

Comparative Evaluation of Mandibular Endosteal Margin Erosions on Panoramic Radiographs in Dentulous and Edentulous Elderly Population: A Retrospective Study

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ABSTRACT

Introduction: The mandibular bone is an important component of the facial bone and this bone shows the measurable osteoporotic changes on radiographs. One of the changes shown is mandibular endosteal margin erosions and on panoramic radiograph the changes are seen as cortical cavities and cortical residues.

Aim: To evaluate and compare mandibular endosteal margin erosions on panoramic radiographs in dentulous and edentulous elderly population.

Materials and Methods: This retrospective study was conducted on 611 panoramic radiographs of elderly population for mandibular endosteal margin erosions using Mandibular Cortical Index (MCI),

devised based on appearance of lower border of mandibular cortex distally from mental foramen as viewed on panoramic radiograph. Data collected was tested statistically using Chi-square test.

Results: The mandibular endosteal margin erosions were more severe in edentulous group. The difference between the groups was found to be statistically significant ($p < 0.05$). As age increased, the likelihood of the C3 category increased and mandibular endosteal erosions were more pronounced among females in both dentulous and edentulous group ($p < 0.05$).

Conclusion: Mandibular Cortical Index is simple index to determine osteoporosis and the severity of osteoporosis is directly related with edentulousness or increased tooth loss.

Keywords: Geriatric, Mandibular cortical index, Osteoporosis, Radio-morphometric indices

INTRODUCTION

Osteoporosis a common geriatric bone condition in which bone becomes porous and fragile which makes it more susceptible to fracture. This is causing a significant and growing economic burden on healthcare systems and societies worldwide [1]. Two factors important for bone strength are bone mass and its density. The first sign of bone loss starts at the age of 30 [2]. Age is one important factor which affects the bone strength. Conventionally, "elderly" means age of 65-year-old or older. Along with ageing, the change in lifestyle has become a leading cofactor for developing osteoporosis [3].

The prevalence of osteoporosis induced bone fractures are increasing day by day. In 2010, there were an estimated 1580 lac people at high fracture risk, by 2040 it was predicted that this number will double because of demographic shifts [4]. The most common bone fracture associated with osteoporosis is hip fracture, followed by vertebral and forearm fractures and fracture of hip bone is associated with serious disability and excess mortality [5]. In total 80%, 75%, 70% and 58% of forearm, humerus, hip and spine fractures, respectively, occur in women. Prevalence of bone fractures due to osteoporosis is seen more among females (61%) and hip, spine and forearm are common bones associated with such fractures [1].

The healthy dentition is a vital part of an individual for his/her overall health. The loss of tooth/teeth will not only lead to edentulousness, it will affect the individual's psychology, esthetics, speech and even the nutrition status. In most of the individuals, as age advances, the teeth will be periodontally compromised and eventually leads to edentulousness which in-turn associated with compromised nutrition [6,7]. Hence, along with age and gender related hormones, the presence or absence of teeth has major role in bone remodeling to maintain the required serum calcium level and indirectly related to severity of osteoporosis affecting the bone [8]. The mandibular bone is an important component of the facial bone and this bone shows

the measurable osteoporotic changes on radiographs [9,10]. There are several studies indicating that dental panoramic radiographs are useful in determining the status of osteoporosis [11-14]. This is done using various radio-morphometric indices like MCI, Panoramic Mandibular Index (PMI), Bone Quality Index (BQI), Gonial Angle (GA), Antegonial Angle (AGA), Antegonial Depth (AGD), and Condyle Angle (CA) etc. Though there are many radiomorphometric indicators designed for panoramic radiographs for evaluation of bone mineral density, MCI has always been proven to be appropriate method to evaluate endosteal erosions in mandible [12-17]. This technique does not require any specialised software tool for calculating measurements. The variation of bone quality which is deteriorated as age advances can be easily evaluated on panoramic image just by careful visual examination. Along with advancing age, the incidence of edentulousness also increases.

In previous studies conducted, MCI has been evaluated elderly population and, in few studies, even MCI has been compared with T-score of Dual X-Ray Absorptiometry (DXA) [18,19]. Only limited number of studies [8,9,13] have checked the association of presence or absence of teeth with cortical bone erosion. Thus, the present study was aimed to evaluate and compare mandibular endosteal margin erosions on panoramic radiographs in dentulous and edentulous elderly population.

MATERIALS AND METHODS

A retrospective study on panoramic radiographs of elderly population. The study was approved by Sumandeep Vidyapeeth Institutional Ethics Committee (SVIEC), Sumandeep Vidyapeeth Deemed to be University, (identification number: 21084). The panoramic radiographs taken during January 2018-December 2020 were selected from department archives as per pre-decided inclusion criteria. The study was initiated in month of August 2021 and completed in month of April 2022.

Inclusion criteria: Correctly positioned and high quality panoramic radiographic images of dentulous and edentulous patients above 65 years were selected from department archives.

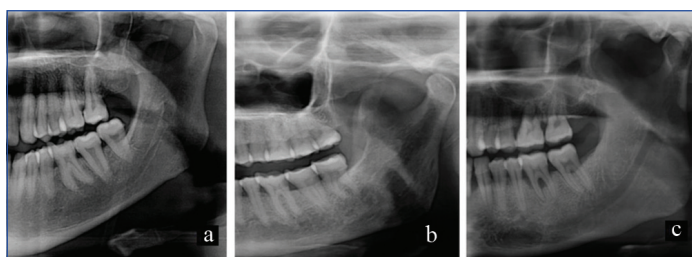
Exclusion criteria: The panoramic images showing any artifacts or with any bony pathology or jaw bone fractures or dental implants or bone plates were not selected for evaluation of mandibular endosteal erosion.

Sample selection: Total 611 (Group-I/Dentulous- 311, Group-II/ Edentulous-300) panoramic radiographs of elderly population was studied.

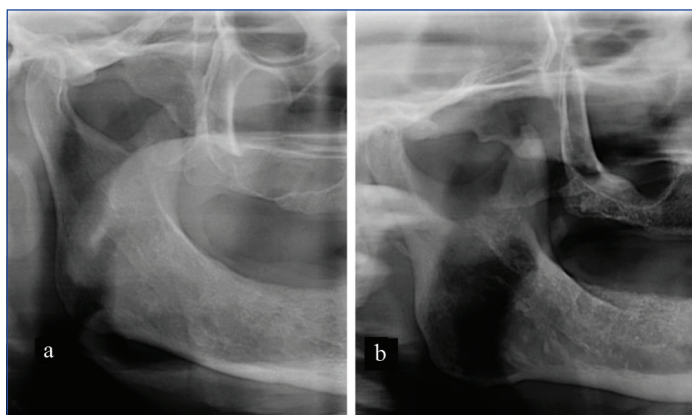
Study Procedure

The panoramic radiographs were taken from KODAK 8000C digital panoramic and cephalometric imaging system.

Radiograph analysis [Table/Fig-1,2]: The selected radiographs were evaluated for mandibular endosteal margin erosions using MCI. MCI was assessed according to criteria described by Klemetti E et al., which was devised based on appearance of lower border of mandibular cortex distally from mental foramen as viewed on panoramic radiograph [Table/Fig-3] [20]. The findings were entered in specially designed proforma after agreement of atleast two investigators.



[Table/Fig-1]: Cropped panoramic images of dentulous patients showing mandibular endosteal margin erosions category normal cortex/C1 (a), mild-moderately eroded cortex C2 (b), and severely eroded cortex C3 (c).



[Table/Fig-2]: Cropped panoramic images of edentulous patients showing mandibular endosteal margin erosions of various category: mild-moderately eroded cortex C2 (a); and severely eroded cortex C3 (b).

Criteria	Description
C1- Normal cortex	The endosteal margin of the cortex is even and sharp on both sides
C2- Mild to moderately eroded cortex	The endosteal margin shows semilunar defects (lacunar resorption) and/or seems to form endosteal cortical residues on one or both sides
C3- Severly eroded cortex	The cortical layer forms heavy endosteal cortical residues and is clearly porous

[Table/Fig-3]: Mandibular Cortical Index (MCI) criteria as described by Klemetti E et al., [20].

STATISTICAL ANALYSIS

The collected data was subjected to descriptive statistics and the statistical difference of endosteal margin erosions among the two study groups was analysed by using chi-square test. The statistical software used was IBM SPSS version 22.0.

RESULTS

Total of 611 (100%) panoramic radiographs were studied. A total of 311 (50.9%) belonged to dentulous group and 300 (49.1%) belonged to edentulous group. The mean age was 66.8±2.70 years and 70.8±2.72 years in dentulous group and edentulous group, respectively. In dentulous group, out of 311 participants, 140 were males and 171 were females. In edentulous group, out of 300 participants, 69 were males and 231 were females.

In dentulous group, total 47 OPGs showed C1 type of endosteal margin, 183 OPGs showed C2 type of endosteal margin and 81 OPGs showed C3 type of endosteal margins. In edentulous group, total 149 OPGs showed C2 type of endosteal margin and 151 OPGs showed C3 type of endosteal margins [Table/Fig-4]. It was observed that the mandibular endosteal margin erosions were more severe in edentulous group. The results of chi-square test suggest that there was statistically significant difference (p<0.001) in mandibular endosteal margin erosions between the study groups.

Group	Number (N)	MCI	n (%)	p-value
Dentulous	311	C1	47 (15.11)	<0.001
		C2	183 (58.8)	
		C3	81 (26.04)	
Edentulous	300	C1	0	
		C2	149 (49.67)	
		C3	151 (50.33)	
Total	611	-	611	

[Table/Fig-4]: Comparison of mandibular endosteal margin erosions using Mandibular Cortical Index (MCI) in panoramic radiograph of dentulous and edentulous individuals (Chi-square test). Bold p-values are significant

Gender wise analysis of MCI showed, mandibular endosteal margin erosions were more severe in females of both dentulous and edentulous group. The difference between the males and females was found to be statistically significant (p<0.05) in both the groups [Table/Fig-5,6].

Sex	MCI category			Total	p-value
	C1 n (%)	C2 n (%)	C3 n (%)		
Male	29 (20.7)	90 (64.2)	21 (15.0)	140	<0.001
Female	18 (10.5)	93 (54.3)	60 (35.0)	171	
Total	47 (15.1)	183 (58.8)	81 (26.0)	311	

[Table/Fig-5]: Gender wise comparison of mandibular endosteal margin erosions using Mandibular Cortical Index (MCI) in panoramic radiograph of dentulous individuals (Chi-Square Test).

Sex	MCI category			Total	p-value
	C1 n (%)	C2 n (%)	C3 n (%)		
Male	0	44 (63.7)	25 (36.2)	69	0.008
Female	0	105 (45.4)	126 (54.5)	231	
Total	0	149 (49.6)	151 (50.3)	300	

[Table/Fig-6]: Gender wise comparison of mandibular endosteal margin erosions using Mandibular Cortical Index (MCI) in panoramic radiograph of edentulous individuals (Chi-Square Test).

DISCUSSION

The MCI is a simple radiomorphometric index for evaluation of osteoporosis using OPG. This index has found to be useful in evaluating osteoporosis through the changes observed in the mandibular endosteal bone and can be used as auxiliary tool to screen post-menopausal women to assess risk of osteoporosis [11,19,21]. The present study was conducted to determine the mandibular endosteal margin erosions determining osteoporosis among dentulous and edentulous elderly population. In the present study, all the participants were in the age range of 65-79 years with mean age of dentulous group and edentulous group 66.8±2.70

years and 70.8 ± 2.72 years, respectively. It was observed that the mean age of the dentulous group was below 70 years and the mean age of the edentulous group was above 70 years. This suggests the frequency of edentulousness increases with age. These results are similar with the studies conducted by Dwivedi H et al., and Hastar E et al., Bozdog G and Sener S [9,13,15]. Age is a useful clinical predictor of osteoporosis as it has been reported as a risk factor for osteoporosis. In an Artificial Intelligence (AI) based-computer aided study on mandibular cortex, authors found that the degree of deformity was mostly found in older individuals [22]. In the present study, age was the most important parameter for MCI. As age increased, the likelihood of the C3 category increased presumably reflecting age-related bone loss and tooth loss. Similar results were seen in studies conducted by various authors [23,24]. Also, in present study, the authors found the mandibular endosteal erosions was more pronounced among females and the difference between the genders was statistically significant in both dentulous and edentulous groups. In study conducted by Dwivedi H et al., authors found C2 and C3 type of cortex was significantly associated with age amongst females [9]. Results of Knezovic-Zlataric D et al., study showed maximum number C3 mandibles were from geriatric females [25]. In AI based study, the MCI of female subjects was significant with aging as compared with men [22].

In present study, total 15.11% OPGs showed C1 type of endosteal margin, 58.8% OPGs showed C2 type of endosteal margin and 26.04% OPGs showed C3 type of endosteal margins in dentulous group. Similarly in edentulous group, total 49.67% OPGs showed C2 type of endosteal margin and 50.33% OPGs showed C3 type of endosteal margins. The mandibular endosteal margin erosions were more severe in edentulous group. This confirms the severity of osteoporosis and edentulousness is positively associated. Similar to the results of the present study, the results of various research studies [8,9,13,25-27] done on edentulous and or partially edentulous mandible for checking endosteal margin erosions using MCI has shown mandibular cortical erosions are more pronounced in edentulous mandible been summary of the previous studies is shown in [Table/Fig-7] [8,9,13,25-27].

Study	Place	N	Radio-morphometric indices assessed on OPG	Conclusion w.r.t MCI and presence/absence of teeth
Knezović Zlatarić D et al., (2002) [25]	Croatia	136	MCI, bone density densitometric assessment of mandibular bone using OPG	Edentulous group only showed C2 and C3 category of cortex which may be correlated to time of edentulous
Gulsahi A et al., (2008) [26]	Turkey	1863	MCI, MI and PMI	The likelihood of the C3 category in edentulous and partially dentate patients was 27.30 and 2.68 times higher than in fully dentate patients
Yüzügüllü B et al., (2009) [27]	Turkey	94	MCI, PMI	Severe erosions on the endosteal margin of the mandible were more frequently observed in age groups of >60 in women
Hastar E et al., (2011) [13]	Turkey	487	MCW, PMI, MCI	more edentulous patients had osteoporotic mandible than did patients who were partially dentate and dentate
Moradi M et al., (2017) [8]	Iran	270	MI, PMI, MCI and M/M ratio	Frequency of C2 and C3 was more in partial and fully edentulous patients.
Dwivedi H et al., (2021) [9]	India	80	MCI, MCW, PMI, ABL	67% of Male edentulous mandible showed C3 cortex in age group >60 years and 73% female edentulous mandible showed C3 cortex <60 years of age.

Present study	India	611	MCI	As age increases, the likelihood of the C3 category increases and also severe mandibular cortical erosion is associated with edentulousness
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[Table/Fig-7]: Summary of the previous studies comparing mandibular endosteal margin erosions on panoramic radiographs using Mandibular Cortical Index (MCI) in dentulous and edentulous elderly population [8,9,13,25-27].

*MCI: Mandibular cortical index; MI: Mental index; MCW: Mandibular cortical width; PMI: Panoramic mandibular index; ANL: Alveolar bone loss; M/M ratio: ratio of total mandibular height to distance from the center of mental foramen to mandibular inferior border

From present study, MCI is found to be highly reproducible and reliable index for evaluation of osteoporosis. Hence MCI on panoramic radiographs can be used as supplementary tool for screening osteoporosis among post-menopausal women.

Limitation(s)

Retrospective design is one of the main limitations of the study. Prospective study correlating MCI with Bone mineral density of hip measured by DXA will give us good idea of relationship between edentulousness and osteoporosis.

CONCLUSION(S)

The mandibular endosteal erosions were more prominent in edentulous mandible and in females. MCI is simple index to determine osteoporosis and the severity of osteoporosis is directly related with edentulousness or increased tooth loss.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Feb 11, 2023
- Manual Googling: Mar 22, 2023
- iThenticate Software: Apr 25, 2023 (16%)

ETYMOLOGY: Author Origin**EMENDATIONS:** 6**AUTHOR DECLARATION:**

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jan 31, 2023**Date of Peer Review: **Mar 24, 2023**Date of Acceptance: **May 04, 2023**Date of Publishing: **Jul 01, 2023**