ORIGINAL ARTICLE

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

Tanya Khaitan,
Anjani Kumar Shukla,
Prashant Gupta,
Shantala R. Naik
Department of Oral Medicine and Radiology, Dental Institute, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India

Address for correspondence:
*Dr. Prashant Gupta,
Department of Oral Medicine and Radiology, Dental Institute, Rajendra Institute of Medical Sciences, Ranchi - 834 009, Jharkhand, India.
E-mail: prashantgupta.omr@gmail.com*

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.[1] Quantity and quality of the jaw bone have important roles in the success of dental care.[2] 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]

Access this article online	
Website: www.jfds.org	**Quick Response Code**
DOI: 10.4103/jfo.jfds_92_19	

How to cite this article: Khaitan T, Shukla AK, Gupta P, Naik SR. Is panoramic mandibular index a reliable marker in the evaluation of bone mineral density and sexual dimorphism??. J Forensic Dent Sci 2019;11:133-6.

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
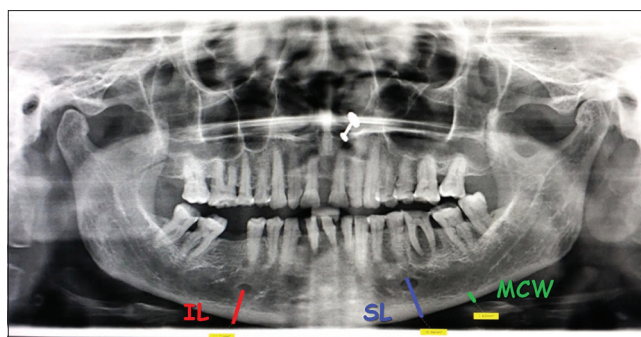

Figure 1: Orthopantomogram showing measurement of SL, IL and mandibular cortical width with the help of Sidexis next-generation software

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
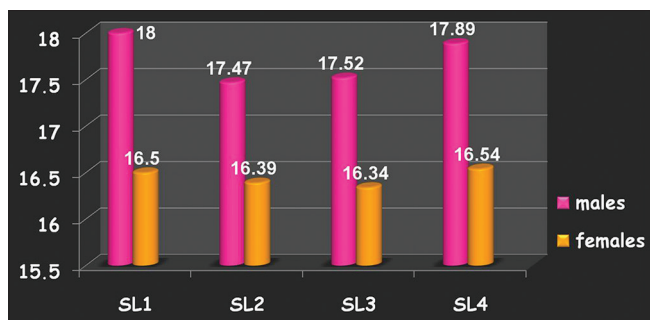
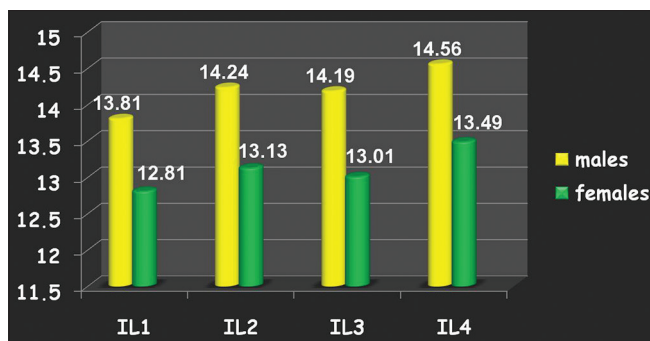**Figure 2:** Graph showing higher values of SL in males than females

Figure 3: Graph showing higher values of IL in males than females
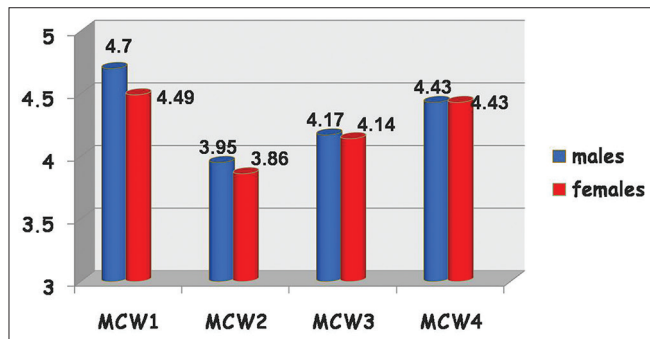

Figure 4: Graph showing no significant difference in levels of mandibular cortical width in males than females
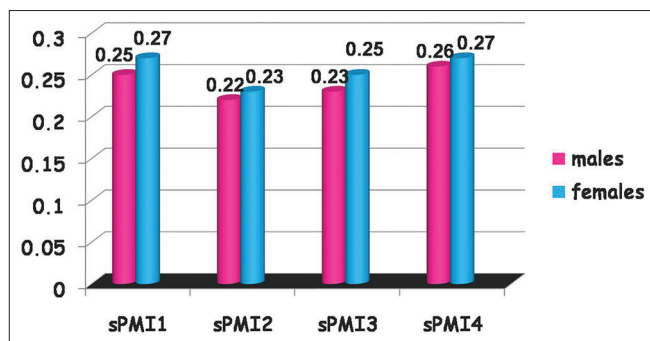

Figure 5: Graph showing slightly higher superior panoramic mandibular index in females than males

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

	sPMI1	sPMI2	sPMI3	sPMI4
sPMI1	1.000			
sPMI2	0.031 $P=0.812$	1.000		
sPMI3	0.832 $P=0$	0.136 $P=0.297$	1.000	
sPMI4	0.527 $P=0$	0.184 $P=0.157$	0.560 $P=0$	1.000

sPMI: Superior panoramic mandibular index

Table 2: Pearson's correlation for inferior panoramic mandibular index to evaluate intraobserver reliability

	iPMI1	iPMI2	iPMI3	iPMI4
iPMI1	1.000			
iPMI2	0.284 $P=0.027$	1.000		
iPMI3	0.874 $P=0$	0.335 $P=0.008$	1.000	
iPMI4	0.805 $P=0$	0.253 $P=0.05$	0.814 $P=0$	1.000

iPMI: Inferior panoramic mandibular index

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).[9] 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.[6,10] The present study sufficiently demonstrates

the reliability of this radiomorphometric index in identifying individuals with a greater risk of osteoporosis as all the parameters were measured by four observers.

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.[5] 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.[11]

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
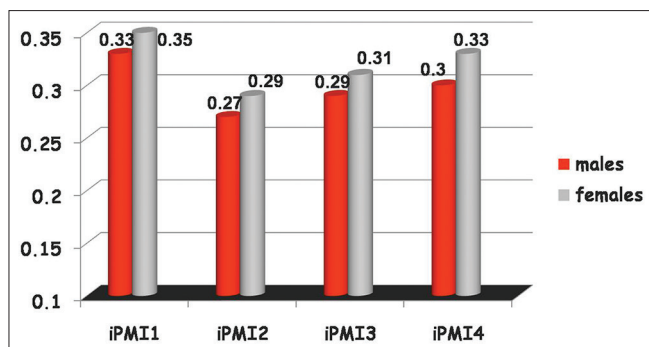
Figure 6: Graph showing slightly higher inferior panoramic mandibular index in females than males

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.

References

1. Alonso MB, Cortes AR, Camargo AJ, Arita ES, Haiter-Neto F, Watanabe PC. Assessment of panoramic radiomorphometric indices of the mandible in a brazilian population. ISRN Rheumatol 2011;2011:854287. doi: 10.5402/2011/854287. Epub 2011 Sep 14.
2. Hardanti S, Azhari, Oscandar F. Description of mandibular bone quality based on measurements of cortical thickness using mental index of male and female patients between 40-60 years old. Imaging Sci Dent 2011;41:151-3.
3. Khojastehpour L, Shahidi SH, Barghan S, Aflaki EL. Efficacy of panoramic mandibular index in diagnosing osteoporosis in women. J Dent Tehran Univ Med Sci Tehran, Iran 2009;6:11-15.
4. Bajoria AA, AshaMl, Kamath G, Babshet M, Patil P, Sukhija P. Evaluation of radiomorphometric indices in panoramic radiograph – A screening tool. Open Dent J 2015;9:303-10.
5. Hastar E, Yilmaz HH, Orhan H. Evaluation of mental index, mandibular cortical index and panoramic mandibular index on dental panoramic radiographs in the elderly. Eur J Dent 2011;5:60-7.
6. Bathla S, Srivastava SK, Sharma RK, Chhabra S. Panoramic mandibular index: Effect of age and gender related variations in the North-Indian population. Int J Med and Dent Sci 2015;4:765-74.
7. Akshita D, Asha V. Reliability of panoramic radiographic indices in identifying osteoporosis among postmenopausal women. J Oral Maxillofac Radiol 2017;5:35-9.
8. Kwon AY, Huh KH, Yi WJ, Lee SS, Choi SC, Heo MS. Is the panoramic mandibular index useful for bone quality evaluation? Imaging Sci Dent 2017;47:87-92.
9. Benson BW, Prihoda TJ, Glass BJ. Variations in adult cortical bone mass as measured by a panoramic mandibular index. Oral Surg Oral Med Oral Pathol 1991;71:349-56.
10. Rao GS, Chatra L, Shenai P. Evaluation of adult cortical bone mass as measured by panoramic mandibular index-A radiological study. Webmed Cent Radiol 2011;2:WMC001447.
11. Saran G, Misra N, Umapathy D, Channaiah SG, Singh P, Srivatava S. Evaluation of the relationship of mandibular cortical index and panoramic mandibular index with bone mineral density using panoramic radiography in postmenopausal women: A short study. J Indian Acad Oral Med Radiol 2015;27:539-43.
12. Kalinowski P, Różyło-Kalinowska I. Panoramic radiomorphometric parameters in polish patients. Folia Morphol (Warsz) 2011;70:168-74.