of diagnosing osteoporosis from spinal radiographs. *Age Ageing* 1994; **23**(4): 283-6.
4. Finsen V, Anda S. Accuracy of visually estimated bone mineralization in routine radiographs of the lower extremity. *Skeletal Radiol* 1988; **17**(4): 270-5.
5. Williamson M R, Boyd C M, Williamson S L. Osteoporosis: diagnosis by plain chest film versus dual photon bone densitometry. *Skeletal Radiol* 1990; **19**(1): 27-30.
6. World Health Organisation. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Geneva, Switzerland: World Health Organisation; 1994.
7. Michel B A, Lane N E, Jones H H, Fries J F, Bloch D A. Plain radiographs can be useful in estimating lumbar bone density. *J Rheumatol* 1990; **17**(4): 528-31.
8. Ahmed A I, Ilic D, Blake G M, Rymer J M, Fogelman I. Review of 3,530 referrals for bone density measurements of spine and femur: evidence that radiographic osteopenia predicts low bone mass. *Radiology* 1998; **207**(3): 619-24.
9. Masud T, Mootoosamy I, McCloskey E V, O'Sullivan M P, Whitby E P, King D *et al.* Assessment of osteopenia from spine radiographs using two different methods; the chingford study. *Br J Radiol* 1996; **69**(82): 1-6.
10. Garton M J, Robertson E M, Gilbert F J, Gomersall L, Reid D M. Can radiologists detect osteopenia on plain radiographs? *Clin Radiol* 1994; **49**(2): 118-22.
11. Epstein D M, Dalinka M K, Kaplan F S, Aronchick J M, Marinelli D L, Kundel H L. Observer variation in the detection of osteopenia. *Skeletal Radiol* 1986; **15**(5): 347-9.
12. Jergas M, Uffmann M, Escher H, Glier C C, Young K C, Granpp S. Interobserver variation in the detection of osteopenia by radiography and comparison with dual X-Ray absorptiometry of the lumbar spine. *Skeletal Radiol* 1994; **23**(3): 195-200.
13. Epseland A, Korsbrekke K, Albrektsen G, Larsen J L. Observer variation in plain radiography of the lumbosacral spine. *Br J Radiol* 1998; **71** (844): 366-75.