Original Article

A Comparative Evaluation of Panoramic Radiomorphometric Indices in Preliminary Diagnosis of Osteoporosis between Both Genders

Ruchita Patel[1]*, Jigar Joshi[1], Riddhi Patel[2], Raksha P. Chavada[2], Kavan A. Patel[3], Sareen S. Duseja[3]

[1]Department of Oral Medicine and Radiology, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.
[2]Private Practitioner, Oral Medicine, and Radiologist, Visnagar, Gujarat, India.
[3]Department of Prosthodontics and Crown and Bridge, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.

Abstract

Background: This study aimed to evaluate the bone mineral density among both genders to diagnosis of osteoporosis and by these results we can plan our future various dental treatments among these patients. **Materials and Method:** A total number of 200 individuals, 100 males and 100 females, between the age ranges of 20−70 years were selected for the present study based on the selection criteria and divided in to 5 age groups. Radio morphometric indices such as (MI) panoramic mandibular index (PMI), mandibular cortical index (MCI), and (QUS) quantitative ultrasound were assessed for evaluation of bone mineral density in both the genders. **Results:** The study showed that mean MI and PMI values were more in male patients as age increases then female patients and in MCI values were higher in female patients then male patients which was commonly found in osteopenic and osteoporotic patients than patients with normal bone mineral density. T-score increased in female as the age was increases then the male patients. **Conclusion:** We can conclude that panoramic radiomorphometric indices can be used as an inexpensive alternative screening method to assess the bone mineral density and identify individuals at risk of osteoporosis and fractures.

Keywords: Bone mineral density, Osteopenia, Osteoporosis.

Introduction

Osteo' is a Latin word for "bones," "penia" stands for "less" and word "pores" suggests "holes." Bone remodeling is a coordinated process of cellular activity that is responsible for the renewal and repair of damaged bone throughout adult life.[1] Osteoporosis is a well-known and common systemic skeletal disease, characterized by low bone mass and microarchitectural deterioration of bone tissue, with subsequent increase in bone fragility and risk of fractures.[2] Besides a natural reduction in bone mineral density with age, the National Osteoporosis Foundation has identified many risk factors and predisposing factors for osteoporosis and related fractures in women with the age above 45 years. The prevalence of vertebral fractures increases rapidly after the age of 65 years in women. However, they are frequently asymptomatic and they go undetected. Therefore, we should focus on identifying subjects with high risk of fractures and preventing osteoporosis-related mortality and morbidity as early as possible.[3]

The detection of an eroded or thin inferior cortex of the mandible on dental panoramic radiographs may be useful for identifying patients with low bone mineral density (BMD), skeletal osteopenia, or osteoporosis.[2] In our study, we have also assessed BMD by modernized techniques such as QUS (quantitative ultrasound) in different age groups between genders.

Materials and Methods

A total of 200 individuals, 100 males and 100 females, between the age ranges of 20 and 70 years were selected in this study. The proposal for study was approved by the Institutional Ethical Committee NPDCH, Visnagar on 19/01/2017[CDSCO NO: ECR/600/Inst/GJ/2014/RR-20]. The procedure followed

Access this article online

Website: www.jrad.co.in

DOI: https://doi.org/10.53064/jrad.2022.13.4.207

Address for correspondence: Dr. Ruchita Patel, Department of Oral Medicine and Radiology, Narsinhbhai Patel Dental College and Hospital, Sankalchand Patel University, Visnagar, Gujarat, India.
Email: rk1dentist4u@gmail.com

Received: Mar. 02, 2022; **Accepted:** Mar. 22, 2022; **Published:** May. 16, 2022

How to cite this article: Patel R, Joshi J, Patel R, Chavada RP, Patel KA, Duseja SS. A Comparative Evaluation of Panoramic Radiomorphometric Indices in Preliminary Diagnosis of Osteoporosis between Both Genders. J Res Adv Dent 2022;13(4):85-89.

was by the ethical standards of Helsinki Declaration of 1964 and later versions. The selected individuals had their Digital Panoramic radiograph and BMD analysis done using necessary radiation protection measures after taking their consent.

The sample size was calculated using the formula:

$N=z^2[p(1-p)]^2/ME^2$

The study population consisted of 200 subjects belonging to both genders and all subjects were selected for routine Panaromic radiographic examination.

We excluded these patients with history of smoking, alcohol and tobacco habits without any systemic diseases, females with menstrual irregularities (e.g., Pregnancy, lactation, eumenorrheic, oligomenorrhea, and amenorrhea), patients with history of any metabolic bone disease (e.g., hyperparathyroidism, Paget's disease, osteomalacia, renal osteodystrophy, or osteogenesis imperfecta), cancer with bone metastasis, significant renal impairment, and osteomyelitis from our study.

The patients for the study were selected randomly from individuals reporting to the department after they fulfilled the selection criteria. The selected individuals were explained the intention and procedures to be performed and subsequently consented voluntarily to be part of the study. Panoramic radiograph was obtained for all these selected subjects employing Kodak 8000 C machine. All the linear measurements for radio-morphometric analysis (e.g., MCI, MI, and PMI were obtained from these radiographs using Kodak Dental Imaging Software).

All measurements were done by the same operator. Subsequently bone mineral density (BMD) was measured from right calcaneus of selected subjects using quantitative ultrasound machine (Osteosys SONOST-2000). Mean, ANOVA test, Pearson's coefficient of correlation, chi-square independence test, *post hoc* Tukey test was used for analyzing data.

The following radio morphometric indices were measured on each radiograph (Figure 1):

1. Mental Index (MI): Mandibular cortical thickness was measured on the line which was perpendicular to the bottom of the mandible at the middle of the mental foramen.

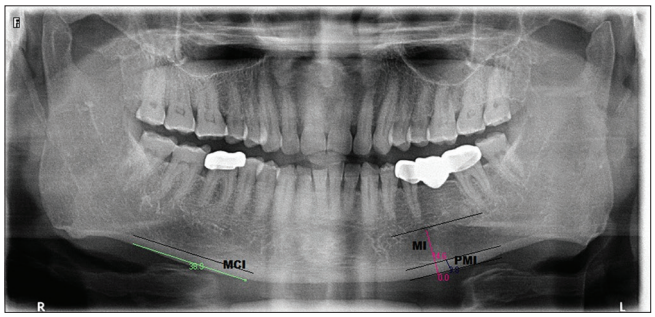

Figure 1: All the measurements on OPG have recorded. (a) MCI, (b) MI, (c) PMI

2. Panoramic Mandibular Index (PMI): The PMI is the ratio of the thickness of the mandibular cortex to the distance between the mental foramen and the inferior mandibular cortex.
3. Mandibular cortical index (MCI): The thinning of the inferior mandibular cortex was observed on both side of the mandible distal to the mental foramen. Classification of the appearance of the lower border of cortex of the mandible distal to the mental foramen, described by Klemetti *et al*.

C1 - Endosteal margin of the cortex is even and sharp on both sides

C2 - Endosteal margin shows semilunar defects (lacunar resorption) and/or seems to form endosteal cortical residues on one or both sides.

C3 -The cortical layer forms endosteal cortical residues and is clearly porous.

Results

In the cases of mean PMI value of 100 male patients was 0.348 ± 0.07 and 100 female patients was 0.350 ± 0.07. Non-significant difference was present in PMI values between male and female patients as P = 0.845 (Table 1). Among the following age group of 20−30 years, mean PMI value between male and female patients was 0.766, with age group of 31−40 years PMI value between male and female patients was 0.765, with age group of 41−50 years PMI value between male and female patients was 0.277, with age group of 51−60 years PMI value between male and female patients was 0.939, and with age group of more than 60 years PMI value between male and female patients was 0.881 (Table 1).

In the cases of mean MI score were higher in male patients (11.20 ± 1.52 mm) than female patients (10.15 ± 1.30 mm) who were statistically significant between male and female patients P = 0.000 (Table 2). Among the all age group of male patients, highest mean MI value with age group of 31−40 years (11.46 ± 1.49 mm), followed by 41−50 years (11.26 ± 1.31 mm), >60 years (11.23 ± 1.44 mm), 51−60 years (11.15 ± 1.87 mm), and 20−30 years (10.77 ± 1.37 mm) (Table 2).

Among the all age group of female patients, the highest mean MI value with age group of 41–50 years (10.42 ± 1.17 mm) followed by 51−60 years and also 31−40 years (10.37 ± 1.24 mm), >60 years (9.81 ± 1.39 mm), and 20−30 years (9.40 ± 1.38 mm) (Table 2). In the cases of MCI value in genders, majority of the female patients were having C2 score (46%) followed by C1 (29%) and C3 (25%) score. Majority of the male patients were having C1 score (57.1%) followed by C2 (37.8%) and C3 (7%) score. Statistically significant difference was present between gender and MCI score as P = 0.000 (Table 3).

Out of 200 patients, 85 patients were having C1 score, 83 patients were having C2 score, and 32 patients were

Table 1: Mean PMI values in male and female patients

Age groups (in years)	Male Mean±SD	Female Mean±SD	DIFF	*P* value
20–30	0.343±0.04	0.348±0.06	0.005	0.766^{NS}
31–40	0.334±0.07	0.328±0.07	0.006	0.765^{NS}
41–50	0.320±0.06	0.353±0.08	0.033	0.277^{NS}
51–60	0. 371±0.06	0.373±0.07	0.002	0.939^{NS}
>60	0.387±0.08	0.394±0.09	0.007	0.881^{NS}
Total	0.348±0.07	0.350±0.07	0.002	0.845^{NS}

Test used: (Unpaired t-test), S: Significant, NS: Non significant, *P*<0.05=S, *P*>0.05=NS

Table 2: Mean MI values among the genders in various age groups

Age group (years)	Male Mean±SD (mm)	Female Mean±SD (mm)	Difference	*P* value
20–30	10.77±1.37	9.40±1.38	1.37	0.002^{S}
31–40	11.46±1.49	10.37±1.24	1.11	0.001^{S}
41–50	11.26±1.31	10.42±1.17	0.84	0.084^{NS}
51–60	11.15±1.87	10.37±1.24	0.78	0.150^{NS}
>60	11.23±1.44	9.81±1.39	1.42	0.065^{NS}
Total	11.20±1.52	10.15±1.30	1.05	0.000^{S}

Test used: (Unpaired *t*-test), S: Significant, NS: Non-significant, *P*<0.05=S, *P*>0.05=NS, SD: Standard deviation, MI: Mental index

Table 3: Comparison of MCI value in both gender

Gender	MCI			*P* value
	C1	C2	C3	
Male	56 (57.1%)	37 (37.8%)	7 (7%)	0.000 S
Female	29 (29%)	46 (46%)	25 (25%)	
Total	85 (85%)	83 (83%)	32 (32%)	

Test used: (Chi-square test), S: Significant, NS: Non-significant, *P*<0.05=S, *P*>0.05=NS, MCI: Mandibular cortical index

Table 4: Comparison of bone mineral density (QUS-mean t score)

Gender	Mean T score	*P* value
Male	−1.44±0.83	0.387^{NS}
Female	−1.54±0.79	
Difference	0.10	

Test used: (Unpaired *t*-test), S: Significant, NS: Non-significant, *P*<0.05=S, *P*>0.05=NS

having C3 score. In the cases of mean bone mineral density (QUS-mean T score) in both the gender mean bone mineral density was (−1.44 ± 0.83) in male patients and (−1.54 ± 0.79) in female patients who were statistically non-significant difference present in between male and female patients and *P* = 0.387 (Table 4).

Mean t-score in female patients was lesser than male patients and that difference was 0.10 also shows that bone mineral density in female patients was decreases.

Discussion

Dental panoramic radiography is frequently performed for the diagnosis of diseases which affect the dentomaxillofacial complex. The incidental findings which are detected on dental panoramic radiographs may be used to identify bone mineral density to evaluate osteoporosis among the genders in different age groups. Study has compared all these indices (MI, PMI, and MCI) and T –score by QUS measured for evaluation of bone mineral density.[4-7]

Handa *et al*. in her study was conclude that with increasing age (60–70 and 70–80 years) there was decrease in the value of MI and comparison of mean values of indices among male and female groups and it was statistically significant for MI. There was no difference showed between gender groups.[8] Study was done by Mohammed *et al*. also showed that the MI was higher in younger age groups. MI was higher in men than women which was correlate with in the present study.[9]

In our study, MI value was higher in male patients (11.20 ± 1.52 mm) than female patients (10.15 ± 1.30 mm). Statistically significant difference was present between male and female patients as *P* = 0.000. Yashoda Devi *et al*. in her study showed PMI values found that the values that decrease with increasing age are smaller among white individuals than among black individuals and among women compared with men. They are also smaller in female patients with osteoporosis than in healthy female individuals; this was found statistically significant in the present study at *P* < 0.001.[10-13]

Bajoria *et al*. evaluated PMI in his study which was decreased with age and was smaller among women when compared with men; which is similar to the study done by Dagistan S Furthermore, a gradual increase was found up to the sixth decade and then decreased, which was found in our study as well.[3,4]

In our study, PMI value in elder women patients (>60 year) showed non significantly higher measurement with Mean ± SD (mm) as compare to the male patients (>60 year) and lowest measurements found in women patients (31–40 years) with Mean ± SD (mm) as compare to male patients (41–50 years).

According to Bajoria *et al*. patients showed C3 type of MCI among which all were elderly females.[4] In a study done by Gulsahi *et al*., patients with C3 type of MCI should be considered as high-risk individuals for osteoporosis irrespective of age and gender.The radiomorphometric index assessment in the present study showed that the mean PMI in younger individuals was 0.69 whereas in older individuals it was 0.64. Furthermore, the mean PMI in males was 0.73 whereas in females it was 0.58. In a study conducted by Benson *et al.,* the mean PMI in younger females and males was 0.32 and the value of PMI showed a negative correlation with the age and was found to be 0.353 and 0.266 in males and females, respectively.[3-7]

In our study MCI value, majority of the female patients were having C2 followed by C1 and C3. Majority of the male patients were having C1 followed by C2 and C3. Statistically significant difference was present between gender and MCI score as $P = 0.000$.

Akshita *et al*.[14] and Mamadou Lamine *et al*.,[15] MCI was a reliable index in identifying osteoporosis ($P = 0.01$). The findings in our study reported postmenopausal women with distinctly thinner and porous mandibular cortices presented with the lower BMDs which were in congruent with the study done by Bras *et al.* We observed a relatively high frequency of moderately eroded cortex on orthopantomographs (OPGs) of women aged between 50 years and 60 years. This finding was in accordance with the studies done by Katarzyna *et al*.[16] and Khaled Abdullah *et al*.[16] who reported that patients with the lower BMD values in the mandible have a much more porous mandibular cortex. Unlike the other quantitative indices, MCI (qualitative index) did not require exact identification of radiographic landmarks and precise measurements.[17-19]

The MCI is subjective in nature and requires repeated training, which explains its lower reproducibility, both indices, MCI and MCW, have been studied more extensively and in more depth than the other indices. When the MCI was introduced by Klemetti *et al*., they were not enthusiastic about its potential, so they did not recommend it for identifying osteoporosis in women. It is possible that Klemetti *et al*. expected a stronger correlation of jawbone measurements with bone fragility status.[20,21]

Comparison of bone mineral density (QUS-mean t score) among both gender, mean t-score was decreased in female as compared to male patients, which was statistically non-significant in our study.

Shakeel *et al*. reported that male and female were compared T score separately by paired *t*-test, it was observed that there was no statistically significant difference between the two groups. Reduced bone mineral density (BMD), and thus the development of osteoporosis, is more pronounced in postmenopausal women than in male patients.[22-26]

Conclusion

Finally, dentists who use MCI, PMI, AI, and MI can be measured on a panoramic radiograph, hence, could be used as a screening tool for determining osteoporosis because, it is most often advised as a part of routine investigation and as it is also less expensive than QUS scan. Mandibular Cortical Index can reliably be used as a diagnostic tool for screening patients with osteoporosis. By utilizing the results of this study, undertaking further studies in this field may throw some light on patients with secondary osteoporosis and on male patients with low bone mineral density.

MI and MCI indices in this study have a significant difference between the female and male groups. All indices measured on a panoramic radiograph were significantly lower in females when compared to males of the same age group. Thus radiomorphometric indices in a panoramic radiograph may possibly be used as a potential screening tool in identifying individuals with osteoporosis.

References

1. Jagelavičienė E, Krasauskienė A, Žalinkevičius R, Vaitkevičienė I, Kubilius R. Relationship between the mandibular cortical index and calcaneal bone mineral density in postmenopausal women. Medicina 2016;52:125-31.
2. 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.
3. Wanjari PV, Basavaraj P. Evaluation of panoramic radiographs as a screening tool of osteoporosis in post-menopausal women: A cross sectional study. J Clin Diagn Res 2013;7:2051-5.
4. Bajoria AA, Ml A, 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. Gulsahi A, Yuzugullu B, Imiralioglu P, Genc Y. Assessment of panoramic radiomorphometric indices in Turkish patients of different age groups, gender and dental status. Dentomaxillofac Radiol 2008;37:288-92.
6. Nemati S, Kajan ZD, Saberi BV, Arzin Z, Erfani MH. Diagnostic value of panoramic indices to predict osteoporosis and osteopenia in postmenopausal women. J Oral Maxillofac Radiol 2016;4:23-30.
7. Gaur B, Chaudhary A, Wanjari PV, Sunil MK, Basavaraj P. Mineral evaluation of panoramic radiographs as a screening tool of osteoporosis in post-menopausal women: A cross sectional study. J Clin Diagn Res 2013;7:2051-5.
8. Handa H, Singh A. Evaluation of mandibular indices in panoramic radiography. Int Dent J Stud Res 2020;8:60-4.
9. Cakur B, Dagistan S, Sahin A, Harorli A, Yilmaz AB. Reliability of mandibular cortical index and mandibular bone mineral density in the detection of osteoporotic women. Dentomaxillofac Radiol 2009;38:255-61.
10. Devi BK, Rakesh N, Ravleen N. Diagnostic efficacy of panoramic mandibular index to identify postmenopausal women with low bone mineral densities. J Clin Exp Dent 2011;3:e456-61.
11. Dagistan S, Bilge OM. Comparison of antegonial index, mental index, panoramic mandibular index and mandibular cortical index values in the panoramic radiographs of normal males and male patients with osteoporosis. Dentomaxillofac Radiol 2010;39:290-4.
12. Hastar E, Yilmaz HH, Orhan H. Evaluation of mental index, mandibular cortical index and panoramic mandibular index on dental panoramic radiographs in elderly. Eur J Dent 2011;5:60-7.
13. Taguchi A, Ohtsuka M, Tsuda M, Nakamoto T, Kodama I, Inagaki K, *et al*. Risk of vertebral osteoporosis in post-menopausal women with alterations of the mandible. Dentomaxillofac Radiol 2007;36:143-8.
14. Akshita D, Asha V. Reliability of panoramic radiographicindices in identifying osteoporosis among postmenopausal women. J Oral Maxillofac Radiol 2017;5:35-9.
15. Lamine M, Abdou P, Mamadou S, Augustin V, Babacar T. Radiographic evaluation of mandibular bone remodeling by mandibular cortical index (MCI) in a Senegalese population. J Oral Med Oral Surg Oral Pathol Oral Radiol 2018;4:136-8.
16. Grocholewicz1 K, Janiszewska-Olszowska J, Aniko-Włodarczyk M, Preuss O, Trybek G, Sobolewska E, *et al*. Panoramic radiographs and quantitative ultrasound of the radius and phalanx III to assess bone mineral status in postmenopausal women. BMC Oral Health 2018;18:127.
17. Miliuniene E, Alekna V, Peciuliene V, Tamulaitiene M, Maneliene R. Relationship between mandibular cortical bone height and bone mineral density of lumbar Spine. Stomatologija 2008;10:72-5.
18. Grocholewic K, Janiszewska-Olszowska J, Aniko-Wodarczyk M, Preuss O, Trybek G, Sobolewska E, *et al*. Panoramic radiographs and quantitativeultrasound of the radius and phalanx III to assess bone mineral

status in postmenopausal women. BMC Oral Health 2018;18:127.
19. Taguchi A, Suei Y, Sanada M, Ohtsuka M, Nakamoto T, Sumida H, *et al*. Validation of dental panoramic radiography measures for identifying post-menopausal women with spinal osteoporosis. AJR Am J Roentgenol 2004;183:1755-60.
20. Barngkgei I, Halboub E, Almashraqi AA, Khattab R, Al Haffar I. IDIOS: An innovative index for evaluating dental imaging-based osteoporosis screening indices. Imaging Sci Dent 2016;46:185-202.
21. Klemetti E, Kolmakov S, Kröger H. Pantomography in assessment of the osteoporosis risk group. Scand J Dent Res 1994;102:68-72.
22. Shakeel MK, Daniel MJ, Srinivasan SV, Koliyan R, Kumar JV. Comparative analysis of linear and angular measurements on digital orthopantomogram with calcaneus bone mineral density. J Clin Diagn Res 2015;9:12-6.
23. Balto KA, Gomaa MM, Feteih RM, AlAmoudi1 NM, Elsamanoudy AZ, Hassanien MA, *et al*. Dental panoramic radiographic indices as a predictor of osteoporosis in postmenopausal Saudi women. J Bone Metab 2018;25:165-173.
24. Leite AF, Figueiredo PT, Guia CM, Melo NS, de Paula AP. Correlations between seven panoramic radiomorphometric indices and bone mineral density in postmenopausal women. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109:449-56.
25. Mahl CR, Licks R, Fontanella VR. Comparison of morphometric indices obtained from dental panoramic radiography for identifying individuals with osteoporosis/osteopenia. Radiol Bras 2008;41:183-7.
26. Yasar F, Akgunlu F. The differences in panoramic mandibular indices and fractal dimension between patients with and without spinal osteoporosis. Dentomaxillofac Radiol 2006;35:1-9.