



ISSN Print: 2394-7489  
ISSN Online: 2394-7497  
IJADS 2023; 9(1): 106-109  
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[www.oraljournal.com](http://www.oraljournal.com)  
Received: 08-11-2022  
Accepted: 12-12-2022

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## Detection of osteoporosis using orthopantomography: An analytical study

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DOI: <https://doi.org/10.22271/oral.2023.v9.i1b.1666>

### Abstract

**Background:** Osteoporosis is a condition characterized by low bone mass and micro-architectural deterioration of bone tissue. Dual Energy X-ray Absorptiometry (DEXA) is considered to be the "gold standard" in diagnosing osteoporosis. However, because of the cost and limited availability, these are less suitable for large-scale screening. Osteoporosis has several manifestations in the jaw bone which can be identified by dentists on panoramic radiographs by measuring various mandibular morphometric indices. This study aims at assessing the reliability of radio morphometric indices of panoramic radiographs namely Mental Index (MI), Antegonial Index (AI), Gonial Index (GI), Panoramic Mandibular Index (PMI), and Mandibular Cortical Index (MCI) in diagnosing osteoporosis by measuring mandibular cortical width.

**Materials and Methods:** Patients who were advised for panoramic radiographs after a thorough clinical examination were enrolled in this study. A total of 56 patients (28 male and 28 female) aged between 30 and 75 years are the participants. Panoramic radiographs were taken in a standardized position and all the indices were measured using Romexis 2.1.1.R software.

**Results:** This study was statistically significant for Mandibular cortical index (MCI) with  $p < 0.05$ . Mental index with ( $P=0.3$ ), Antegonial index ( $P=0.4$ ), Gonial Index ( $P=0.8$ ), and Panoramic mandibular index ( $P=0.5$ ) were statistically insignificant.

**Conclusion:** Our study results indicate that among the 5 indices, MCI is the reliable index in the detection of osteoporosis.

**Keywords:** Detection, osteoporosis, orthopantomography, analytical

### Introduction

According to World Health Organization (WHO), Osteoporosis is defined as "a skeletal disease, characterized by low bone mass and micro-architectural deterioration of bone tissue leading to enhanced bone fragility, with the consequent increase in fracture risk<sup>[1]</sup>. Menopause, aging, dietary insufficiency of calcium, familial education, and lack of physical activity are the risk factors for the development of osteoporosis<sup>[2]</sup>. Although studies have shown that there is more of a decrease in BMD in women, the male mortality rate from hip fracture is two to three times higher than the female mortality rate<sup>[3]</sup>.

Even though the gold standard to diagnose osteoporosis is a Dual-energy X-ray absorptiometry (DEXA) scan<sup>[4]</sup>, because of the cost and region-dependent availability these are considered less suitable for large-scale screening. Many studies on panoramic radiographs proposed radio morphometric indices as a diagnostic tool for osteoporotic conditions<sup>[5-11]</sup>.

This study aims at assessing the reliability of radio morphometric indices of panoramic radiograph (Mental Index (MI), Antegonial Index (AI), Gonial Index (GI), Panoramic Mandibular Index (PMI), and Mandibular Cortical Index (MCI)) in diagnosing osteoporosis by measuring mandibular cortical width.

### Materials and Methods

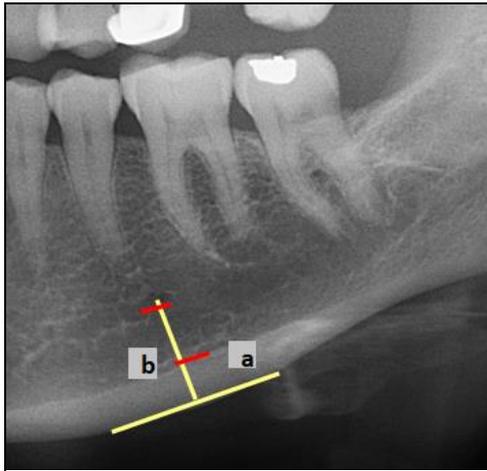
The patients aged 30-75 years, who visited our outpatient department after a thorough clinical examination and who were advised for OPG (orthopantomogram) for their other dental problems were included in this study. The patients with a history of any recent fracture of the mandible and the presence of an implant in the region of interest were excluded from the

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study. Additionally, those patients with the OPG not showing the mental foramen clearly and any ghost image overlapping the region of interest were excluded.

After applying the above criteria, a total of 56 patients (28 male and 28 female) were selected as the participants. They were divided into two groups based on gender (Male and Female) and Age (below 40 years and above 40 years). Panoramic radiographs were taken in a standardized position by Planmeca Proline XC Digital Panoramic System (66KV, 8mA, 18s) for the study population. Mandibular morphometric indices were measured bilaterally using Romexis 2.1.1 R software and the average value was calculated.

The method to measure various panoramic mandibular morphometric indices is shown in the following figures.



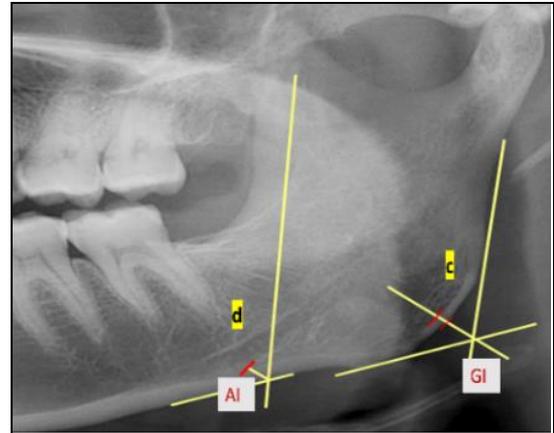
**Fig 1:** Method to measure Mental Index (MI) and Panoramic Mandibular Index (PMI)

‘A’ = MI, ‘b’ = the distance between the inferior border of the mental foramen to the inferior border of the mandible.

$$PMI = a/b$$

PMI is the ratio of the inferior mandibular cortex width to the distance between the inferior borders of the mandible to the inferior border of the mental foramen

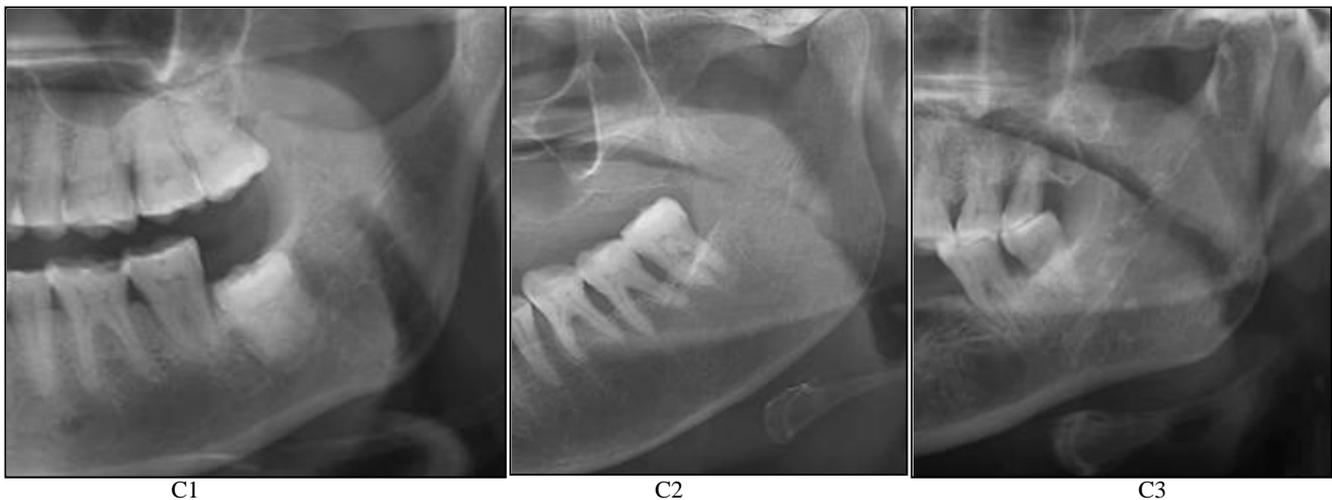
MI is the mandibular cortical thickness measurement by drawing a line perpendicular to the bottom of the mandible from the middle of the mental foramen.



**Fig 2:** Method of measuring Antegonial Index and Gonial Index

Antegonial Index (AI) = D, Gonial Index (GI) = C AI is measured by drawing a line perpendicular to the mandibular cortex at the intersection with the tangent line to the anterior border of the ramus.

GI is the measurement of the Bisectrix of the angle between the tangent lines to the posterior border of the ramus of the mandible and the bottom of the mandible.



**Fig 3:** Mandibular Cortical Index (MCI) = Qualitative analysis.

It is the appearance of the cortical border of the mandible distal to the mental foramina.

- C1: The endosteal margin of the cortex is even and sharp.
- C2: The endosteal margin presents semilunar defects (lacunar desorption) or appears to form endosteal cortical residues.
- C3: The cortical layer forms heavy endosteal cortical residues and is porous.

**Results**

In this study, we have measured all the indices on the panoramic radiographs of 56 patients. The measured indices were subsequently grouped based on age and gender followed

by statistical analysis. The normal values of different indices as reported in different literature are tabulated in Table 1.

Different measured indices and their statistical significance for gender and age groups inferred using the Chi-square test are shown in Table 2 and Table 3 respectively. It is clear that the Mandibular cortical index (MCI) with  $p < 0.05$  is statistically significant and hence a reliable tool for predicting osteoporosis. However Mental index ( $P=0.3$ ), Antegonial index ( $P=0.4$ ), Gonial Index ( $P=0.8$ ) and Panoramic mandibular index ( $P=0.5$ ) were statistically insignificant. This can be attributed to an uneven number of samples across different age groups, the presence of outliers, and an overall

small sample size.

We have further calculated the sensitivity and specificity of different indices (Table 4) with statistically significant MCI and inferred that GI has more sensitivity showing 79.1% and PMI has more specificity of 84.6%.

**Table 1:** The standard normal and abnormal values of different indices as reported in different literature

Index	Normal	Abnormal
MI	> 3.1.	< 3.1
AI	> 3.20	< 3.20
PMI	> 0.3	< 0.3
GI	> 1.2	< 1.2
MCI	C1	C2 & C3

**Table 2:** Gender-based distribution of different indices predicting osteoporosis among study subjects using the Chi-Square Test

Indices	Category	Males		Females		p-value
		N	%	N	%	
MI	Normal	9	32.1%	6	21.4%	0.37
	Abnormal	19	67.9%	22	78.6%	
AI	Normal	17	60.7%	15	53.6%	0.59
	Abnormal	11	39.3%	13	46.4%	
GI	Normal	8	28.6%	5	17.9%	0.34
	Abnormal	20	71.4%	23	82.1%	
MCI	Normal	4	14.3%	9	32.1%	0.04*
	Abnormal	24	85.7%	19	67.9%	
PMI	Normal	21	75.0%	20	71.4%	0.76
	Abnormal	7	25.0%	8	28.6%	

**Table 3:** Age-based distribution of different indices predicting osteoporosis among study subjects using the Chi-Square Test

Indices	Category	N	<40 yrs.		>40 yrs		p-value
			%	N	%	N	
MI	Normal	4	19.0%	11	31.4%	0.31	
	Abnormal	17	81.0%	24	68.6%		
AI	Normal	13	61.9%	19	54.3%	0.58	
	Abnormal	8	38.1%	16	45.7%		
GI	Normal	7	33.3%	6	17.1%	0.17	
	Abnormal	14	66.7%	29	82.9%		
MCI	Normal	11	52.4%	2	5.7%	<0.001*	
	Abnormal	10	47.6%	33	94.3%		
PMI	Normal	14	66.7%	27	77.1%	0.39	
	Abnormal	7	33.3%	8	22.9%		

**Table 4:** Sensitivity (Sn) and specificity (Sp) of different indices with statistically significant MCI

	MI	AI	GI	PMI
Sn	72.1%	46.5%	79.1%	30.2%
Sp	23.1%	69.2%	30.8%	84.6%
PPV	75.1%	83.3%	79.1%	86.7%
NPV	20.0%	28.1%	30.1%	26.8%
Accuracy	60.7%	51.8%	67.9%	42.9%

## Discussion

Panoramic radiographs are the extra oral radiographs that provide overall hard tissue details of the maxilla and mandible which can be saved and stored for years. In general dental practice, dental panoramic radiography is used as a routine screening tool, assessment of radio morphometric indices may be helpful to identify low Bone Mineral Density (BMD) and can create awareness of osteoporosis [5]. Many studies have reported both positive and negative correlations between these indices of panoramic radiographs and osteoporotic conditions [6-11]. The indices provide an advantage to dental practitioners by using them as a low-cost and easy tool for diagnosing

osteoporosis.

In the present study, MCI showed a statistically significant difference with  $p = < 0.001$  and  $0.04$  among age and gender respectively. We have categorized C2 and C3 as abnormal in this study and found that males > 40 years showed a relatively high frequency of moderately eroded mandibular cortex. Hence, MCI is a reliable index for identifying low BMD conditions. This finding was from a study done by Gulsahi, *et al.* [11], which suggested that MCI can be considered as one of the accurate indices for assessing osteoporosis irrespective of age and gender. Similar results were found in the studies conducted by Horner and Devlin [12], and Taguchi, *et al.* [13] suggesting MCI is easy to determine thus establishing it as a reliable index in identifying low BMD conditions. On the contrary, studies were done by Jowitt, *et al.* [14] and Drozdowska, *et al.* [15] did not show an association between MCI and BMD condition.

In our study, the difference in the mean MI, PMI, AI, and GI scores across the study groups (age and gender) was statistically insignificant. Many studies were in accordance and contradictory to these findings [6-11].

Overall small sample size, uneven sample across age groups, and presence of outliers may be the reason for showing insignificant differences among study groups in other indices. So, further elaborate study with an adequate sample size is required to overcome this lacuna.

**Limitations:** Overall small sample size, uneven sample across age groups, and presence of outliers may be the reason for showing insignificant differences among study groups in other indices.

**Future prospects:** An elaborate study with an adequate sample size is required to overcome this lacuna.

## Conclusion

Our study results indicate that among the 5 indices, MCI is a reliable index in diagnosing osteoporosis as it showed a significant difference between both gender and age group distribution. However, as mentioned earlier, the uneven sample size across the age group, presence of outliers, and overall small sample size suggests an elaborate study to further explore the significance of other indices.

## Acknowledgement

Not available

## Author's Contribution

Not available

## Conflict of Interest

Not available

## Financial Support

Not available

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**How to Cite This Article**

Asha V, Kaimal VG. Detection of osteoporosis using orthopantomography: An analytical study. *International Journal of Applied Dental Sciences*. 2023;9(1):106-109.

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