Occurrence of vertebral fracture more closely associated with decreased anteroposterior than lateral lumbar bone mineral density

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Abstract

Objectives: While it has been pointed out that an anteroposterior (AP) view of the lumbar spine may lead to overestimation of the bone mineral density (BMD), a lateral view is expected to lead to the early detection of BMD loss on scanning cancellous bone. Vertebral fracture is often seen in aged osteoporotic patients, and it is important to prevent this fracture. Therefore, we aimed to identify the optimal site for BMD measurement to assess the risk of vertebral fracture.

Methods: Forty-seven female patients with fresh osteoporotic vertebral fracture and BMD measurements were included in this study (Fracture group). As a non-fractured control group, 218 female patients with BMD measurements were enrolled (Control group). We compared BMD values based on AP and lateral views of the lumbar spine from L2 to L4 and the femoral neck. With a lateral view of the lumbar spine, we measured both the total vertebral body and vertebral body center, mainly composed of cancellous bone.

Results: BMD of the AP lumbar spine in the Fracture group was significantly lower than in the Control group (P < 0.05). In the subanalyses for comparisons between age-matched fracture and control groups, BMD of only the AP lumbar spine in the Fracture group was significantly lower than in the Control group (P < 0.01).

Conclusions: AP lumbar spine BMD is optimal for assessing vertebral fracture occurrence.

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Keywords: Anteroposterior; Lateral; Lumbar; Vertebral fracture

1. Introduction

Dual energy X-ray absorptiometry (DXA) is often used to measure the bone mineral density (BMD) because of its high accuracy, speed, and low level of X-ray exposure. The lumbar spine and femoral neck are often evaluated for measuring BMD, and, in the lumbar spine, both anteroposterior (AP) and lateral scans are performed. An AP view of the lumbar spine may lead to overestimation of BMD due to calcification of the abdominal aorta and lymph nodes and arthrosis of the facets. On the other hand, a lateral view can resolve these interfering factors, and it is possible to detect a loss of BMD early by scanning cancellous bone of vertebral bodies [1–3]. However, it has been reported that a lateral view is inferior to an AP view in terms of reproducibility [1]. Bone densitometry devices have recently made it possible to measure BMD by moving an X-ray tube bulb, and we can measure the lateral vertebral spine BMD in a supine position, not requiring a lateral position. Therefore, the problem regarding reproducibility due to positioning has been partially resolved.

Vertebral fracture is often seen in aged osteoporotic patients, and causes a decline in activities of daily living because of lower-limb muscle weakness and dementia.
Therefore, it is important to treat osteoporotic patients who are likely to develop vertebral fracture. Although BMD of the lumbar spine is significantly correlated with vertebral fractures, we do not know which vertebral view, AP or lateral, is optimal to assess the risk of vertebral fracture.

The aim of this study was to clarify the optimal site to measure BMD in order to assess the fracture risk.

2. Methods

A total of 47 consecutive female patients with fresh osteoporotic vertebral fracture who underwent BMD measurement within 3 days after injury in our hospital between April 2012 and March 2014 were included in this study (Fracture group). They were all primary osteoporosis patients, and we excluded patients who had been unable to walk by themselves before the fracture. Their mean age was 82 years (68–94). As a non-fractured control group, a total of 218 consecutive female patients aged 65 or over who underwent BMD examination to check the control of osteoporosis treatment or existence of osteoporosis in our hospital between April 2012 and March 2014 were enrolled (Control group). Their mean age was 76.2 years (65–90).

We used Discovery (Hologic Inc., MA, USA) to measure BMD by DXA, and we employed AP and lateral views of the lumbar spine from L2 to L4 and femoral neck scanning all in a supine position. With a lateral view of the lumbar spine, we measured both the total vertebral body and vertebral body center, mainly composed of cancellous bone (about 20% of all vertebral bodies). BMD scans of all regions were measured by one expert radiologic technologist. In addition, we compared some laboratory examinations, such as bone-specific alkaline phosphatase (BMP) and serum cross-linked N-telopeptide of type I collagen (NTX).

Because the backgrounds of patients differed significantly between groups, comparisons between groups were considered to lack meaning. We, therefore, excluded patients with diabetes mellitus, any form of steroid use, and non-osteoporotic conditions, and performed subanalyses for comparisons between age-matched Fracture and Control groups.

All values are expressed as the mean ± SD. Analysis of covariance was used to compare the 2 groups.

3. Results (Tables 1 and 2)

In the Fracture group, the levels of vertebral fracture were from T8 to L5: 3 patients in T8, 1 in T9, 4 in T10, 5 in T11, 8 in T12, 16 in L1, 7 in L2, 7 in L3, 1 in L4, and 3 in L5. Although BMD of the AP lumbar spine and femoral neck in the Fracture group was significantly lower than in the Control group (P < 0.01 and P < 0.05, respectively), there was no significant difference in BMD of the total or central lateral lumbar spine between the 2 groups (Table 1). Because the Fracture group was older than the Control group, we conducted analysis using age-matched Fracture and Control groups. In the subanalyses between age-matched groups, BMD of only the AP lumbar spine in the Fracture group was significantly lower than in the Control group (P < 0.01) (Table 2). The femoral neck in the Fracture group showed a tendency toward a low BMD. Serum NTX in the Fracture group was significantly higher than in the Control group (P < 0.05, respectively).

4. Discussion

The usefulness of a lateral view of the vertebral body has been reported [1–3]. We hypothesized that BMD could be measured more precisely by focusing on cancellous bone because we can exclude the interference of vertebral osteophytes. However, in this study, there was no significant difference in BMD of the total or central lateral lumbar spine between the 2 groups, although BMD of the AP lumbar spine in the Fracture group was significantly lower than in the Control group.

We considered possible reasons for this. Although we have no need to adopt a lateral position to measure the lateral vertebral spine BMD, lateral scanning still may be inferior to AP scanning in terms of reproducibility. Okumura et al. stated that rotation of only 10° led to a 20% change in BMD [4]. Although lateral scanning of central cancellous bone of the vertebral body can detect BMD loss early, there may be little difference in BMD of central cancellous bone among patients with advanced osteoporosis causing fracture. Actually, BMD of the femoral neck was relatively low in the fracture group in this study, and advanced osteoporosis may be necessary for vertebral fracture. In addition, a decrease in BMD of the

| Table 1 | Comparisons between control and fracture groups |
|---------|-----------------------------------------------|
|          | Control group | Fracture group | P       |
| Number (N) | 218          | 47             |         |
| Age (years) | 76.2 ± 5.8   | 82.0 ± 6.2    | <0.001  |
| Laboratory examinations                           |                 |               |         |
| BAP (U/L) | 20.7 ± 6.3   | 17.4 ± 8.1    | 0.952   |
| Serum NTX (nmol BCE/L) | 16.5 ± 5.4 | 21.9 ± 7.1   | 0.018   |
| BMD (g/cm²) |             |               |         |
| Lumbar spine                                      |                 |               |         |
| AP       | 0.760 ± 0.163| 0.671 ± 0.127| 0.007   |
| All lateral | 0.601 ± 0.132| 0.577 ± 0.103| 0.492   |
| Central lateral | 0.505 ± 0.143| 0.469 ± 0.115| 0.525   |
| Femoral neck | 0.539 ± 0.107| 0.471 ± 0.118| 0.046   |

All values are mean ± standard deviation.

| Table 2 | Comparisons between age-matched control and fracture groups |
|---------|-----------------------------------------------|
|          | Control group | Fracture group | P       |
| Number (N) | 90          | 45             |         |
| Age (years) | 81.6 ± 3.8  | 81.6 ± 5.9    | 0.973   |
| Laboratory examinations                           |                 |               |         |
| BAP (U/L) | 17.1 ± 8.9  | 17.3 ± 8.4    | 0.922   |
| Serum NTX (nmol BCE/L) | 16.9 ± 5.6 | 20.6 ± 6.3   | 0.011   |
| BMD (g/cm²) |             |               |         |
| Lumbar spine                                      |                 |               |         |
| AP       | 0.755 ± 0.160| 0.670 ± 0.123| 0.002   |
| All lateral | 0.596 ± 0.137| 0.578 ± 0.104| 0.401   |
| Central lateral | 0.491 ± 0.155| 0.471 ± 0.113| 0.410   |
| Femoral neck | 0.514 ± 0.106| 0.476 ± 0.118| 0.060   |

All values are mean ± standard deviation.
posterior elements of the spine may also be involved in fracture. There may be a number of reasons for the results of the current study; therefore, further research is necessary.

A limitation of this study was the possibility of background differences between groups. We did not conduct any evaluation of X-ray of the spine. Osteophyte formation in the vertebral body and spinal deformity vary markedly among patients, and the results may vary with differences in populations. Also, we included patients whose fracture levels were from L2 to L4 in this study. We do not know what influences affect the results of BMD by examining fracture vertebræ. However, if we excluded patients with the fracture of L2 to L4 vertebræ, the subject number would be too low. We need to accumulate more fresh vertebral fracture patients. In this study, bone resorption marker levels in the Fracture group were significantly higher than in the Control group. Bone resorption marker levels may become a basis for assessing appropriate sites for measuring BMD. However, we measured bone resorption marker levels after the onset of fracture in this study, and so the elevation of their levels may be the result of a reaction to the fracture itself [5].

In conclusion, to the best of our knowledge, the present study is the first to show an optimal site for BMD measurement to assess vertebral fracture risk in the English literature. An AP view of the lumbar spine BMD is the most relevant regarding vertebral fracture occurrence, and there is a possibility that we can predict vertebral fracture occurrence with this BMD measurement. However, we did not clarify the exact reason why a lateral view did not show any relevance concerning vertebral fracture occurrence. Therefore, further research is necessary.

Conflict of interest

The authors declare that they have no conflict of interest.

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