ISSN No:-2456-2165

Forecast of Risk of Osteoporosis Using Digital Orthopantomography as a Yard Stick – A Retrospective Study

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Abstract:-

➢ ***Background:-***

A number of indices have been developed to assess and quantify the quality of mandibular bone mass and to observe the signs of resorption using panoramic images.

➢ ***Aim:-***

To evaluate the reliability of digital morphometric indices-Panoramic mandibular index (PMI), Mental index (MI)& Mandibular cortical index (MCI) in detection of osteoporosis.

➢ ***Objectives:-***

- **To investigate influence of age and gender for osteoporosis.**
- **To assess digital radio morphometric indices with bone density in identifying risk group for osteoporosis.**

➢ ***Materials & Methods:-***

Retrospectively digital OPG images are collected from archives of stored data from CS 8100 care stream panoramic machine which are subjected to digital radio morphometric measurements to assess the bone mineralised density of mandibular bone. Samples are divided as follows (years)

- **Group-1: 21-30 Years.**
- **Group-2: 31-40 Years.**
- **Group-3: 41-50 Years.**
- **Group-4: 51-60 Years.**

➢ ***Results:-***

According to gender MI, MCI &according to age PMI are significant in accessing risk of osteoporosis. Statistical analysis revealed that females & old age group subjects are more prone.

➢ ***Conclusion:-***

Our study concluded that millions of people undergo OPG annually, so OPG is not only used for dental problems but can also be used as screening tool to prevent further complication of bone diseases. Well trained dental practitioner can detect low mineral bone density by simple screening analytical method, using above panoramic indices.

Keywords: *OPGs, PMI, MI, & MCI.*

I. INTRODUCTION

Annually around millions of dental radiographs are taken world-wide. Panoramic device being very important components in dental radiography. Bone changes occurs as the age passes, women are more prone for osteoporosis as the first sign is osteopenia which is observed in 3rd decade of life and as the age passes it progresses to osteoporosis due to loss of bone mineral density (BMD). Further resulting in weaking of microarchitectural weaking leading to bone fragility and increase of fracture risk.[1,2,3.] In America it is estimated that 1among 5 men is diagnosed with osteoporosis the prevalence is increased. India is the largest country affected by osteoporosis due to low socioeconomic status there is low dietary calcium intake among toddler, adolescent, pregnant, lactating mother and postmenopausal women. It has been estimated that 1 out of 8 males and 1 out of 3 females suffer from osteoporosis.[4,5,6.]

The American College of Preventive Medicine (ACPM) recommended that BMD testing should be done in younger postmenopausal females and men aged 50–69 years who come across at least one major or two minor risk factors for osteoporosis. However, BMD testing for all such individuals is not practical in many countries where Dual-energy X-ray absorptiometry DEX is not widely available and expensive. Various researchers have conducted study on Digital panoramic can be used to screen the osteoporosis by measuring various parameters in mandible & also it presents with advantages of minimal exposure and cost effective.[7,8,9.] Our study investigated the importance of computed and non-computed radio morphometric indices in screening the risk of osteoporosis in different age groups and gender resulting in early detection of the risk of osteoporosis using digital panoramic radiographs. Thus, providing good bone health and preventing further complication of bone disorder.

ISSN No:-2456-2165

II. MATERIALS AND METHODS

Retrospective study in which total 208 archives digital orthopantomography were collected from Al-Badar Rural Dental College Kalaburagi. The images were obtained under standard exposure condition as recommended by the manufacturer. The OPG device used is Toshiba accompanied by Carestream imaging software -7.02. The study was approved by institutional ethical committee with registration number EC/NEN/INST/2022/2710.

➢ *The study includes 4 age groups with equal gender distribution of 26 digital OPG images in each gender according to each age groups:*

- 21-30 years
- 31-40 years
- 41-50 years
- 51-60 years

➢ *Inclusion Criteria:*

- Good quality radiograph.
- Radiograph that covers area of interest.

➢ *Exclusion Criteria:*

- The radiograph of the patients with congenital, developmental anomalies or pathology of bone, images of the patients with history of trauma radiographs that do not cover the area of interest
- Bad quality radiographs were excluded from the study.

The selected digital OPG's were subjected to perform to measure computed indices -Mental Index (MI), Panoramic Mandibular Index (PMI) and non-computed index -Mandibular cortical index (MCI) bilaterally by Carestream software in the device.

To assess the intraobserver error. After 1 month 50 OPG's were reanalysed were subjected to statistical analysis to check the reliability after 1 month.

➢ *Calculation of Mental, Panoramic Mandibular, Mandibular Cortical Width Indices:*

- *Panoramic Mandibular Index:*

PMI the ratio of the mandibular cortical thickness measured on the line perpendicular to the bottom of the mandible, at the middle of the mental foramen, by the distance between the inferior mandibular cortex and the bottom of the mandible.

Fig 1 Panoramic Index

- *Mental Index:*

MI mandibular cortical thickness measured on the line perpendicular to the bottom of the mandible at the middle of the mental foramen.

Fig 2 Mental Index

ISSN No:-2456-2165

➢ *Mandibular Cortical Index MCI/Kelmetti Index:*

The porosity of the inferior border of the mandible is described with cortical erosion is related to the mandibular bone mineral density. This index involves measurements at the inferior mandibular cortex at the distal to the mental foramina part of the mandible, bilaterally, and findings are separated into three groups.

- (C1) Uniform inferior border of mandibular cortical bone margins. (Fig.3)
- (C2) Semilunar defects with moderate erosion along the mandibular margin. (Fig.4)
- (C3) Major erosion and cortical porosity. (Fig.5)

Fig 3 C1- Uniform Inferior Border of Mandibular Cortical Bone Margins

Fig 4 C2-Semilunar defects with moderate erosion along the mandibular margin.

Fig 5 C3-Major erosion and cortical porosity.

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➢ *Statistical Analysis:*

The data obtained is subjected to statistical analysis using R software. Influence of age & gender of computed indices was done using ANOVA& unpaired t -test respectively. Influence of age and gender of non-computable index MCI was done using Chi square test. The correlation of non-computed index with computable index was done using ANOVA. Reliability of intra observer after 1month duration for 50 subjects was done for computed indices using paired t-test & for non-computed index by chi square test.

III. RESULTS

➢ *Total (n= 208) digital OPG's images were consider for study. Samples were divided in to 4 groups:*

- 21-30 years.
- 31-40 years.
- 41-50 years.
- 51-60 years.

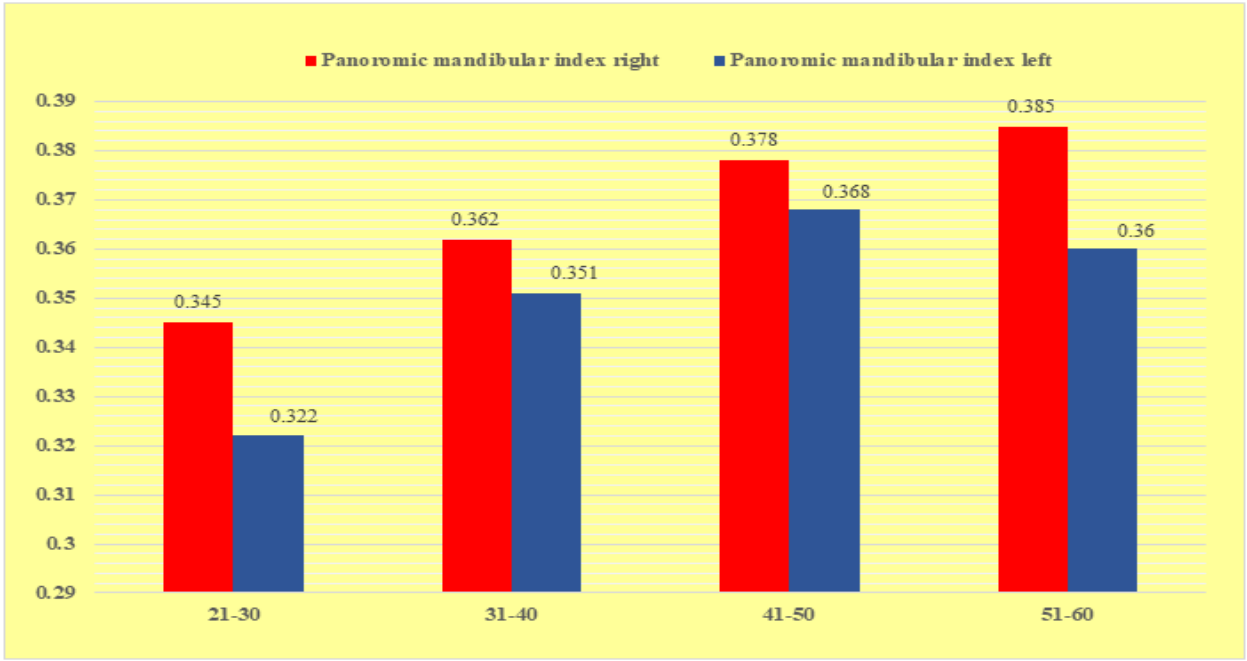
With equal gender distribution male n=26 & female n=26 in each group.

Influence of age on PMI on left side showed Statistically significant with P value=0.0234 whereas on right side it was not significant. (Graph:1).MI was not significant statistically with P value ≥ 0.05. Table -1, (Graph:2). MCI was statistically significant with p value 2.2e-16 revealing that C3 is most commonly seen in old age group. Table 2, (Graph-3).

Table 1 Computed Indices According to Age Using ANOVA

Index	Age group (years)				P value
	21-30	***31-40***	***41-50***	***51-60***	
Panoromic mandibular index right Mean SD	 0.345 0.0717	 0.362 0.0901	 0.378 0.0793	 0.385 0.0955	0.0767(NS)
Panoromic mandibular index Left Mean SD	 0.322 0.0735	 0.351 0.0801	 0.368 0.0783	 0.360 0.0907	0.0234(S)*
Mental index Right Mean SD	 12.4 1.49	 12.5 1.71	 12.7 1.49	 12.7 1.64	0.8290(NS)
Mental index Left Mean SD	 12.6 1.97	 12.7 1.73	 12.7 1.47	 13.1 1.36	0.4820(NS)

*P value≤0.05 is statistically significant



Graph 1 Age -wise distribution of panoramic mandibular index on right and left side of mandible

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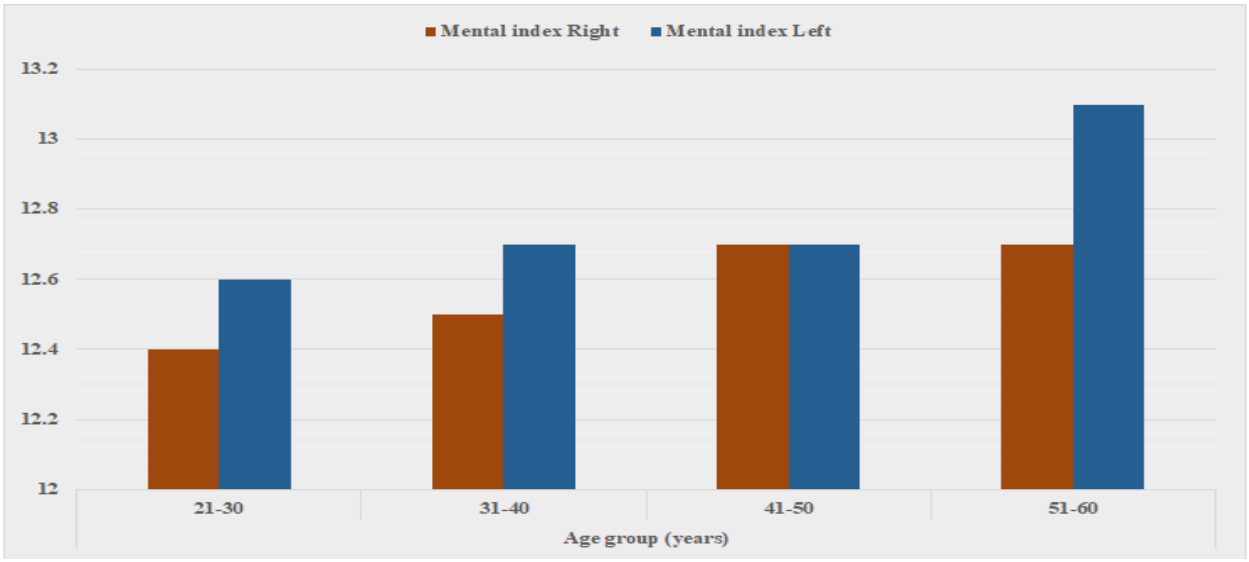
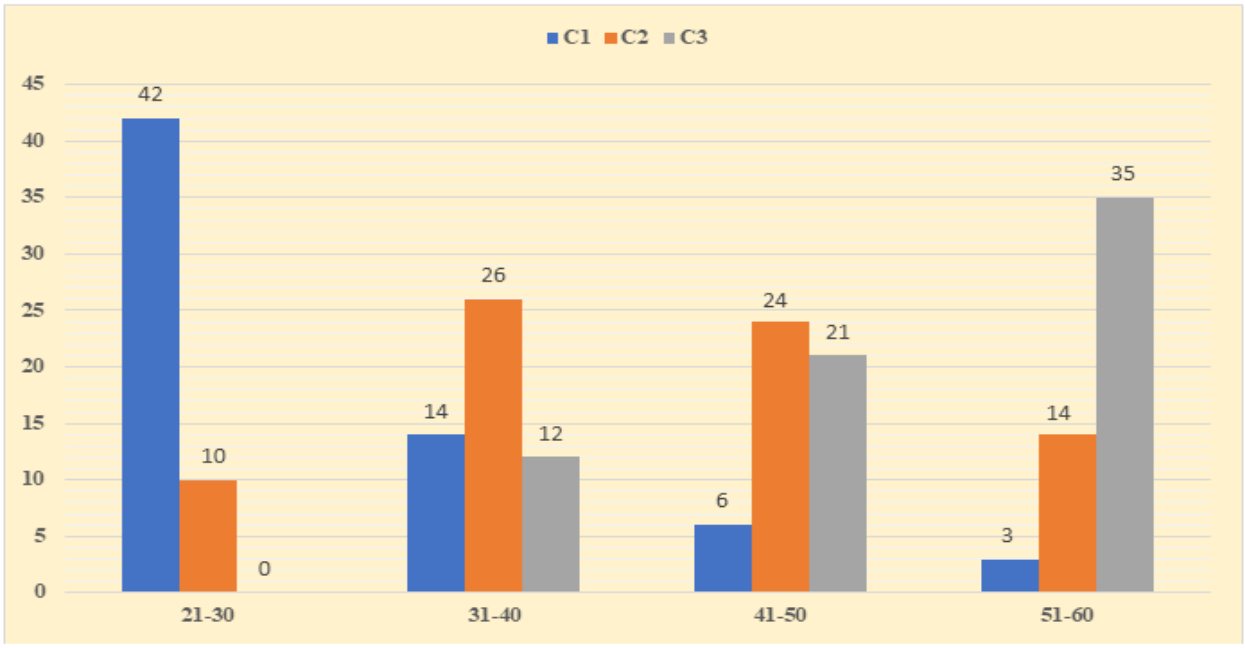


Graph 2 Age -wise distribution of mental index on right and left side of mandible

Table 2 Comparison of non-computed index Mandibular cortical index with age by Chi square

Age (in years)	Mandibular cortical index			
	C1	***C2***	***C3***	***Total***
21-30	42	10	00	52
31-40	14	26	12	52
41-50	06	24	21	51
51-60	03	14	35	52
Total	65	74	68	207
P value	2.2e-16(S)*			

*P value≤0.05 is statistically significant.



Graph 3 Bar graph representing age -wise distribution of mandibular cortical index revealing C1-younger age group and more erosion and porosity- C3 noticed in older age group.

Statistical analysis for influence of gender revealed that among computed indices Mental index on both right and left side revealed statistically significant with p value 3.033e-10 & 2.892e-10 respectively. Panoromic index showed insignificant on both sides. Table-3, (Graph-4 & Graph-5). The non-computed index mandibular cortical index was found to statistically not significant with p value 0. 0727. Table-4 (Graph-6)

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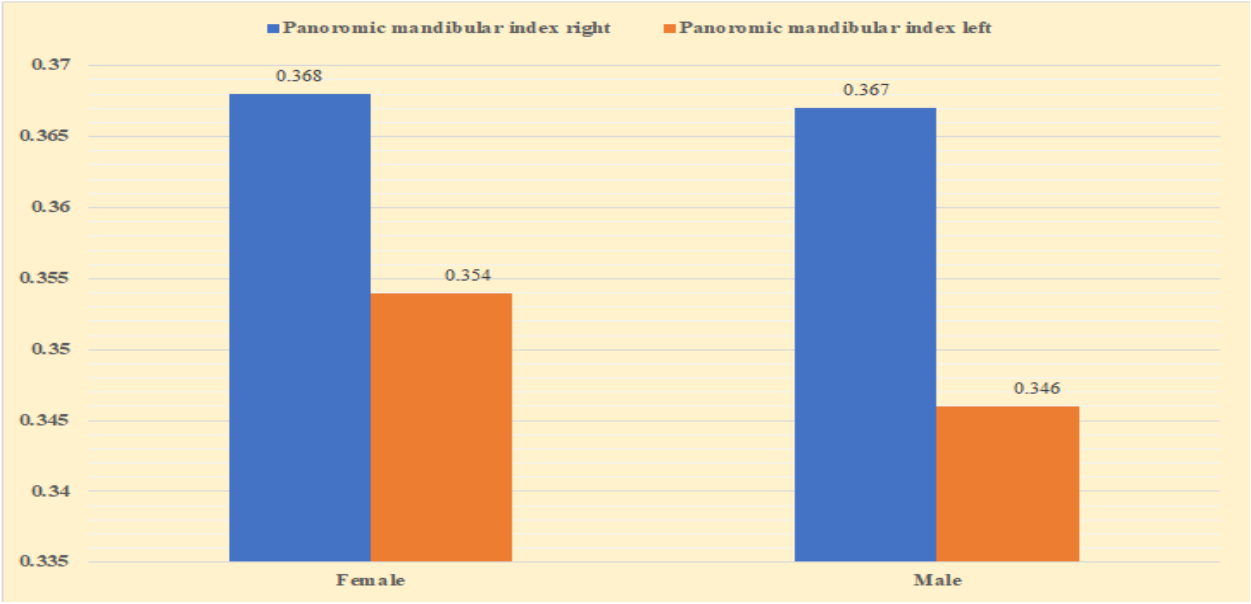
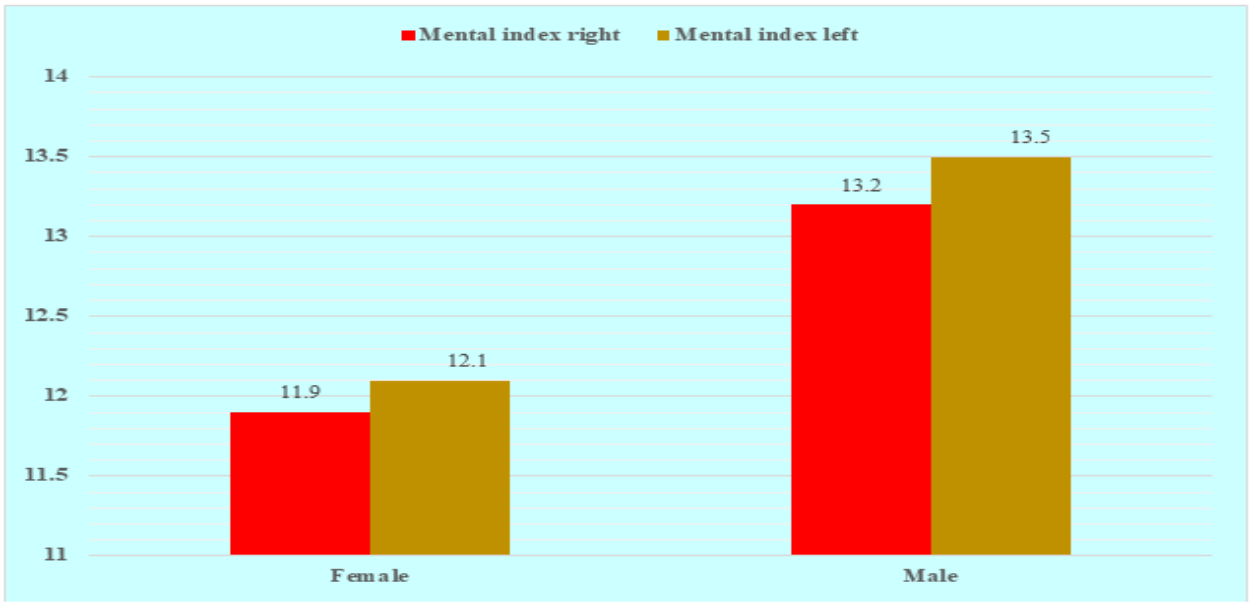
Table 3 Mean and Standard deviation (SD) computed indices according to gender. P value by unpaired t test

Index	**Gender**		
	Female	***Male***	***P value***
Panoromic mandibular index right Mean SD	 0.368 0.0817	 0.367 0.0895	0.9210(NS)
Panoromic mandibular index Left Mean SD	 0.354 0.0796	 0.346 0.0848	0.4509(NS)
Mental index Right Mean SD	 11.9 1.39	 13.2 1.48	3.033e-10(S)*
Mental index Left Mean SD	 12.1 1.37	 13.5 1.61	2.892e-10(S)*

*P value≤0.05 is statistically significant.



Graph 4 Bar graph representing gender-wise distribution of MCI with same mean value on right side in both gender which is greater than left side.



Graph 5 Bar graph representing that influence of gender-wise distribution of mental index with greater mean value on left side than right side in both genders.

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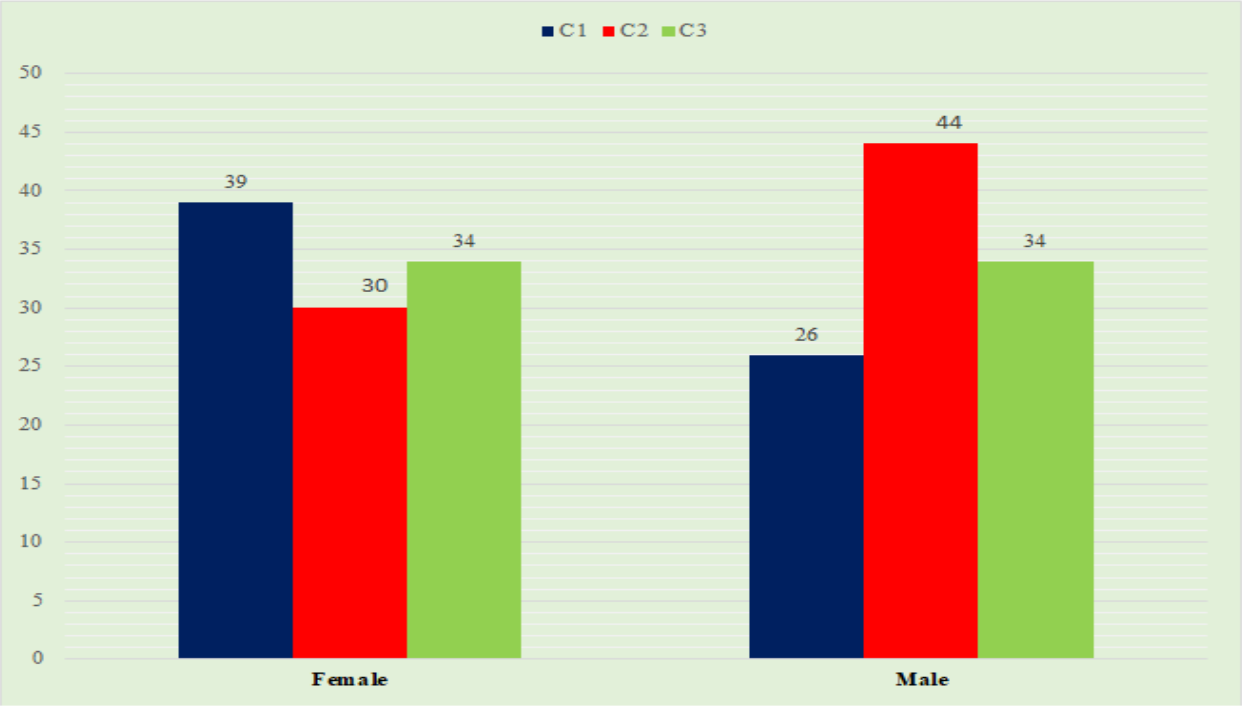
Table 4 Comparison of non-computed index Mandibular cortical index with gender. P value by Chi square

Age (in years)	Mandibular cortical index			
	C1	*C2*	*C3*	*Total*
Female	39	30	34	103
Male	26	44	34	104
Total	65	74	68	207
P value	0.0727(NS)			

*P value≤0.05 is statistically significant.



Graph 6 Bar graph representing that even endosteal margins of mandibular cortex (C1) is seen in females & semilunar defects of endosteal margins (C2) are seen in male group.

Co-relation of Non computed index Mandibular cortical index with computed indices revealed statistically significant with panoramic mandibular index on both right and left side with P value 0.0015 & 1.13e-05 respectively. Mental index on right side showed significant with P value =0.0554 whereas on left side it was statistically insignificant.

Table 5 Correlation of non-computed index with computed indices. Mean and Standard deviation (SD) of index according to Mandibular cortical index. P value by ANOVA

Index	Mandibular cortical index			P value
	C1	*C2*	*C3*	
Panoromic mandibular index right				0.0015(S)*
Mean	0.344	0.361	0.396	
SD	0.0689	0.0818	0.0962	
Panoromic mandibular index Left				1.13e-05(S)*
Mean	0.328	0.335	0.388	
SD	0.0695	0.0641	0.0973	
Mental index Right				0.0554(S)*
Mean	12.2	12.8	12.6	
SD	1.50	1.60	1.58	
Mental index Left				0.238(NS)
Mean	12.5	13.0	12.8	
SD	1.85	1.54	1.54	

*P value≤0.05 is statistically significant.

Reliability of intra observer after 1month for 50 subjects was subjected to statistical analysis in which computed indices on both sides showed statistically insignificant. Table-6 (Graph7&8). Non-computed index also showed statistically insignificant with P= 0.2378. Table-7. (Grpah-9)

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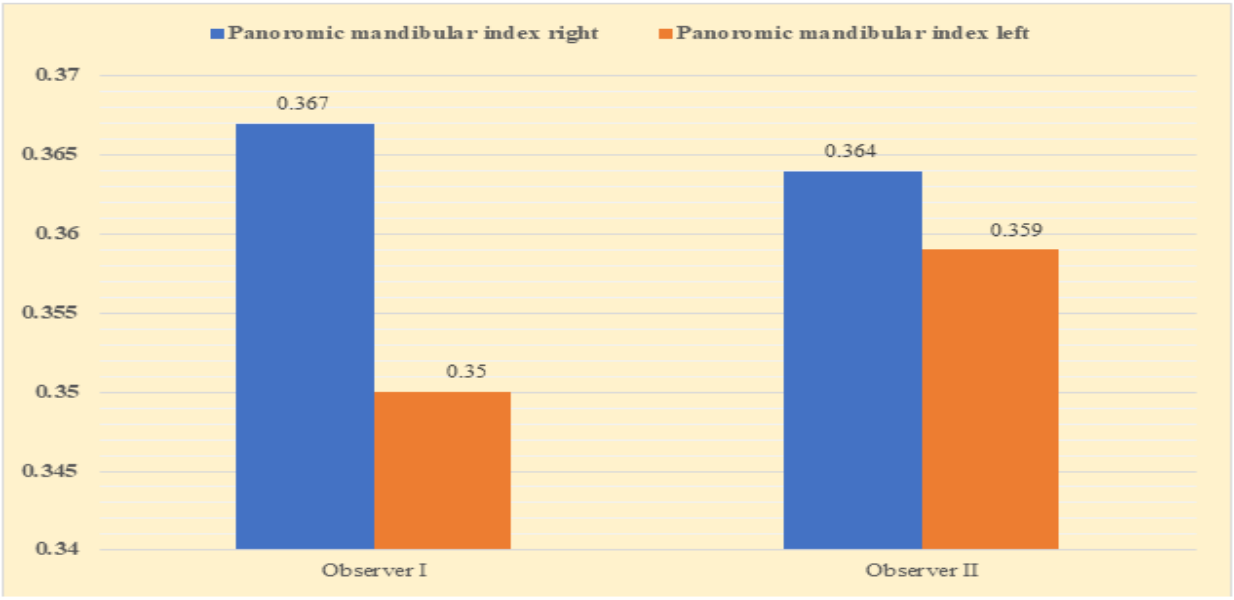
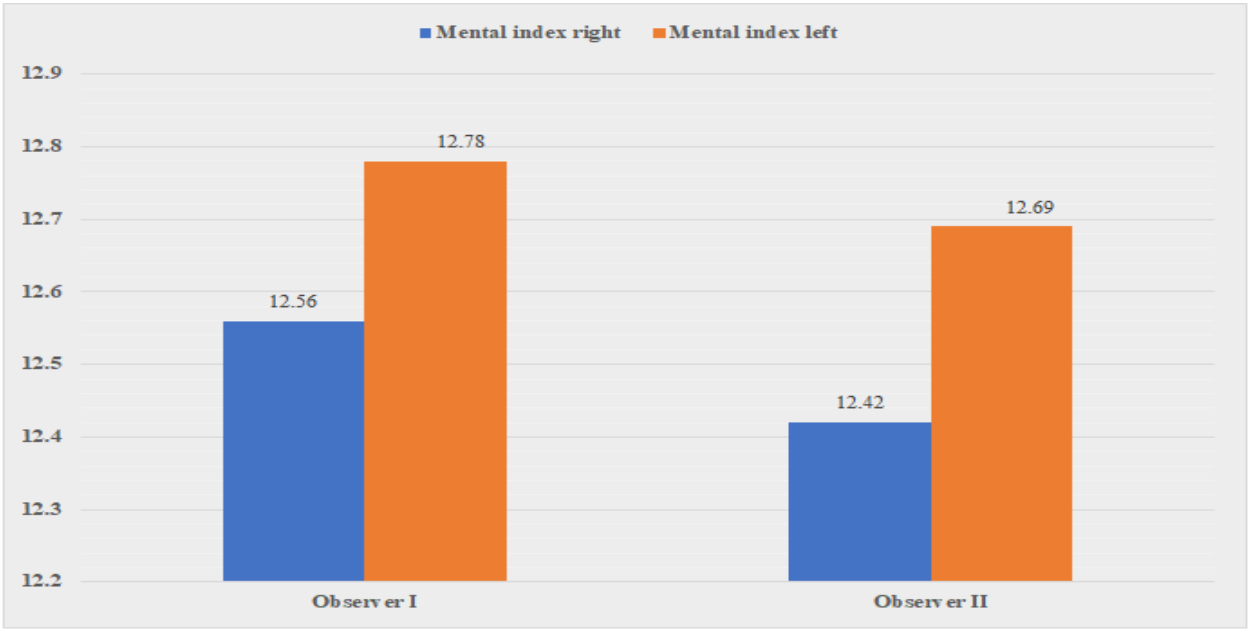
Table 6 Mean and Standard deviation (SD) all index for two observers. P value to find reliability by paired t test

Index	Observer		
	I	*II*	*P value*
Panoromic mandibular index right Mean SD	 0.367 0.0855	 0.364 0.0766	0.8253(NS)
Panoromic mandibular index Left Mean SD	 0.350 0.0822	 0.359 0.0804	0.5069(NS)
Mental index Right Mean SD	 12.56 1.5778	 12.42 1.4834	0.5502(NS)
Mental index Left Mean SD	 12.78 1.6457	 12.69 1.6286	0.7378(NS)

*P value≤0.05 is statistically significant.



Graph 7 Bar Graph representing intraobserver reliability for panoramic mandibular index with greater mean value on right side according to both observers.



Graph 8 Bar graph representing reliability that mean value is greater on left side according to both observer

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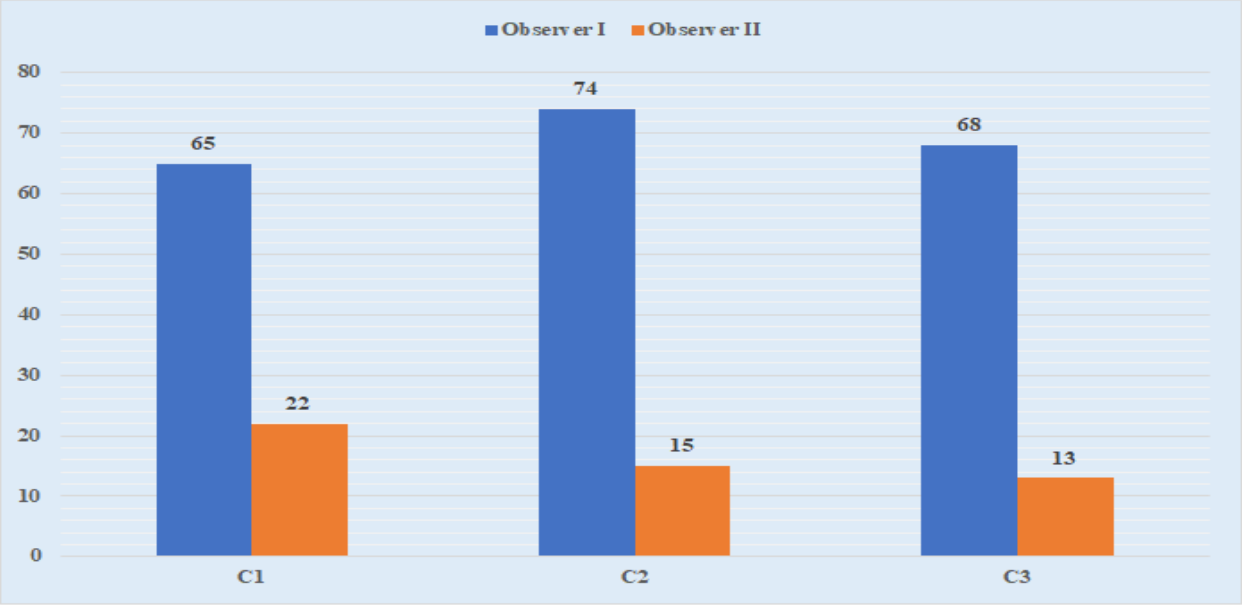
Table 7 Mandibular cortical index for two observers. P value to find reliability by Chi square test

Index	Observer		
	I	*II*	*Total*
C1	65	22	87
C2	74	15	89
C3	68	13	81
Total	207	50	257
P value	0.2378(NS)		

*P value≤0.05 is statistically significant.



Graph 9 Bar graph representing reliability of intra observer for non-computed index.

IV. DISCUSSION

Bone remodelling takes place in humans at every stage of life. Approximately equal Bone resorption and formation takes place from third decade to fifth decade of life irrespective of gender as the age progresses the amount of bone resorbed by osteoclasts is not fully restored with full bone formation further resulting in imbalance and causing the loss of bone mass and strength.

Our study included 208 digital orthopantomography collected retrospectively. The radiograph was divided in to 4 age groups with equal gender distribution in each age group. The risk of osteoporosis is assessed computed indices and non-computed index. Various studies demonstrated that osteoporosis have correlation with the radio morphometric mandibular indices.

Most of research carried out on mandibular bone for assessment of osteoporosis which revealed that there is a relationship between osteoporosis and bone loss in jaw bones evaluated by histology (microradiography), single photon absorptiometry, dual photon absorptiometry, quantitative computed tomography and more recently, dual-energy X-ray absorptiometry. Although, these measuring techniques are considered as gold standard or precise than simple visual analytical methods these methods possess certain drawbacks that they increase treatment cost and require expensive measurement equipment hence these methods cannot be applicable in the developing countries.

OPGs would be economical and beneficial if panoramic radiographs could be used for identifying subjects with undetected osteoporosis so that we could refer subjects for confirmatory evaluation methods and further treatment which in turn can control the disease progression.

Various studies suggested that there is a positive relationship between BMD with mandibular cortical index that the most osteoporotic risk is seen with C3 group which was suggested by Balcikonyte E[3] et al. Bhatnagar S,[1111]revealed that the degree of mandibular cortical shape erosion was found to significantly correlate with BMD and panoramic radiograph showed 96% specificity and 60% sensitivity in assessing osteoporosis, establishing it to be an effective indicator. These are similar to the findings of the studies conducted by Taguchi et al.[12] and by Devlin and Horner.[13]

In course of our study, the thickness of cortical bone was measured using digitized panoramic radiographic images, which facilitated the evaluation of trabecular to cortical bone thickness ratio in the mandible and precise determination of inner and outer margins of cortical bone together with vertical linear measurement analysis which is a prerequisite for calculation of panoramic radio morphometric indices.

A study by Alpatti S et al [1]suggested that PMI has negative correlation with age and gender where MI & MCI had positive corelation with gender. MCI was also significant in detection of osteoporosis according to age.Our study also showed similar results that MI has negative correlation and PMI on left side which was found be statistically significant according to age. In contrast to study conducted by Alpatti et al.[1] the present study revealed that Positive corelation was found between MCI and PMI on both right and left side where as with MI it was found to be statistically significant only on right side.

A study conducted by by Handa H [7]et al stated that MI&PMI have influence on age whereas MCI was significant in detection of osteoporosis according to age the same was observed in our study[7].In contrast our study revealed that MI does not have influence on age but have influence on gender for osteoporosis. PMI on left side showed significant with influence of age for risk of osteoporosis.

A study by Youssif FS[9] et al conducted study to find the reliability of different radio morphometric indices in prediction of osteoporosis and osteopenia MCW (Mandibular cortical width, MI, PMI MCI and gonial index revealed positive corelation between indices.[9] Our study also showed the significant analysis of variance between the MCI and PMI index on right and left side and also MI on right-side.

A study by Sangeetha J[10] et al showed similar results that MI is statistically not significant with influence of age whereas PMI showed statistically significant.[10]our study showed that smaller MI values are seen in younger age group and in females and is found to be statistically significant with influence of gender for risk of osteoporosis.

Knezovic Zlataric et al.[14] also reported that there was an age-related increase in the number of individuals with C3 cortex appearance and a significantly higher incidence of C3 among older women. Concurrently, the results of present study were in agreement with the results of previous studies which were conducted by Knezovic-Zlataric et al.[14], Gulsahi et al.[15] and Haster et al.[16]

Our study presented that OPG's can be used as only screening tool for prediction of risk of osteoporosis by using computed and non-computed radio morphometric mandibular indices. Other devices which are used to determine BMD are very expensive and facilities are not available in every part of the world. Researches said that millions of OPG's are taken per year in various parts of country so OPG's can be used to predict the risk of osteoporosis.

V. CONCLUSION

OPG's are taken world-wide about millions of OPG's are taken per year in India. Dual-energy X-ray absorptiometry (DEXA) high reliability so it is tremendously used all over world to determine low BMD. Single- or dual-photon absorptiometry, quantitative computed tomography QCT), and quantitative ultrasound are some of the techniques to measure BMD but as these are expensive every part of the country cannot afford the devices. Researchers says that the life expectancy is increased in India about 34% by 2050. so, there we can use OPG's as screening tool by measuring radio morphometric mandibular indices by well-trained dental practioner to prevent further complication of osteoporosis patient.

ACKNOWLEDGEMENT

We acknowledge all the staff members of Oral Medicine and Radiology for their kind help and support throughout the research.

REFERENCES

[1]. Alapati S, Reddy RS, Tatapudi R, Kotha R, Bodu NK, Chennoju S. Identifying risk groups for osteoporosis by digital panoramic radiography. Contemporary Clinical Dentistry. 2015 Sep;6(Suppl 1): S253.
[2]. Tounta TS. Diagnosis of osteoporosis in dental patients. Journal of Frailty, Sarcopenia and Falls. 2017 Jun;2(2):21.
[3]. Balcikonyte E, Balciuniene I, Alekna V. Panoramic radiographs in assessment of the bone mineral density. Stomatologija. 2004;6(1):17-9.
[4]. Tu KN, Lie JD, Wan CK, Cameron M, Austel AG, Nguyen JK, Van K, Hyun D. Osteoporosis: a review of treatment options. Pharmacy and Therapeutics. 2018 Feb;43(2):92.
[5]. Vijay G, Chitroda PK, Katti G, Shahbaz S, Baba I. Prediction of osteoporosis using dental radiographs and age in females. Journal of mid-life health. 2015 Apr;6(2):70.
[6]. Khadilkar AV, Mandlik RM. Epidemiology and treatment of osteoporosis in women: an Indian perspective. International journal of women's health. 2015; 7:841.
[7]. Handa H, Singh A. Evaluation of mandibular indices in panoramic radiography. International Dental Journal of Student's Research. 2020 Aug 15;8(2):60-4.
[8]. Sindhu YU, Samatha Y, Ravikiran A, Swamy PR, Nayyar AS, Kartheeki B. Digital panoramic radiography: An aid in the early detection of osteoporotic signs. Archives of Medicine and Health Sciences. 2016 Jul 1;4(2):205.
[9]. Youssif FS, Elshall OA. Reliability of Different Mandibular Radio morphometric Indices in Prediction of Osteoporosis and Osteopenia. Al-Azhar Dental Journal for Girls. 2020 Apr 1;7(2-B):247-53.
[10]. Sangeetha J, Balaji Pachipulusu, Poornima Govindraju1, Syeda Muskan Jan1 Radio morphometric indices as indicator in osteoporosis-A digital panoramic study journal of oral medicine, oral surgery, oral pathology and oral radiology 2022;8(1):27–34

[11]. Bhatnagar S, Krishnamurthy V, Pagare SS. Diagnostic efficacy of panoramic radiography in detection of osteoporosis in post-menopausal women with low bone mineral density. Journal of clinical imaging science. 2013;3.
[12]. Taguchi A, Sanada M, Krall E, Nakamoto T, Ohtsuka M, Suei Y, Tanimoto K, Kodama I, Tsuda M, Ohama K. Relationship between dental panoramic radiographic findings and biochemical markers of bone turnover. Journal of bone and mineral research. 2003 Sep;18(9):1689-94.
[13]. Devlin H, Horner K. Mandibular radiomorphometric indices in the diagnosis of reduced skeletal bone mineral density. Osteoporosis international. 2002 May;13(5):373-8
[14]. Knezović Zlatarić D, Čelebić A, Lazić B, Baučić I, Komar D, Stipetić-Ovčariček J, Ibrahimagić L. Influence of age and gender on radiomorphometric indices of the mandible in removable denture wearers. Collegium antropologicum. 2002 Jun 17;26(1):259-66.
[15]. Gulsahi A, Yuzugullu B, Imirzalıoglu P, Genç Y. Assessment of panoramic radiomorphometric indices in Turkish patients of different age groups, gender and dental status. Dentomaxillofacial Radiology. 2008 Jul;37(5):288-92.
[16]. Hastar E, Yilmaz HH, Orhan H. Evaluation of mental index, mandibular cortical index and panoramic mandibular index on dental panoramic radiographs in the elderly. European journal of dentistry. 2011 Jan;5(01):060-7.