Is panoramic mandibular index a reliable marker in the evaluation of bone mineral density and sexual dimorphism??

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Abstract

Introduction: Osteoporosis is a silent, progressive, and chronic disease affecting bones of the adults, especially postmenopausal women. Its effect on mandibular bone quality has also been described by some authors in men inferring that gender and age are factors that may influence bone mineral density (BMD) and prognosis. The panoramic radiograph is used widely for the early detection of osteoporosis. The present study was undertaken to evaluate whether the panoramic mandibular index (PMI) is useful for BMD and sexual dimorphism. Materials and Methods: A total of 60 patients (30 males and 30 females) in the age group of 25–40 years were selected for the study. Orthopantomograph was taken and PMI determined with the help of Sidexis next-generation software. All the measurements were performed by four observers and data subjected to the statistical analysis. Results: The mean superior PMI was 0.22–0.27, and the inferior PMI was 0.28–0.34. The mean superior and inferior linear measurements from the mental foramen were higher in males than females and statistically significant. The mean mandibular cortical width was 3.8–4.7 mm but did not show much gender difference. Conclusion: PMI is a reliable indicator for determining BMD but is not much influenced by gender variation.

Key words: Bone mass, estrogen, radiomorphometric index

Introduction

Bone undergoes incessant transformation caused by the concurrent processes of resorption and regeneration known as bone remodeling. This turnover ensures continuous replacement of old bone tissue, in turn, affects bone adaptation to various mechanical forces exerted on the skeleton. Quantity and quality of the jaw bone have important roles in the success of dental care. The detection of an eroded or thin inferior cortex of the mandible on orthopantomogram may be useful for identifying patients with low bone mineral density (BMD), skeletal osteopenia, or osteoporosis.[1,3]
Osteoporosis is defined as “a disease characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk.”[4,5] Although osteoporosis has been established as an imperative disease in postmenopausal women, its effect on mandibular bone quality has also been described by few studies in men, assuming that sex and age are factors that may influence BMD and the prognosis of osteoporosis. Nevertheless, details on the difference between males and females remain vague in the literature.[1,6]

Panoramic mandibular index (PMI) is a radiomorphometric index used in the detection of osteoporosis and osteopenia and also the discretion to differentiate between the two conditions. It is the ratio of the thickness of the mandibular cortex to the distance between the mental foramen and the inferior mandibular cortex. A thin mandibular cortical width (MCW) has been shown to be correlated with reduced skeletal BMD.[2,3] Considering the above background, the aim and objective of the present study were to evaluate whether the PMI is useful for BMD and sexual dimorphism.

Materials and Methods

The study was initiated after the protocol had been approved by the institutional committee of research ethics. A total of 60 patients (30 males and 30 females) in the age group of 25–40 years attending the Outpatient Department of Oral Medicine and Radiology, Dental Institute, RIMS were selected for the study by simple random sampling. The importance of this study was explained to all the patients and instructed to remove any dental appliances and metal objects from the head-and-neck region before the procedure. Informed consent was obtained for the same.

The patients were subjected to digital orthopantomogram (Sirona Orthophos XG Model M6317007S08585, Germany) with proper radiation protection measures with exposure factors as applicable to their age. The radiographs were then stored with patients details incorporated. The following parameters were being measured using Sidexis next-generation software: (1) distance between the superior margin of the mental foramen and the inferior border of the mandible (SL), (2) distance from the inferior margin of the mental foramen to the inferior border of the mandible (IL), and (3) MCW. Henceforth, PMI was calculated as: superior PMI (sPMI = MCW/SL) and inferior PMI (iPMI = MCW/IL). All the parameters were measured bilaterally on all radiographs, and the mean of right- and left-sided measurements was calculated [Figure 1].

All the measurements were performed by four observers to avoid any bias and reproduce better results. The data obtained were recorded in a pro forma especially designed for the study and subjected to the statistical analysis using $t$-test. The Pearson’s correlation was performed to determine the intraobserver reproducibility. The significance level was based on $P < 0.05$.

Results

The mean range of SL and IL was found to be 16.93–17.25 mm and 13.31–14.03 mm, respectively. The mean range of MCW was found to be 3.91–4.60 mm. The mean range of sPMI was calculated to be 0.23–0.27 and iPMI 0.29–0.34, respectively.

The mean SL and IL were higher in males when compared to females with a mean difference of 1.07–1.35 mm and 1.00–1.18 mm, respectively, and found to be statistically significant at $P < 0.05$ [Figures 2 and 3]. The mean range of MCW did not show much gender difference (males - 3.96–4.71 mm and females - 3.86–4.54 mm) and found to be statistically nonsignificant [Figure 4]. The mean sPMI and iPMI were slightly higher in females (sPMI: 0.23–0.27, iPMI: 0.29–0.35) than males (sPMI: 0.22–0.26, iPMI: 0.27–0.33) with a mean difference of 0.01–0.02 and 0.01–0.03, respectively, and statistically nonsignificant [Figures 5 and 6].

The Pearson’s correlation was performed to obtain intraobserver reproducibility and found to be statistically significant at $P$ value $<0.05$ [Tables 1 and 2].

Discussion

PMI has been presented as a radiomorphometric method in 1991 by Benson et al. who suggested, despite the alveolar bone resorption above the mental foramen, the distance from the mental foramen to the inferior border of the mandible remains relatively constant throughout the life. Difficulties in assessing PMI could be attributed to an inability of identifying the borders of the mental foramina.[7,8] In the present study, sPMI and iPMI were measured bilaterally on all radiographs and the mean calculated.

The mean range of sPMI and iPMI was 0.23–0.27 and 0.29–0.35 in females and 0.22–0.26 and 0.27–0.33 in
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males, respectively, in the present study. This was in
accordance with studies conducted by Benson et al. in
the American population (mean PMI - 0.26–0.25 in females
and 0.31–0.35 in males). Similar results were observed
by Bathla et al. (males - 0.30–0.38 and females - 0.28–0.36)
and Rao et al. (males and females - 0.26–0.28) in the Indian
population. The present study sufficiently demonstrates

measurement of the thickness of the MCW in panoramic
radiographs is also useful to evaluate patients with low BMD. A cortical width of 3 mm was considered
the most appropriate threshold for referral for bone
densitometry by Devlin and Horner. White et al. and
Klemetti et al. believed that it is more pertinent to post
the threshold in the mid 4 mm range. The mean range
of MCW was 3.96–4.71 mm in males and 3.86–4.54 mm in
females in the present study which was in accordance
with the threshold limit in previous studies.

Sexual hormones such as testosterone in males and estrogen
in females encourage bone growth. Bone mass increases
constantly and reach the peak bone mass at the age of 40 in
males and 30–35 in females. Estrogen prevents osteoporosis
by inhibiting the stimulation effect on specific cytokines in
the osteoclast. Decreased levels of estrogen will increase the
sensitivity of osteoclasts to parathyroid hormone. Moreover,
estrogen deficiency affects the active Vitamin D synthesis in
renal tubules and lead to reduction of calcium absorption.

Considering sexual dimorphism, the mean sPMI and
iPMI were slightly higher in females than males with a
mean difference of 0.01–0.02 and 0.01–0.03, respectively
which was found to be statistically nonsignificant. Sexual

Table 1: Pearson’s correlation for superior panoramic mandibular
index to evaluate intraobserver reliability

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<tr>
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<th>sPMI1</th>
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<td>sPMI1</td>
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<tr>
<td>sPMI2</td>
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Table 2: Pearson’s correlation for inferior panoramic mandibular
index to evaluate intraobserver reliability

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<tbody>
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<tr>
<td>iPMI2</td>
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<td>iPMI3</td>
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<tr>
<td>iPMI4</td>
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<td>0.814</td>
<td>1.000</td>
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sPMI: Superior panoramic mandibular index
iPMI: Inferior panoramic mandibular index
dimorphism was absent in studies conducted by Benson et al., Rao et al., and Bathla et al., whereas observed positively by Kalinowski et al.[6,9,10,12] On the contrary, the mean superior and inferior linear measurements from the mental foramen (SL and IL) were significantly higher in males than females at $P < 0.01$.

**Limitation**
The sample size in our study was small and should be conducted on a larger sample to conclude and obtain beneficial results.

**Conclusion**
The results of the present study showed that PMI can be considered as a reliable indicator for determining BMD but is not much influenced by gender discrepancy. PMI is one of the most accurate radiomorphometric indices because of its method of calculation that takes account of the differences in magnification associated with different panoramic equipments.

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**Conflicts of interest**
There are no conflicts of interest.

**References**