Efficacy of Panoramic Mandibular Index in Diagnosing Osteoporosis in Women

L. Khojastehpour 1, SH. Shahidi 1, S. Barghan 2, EL. Aflaki 3

1 Associate Professor, Department of Oral and Maxillofacial Radiology, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran
2 Oral Radiologist, Private Practice
3 Assistant Professor, Department of Romatology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract:
Objective: In this study, the usefulness of Panoramic Mandibular Index (PMI) on panoramic radiographs in diagnosis of osteoporosis was evaluated and its correlation with bone mineral density (BMD) of the neck of femur and spine was determined.

Materials and Methods: In this cross-sectional study, 140 patients (all females) were categorized as either normal, osteopenic or osteoporotic according to the WHO classification in relation to their spinal and femoral BMD determined by dual energy X-ray absorptiometry. Regarding menstruation, they were also divided into menopausal, non-menopausal, or oophorectomized groups. Panoramic radiographs were taken from all the women in the study. PMI was calculated. The data were analyzed using Kruskal-Wallis, Mann-Whitney, and Pearson tests.

Results: Specificity and sensitivity of PMI in differentiating normal and osteopenic/osteoporotic cases were 88% and 44%, respectively. The mean PMI of non-menopausal women was significantly different from those of menopausal and oophorectomized ones. There was a weak correlation between PMI and spinal BMD (r=0.23, P<0.05) and a moderate negative one between age and mean PMI (r=-0.45, P<0.0001).

Conclusion: Dental panoramic radiographs can be used in clinical practice to assist identifying individuals with low bone mass.

Key Words: Radiography, Panoramic; Osteoporosis; Bone Density

INTRODUCTION
Osteoporosis is one of the most common disorders of the elderly, increasing bone fragility and susceptibility to fracture, and is estimated to affect 75 millions people in Europe, Japan and the USA [1]. Clinical risk factors for low bone mass or fractures are low body weight, history of prior fragility fractures or corticoid steroid use, tallness, being female and elderly. Dentists are in a potentially valuable position for patient screening regarding signs of osteoporosis as a considerable proportion of population visit their dentist annually and dental radiographs are prescribed for many. The current golden standard for diagnosing osteoporosis is Bone Mineral Density (BMD) [2]. Practically, osteoporosis was defined by WHO as having a BMD 2.5 (standard deviations) below the mean for young adult women. Bone status at various sites may be assessed using dual energy X-Ray absorptiometry (DXA), quantitative ultrasound (QUS) or quantitative computed tomography (QCT) [3-5]. In the last four decades, numerous researchers have reported osteoporosis to be di-
agnosable through oral radiographs and as panoramic radiography is widely used for routine dental examinations, it would be very useful to determine if radiographic changes in the mandible can show skeletal osteopenia and have an important role in detection of osteoporosis.

Thickness of the inferior border of the mandible below the mental foramen has often been measured as the panoramic mandibular index (PMI) either directly or as a ratio of the thickness to the distance of the mental foramen from the inferior border [6]. This study was preformed to evaluate the diagnostic efficacy of PMI and its correlation with BMD of the femur (FBMD) and spine (SBMD).

MATERIALS AND METHODS
A cross-sectional study was performed from January 2003 to May 2003 on 140 female patients with a mean age of 53.6 years (SD=8.4 years), who were referred to Namazi Hospital of Shiraz University of Medical Sciences for evaluation of osteoporosis. Signed informed consents were obtained from all participants and twenty-six individuals were excluded from the study due to their bone metabolism altering medications. The samples were divided into three groups according to their menstruation status: menopausal, oophorectomized, and non-menopausal. They were also divided into normal, osteopenic, and osteoporotic groups in relation to their SBMD and FBMD determined by DXA measurements of the spine and femur according to WHO.

Panoramic x-rays were examined and measurements were made with a transparent millimeter ruler placed across the image perpendicular to the horizontal axis of the mandibular body.

Two measurements were recorded as the height from the lower border of the mandible to the lower border of the mental foramen and the height of the mandibular inferior cortex, which are indicating, by H (mm) and C (mm) respectively (Fig 1).

PMI was calculated according to the method of Benson et al [6] as a ratio of C/H. Panoramic radiographs were viewed by two maxillofacial radiologists three times with one-week intervals. The data were analyzed using Kruskal-Wallis, Mann-Whitney, and Pearson tests.

RESULTS
PMI sensitivity and specificity to differentiate normal and osteopenic/osteoporotic cases were determined as 44% and 88%, respectively (Table 1). There was a weak positive correlation between PMI and SBMD (r=0.23, P<0.05) and no correlation between PMI and FBMD (r=0.155, P>0.05).

Based on SBMD as well as FBMD, there was a statistically significant difference between the mean PMI of normal, osteopenic and osteoporotic women (P<0.05) (Table 2). As for women aged 50 years and older, the differences among mean PMIs of normal, osteopenic, and osteoporotic groups in relation to their SBMD and FBMD determined by DXA measurements of the spine and femur according to WHO.

Table 1. The ability of PMI to discriminate between normal and osteopenic/osteoporotic cases.

<table>
<thead>
<tr>
<th>PMI</th>
<th>Normal</th>
<th>Osteopenic/Osteoporotic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥0.33</td>
<td>42</td>
<td>37</td>
<td>79</td>
</tr>
<tr>
<td>&lt;0.33</td>
<td>6</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>66</td>
<td>114</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>44%</td>
<td>Specificity Negative</td>
<td>88%</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>53%</td>
<td>Negative predictive value</td>
<td>83%</td>
</tr>
</tbody>
</table>

PMI=panoramic mandibular index

2009; Vol. 6, No. 1
groups was significant (P<0.0001), however, there were no such differences between the PMIs of menopausal and oophorectomized women (P=0.41).

Regarding SBMD of normal, osteopenic, and osteoporotic women in menopausal and oophorectomized groups, the difference among the mean PMIs was significant; however, based on the FBMD, there was a significant difference among the mean PMIs of normal, osteopenic, and osteoporotic women only in the menopausal group. Both intra and inter observer agreements in PMI measurement were also recorded in the Intra and inter observer agreements were 94 % and 96% respectively.

DISCUSSION
In our study, the differences of mean PMI among menopausal, oophorectomized, and non-menopausal women were statistically significant. On the other hand, according to the literature, most of the studies evaluating the efficacy of dental panoramic radiography in identifying individuals with low bone mass have been performed on the menopausal group. Therefore, PMI of the subjects were also evaluated in relation to their BMD and menstruation. Statistical analysis showed that the mean PMI of menopausal osteoporotic women was significantly different from those without osteoporosis; whilst, in the non-menopausal group there was no such difference between PMI values of normal and osteoporotic subjects.

There was a strong negative correlation between age and the mean PMI (r=-0.45, P<0.0001), meaning that by getting older the mean PMI decreased.

Diagnostic efficacy of panoramic-based indices including mandibular cortical index (MCI), height of mandibular inferior cortex IC, PMI and mandibular ratio has previously been evaluated through which it was shown that the ability of mandibular variables to discriminate between normal and osteopenic/osteoporotic subjects was generally low to moderate; however, PMI revealed the best specificity, sensitivity along with negative and positive predictive values (81%, 79%, 81%, 79%, respectively). In our study, the ability of PMI to differentiate normal and osteopenic/osteoporotic cases revealed a specificity of 88%, a sensitivity of 44%, and a negative predictive value of 83% with a positive predictive value of 53% (Table 2). Similarly, in the previous study, FBMDs of 30 post-menopausal 48 to 71 year old women were evaluated, while our study was based on

Table 2. PMI data of women studied by SBMD and FBMD.

<table>
<thead>
<tr>
<th>Group</th>
<th>SBMD N</th>
<th>Mean PMI (SD)</th>
<th>P value</th>
<th>FBMD N</th>
<th>Mean PMI (SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>34</td>
<td>0.37 (0.07)</td>
<td></td>
<td>42</td>
<td>0.37 (0.07)</td>
<td></td>
</tr>
<tr>
<td>Osteopenic</td>
<td>44</td>
<td>0.34 (0.06)</td>
<td>0.0001</td>
<td>52</td>
<td>0.34 (0.06)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Osteoporotic</td>
<td>36</td>
<td>0.30 (0.08)</td>
<td></td>
<td>20</td>
<td>0.26 (0.07)</td>
<td></td>
</tr>
</tbody>
</table>

PMI=panoramic mandibular index, SBMD=BMD of the femur, FBMD=BMD of the spine, SD=standard deviation
SBMD and FBMDs of 114 non-menopausal, oophorectomized, and menopausal females [7].

We found a correlation between PMI and SBMD (r=0.23, P<0.05) which seems comparable with the results depicted earlier showing weak but significant correlations (r=0.20-0.24, P<0.001) between PMI and BMD of spine and femoral neck measured by DXA in 355 postmenopausal women [8]. In the study, the authors concluded that it is difficult to find a strong positive correlation between PMI and general mineral status of the skeleton in a population of postmenopausal middle-aged women. However, PMI can perhaps be used as an indicator of bone mineral changes, when the values deviate markedly from mean PMI of the population. Contrary to our results, there have been colleagues reporting cortical bone thickness not differentiating postmenopausal osteoporotic women from non osteoporotic ones through their study [10,11].

Mean mandible cortical width (P<0.0001), cortical index (P<0.0001) and trabecular features (P=0.02) have been pointed out to be significantly different in the three bone density groups (normal, osteopenic or osteoporotic) based on FBMD [12].

In the present study, we found a significant negative correlation between the width of the mandibular inferior cortex and SBMD (r=-0.36). They also suggested that the mandibular inferior cortical shape in dental panoramic radiographs may as well be an indicator of bone turnover and SBMD in postmenopausal women [9]. In another study, the cortex was reported to be significantly thinner in subjects with osteoporotic fractures compared to controls, which confirms our results, nevertheless, there have been colleagues reporting cortical bone thickness not differentiating postmenopausal osteoporotic women from non osteoporotic ones through their study [10,11].

### Table 3. PMI of women studied by SBMD or FBMD and menstruation.

<table>
<thead>
<tr>
<th>Menstruation</th>
<th>SBMD</th>
<th>Normal</th>
<th>Mean PMI (SD)</th>
<th>N</th>
<th>Osteopenic</th>
<th>Mean PMI (SD)</th>
<th>N</th>
<th>Osteoporotic</th>
<th>Mean PMI (SD)</th>
<th>N</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menopaused</td>
<td>0.32 (0.06)</td>
<td>25</td>
<td>0.37 (0.08)</td>
<td>15</td>
<td>0.29 (0.07)</td>
<td>29</td>
<td>0.003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oophorectomized</td>
<td>0.36 (0.07)</td>
<td>11</td>
<td>0.36 (0.07)</td>
<td>5</td>
<td>0.25 (0.06)</td>
<td>4</td>
<td>0.021</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-menopaused</td>
<td>0.38 (0.05)</td>
<td>8</td>
<td>0.38 (0.06)</td>
<td>14</td>
<td>0.44 (0.04)</td>
<td>3</td>
<td>0.162</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Menopaused</td>
<td>0.32 (0.05)</td>
<td>31</td>
<td>0.37 (0.08)</td>
<td>22</td>
<td>0.25 (0.05)</td>
<td>16</td>
<td>0.0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oophorectomized</td>
<td>0.35 (0.08)</td>
<td>13</td>
<td>0.35 (0.03)</td>
<td>5</td>
<td>0.21 (0.07)</td>
<td>2</td>
<td>0.071</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-menopaused</td>
<td>0.37 (0.03)</td>
<td>8</td>
<td>0.39 (0.06)</td>
<td>15</td>
<td>0.41 (0.12)</td>
<td>2</td>
<td>0.808</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PMI=panoramic mandibular index, SBMD=BMD of the femur, FBMD=BMD of the spine, SD=standard deviation
difference was found in the over 50 years age group (Table 3). Previous studies did not demonstrate any significant correlation between age and mean PMI in normal, osteopenic and osteoporotic groups [7,13].

In our study, we observed both intra and interobserver agreements (K=0.70, 0.66, 0.68). The use of PMI in clinical practice with a trained observer seems to be sufficient. Most authors have concluded that there are limitations in repeatability of PMI assessments, which might restrict its utility in clinical practice. This appears not to be correct according to our study.

**CONCLUSION**

As dental panoramic radiographs are usually prescribed for patients in dental practices, they can be used in clinical practice to assist in identifying individuals with low bone mass. Once patients are identified in the dental office as being at risk of osteoporosis, they should be referred to a physician for appropriate evaluations and undergo further tests such as bone densitometry.

**ACKNOWLEDGMENTS**

We would like to thank the office of Vice Chancellor for Research of Shiraz University of Medical Sciences for financial support, Dr. Lankarani, Dr. Bagheri, Mr. Talezadeh and the staff of the Department of Bone Densitometry of Namazee Hospital for their sincere cooperation.

**REFERENCES**


