Relationships between mandibular cortical indexes, bone mineral density, and osteoporotic fractures in Brazilian men over 60 years old

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Objective. The aim of this study was to assess relationships between panoramic indexes, bone mineral density (BMD), and osteoporotic fractures in men >60 years old.

Study design. Body height and weight, body mass index, lumbar spine and hip BMD, and the presence of osteoporotic fractures were determined in the 127 studied men. Dental panoramic radiographs (DPRs) were used for measuring mandibular cortical indexes.

Results. BMDs were lower in patients with thinning and resorption of mandibular cortex. No association was found between mandibular indexes and the presence of osteoporotic fractures. In a forward stepwise logistic regression model, the odds of having a T score ≤−2.5 was increased by 1.97 times for every 1-mm reduction in average mandibular cortical width.

Conclusions. DPRs could show pronounced thinning of the inferior mandibular cortices in men >60 years old. However, there was no apparent association between vertebral fragility fractures and the appearance of mandibular cortex in elderly men. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:648-656)

Osteoporosis is a serious public health concern, which entails significant social and economic burdens. Because the number of elderly people is the fastest growing in the world, the high rates of fractures associated with substantial morbidity is notable, and costs of patients management are increasing rapidly.1 Postmenopausal women are more likely to develop osteoporosis and have the highest fracture risk. In a Brazilian study with individuals >70 years old, the prevalence of osteoporosis in women was 22% for the proximal femur and 33% for lumbar spine. In the same study, the prevalence of male osteoporosis was 6% for the proximal femur and 16% for the lumbar spine.2 However, men have a greater chance of being undertreated, being undiagnosed, or dying from fractures than women.3,4 Mortality after hip fracture is greater for men (20.7%) than for women (7.5%).5 Therefore, osteoporosis is considered a worldwide public health concern in the male population as well.6 The consequences of the disease in men tend to increase given present-day population demographics and increased life expectancy. The early identification of risk of fractures in men is the basis of any preventive osteoporosis program. Early intervention may maximize bone mass retention and enhancement and thus reduce the risk of fracture.

Bone mineral density (BMD) measurements, expressed as a T score, is mandatory to establish the diagnosis of osteoporosis and important to make treatment decisions. According to the World Health Organization (WHO) criteria,7 BMD values are divided according the following diagnostic guidelines: normal (T score ≥−1.0), osteopenia (−1.0 > T score ≥−2.5) and osteoporosis (T score ≤−2.5). Although osteoporosis is defined as a T score ≤−2.5, pharmacologic treatment should be considered for men with a T score ≤−2.0 and other clinical risk factors for fractures, such as family history of osteoporosis, glucocorticoid treatment, a personal history of fracture, active smoking, alcohol, etc.8

Vertebral fractures are one of the most common complications of osteoporosis. However, they are frequently asymptomatic and go unreported.9 A diagnosis of vertebral fracture carries prognostic information, independently from the results of dual-energy x-ray absorptiometry (DXA) measurements.10

Several clinical trials have demonstrated that a substantial improvement in the assessment of the risk for
future fractures can be accomplished by the assessment of prevalent fractures in combination with BMD measurements.\textsuperscript{11,12} Epidemiologic studies are difficult to carry out, because radiographic evaluation is one of the most common and useful methods used to identify the presence of vertebral fractures.\textsuperscript{13} Although DXA is considered to be the criterion standard assessment of bone strength and the best predictor for risk of fractures, its routine use in population screening is impractical.\textsuperscript{14} Several studies have demonstrated that the appearance of the inferior mandibular cortex on dental panoramic radiographs may provide an appropriate and more cost-effective use of DXA in postmenopausal women.\textsuperscript{15-19} Therefore, the wide availability of dental panoramic radiographs has been shown to be a potentially useful method for assessing an individual’s risk of osteoporosis.\textsuperscript{20} Only 1 study was found in the literature reporting 20 normal men and 20 men with osteoporosis where panoramic indexes (mental index [MI], panoramic mandibular index [PMI], and antegonial index [AI]) were lower among men with osteoporosis.\textsuperscript{21} This means that mandibular cortex is thinner in osteoporotic men compared with men with normal BMD.

Few studies have analyzed the relationships between the occurrence of fractures with mandibular cortical width and porosity in postmenopausal women, and the results are conflicting.\textsuperscript{22-25} Two of these studies used radiographic techniques for vertebral fractures identification,\textsuperscript{22,24} and the other 2 studies were based on reports of fractures.\textsuperscript{23,25} No study was found correlating BMD measured at the lumbar spine and hip, osteoporotic fractures, and panoramic dental indexes in men.

It would be interesting if dentists could refer men suspected of osteoporosis for further medical investigation. The purpose of this study was to assess whether or not there are relationships between panoramic radiomorphometric indexes, bone mineral density, and the presence of osteoporotic fractures in men aged over 60 years old.

**MATERIALS AND METHODS**

**Subjects**

Initially, 258 men aged >60 years were selected from the osteoporosis prevention and diagnosis program of the Federal District Health Department, Brazil, between 2007 and 2009. Of these men, 127 were included in this study. Participants who were previously diagnosed with any metabolic bone disease other than osteoporosis and those who had taken medications affecting bone metabolism were excluded. This study was approved by the Research Ethics Committee of the University of Brasília (Brazil), and informed consent was obtained from each of the individuals.

The subjects had an initial medical examination that included determining the body height and weight, body mass index (BMI), and smoking habits. Participants were classified as “nonsmokers,” “former smokers” and “current smokers.” An interview was also performed to determine nonvertebral fragility fractures, which was defined as a fracture with minimal trauma that was confirmed by either radiographic or medical report. Lumbar spine (L1-L4) and hip BMD was measured in all studied men by DXA. All individuals also underwent lateral spine radiographs for detecting vertebral fractures and dental panoramic radiographs.

**BMD assessment**

Lumbar spine (L1-L4) and hip DXA scans were performed by 1 experienced radiographer on the GE DPX-NT. BMD values were classified as normal (\(T\) score \(\geq -1.0\)), osteopenia (\(-1.0 > T\) score \(> -2.5\)) and osteoporosis (\(T\) score \(\leq -2.5\)), according to the WHO criteria. Osteoporosis was defined as a BMD \(T\) score of \(\leq -2.5\) at either the lumbar spine or the hip. The BMD \(T\) score at the hip was represented by the lowest \(T\) score at the femoral neck or the total hip. The coefficients of variation of the lumbar spine and the hip measurements were 1% and 1.6%, respectively. The DXA examiners were blinded to the radiographic results.

**Vertebral fracture assessment**

Lateral radiographs of the thoracic and lumbar spine were taken with a 101.6-cm tube-to-film distance using protocols in accordance with guidelines issued by the National Osteoporosis Foundation Working Group on Vertebral Fractures.\textsuperscript{26} Vertebral fractures were evaluated with the use of semiquantitative assessment based on vertebral shape (wedge, concave, or crush) and on decreases in anterior, posterior, and/or middle vertebral height (Grade 0, no reduction; grade 1, minimal fracture, 20%-25% height decrease; grade 2, moderate fracture, 25%-40% height decrease; and grade 3, severe fracture, >40% height decrease.\textsuperscript{27} Vertebral dimensions were measured with a caliper with accuracy to 0.05 mm (Starrett, São Paulo, Brazil). An experienced medical radiologist marked 6 points on each vertebral body from T4 to L4 to describe vertebral shape. The vertebrae were measured twice by the same observer with a 1-month interval between the assessments. The Cohen kappa index was 0.86 for intraobserver agreement.

**Dental panoramic radiographic measurements**

The dental panoramic radiographs of all subjects were taken with the same panoramic machine (Rograph Plus; Villa Medical System, Buccinisco, Italy) at 10 mA and 15 s; the voltage varied between 70 and 80 kV. Patients were positioned in the dental panoramic machine in such a way that the vertical line produced...
by the machine was aligned with the patient’s sagittal plane and the horizontal line (Frankfort plane) parallel to the floor. The following radiomorphometric indexes were measured bilaterally on each panoramic radiograph:

Simple visual estimation (Fig. 1, A): modification of the method proposed by others. The cortex was classified qualitatively in 3 categories based on simple visual estimations of mandibular inferior cortex widths: normal, intermediate, or very thin.

Mandibular cortical index (Fig. 1, B): The appearance of the inferior cortex of the mandible was classified as: C1) the endosteal margin of the
cortex was even and sharp; C2) the endosteal margin presented semilunar defects (lacunar resorption) or appeared to form endosteal cortical residues; or C3) the cortical layer formed heavy endosteal cortical residues and was clearly porous.  

Mental index (Fig. 1, C): measurement of the cortical width at the mental foramen region, according to the technique previously described. A line parallel to the long axis of the mandible and tangential to the inferior border of the mandible was drawn. A line perpendicular to this tangent intersecting the inferior border of the mental foramen was constructed, along which mandibular cortical width was measured with a caliper. Panoramic radiographs were viewed on a flat viewing box under dim lighting. Measurements were made manually, using an ×6 magnifying loupe (Brookstone, Merrimack, NH), a clear plastic protactor (Acrimet, São Paulo, Brazil) and the same caliper used to measure vertebral dimensions (Starrett). All measurements were made with the observers blinded to the reference osteoporotic diagnosis and to the spine radiographs results.

To quantify intraobserver agreements, all panoramic radiographs were analyzed twice by the main observer. There was a period of 1 month between readings. Another observer also measured the same radiographs to verify interobserver reliability. Both observers were oral and maxillofacial radiologists, with extensive experience of measuring panoramic radiomorphometric indexes. They were not aware of the DXA results and had no access to any information regarding the participants, such as age.

For the qualitative indexes (mandibular cortical index and visual estimation of cortical width), agreements were calculated as a Cohen kappa index. Intraclass correlation coefficients (ICCs) were used to verify the reproducibility of the mental index. P values of <.05 were considered to be statistically significant for both tests.

No significant differences between the right and left sides were found for any of the qualitative or quantitative indexes. Therefore, the right side was selected for further analyses.

For intraobserver agreement, all kappa values and ICCs were >.9. The kappa values for interobserver agreement were 0.775 and 0.856 for the mandibular cortical index and simple visual estimation of the cortical width, respectively. For the mental index, the ICC was 0.926 (95% confidence interval [CI] 0.896-0.947). Only the measurements and the classifications of the main observer were used in the analysis of all parameters.

Statistical analyses

The statistical analyses were performed with SPSS for Windows 13.0 (Statistical Package for the Social Sciences, Chicago, IL, USA). Calculations of means and SDs were performed. The correlations between the mental index and BMDs were tested with the Pearson correlation coefficient (r). Spearman correlation coefficient was used to test for correlation of mandibular cortical index with BMDs. χ² test was used to examine possible associations between the qualitative indexes and the presence of osteoporotic fractures, as well as between the qualitative indexes and BMDs.

The mean BMD values for each qualitative index were compared using a 1-way analysis of variance. This test was also used to compare the means of the quantitative indexes between patients with different densitometric diagnoses.

Receiver operating characteristic (ROC) curve analysis was used to determine the optimal cutoff threshold and the accuracy of cortical measurements in the diagnosis of osteoporosis, T score ≤-2.0, and osteoporotic fractures. The sensitivity, specificity, positive and negative predictive values, and likelihood ratio in identifying men with osteoporosis and a T score ≤-2.0 were tested with dichotomous 2 × 2 tables.

The same aforementioned measurements of accuracy were tested with dichotomous 2 × 2 tables for the qualitative indexes (mandibular cortical index and simple visual estimation of cortical index). For the mandibular cortical index, the subjects were divided into the following groups: 1) men diagnosed as C1 and C3; and 2) men with normal BMDs (T score ≥-1.0) and men with osteoporosis (T score ≤-2.5). To identify men with T score ≤ -2.0 in the mandibular cortex index, men classified as C1 and C3, and men with a T score ≤-2.0 and ≥-2.0 were considered. The testing of simple visual estimation of cortical width, on the other hand, included 2 groups: 1) men classified as having normal cortical widths and very thin cortices; and 2) men with normal BMDs (T score ≥-1.0) and men with osteoporosis (T score ≤-2.5). To identify men with T scores ≤-2.0 in simple visual estimation of cortical widths, men classified as having normal cortical widths and very thin cortices, and men with T scores ≤-2.0 and >-2.0 were considered.

Forward stepwise logistic regression models were used, using the following references: T score ≤-2.5 and T score ≤-2.0. Significance was achieved with P < .05 for all statistical tests.
RESULTS

Characteristics of the studied population are shown in Table I. The average age was 68.7 (range 60-97) years. Age was significantly correlated with BMD at the femoral neck ($r = -0.24$), and at the total hip ($r = -0.22$); $P < .05$. No correlation was found between age and BMD at the lumbar spine. Body mass index was significantly correlated with BMDs at the lumbar spine, femoral neck, and total hip ($r = 0.31, 0.42, 0.36$, respectively; $P < .05$). No association was found between weight, height, BMI, and the presence of osteoporotic fractures ($P > .05$). No correlation was found among any panoramic index, age, or BMI.

Relationship between mandibular indexes and bone mineral density

The Spearman correlation coefficients of the mandibular cortical index with BMDs were $-0.35$ (lumbar spine), $-0.37$ (femoral neck), and $-0.42$ (total hip); $P < 0.05$. The mental index demonstrated the following positive correlations with BMDs: lumbar spine: $r = 0.35$; femoral neck: $r = 0.29$; total hip: $r = 0.36$. Significant association was found between the visual estimations of cortical width and BMD at the 3 bone sites ($\chi^2$ test: $P < 0.05$). BMDs were significantly lower in patients with thinning and resorption of mandibular cortex identified by the panoramic indexes ($P < .05$).

Table I. Characteristics of the studied population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>68.7 ± 5.80</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.4 ± 11.8</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.63 ± 0.06</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>25.2 ± 3.43</td>
</tr>
<tr>
<td>Mental index (mm)</td>
<td>4.23 ± 1.60</td>
</tr>
<tr>
<td>Current smoking</td>
<td>35 (27.6)</td>
</tr>
<tr>
<td>Densitometric diagnosis</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>10 (7.9)</td>
</tr>
<tr>
<td>Osteopenia</td>
<td>53 (41.7)</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>64 (50.4)</td>
</tr>
<tr>
<td>T score ≤ -2.0</td>
<td>89 (70.0)</td>
</tr>
<tr>
<td>Number of teeth</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>53 (41.7)</td>
</tr>
<tr>
<td>1-9</td>
<td>33 (26.0)</td>
</tr>
<tr>
<td>≥10</td>
<td>41 (32.3)</td>
</tr>
<tr>
<td>Mandibular cortical index</td>
<td></td>
</tr>
<tr>
<td>Normal cortex (C1)</td>
<td>48 (37.8)</td>
</tr>
<tr>
<td>Moderately eroded (C2)</td>
<td>62 (48.8)</td>
</tr>
<tr>
<td>Severely eroded (C3)</td>
<td>17 (13.4)</td>
</tr>
<tr>
<td>Simple visual estimation of cortical width</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>50 (39.4)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>55 (43.3)</td>
</tr>
<tr>
<td>Very thin</td>
<td>22 (17.3)</td>
</tr>
</tbody>
</table>

Fig. 2. Lateral spine radiographs of 2 patients revealing compression fractures of the thoracic and lumbar vertebrae. A, Compression fractures of the L2 and L3 vertebral bodies, grades (G) 3 and 1, respectively. B, Compression fractures of T12 (G2), L1 (G1), and L2 (G2).

Relationship between mandibular indexes and osteoporotic fractures

Twenty-eight men presented osteoporotic fractures (4 nonvertebral and 26 vertebral fractures). Eighteen patients (69.2%) presented more than 1 vertebral fracture. In total, vertebral fractures were identified morphometrically in 58 vertebrae. Most of the fractures occurred in T10 (10th thoracic vertebra) to L2 (second lumbar vertebra). The distribution of the fractures, according to their degree of severity was 35 mild fractures (60.3%), 20 moderate fractures (34.5%), and 3 severe fractures (5.2%). Figure 2 demonstrates the grades of fractures in lateral spine radiographs of 2 studied men. From the 26 men with vertebral fractures, 2 presented both vertebral and nonvertebral fractures. The nonvertebral fractures were located in the hip (2), wrist, and rib. No association was found between the mandibular panoramic indexes and the presence of osteoporotic fractures ($P > .05$). Figure 3 shows an example of vertebral fractures, but with a normal mandibular cortex. No association was found between fractures and
dental panoramic indexes when vertebral fragility fractures were analyzed separately. Regarding the nonvertebral fractures, of the 4 patients with reports of fractures, one was classified as C1, 2 as C2 and 1 as C3, according to the mandibular cortical index. According to visual estimation of cortical index, patients with nonvertebral fractures were classified as very thin cortex (3) and intermediate cortex (1).

Accuracy of the panoramic indexes for identifying osteoporosis and $T$ score $\leq -2.0$

Regarding the mental index, the areas under the ROC curve for identification of men with osteoporosis and $T$ score $\leq -2.0$ were 0.771 and 0.737, respectively. The mental index optimal cutoff value was 3.92 mm for identifying men with osteoporosis, and 3.90 mm for identifying men with $T$ score $\leq -2.0$. Tables II and III show sensitivity, specificity, and positive (PPV) and negative (NPV) predictive values for osteoporosis diagnosis and $T$ score $\leq -2.0$, respectively.

Regarding the dental panoramic indexes, only the mental index entered into the forward stepwise logistic regression models adjusted for age and body mass index ($P < .05$). The odds of having a $T$ score $\leq -2.5$ and a $T$ score $\leq -2.0$ was increased by 1.97 (95% CI 1.28-3.03) and 1.85 (95% CI 1.25-2.75) times, respectively, for every 1-mm reduction in average mental index.

Fig. 3. Patient with vertebral fractures (T4 and T5, arrows) and normal mandibular cortex. A, Vertebral fractures were evaluated on lateral spine radiograph with the use of semiquantitative assessment based on vertebral shape and on decreases in anterior, posterior, and/or middle vertebral height. B, Magnification of the lateral radiograph showing mild fracture in T4 and severe fracture in T5, with narrowing and collapse of the vertebral bodies of T4 and T5 vertebrae. C, Magnification of the dental panoramic radiograph showing the cortex classified as normal and C1.
Table II. Sensitivity, specificity, and positive and negative predictive values (PPV and NPV) of the panoramic indexes for identification of men with osteoporosis by mandibular cortical index, visual estimation of cortical width, and the cutoff value of mental index (95% CI)

<table>
<thead>
<tr>
<th></th>
<th>Mandibular cortical index</th>
<th>Visual estimation of cortical width</th>
<th>Mental index (5.92 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.625 (0.585-0.665)</td>
<td>0.645 (0.606-0.685)</td>
<td>0.656 (0.617-0.695)</td>
</tr>
<tr>
<td>Specificity</td>
<td>1</td>
<td>1</td>
<td>0.900 (0.885-0.915)</td>
</tr>
<tr>
<td>PPV</td>
<td>1</td>
<td>1</td>
<td>0.977 (0.973-0.981)</td>
</tr>
<tr>
<td>NPV</td>
<td>0.400 (0.359-0.441)</td>
<td>0.389 (0.348-0.430)</td>
<td>0.290 (0.255-0.453)</td>
</tr>
</tbody>
</table>

Table III. Sensitivity, specificity, and positive and negative predictive values (PPV and NPV) of the panoramic indexes for identification of men with T score ≤ -2.0 by mandibular cortical index, visual estimation of cortical width, and the cutoff value of mental index (95% CI)

<table>
<thead>
<tr>
<th></th>
<th>Mandibular cortical index</th>
<th>Visual estimation of cortical width</th>
<th>Mental index (5.90 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.436 (0.394-0.478)</td>
<td>0.478 (0.435-0.521)</td>
<td>0.539 (0.497-0.582)</td>
</tr>
<tr>
<td>Specificity</td>
<td>1</td>
<td>1</td>
<td>0.895 (0.879-0.911)</td>
</tr>
<tr>
<td>PPV</td>
<td>1</td>
<td>1</td>
<td>0.923 (0.911-0.935)</td>
</tr>
<tr>
<td>NPV</td>
<td>0.542 (0.499-0.584)</td>
<td>0.520 (0.477-0.563)</td>
<td>0.453 (0.411-0.496)</td>
</tr>
</tbody>
</table>

Accuracy of the panoramic indexes for predicting osteoporotic fractures

Mandibular cortical index and visual estimation of cortical width have not yielded accurate predictions of osteoporotic fractures (Table IV). The area under the ROC curve for identifying men with osteoporotic fractures was 0.544 (95% CI 0.425-0.663) for the mental index. It was not possible to create a logistic regression model from the radiomorphometric indexes for predicting osteoporotic fractures.

DISCUSSION

In the 127 studied male subjects, there were associations between the panoramic radiomorphometric indexes and BMD. Only 10 subjects presented normal BMD. From these, none presented C3 classification by the mandibular cortical index. Moreover, none of them were shown to have very thin mandibular cortex evaluated by simple visual estimation of cortical width. The panoramic indexes also demonstrated accuracy in predicting the densitometric diagnosis of osteoporosis and T score ≤ -2.0. Subjects aged >60 years with severely eroded mandibular cortices or substantial thinning of the cortices presented lower BMD values. Furthermore, no association was found between panoramic indexes and the presence of osteoporotic fractures.

The higher prevalence of osteoporosis (50.4%) may be explained by the fact that this study was conducted in a sample of patients from primary health care service, contrasting with earlier studies with patients from secondary and tertiary health care services.²⁴,²⁹,³⁰

These results demonstrate the impact of the disease in the male population, reinforcing the need for prevention and early diagnosis of the disease. Because dental panoramic radiographs are frequently taken for the examination of teeth and jaws in general dental practice over the world, dentists could play an important role in referring patients with suspected osteoporosis for further medical examination.¹⁷

In our logistic regression models, only the mental index entered into the equation. Although the qualitative indexes (mandibular cortical index and visual estimation of cortical width) also correlated with BMDs, this subjective analysis should be used with caution in elderly men, who probably have a naturally thicker cortex than women. Therefore, when assessing mandibular cortical width in men, it is preferably to measure the mandibular cortex or to associate the qualitative and quantitative indexes. An earlier study has also verified that the mental index is significantly lower in men with osteoporosis than in those with normal BMD. Although that study did not find any relationship between mandibular cortical index and BMD in men, the authors

Table IV. Sensitivity, specificity, and positive and negative predictive values (PPV and NPV) of the qualitative panoramic indexes for identifying men with osteoporotic fractures (95% CI)

<table>
<thead>
<tr>
<th></th>
<th>Mandibular cortical index</th>
<th>Visual estimation of cortical width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.250 (0.218-0.282)</td>
<td>0.333 (0.295-0.372)</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.736 (0.702-0.769)</td>
<td>0.667 (0.628-0.705)</td>
</tr>
<tr>
<td>PPV</td>
<td>0.176 (0.151-0.201)</td>
<td>0.182 (0.156-0.207)</td>
</tr>
<tr>
<td>NPV</td>
<td>0.813 (0.786-0.839)</td>
<td>0.818 (0.793-0.844)</td>
</tr>
</tbody>
</table>
recognized the limitation of the sample size, with only 20 normal and 20 osteoporotic men.\textsuperscript{21} Another study found a significant correlation between mandibular cortical index and bone stiffness in 70-year-old Japanese subjects (263 men and 256 women) after controlling for confounding factors.\textsuperscript{31}

To our knowledge, the present study is the only one to have tested men aged \textgreek{>60} years regarding the associations between lumbar spine and hip BMD, nonvertebral and vertebral fragility fractures, and panoramic indexes. The lack of earlier studies with age- and gender-matched samples precludes direct comparisons. Another earlier longitudinal study also failed to find any association between cortical thickness of the mandible and the occurrence of reported fractures, but the authors recognized 3 important limitations.\textsuperscript{25} First, they mentioned the low number of reported fractures. The study, which began with 262 women and 397 men, ended after 5 years with 191 patients. Of these, 20 women reported fractures. There were no reports of fractures among men. Second, because spine radiographs were not obtained from the individuals, those fractures were probably underestimated. Finally, that study also did not differentiate traumatic and minimal trauma fractures. Earlier studies have found association between osteoporotic fractures and panoramic radiomorphometric indexes, but with significant methodologic limitations, such as sample size,\textsuperscript{22,24} unusual analysis of spine radiographs,\textsuperscript{22} and use of self-reports of fractures.\textsuperscript{23,25}

In the present study, most of the elderly men presented mandibular cortical erosions and thinning of this cortex, which may be accounted for the subjects’ advanced age. Other authors also have found higher probability of cortical thinning and erosions in elderly people.\textsuperscript{25,32}

Our study has also its own limitations. First, owing to the low number of nonvertebral fractures reported, it was not possible to conclude whether or not the nonvertebral fractures are associated with height, weight, and BMI. In the same way, the association between osteoporotic fractures and panoramic indexes should be better investigated, owing to the low number of nonvertebral fractures in this study. The panoramic indexes are based on cortical bone. The thoracic and lumbar vertebrae are composed predominantly of trabecular bone, which could also explain why no association was found between panoramic indexes and osteoporotic fractures in these bones. A recent study demonstrated that an index based on radiographic mandibular cortical width and clinical information, called osteodent index, has a predictive value for hip fracture risk, as determined by the WHO Fracture Risk Assessment Tool (FRAX).\textsuperscript{33} Another limitation in the present study was the low number of men with normal BMD, which may explain the low NPVs found. Finally, although some earlier studies have shown associations between tooth count and skeletal status,\textsuperscript{25,30} it was not possible to test such association in our study, owing to the high percentage of edentulous subjects and low number of remaining teeth. Further studies are needed to verify a possible connection between tooth loss and osteoporosis.

In conclusion, as previously demonstrated for postmenopausal women, dental panoramic radiographs could represent men aged \textgreek{>60} years with pronounced thinning or resorption of the inferior mandibular cortices who should be referred for further osteoporosis investigation. However, there is no apparent association between vertebral fragility fractures and the appearance of mandibular cortex in elderly men. Further studies are necessary both in men and women to verify whether there are associations between nonvertebral fragility fractures and panoramic radiomorphometric indexes.

REFERENCES


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