Identification of postmenopausal women at risk of osteoporosis by trained general dental practitioners using panoramic radiographs

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Abstract

Background. Eroded inferior cortex of the mandible on panoramic radiographs may be useful for identifying postmenopausal women with low bone mineral density (BMD) or osteoporosis. The purpose of this study was to assess whether trained general dental practitioners (GDPs) can identify postmenopausal women with undetected low skeletal BMD as well as spine fractures by panoramic radiographs in their clinics sufficiently.

Methods. Of 455 women aged 50 years and older who visited the dental clinics of 22 trained GDPs and had panoramic radiographic assessment for the examination of dental diseases between June and December 2004, 168 postmenopausal women were diagnosed as having low skeletal BMD based on cortical erosion finding. Of these women, 39 women aged 50 to 84 years (mean [SD] age, 64.8 [7.4] years) with no previous diagnosis of osteoporosis participated in this study. BMD at the lumbar spine and femoral neck was measured by dual energy x-ray absorptiometry (DXA). Spine fractures were assessed on lateral radiographs obtained at the time of DXA assessment.

Results. Two women (5.1%) had normal BMD (BMD T score more than -1.0), 21 women (53.9%) had osteopenia (BMD T score of -2.5 to -1.0) and 16 women (41.0%) had osteoporosis (BMD T score less than -2.5). Eight women (20.5%) had fractures at the thoracic spine or lumbar spine or both.

Conclusions. Our results suggest that higher percentage of postmenopausal women with undetected low skeletal BMD as well as spine fractures may be identified based on trained GDPs' analyses of their panoramic radiographs.

Keywords: osteoporosis; fracture; dentist; menopause; panoramic radiography

Introduction

Increases in the elderly population worldwide will cause a dramatic rise in osteoporotic fractures. Both vertebral and hip fractures increase risk of mortality in older women.[1,2] The Surgeon General in the United States warns that by 2020, half of all American citizens older than 50 will be at risk for fractures from osteoporosis and low bone mass if no immediate actions are taken by individuals at risk, doctors, health systems, and policymakers.[3] Since dual energy X-ray absorptiometry (DXA) is the most reliable way to determine bone mineral density (BMD) that is one of the major risk factors for fractures from osteoporosis, BMD testing for all elderly population by DXA is considered one of the immediate actions to conquer osteoporotic fractures. Several reports have recommended that all women should have a measurement of BMD at the age of 65 years because of the sharp increase in the incidence of fracture that occurs in association with low BMD after the age of 65.[4,5,6] BMD testing for postmenopausal women before the age of 65 years is also recommended if they have had additional risk factors for osteoporotic fractures.[5,6] However, BMD testing for all such women is not practical in many countries where BMD assessment equipments, especially DXA, are not widely available.[7]

A large number of panoramic radiographs (approximately 11 million per year in Japan[8] and approximately 17 million per year in the United States[9]) are taken for the examination of the oral and maxillofacial regions. Some investigators indicate that mandibular inferior cortical erosion detected on panoramic radiographs may be useful indicator for identifying postmenopausal women with low skeletal BMD or osteoporosis.[10-19] We recently demonstrated that the diagnostic performance of cortical erosion finding on panoramic radiographs for identifying postmenopausal women with

suspected spinal osteoporosis was similar to that of Osteoporosis Self-Assessment Tool (OST),[16] which was a useful questionnaire-based screening tool for both Asian and Caucasian postmenopausal women.[20,21,22] However, in the previous studies, the experienced observers such as oral radiologists in the University or the Dental College determined cortical erosion finding on panoramic radiographs. Little is known as to whether general dental practitioners (GDPs) can identify postmenopausal women with low skeletal BMD or osteoporosis sufficiently based on cortical erosion finding if they are trained about this finding. It also remains unknown whether GDPs can identify such women by their own panoramic radiographs which image quality may be different from that of the radiographs taken in the University. Further, there is no previous study about whether GDPs can identify postmenopausal women with undetected spine fractures.

The purpose of this study, therefore, was to assess whether general dental practitioners (GDPs) who were trained about cortical erosion finding can identify postmenopausal women with undetected low skeletal BMD as well as spine fractures by means of panoramic radiographs in their dental clinics sufficiently.

Methods

Training of GDPs

Twenty-two GDPs (mean [SD] age, 48.2 [5.0] years) in Hiroshima Dental Association first took one hour of lecture about the background of osteoporosis including the association between osteoporosis and panoramic radiographic measures, and the instruction how to determine mandibular inferior cortical erosion on panoramic radiographs. Mean year of clinical experience of these GDPs was 24.1. After the lecture, these GDPs was trained one hour by using panoramic radiographs of 100

postmenopausal women of whom skeletal BMD (at the lumbar spine and femoral neck) have already been measured by DXA and who were divided as normal (BMD T score more than -1.0), osteopenic (BMD T score of -2.5 to -1.0) or osteoporotic (BMD T score less than -2.5) in accordance with the World Health Organization (WHO) classification. These panoramic radiographs were the same as those used in our previous study.[14] One oral radiologist with 16 years of experience gave a lecture to 22 GDPs and trained them after the lecture. Each GDP independently determined mandibular inferior cortical erosion on panoramic radiographs using reference film according to our recent study as follows (Figure 1).[10]

1. Normal cortex: the endosteal margin of the cortex is even and sharp on both sides.
2. Mildly to Moderately eroded cortex: the endosteal margin shows semilunar defects (lacunar resorption) or appears to form endosteal cortical residues.
3. Severely eroded cortex: the cortical layer forms heavy endosteal cortical residues and is clearly porous.

After the reading of these 100 panoramic radiographs, 22 GDPs compared their cortical erosion finding (normal, mildly to moderately eroded or severely eroded) with the diagnosis (normal, osteopenia or osteoporosis) based on skeletal BMD. In this reading, the mean sensitivity and specificity of 22 GDPs in identifying postmenopausal women with low BMD (osteopenia or osteoporosis) at either the lumbar spine or the femoral neck by any cortical erosion (mildly to moderately eroded or severely eroded) was 86.5 % and 36.1%, respectively. Each GDP reconfirmed his or her reading of cortical finding and calibrated among 22 GDPs after the reconfirmation.

Study sample

Of 455 women aged 50 years and older who visited the dental clinics of 22 trained GDPs and had panoramic radiographic assessment for the examination of dental diseases between June and December 2004, 168 postmenopausal women (mean [SD] age, 67.0 [8.9] years) were diagnosed as having low skeletal BMD by cortical erosion finding on panoramic radiographs. Of these women, 41 (24.4%) postmenopausal women with any cortical erosion (28 mildly to moderately and 13 severely) gave informed consent to participate in this study. There were no significant differences in the age (mean [SD] age, 65.1 [7.5] years vs. 67.6 [9.3] years) and mandibular cortical erosion severity between women who gave and did not give informed consent to this study. Since 2 of 41 these women have had previous diagnosis of osteoporosis, 39 postmenopausal women aged 50 to 84 years (mean [SD] age, 64.8 [7.4] years) with cortical erosion (28 mildly to moderately and 11 severely eroded cortices) were finally analyzed in this study.

Skeletal BMD and spine fracture assessments

For these 39 postmenopausal women, BMD of the lumbar spine (L2-L4) and the femoral neck was determined by DXA (DPX-alpha, Lunar Co., Madison, WI, U.S.A.) at the Oral and Maxillofacial Radiology clinic in Hiroshima University Hospital. Any fractured spines between L2 and L4 were not included in BMD calculation. Height and weight were measured at the time of DXA measurement. The *in vivo* short-term precision error for the lumbar spine and the femoral neck BMD in our clinic was 1.0% and 2.8%, respectively. Osteopenia was defined as a BMD T score of -2.5 and -1.0 at either the lumbar spine or the femoral neck according to the WHO classification. Osteoporosis was defined as a BMD T-score less than -2.5. The fractures at the thoracic

and lumbar spine were assessed on lateral spine radiographs using semi-quantitative assessment.[23] The ethics committee in Hiroshima Dental Association reviewed and approved this study protocol.

Data analysis

All subjects were classified into 3 groups (normal, osteopenia or osteoporosis) based on skeletal BMD. All characteristics of study subjects were compared between subjects with a mildly to moderately eroded cortex and with a severely eroded cortex by unpaired t-test, chi-square test or Fisher exact test. Analysis of covariance adjusting for age was also performed in continuous variables between two groups. A logistic regression analysis was used to calculate the odds ratio for osteoporosis diagnosis based on skeletal BMD and for having spine fractures associated with a severely eroded cortex in comparison with a mildly to moderately eroded cortex. P values less than 0.05 were considered statistically significant. Data analyses were performed using Statistical Package for the Social Sciences (SPSS; version 8.0; SPSS Inc, Chicago, IL).

Results

Of 39 postmenopausal women with no previous diagnosis of osteoporosis who participated in this study, two women (5.1%) were normal, 21 women (53.9%) had osteopenia and 16 women (41.0%) had osteoporosis on the basis of skeletal BMD (Table 1). Eight women (20.5%) had spine fractures. None of these women with newly diagnosed fractures had prior known fractures. Of eight women with spine fractures, four women had one fracture at the thoracic spine or lumbar spine, two women had two fractures at the lumbar spines (L3 and L5, L4 and L5), one woman had three fractures at

thoracic and lumbar spine (Th11, L1 and L5), and one woman had multiple fractures at thoracolumbar spines (Figure 2).

There were significant differences in age (P=0.023), BMD T score of the femoral neck (P=0.037) and WHO classification based on skeletal BMD (P=0.020) between subjects with mildly to moderately and severely eroded cortices, although there were no significant differences in height, weight, age at menopause, BMD T score of the lumbar spine and the prevalence rate of spine fractures between them (Table 2). After adjustment for age, no significant difference was found in BMD T score of the femoral neck between two groups. The odds ratio for osteoporosis diagnosis based on skeletal BMD associated with a severely eroded cortex was 6.67 (95% confidence interval [CI], 1.40 to 31.70). The odds ratio for having spine fractures associated with a severely eroded cortex was 1.73 (95% CI, 0.33 to 8.91). After adjustment for age, these decreased to 3.64 (95% CI, 0.54 to 26.29) and 0.58 (95% CI, 0.07 to 4.91), respectively.

Discussion

This is the first report about whether trained GDPs can identified postmenopausal women with undetected low BMD or osteoporosis sufficiently by cortical erosion finding in their dental clinics. Of 39 subjects who were identified by trained GDPs and gave informed consent to this study, 37 (94.9%) subjects had osteopenia or osteoporosis. Eight subjects (20.5%) also had spine fractures. Siris et al. recently reported in the National Osteoporosis Risk Assessment that using peripheral BMD measurement devices, 82% of postmenopausal women with fractures had T scores more than -2.5.[24] They suggest that efforts of fracture risk reduction should be performed in postmenopausal women with a BMD T score of -2.5 to -1.0 as well as those with a

BMD T-score less than -2.5. In this point of view, most of postmenopausal women identified by trained GDPs using their own panoramic radiographs in this study may benefit from bone densitometry.

Relatively higher mean age of these subjects (mean [SD] age, 64.8 [7.4] years) identified by GDPs might contribute to higher prevalence of subjects with osteopenia or osteoporosis. However, Iki et al. recently reported that prevalence rate of femoral osteoporosis according to the WHO classification in 1383 healthy Japanese women aged 50 to 79 years was 11.6%.[25] In our study, the prevalence rate of osteoporosis based on only femoral BMD was 33.3%, indicating that postmenopausal women identified by GDPs had approximately three-fold risk for femoral osteoporosis. Further, Kitazawa et al. reported that the prevalence of spine fractures in epidemiological population-based research was 2.0% for 50–54 year olds, 2.6% for 55–59 year olds, 5.7% for 60–64 year olds, and 13.0% for 65–69 year olds.[26] The prevalence rate of spine fractures in our study (20.5%) was considerably higher than that reported in their study, suggesting that postmenopausal women identified by GDPs also had high risk for spine fractures.

In our recent study limited to postmenopausal women aged 46 to 64 years, the prevalence rate of osteoporosis was 33.9% in subjects with a mildly to moderately eroded cortex and 62.5% in subjects with a severely eroded cortex, respectively.[19] This tendency was similar to the result of the present study (28.5% and 72.7%, respectively). Compared to subjects with normal cortex, likelihood ratio for a positive risk result for osteoporosis was 2.19 (95% CI, 1.55 to 3.08) in subjects with a mildly to moderately eroded cortex and 7.11 (95% CI, 1.80 to 28.12) in subjects with a severely eroded cortex, respectively, in our recent study.[19] In the present study, the odds ratio for osteoporosis diagnosis based on skeletal BMD associated with a severely eroded cortex

was 3.64 (95% confidence interval [CI], 0.54 to 26.29) after adjustment for age. Age is the strong confounding variable linked osteoporosis diagnosis with the severity of eroded cortices; however, subjects with a severely eroded cortex might have an increased risk of osteoporosis compared with those with a mildly to moderately eroded cortex if a larger number of subjects are investigated.

There was no significant difference in the prevalence rate of having spine fractures between subjects with mildly to moderately and severely eroded cortices in this study. This was not in accordance with the results of the previous study in which after adjustment for potentially confounding factors including the age, the odds ratio for an osteoporotic fracture associated with moderately eroded and severely eroded mandibular cortices was 2.0 (95% CI, 1.2 to 3.3) and 8.0 (95% CI, 2.0 to 28.9), respectively.[12] However, 91 of 93 osteoporotic fractures in this previous study were non-vertebral fractures. Association between cortical erosion finding and the presence of spine fractures might be different from that between cortical erosion finding and non-spine fractures. Halling et al. considered the subjects with a mildly to moderately eroded cortex as “normal group”.[18] However, our results suggest that subjects with any eroded cortices may have at risk of having spine fractures and should be identified in dental clinic.

This study has some limitations. In this study, postmenopausal women who were diagnosed as having low skeletal BMD based on cortical erosion finding by 22 trained GDPs were asked whether they wanted to have BMD assessment. Since GDPs will identify postmenopausal women with any cortical erosion, but not those with normal cortex, in clinical dental practice, we only assessed postmenopausal women with any cortical erosion in this study; however, postmenopausal women who are not diagnosed

as having low BMD based on cortical erosion finding by trained GDPs might have similar prevalence rate of osteopenia or osteoporosis compared to that obtained in this study. Prior to the present study, the pilot study including 61 women aged 50 years and older (mean age [SD], 62.8 [7.9] years) was conducted between May and December 2003. In this study, only 2 (9%) of 22 women who were not diagnosed as having low skeletal BMD based on cortical erosion finding by 14 trained GDPs in their clinic had osteoporosis, whereas 14 (36%) of 39 women who were diagnosed as having low BMD had osteoporosis.[27] The former included no subjects with spine fractures, whereas the latter included 6 subjects with spine fractures. This implies the possibility that postmenopausal women who were not diagnosed as having low BMD based on cortical erosion finding by 22 trained GDPs in the present study may had low risk for osteoporosis as well as spine fractures.

Second limitation was that we did not assess the intra-observer agreement of 22 trained GDPs in this study. However, the sensitivity of 22 trained GDPs was somewhat higher than that of untrained 19 GDPs with sufficient intra-observer agreement in our previous study.[14] In our previous study[14], untrained GDPs with sufficient intra-observer agreement had higher sensitivity than those with insufficient intra-observer agreement (mean sensitivity and specificity, 71% and 40%). It is likely that intra-observer agreement of almost of 22 trained GDPs in the present study may be sufficient.

In the present study, only 41 (24.4%) of 168 women agreed to have BMD assessment. Since there were no significant differences in the mean age and the severity of eroded cortices between 41 responders and 127 non-responders, about 120 women with undetected low BMD or osteoporosis might be identified by GDPs if all 127 non-responders agreed to participate in our study. An enlightenment of screening for

osteoporosis in dental clinics would be necessary for individuals at risk, dentists and medical doctors to conquer osteoporosis in the future.

In conclusion, 37 (94.9%) of 39 postmenopausal women identified by 22 trained GDPs based on cortical erosion finding in their dental clinics had low skeletal BMD (osteopenia or osteoporosis). Eight women (20.5%) had spine fractures. Our results suggest that higher percentage of postmenopausal women with osteopenia and osteoporosis as well as spine fractures may be identified based on trained GDPs' analyses of their panoramic radiographs.

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Figure legends

Figure 1. Panoramic radiographs of 58-year-old postmenopausal women with normal mandibular inferior cortex (a), mildly to moderately eroded cortex (b), and severely eroded cortex (c)

Figure 2. Lateral spine radiograph of 78-year-old postmenopausal woman with multiple thoraco-lumbar vertebral fractures

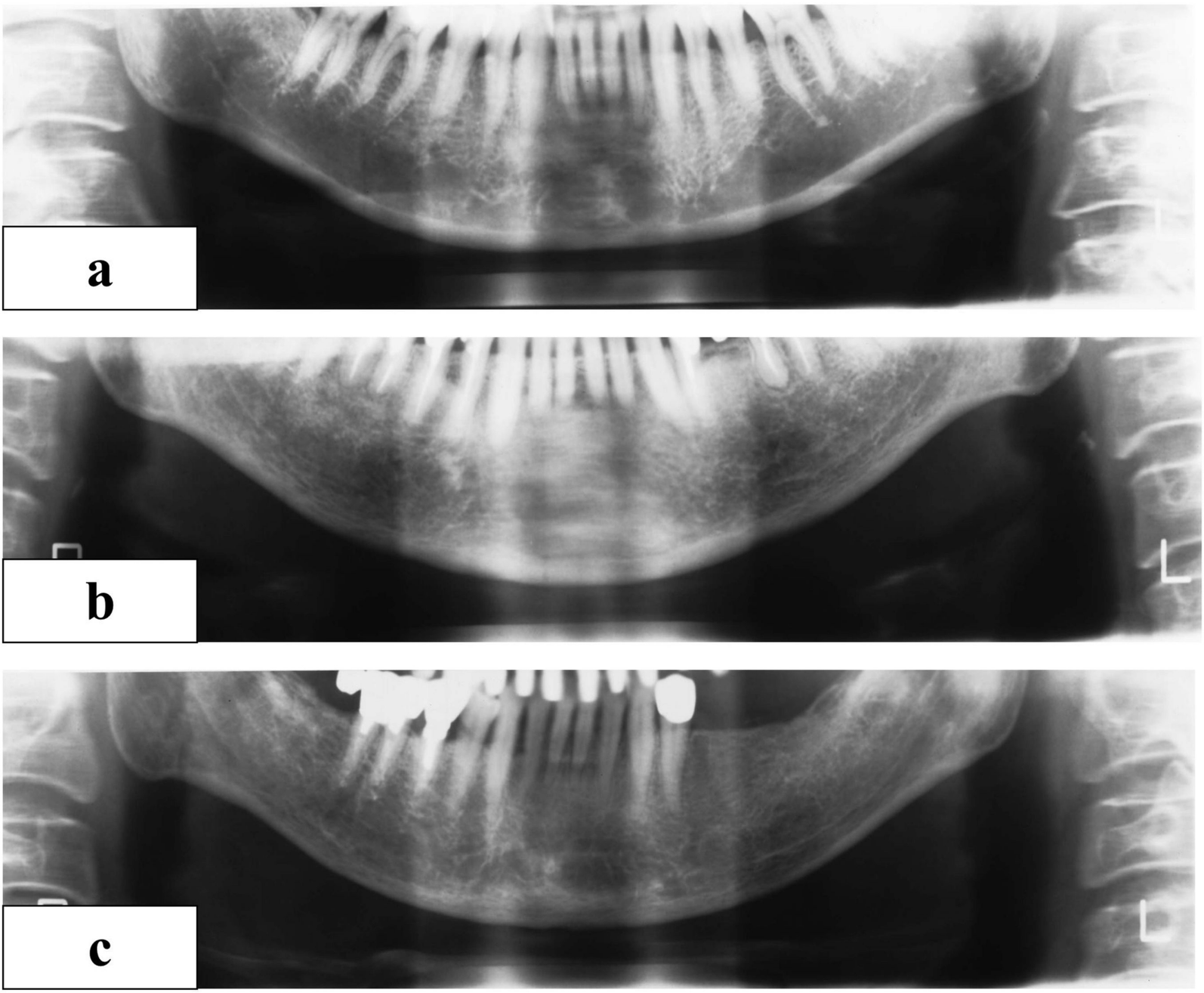

Figure 1

Figure 2

Table 1. Characteristics of 39 study subjects

	Mean +/- SD or number of subjects (% subjects)
Age (years)	64.8 +/- 7.5
Height (cm)	152.3 +/- 6.3
Weight (kg)	51.4 +/- 7.7
Age at menopause (years)	50.1 +/- 3.4
BMD T score of the lumbar spine	-1.65 +/- 1.26
BMD T score of the femoral neck	-1.99 +/- 0.73
WHO classification based on skeletal BMD	
Normal	2 (5.1%)
Osteopenia	21 (53.9%)
Osteoporosis	16 (41.0%)
Spine fractures	8 (20.5%)

WHO: World Health Organization; BMD: bone mineral density

Table 2. Characteristics of study subjects by cortical erosion finding on panoramic radiographs

	Cortical erosion finding		P-value*	Age adjusted P-value**
	Mildly to moderately	Severely		
No. of subjects	28	11		
Age (years)	63.1 +/- 6.0	69.1 +/- 9.3	0.023	
Height (cm)	153.5 +/- 5.3	149.3 +/- 7.8	0.058	0.493
Weight (kg)	52.5 +/- 7.0	48.6 +/- 9.1	0.151	0.543
Age at menopause (years)	50.5 +/- 3.6	49.0 +/- 2.8	0.228	0.197
BMD T score of the lumbar spine	-1.55 +/- 0.93	-1.90 +/- 1.90	0.572	0.940
BMD T score of the femoral neck	-1.83 +/- 0.93	-2.37 +/- 0.98	0.037	0.429
WHO classification based on BMD				
Normal	1 (3.6%)	1 (9.1%)		
Osteopenia	19 (67.9%)	2 (18.2%)	0.020	
Osteoporosis	8 (28.5%)	8 (72.7%)		
Vertebral fractures	5 (17.9%)	3 (27.3%)	0.663	

WHO: World Health Organization; BMD: bone mineral density; Data are shown as mean +/- SD or number of subjects (% subjects).

* Based on unpaired t-test, chi-square or Fisher exact test, ** Based on analysis of covariance