Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 3664 - 3670
Received 20 January 2021; Accepted 08 February 2021.

Efficacy of the Panoramic Radiography for Exploring Bone Mineral Density and Oral Health

Ankur Jethlia[1], Honey Lunkad[2],Shaista Haleem[3],FazilArshad Nasyam[4]

[1]Assistant Professor, Department of Maxillofacial and Diagnostic sciences, Diagnostic Division College of Dentistry Jazan University;
[2]Assistant Professor, Department of Prosthetic Dental Sciences, College of Dentistry, Jazan University, Saudi Arabia;
[3]MSc Restorative and Aesthetic Dentistry (Manchester UK), Faculty Dental Health department Inaya Medical College Riyadh ELM University [REU];
[4]Assistant Professor, Department Of Oral And Maxillofacial Surgery And Diagnostic Sciences College Of Dentistry, Prince Sattam Bin Abdulaziz University, Al-Kharj, Riyadh, KSA
[1]Email id: jethliaankur@yahoo.co.in
[2]Email id: drhoney_82@yahoo.co.in

ABSTRACT

Background: Established osteoporosis is not possible to return to normal condition, but in many cases, it can be prevented with early intervention. With increasing age, progressive changes occur throughout the body, including osteoporotic.This disease can be diagnosed by panoramic radiography in dental clinics.

Aim: The aim of the present study was to evaluate the diagnostic efficacy of the panoramic radiographs in the assessment of BMD and the influence of gender and dental status on the various indices.

Materials and Methods: 1000 dental panoramic radiographs of patients reporting at the Department of Oral Diagnosis and Radiology were evaluated for radio morphometric indices. PMI and MI were calculated using 17" screen, 1024 x 768 minimum screen, resolution - 32 bits colour mode, and were calculated by a maxillofacial radiologist.The relationship between these indices among different age groups and gender were analysed using the Chi-square test, independent‘t' test, and Post Hoc Bonferroni test.

Results: Statistical analyses revealed a significant difference between the results of each group analysed in both male and female patients. Chi-square test was applied and a significant difference was found between MCI and gender and age group respectively. Correlation between age and PMI was statistically significant between group 1 and group 2; group 1 and group 3; however the difference between group 2 and group 3 was not statistically significant. Correlation between age and MI was evaluated using the Post hoc Bonferroni test. Statistically significant differences were found between group 1 and group 2; group 1 and group 3; however the difference between group 2 and group 3 was not statistically significant.

Conclusion:MI and PMI, in the present study, present a statistically significant correlation with respect to the age of the study subjects ($P<0.05$). MI and PMI had a significant relationship with MCI ($P<0.05$).

Keywords: Bone mineral density, Osteoporosis, indices, panoramic radiography.

Keynote: Bone mineral density (BMD) refers to the amount of mineral matter per square centimetre of bones. It is used in clinical medicine as an indicator of osteoporosis and fracture risk. Osteoporosis is a systemic skeletal disease characterized by a loss in bone mineral density and micro-architectural deterioration in bone tissue leading to enhanced bone fragility and increased risk of fracture

INTRODUCTION

Bone mineral density (BMD) refers to the amount of mineral matter per square centimetre of bones. It is used in clinical medicine as an indicator of osteoporosis and fracture risk. Osteoporosis is asystemic skeletal disease characterized by a loss in bone mineral density and micro-architectural deterioration in bone tissue leading to enhanced bone fragility and increased risk of fracture.[1] Osteopenia refers to bone density that is lower than normal peak density but not low enough to be classified as osteoporosis. It is recently acknowledged as one of the main public health issues of developed countries.[2]

Factors such as weight, age, functional level, nutritional state, previous fracture history, use of anticonvulsant effect the BMD in children and adults. [3] Factors affecting the BMD in jawbones are the history of extraction, denture wearing, muscular activity, drug intake, the thickness of mandibular bone, number of teeth present, etc.[4]There is a considerable correlation between the densities of skeletal and jawbones; therefore, the density of skeletal bones and the presence of osteoporosis or osteopenia in these bones might reflect the same state in the jaws or vice versa.[5]

Dual-energy X-ray Absorptiometry (DEXA) is considered to be the gold standard for the estimation of bone mineral density due to good precision of the measurements, and the availability of reliable reference ranges. [6]

Panoramic radiography has been used as an excellent tool for the overview of the maxillofacial area, including many of the vital structures, such as the maxillary sinus, inferior alveolar nerve, and nasal fossa. It can also be used to predict low mineral density in patients.A numberof indices, namely the mandibular cortical index (MCI), panoramic mandibular index (PMI), and mental index (MI) have been developed to assess the quality of mandibular bone mass and to observe signs of osteopenia on panoramic radiographs.[7]

The aim of the present study was to evaluate the diagnostic efficacy of the panoramic radiographs in the assessment of BMD and the influence of gender and dental status on the various indices.

MATERIAL AND METHODS

1000 dental panoramic radiographs of patients reporting at the Department of Oral Diagnosis and Radiology were evaluated for radio morphometric indices. All panoramic radiographs were made using KODAK 8000C Digital Panoramic and Cephalometric Extraoral Imaging System (Focal Spot size: 0.5 mm (IEC 336), Tube voltage: 60-90 kV, Tube current: 2-15 mA, Exposure time: 13.9 s., Magnification: 1.27%, Grey scale: 16384 (14bits). Linear measurements were performed using KODAK Dental Imaging Software Windows v6.5.4.

Patients without any systemic diseases that would affect bone metabolism and possibly cause bone lesions and fractures were included in the study. Patients with a history of maxillofacial trauma with reconstruction were excluded from the study.

MCI was calculated by observing the inferior cortex distal to the mental foramen bilaterally, using the criteria described by Klemettiet al. (1997) [8]

C 1 - The endosteal margin of the cortex is even and sharp on both sides of the mandible.

C 2 - The endosteal margin has semilunar defects (resorption cavities) with cortical residues one to three layers thick on one or both sides.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 3664 - 3670
Received 20 January 2021; Accepted 08 February 2021.

C 3 - The endosteal margin consists of thick cortical residues and is clearly porous.
PMI represents the ratio of the thickness of the mandibular cortex to the distance between the inferior margin of mental foramen and the inferior mandibular cortex.[9] MI is the measurement of the cortical width on the line perpendicular to the bottom of the mandible at the middle of the mental foramen.[10] Cortices of male and female subjects are depicted in Figure 1 and 2 respectively.
These indices were viewed using a Sony VAIO VGN-CS118E and calculated using 17" screen, 1024 x 768 minimum screen, resolution - 32 bits colour mode, and were calculated by a maxillofacial radiologist.
The relationship between these indices among different age groups and gender were analysed using the Chi-square test, independent‘t’ test, and Post Hoc Bonferroni test.

RESULTS
Out of 1000 patients, 403 were males and 597 were females. 368 were <25 years of age (group 1), 357 were 25-35 years of age (group 2) and 275 were above >35 years (group 3). The C1 category of MCI was observed in 734 patients (274 males, 460 females), whereas C2 was observed in 266 patients (129 males, 137 females) (Table 1).
Statistical analyses revealed a significant difference between the results of each group analysed in both male and female patients. Chi-square test was applied and a significant difference was found between MCI and gender and age group respectively (Table 2). Independent‘t' test was applied and a significant difference was found between PMI, MI, and gender (Table 3).
Correlation between age and PMI was evaluated using the Post hoc Bonferroni test. Statistically significant differences were found between group 1 and group 2; group 1 and group 3; however the difference between group 2 and group 3 was not statistically significant (Table 4).
Correlation between age and MI was evaluated using the Post hoc Bonferroni test. Statistically significant differences were found between group 1 and group 2; group 1 and group 3; however the difference between group 2 and group 3 was not statistically significant (Table 4)

Crosstab					
			MCI		Total
			1	2	
aGEgRP	< 25	Count	368	0	368
		% within aGEgRP	100.0%	.0%	100.0%
	25 - 35	Count	220	137	357
		% within aGEgRP	61.6%	38.4%	100.0%
	> 35	Count	146	129	275
		% within aGEgRP	53.1%	46.9%	100.0%
Total		Count	734	266	1000
		% within aGEgRP	73.4%	26.6%	100.0%

Table 1: MCI and age group correlation

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 3664 - 3670
Received 20 January 2021; Accepted 08 February 2021.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	216.811[a]	2	<.001
Likelihood Ratio	302.867	2	.000
Linear-by-Linear Association	190.643	1	.000
N of Valid Cases	1000		

Table 2: Chi-square test 0 cells (.0%) have expected count less than 5. The minimum expected count is 73.15.

Independent Samples Test								
		t-test for Equality of Means						
		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
PMI	Equal variances assumed	5.173	998	<.001	.03428	.00663	.02128	.04728
	Equal variances not assumed	5.256	907.934	.000	.03428	.00652	.02148	.04708
MI	Equal variances assumed	6.569	998	< .001	.41921	.06381	.29398	.54443
	Equal variances not assumed	6.809	956.381	.000	.41921	.06157	.29838	.54004

Table 3: Independent t test for MI and PMI

Dependent Variable	(I) aGEgRP	(J) aGEgRP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PMI	< 25	25 - 35	-.03481*	.00766	<.001	-.0532	-.0164
		> 35	-.02361*	.00822	.012	-.0433	-.0039
	25 - 35	< 25	.03481*	.00766	<.001	.0164	.0532
		> 35	.01120	.00827	.528	-.0086	.0310
	> 35	< 25	.02361*	.00822	.012	.0039	.0433

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 3664 - 3670
Received 20 January 2021; Accepted 08 February 2021.

		25 - 35	-.01120	.00827	.528	-.0310	.0086
MI	< 25	25 - 35	-.39742*	.07372	<.001	-.5742	-.2206
		> 35	.02273	.07910	1.000	-.1670	.2124
	25 - 35	< 25	.39742*	.07372	<.001	.2206	.5742
		> 35	.42014*	.07962	<.001	.2292	.6111
	> 35	< 25	-.02273	.07910	1.000	-.2124	.1670
		25 - 35	-.42014*	.07962	<.001	-.6111	-.2292

Table 4: **Post Hoc Tests Multiple Comparisons** *. The mean difference is significant at the 0.05 level.

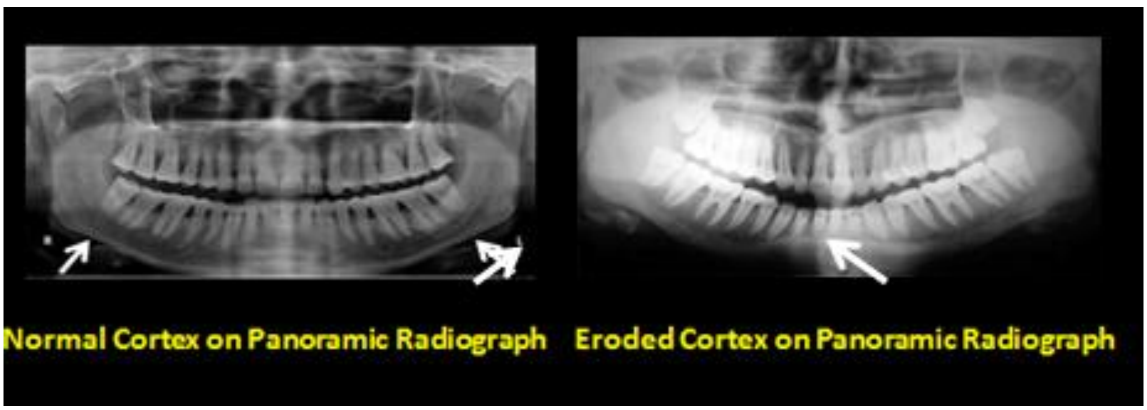

Figure 1: Normal and Eroded Cortex in a male subject

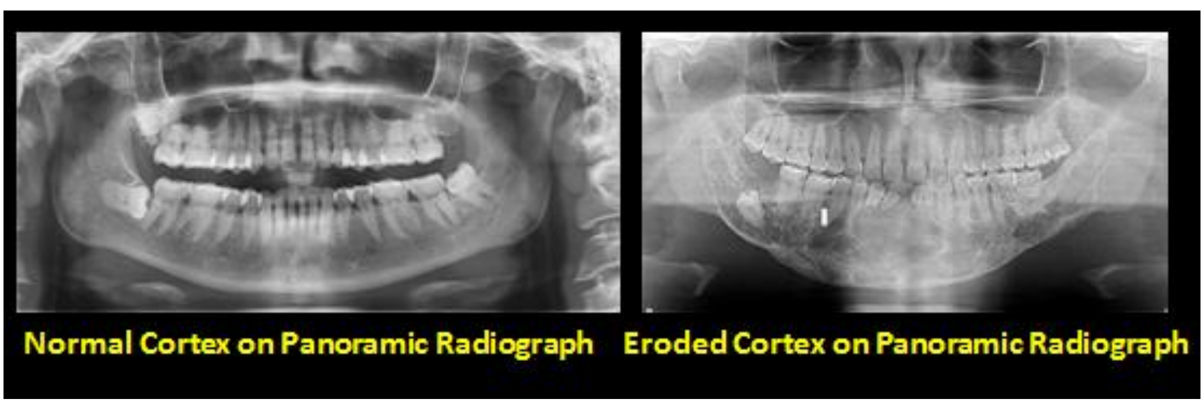

Figure 2: Normal and Eroded Cortex in a Female subject

DISCUSSION

The present study was carried out to evaluate the diagnostic efficacy of the panoramic radiographs in the assessment of BMD and the influence of gender and dental status on the various indices. In the present clinical trial, 1000 dental panoramic radiographs of patients reporting at the Department of Oral Diagnosis and Radiology were evaluated for radio morphometric indices. Out of 1000 patients, 403 were males and 597 were females. 368 were

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 3664 - 3670
Received 20 January 2021; Accepted 08 February 2021.

<25 years of age (group 1), 357 were 25-35 years of age (group 2) and 275 were above >35 years (group 3). The C1 category of MCI was observed in 734 patients (274 males, 460 females), whereas C2 was observed in 266 patients (129 males, 137 females).

Statistical analyses revealed a significant difference between the results of each group analysed in both male and female patients. Chi-square test was applied and a significant difference was found between MCI and gender and age group respectively. Independent‘t' test was applied and a significant difference was found between PMI, MI, and gender with the p-values of.02128 and.29398 respectively. These findings from the present study were in accordance with the various previous other studies in the literature by Knezovic et al[11] in 2002, Raghdaa et al[12] in 2011, and Govindraju et al[13] in 2016 where authors reported that MI and age were related to each other in a negative fashion, where the reduction in MI was observed with an increase in age. Another study by Musa et al[14] in 2002, showed contradictory findings in relation to the present study where no significant correlation between age and MI was observed.

Correlation between age and PMI was evaluated using the Post hoc Bonferroni test. Statistically significant differences were found between group 1 and group 2; group 1 and group 3; however the difference between group 2 and group 3 was not statistically significant with respective p-values of <.001, <.001, and .012. These findings were in agreement with the studies by Taguchi[15] and Bensen BW et al[16] in where authors also reported PMI values are directly proportional to the age of the subjects, whereas, another study by Yȕzȕgȕllȕ et al[17] in 2009 had a disagreement with the findings of the present study where no relationship between two was reported.

PMI showeda statistically significant difference between males and females ($P<0.05$) so that females had higher amounts of PMI. Similar results were also published by Haster and colleagues[18] in 2011and by Ledgerton et al[19] where higher PMI was seen in females compared to male subjects.

CONCLUSION

MI and PMI, in the present study, present a statistically significant correlation with respect to the age of the study subjects ($P<0.05$). MI and PMI had a significant relationship with MCI ($P<0.05$). The study had few biases in regard to sample size and all the radiographs were captured at a single diagnostic centre. Also, the single geographical area was focused on in the present study. More longitudinal studies with a larger sample size and longer monitoring periods are needed to reach a definitive conclusion.

REFERENCES

1. Nakamoto T., Taguchi A., Ohtsuka M., Suei Y., Fujita M., Tanimoto K., Tsuda M., Sanada M., Ohama K., Takahashi J., Rohlin M. Dental panoramic radiograph as a tool to detect postmenopausal women with low bone mineral density: untrained general dental practitioners’ diagnostic performance. Osteoporosis. Int. 2003; 14(8): 59–64.
2. Sundeep Khosla, L. Joseph Melton. Osteopenia. N Engl J Med 2007; 356: 2293-300.
3. Young Kwon Yoon, Ae Ryoung Kim, On Yoo Kim, Kilchan Lee, Young Joo Suh, and Sung-Rae Cho. Factors Affecting Bone Mineral Density in Adults with Cerebral Palsy. Ann Rehabil Med. 2012; 36(6): 770–75.
4. Cakur B1, Dagistan S, Sahin A, Harorli A, Yilmaz A. Reliability of the mandibular cortical index and mandibular bone mineral density in the detection of osteoporotic women. Dentomaxillofac Radiol. 2009; 38(5): 255-61.

5. Nasrin Esfahanizadeh, Sotoudeh Davaie, A. R. Rokn, Hamid Reza Daneshparvar, Noushin Bayat, Nasrin Khondi, Sara Ajvadi, Mostafa Ghandi. Correlation between the bone mineral density of jaws and skeletal sites in an Iranian population using dual X-ray energy absorptiometry. Dent Res J 2013; 10(4): 460–66.
6. Glen M Blake, Ignac Fogelman. The role of DXA bone density scans in the diagnosis and treatment of osteoporosis. Postgrad Med J. 2007; 83(982): 509–17.
7. Esin Hastara, H. Huseyin Yilmazb, Hikmet Orhanc. Evaluation of Mental Index, Mandibular Cortical Index, and Panoramic Mandibular Index on Dental Panoramic Radiographs in the Elderly. European Journal of Dentistry 2011; 5: 60-7.
8. Klemetti E, Kolmakow S. Morphology of the mandibular cortex on panoramic radiographs as an indicator of bone quality. Dentomaxillofacial Radiology 1997; 26: 22-5.
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. Ledgerton D, Horner K, Devlin H, Worthington H. Panoramic mandibular index as a radiomorphometric tool: an assessment of precision. Dentomaxillofac Radiol. 1997; 26(2): 95-100
11. Knezović Zlatarić D, Celebić A, Lazić B, Baucić I, Komar D, Stipetić-Ovcaricek J, et al. Influence of age and gender on radiomorphometric indices of the mandible in removable denture wearers. Coll Antropol 2002;26(1):259-66.
12. Raghda MA, Mohamed EA, Mary FM. Effect of age, sex, and dental status on mental and panoramic mandibular indices of the mandible: a retrospective study. Egyptian J Oral Maxillofac Surg 2011;2(1):22–26.
13. Govindraju P, Chandra P. Radiomorphometric indices of the mandible - an indicator of osteoporosis. J Clin Diagn Res 2014;8(3):195-8.
14. Musa I, Knezovic-Zlataric D, Celebic A, Bosnjak A. The Influence of Gender and Age on the Values of Linear Radiomorphometric Indices Measured on the Lower Border of the Mandible. Acta Stomat Croat 2002;36(2):199-202
15. Taguchi A, Tanimoto K, Suei Y, et al. The estimation of the radiomorphometric indices of the mandible using panoramic radiography. Dent Radiol 1993;33:309-16.
16. 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(3):349-56.
17. Yüzügüllü B, Gulsahi A, Imirzalioglu P. Radiomorphometric indices and their relation to alveolar bone loss in completely edentulous Turkish patients: A retrospective study. J Prosthet Dent 2009;101(3):160-5.
18. Hastar E, Yilmaz HH, Orhan H. Evaluation of a mental index, mandibular cortical index, and panoramic mandibular index on dental panoramic radiographs in the elderly. Eur J Dent 2011;5(1):60–7.
19. Ledgerton D, Horner K, Devlin H, Worthington H. Radiomorphometric indices of the mandible in a British female population. Dentomaxillofac Radiol 1999;28(3):173-81.