# Evaluation of mandibular cortical indexes in digital panoramic radiography

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**Abstract**
**Introduction:** Since radiography plays an important role in the early detection of osteoporosis in patients, we decided to conduct a study to evaluate mandibular cortical indexes in digital panoramic radiography. **Material and method:** This descriptive cross-sectional study was performed randomly on 321 patients aged 20-50 years requiring panoramic radiography referring to a private oral and maxillofacial radiology center in Zanjan in 1398. Only 319 patients (137 males and 182 females) remained by the end of the study divided into three groups of 20-30, 31-40 and 41-50. Radiomorphologic and radiomorphometric indices of GI, MI, PMI and MCI were evaluated. Data were then analyzed using test.t, Pearson and Spearman correlation coefficients. Finally, the data were analyzed using SPSS version 21. **Results:** The results of this study showed that MIC has a direct relationship with age and sex and this relationship is clinically relevant. MI was inversely correlated with age but was significantly correlated with sex but was not clinically significant. GI was inversely correlated with age and significantly correlated with sex. PMI was inversely correlated with age and has a significant relationship with sex, but it was not clinically significant despite its significance.
**Discussion and conclusion:** The results of this study showed the effective role of age and sex variables on radiomorphometric indices and supported the finding that these variables could be useful in identifying osteoporotic conditions.

**Keywords:** radiomorphometric indicators, panoramic radiography, mandible

## INTRODUCTION

Bone mass and density are important factors for bone strength. The bone elastic modulus, a bone property that is conceptually related to its fragility, is proportional to its density cube. Therefore, small changes in bone density are associated with larger changes in bone strength (Seeman and Martin 1989). Bone formation occurs not only during growth, but also throughout life. From the age of thirty to fifty, the amount of bone formed is approximately equal to the amount absorbed. From menopause in women and from about the sixth decade in men, bone resorption begins to go beyond bone formation (Wanner and Riggs 1986). Osteoporosis is a common and well-known systemic disease characterized by decreased bone mass and deterioration of the microscopic structure of bone resulting in increased bone fracture (White and Rudolph 1999). HYSTEROPROTIC FRACTION Causes patient morbidity, medical costs, and high risk of mortality. It is well known that osteoporosis also reduces jaw bone mass and changes the mandibular structure, especially in the lower border (Gulsahi et al. 2008). According to a new World Health Organization (WHO) report in 2015, musculoskeletal conditions such as osteoporosis place a heavy burden on individuals and have a significant impact on the health index of developed and developing countries (Cauley 2017). Osteopenia can be identified by.

Thinning of the inferior mandibular cortex. A number of mandibular markers have been proposed to determine bone mass and identify osteopenia (Devlin and Horner 2002). Panoramic radiography is routinely prescribed in dental treatment planning because of its acceptable quality, low dose, and low cost (Tözüm and

Taguchi 2004). Radiomorphometric indices have been used in this radiography to evaluate the quality and quantity of bone and to observe symptoms of analysis and osteopenia (Gulsahi et al. 2008). The dentist can play an important role in the early diagnosis of osteoporosis by examining this radiograph. Although osteoporosis has been recognized as a major disease in postmenopausal women (Taguchi et al. 2006), few studies have investigated its effect on mandibular bone quality in men (Klemetti et al. 1993, Dagistan and Bilge 2010), that The results of these studies have shown the effective role of gender and age on the incidence and prognosis of osteoporosis (Broussard and Magnus 2004, Dutra et al. 2005), However, the differences in outcomes between men and women in different age groups in the normal population have not yet been clearly stated in the studies. Panoramic radiography is used for early diagnosis and treatment planning in dentistry. Recent studies have shown that panoramic X-ray screening is a cost-effective method of identifying patients with severe osteoporosis risk (Kim et al. 2016). A number of mandibular cortical markers, including the following, have been developed to assess and measure the quality of mandibular mass and to observe absorption symptoms in panoramic radiographs to detect osteopenia (Hastar et al. 2011).

Mandatory Cortical Index (MCI): Morphological form of the mandibular lower cortex in the perforation of the chin in three forms:

C1: The endosteal cortex is distinct at both ends.

C2: A semicircular defect is seen along the endosteal cortex.

C3: Severe endosteal defect is observed and cortex has many pores (Kribbs 1990).

Panoramic Mandibular Index (PMI): The result of dividing the MI by the distance of the center of the chin hole to the lower mandible (Delbalso Angelo and Maxillofacial imaging 1990).

Mental Index (MI): Lower mandibular cortex thickness in chin perforation area.

Antegonial Index (AI)

Gonial Index (GI): The thickness of the inferior mandibular cortex in the angle of the gonius (Androulie 2000, Imani Moghaddam et al. 2005).

In 2019, Kalinowski et al., In the Netherlands, conducted a study evaluating the association between periodontal disease, lower mandibular cortex, and osteoporosis fractures using body massaging tools. They studied 442 people, including 270 women and 152 men, with an average age of 40-89. The severity of chronic periodontitis and inferior mandibular cortex uptake were evaluated based on MIC index. In this study, a 10-year estimate was made to determine the probability of major fractures and hip fractures using the BMI FRAX tool. In conclusion, this study showed that body mass measurements, dental radiographs and Mandibular Inferior Cortex (MIC) are suitable tools for

determining the probability of osteoporosis and its associated fractures and Pelvic hip fractures are more likely in women than men (Kalinowski et al. 2019). Since radiography plays an important role in the early detection of osteoporosis in patients and although osteoporosis is recognized as a major disease in postmenopausal women, few studies have investigated its effect on mandibular bone quality in men, That the results of these studies have shown the effective role of gender and age on the incidence and prognosis of osteoporosis, However, the difference in outcomes between men and women in different age groups in the normal population has not yet been clearly stated in the studies, Therefore, we aimed to conduct a study to evaluate the mandibular cortical indexes in digital panoramic radiography in patients referred to a private jaw and facial radiology center in Zanjan in 1398.

## MATERIAL AND METHOD

This descriptive cross-sectional study was performed randomly on 321 patients aged 20-50 years requiring panoramic radiography referring to a private oral and maxillofacial radiology center in Zanjan in 1398. Patients in the age range of 20-50 years and in need of panoramic referring to a private oral and maxillofacial radiology center in Zanjan were included in the study and Patients with renal disease, hyperparathyroidism, hypothyroidism, Cushing's syndrome and no use of estrogen pills were excluded, Patients also had radiographs with patient head positioning errors, radiographs that were incidentally observed and diagnosed as pathological lesions, and the absence of a mental hole in some images of defects in patient information, which were all excluded.

Sample size was calculated according to the following formula:

$$\frac{(Z1 - \alpha 2 + Z1 - \beta)\, 2\, (\sigma1\, 2 + \sigma2\, 2)}{d\, 2}$$

$\alpha = 0/05 \rightarrow Z1 - \frac{\alpha}{2} = 1/96 \cup$ Significance level

1 Power to test-$\beta = 0/80 \rightarrow Z1$- $\beta = 0/84$

These were obtained by volume C1 and C2, which represents the maximum number of samples compared to other indexes. This descriptive cross-sectional study was performed randomly on 321 patients aged 20-50 years requiring panoramic radiography referring to a private oral and maxillofacial radiology center in Zanjan in 1398. Panoramic radiographs were performed by an operator with Cranex3D, 63-66 KVP and 10-14 MAS depending on the patient's body and gender to achieve optimal contrast and density. Images were processed and measured by Scanora software. Radiomorphological and radiomorphometric indices of GI, MI, PMI and MCI were evaluated. Quantitative indices of MI, PMI, GI were measured bilaterally (left and right mandible) by Scanora software millimeter ruler and

**Table 1.** Overall population distribution by age group

| Groupings | Frequency of data | Percentage of distribution |
|---|---|---|
| 30-20 | 107 | 33.5% |
| 40-31 | 107 | 33.5% |
| 50-41 | 105 | 32.9% |
| total | 319 | 100% |

**Table 2.** Overall population distribution by gender

| Gender | Frequency of data | Percentage of distribution |
|---|---|---|
| men | 137 | 42.1% |
| women | 182 | 57.1% |
| total | 319 | 100% |

**Table 3.** Distribution of MCI Indicators

| MCI indicators | Data distribution | Percentage of distribution |
|---|---|---|
| C1 | 100 | 31.3% |
| C2 | 117 | 36.7% |
| C3 | 102 | 32% |
| total | 319 | 100% |

recorded in patient information form. If the chin hole was not seen in one site, PMI, MI would not be indicated. MCI Qualitative Index was also bilaterally observed and according to the classification mentioned above, it was included in the patient information form. Data were then analyzed using test.t, Pearson and Spearman correlation coefficients. Finally, the data were analyzed using SPSS version 21.

## RESULTS

In this study of 321 patients, only 319 patients (137 males and 182 females) remained by the end of the study, divided into three groups of 20-30, 40-31 and 41-50 that the overall distribution among the groups by age group is outlined in **Table 1**.

Given that gender is also a variable factor, **Table 2** shows the population distribution by sex.

According to the results of the study, the relationship of MCI with the two variables of age and sex was qualitatively divided into 3 categories (**Table 3**) and multiple logistic regression was used to analyze the data. According to (P-Value≤0.05) which was statistically significant and $R^2$ which was 2 independent variables of age and sex 0.8-0.7, it was concluded that 2 independent variables of age and gender were able to explain between 7.5% - 8.4% of MCI changes. And according to the regression coefficient table and the parental statistic (P-Value $0.05$), it can be concluded that the effect of age and sex variable was significant and age and sex were related to MCI.

According to the results of the study, the relationship between MI and two variables of age and sex was found to be in the MI factor (P-Value≤0.05) and according to the regression coefficient (B), there was a relationship between age and sex and MI factor. The relationship between MI and age was the opposite, but the relationship between MI and sex was positive in one direction, however, because of the low conversion coefficients of conversion, $R^2 = 0.05$, this finding was

not clinically relevant. According to the results of the study, the correlation of PMI with 2 variables of age and sex was determined. Since the assumption of normality was not found in the PMI data, second order root transform was used to normalize and then regression analysis was performed. For PMI2, although statistically significant (P-Value≤0.05) and with respect to B regression coefficient, there was a correlation between age and PMI2 factor and were in opposite direction, But there was a positive relationship between sex and PMI2. However, because of low conversion coefficient of determination, $R^2 = 0.06$ was not clinically relevant and there was no clinical difference in PMI2 between men and women and age difference.

According to the results of the study, the relationship between GI and 2 age and gender variables was found to be due to the lack of assumption of normality in the GI data, no conversion was possible to normalize the data, so for analysis of nonparametric regression statistical software R was used. There was a significant relationship between GI factor and age and sex (P-Value≤0.05) and $2e^{n-16} < 0.05$.

## DISCUSSION

Osteoporosis is a well-known disease with low bone mass and micro-structural weakness of bone tissue, leading to increased bone fragility and increased risk of fracture (Nakamoto et al. 2003, Shafiee and Shafieeb). Radiomorphometric methods are non-invasive methods for the examination of osteoporosis. Radiomorphometric indices are mainly based on cortical bone measurements because they are easier to visualize than the trabecular bone (Benson et al. 1991, Sadeghinia and Mighani 2020). Since panoramic radiographs are of acceptable quality, low dose, and cost effective, they are routinely prescribed in dental treatment planning (Tözüm and Taguchi 2004). Radiomorphometric indices were used in this radiograph to evaluate the quality and quantity of bone and to observe symptoms of analysis and osteopenia (Gulsahi et al. 2008). In the present study, there is a direct relationship between MIC with age and sex. The relationship between MI and age was reversed and had a direct relationship with sex but was not clinically relevant. GI is inversely correlated with age and directly related to sex. . PMI was inversely correlated with age and has a significant relationship with sex, but it was not clinically significant despite its significance. In Kalinowski et al. conducted a study evaluating the association between periodontal disease, lower mandibular cortex, and osteoporosis fractures using body massaging tools. They found that there was a relationship between MIC and osteoporosis and the risk of osteoporosis fractures was higher in women. The results are consistent with the results of the present study (Kalinowski et al. 2019).

Bajoria et al. In a study evaluating radiomorphometric indices in panoramic radiography found that MIC, PMI, AI, and MI could be measured effectively on a panoramic radiograph, It can therefore be used as a screening tool to determine osteoporosis. All indices were negatively correlated with age and there was a significant difference between young and adult age groups. All indices were significantly lower in females than males in the same age group. The results were in line with the results of the current study on MI but not on the MIC index, In the case of PMI, although significant in this study, it was concluded that the results of the radiographs were of no value and clinical information should be used, which is one of the strengths of this study (Bajoria et al. 2015). Hashemi et al. Studied radiomorphometric indices of mandibular bone in panoramic radiographs of patients referred to private radiology clinic in Mashhad, The results of this study showed that AI and GI variables were significantly different in men and women and decreased with age, There was also a significant difference in MCI between the two sexes. In conclusion, this study showed the effective role of age and sex variables on radiomorphometric indices and supported the finding that these variables could be useful in identifying osteoporotic conditions. The results were consistent with the current study (Hashemi and Bagherpour 2013). Haster et al. Investigated the Mental Index, Mandibular Cortical Index, and Mandibular Panoramic Index in the elderly. They concluded that the values of MI, PMI and MCI were significantly different in patients with and without osteoporosis (P-Value (0.05). This study showed that there was a clear difference between gender, dental status and MCW, PMI and MCI in healthy and osteoporotic individuals. The results of their work were clearly consistent with the results of this study (Hastar et al. 2011). Kiswanjaya and colleagues investigated the association between mandibular inferior cortex and bone hardness in Japanese elderly. They concluded that MCI could be used as an adjunctive tool to assess low skeletal bone mass, which was consistent with this study (Kiswanjaya et al. 2010). Dagistan and colleagues compared antigonial index, mental index, mandibular panoramic index, and mandibular cortical index in healthy men and men with osteoporosis. They stated

that these indices could be used as an adjunct in the diagnosis of osteoporosis, but MCI did not differ significantly between these groups. Overall this study was in line with the present study but disagreed with the findings of MCI, Also, only men were studied in this study, while women were also identified as one of the strengths of this study (Dagistan and Bilge 2010). Gulsahi and colleagues examined radiomorphometric indices in Turkish patients with age, sex, and dental status. Patients were divided into 3 age groups of 20-49 years, 69-50 years and over 70 years. They found that C3 was more likely to develop MCI in the age group over 70 than in other groups. It is also more likely in patients with MI less than 3 mm and PMI less than 0.3 more than other groups. Therefore, regardless of gender, they concluded that these patients should be considered high-risk individuals for osteoporosis، Despite the differences in sex groups of studies, this was consistent with the current study (Gulsahi et al. 2008). Gadkhari et al performed a study evaluating mandibular radiomorphologic and radiomorphometric indices in postmenopausal women. They examined the radiographs of 40 postmenopausal women. In conclusion, age and duration of menopause were inversely correlated with MI, PMI and GI and directly with MCI. They also stated that as the age progressed, the mandibular cortex form clearly changed and that C3 approached to form more porosity. On the other hand, as menopause progresses, the effect of sex hormone depletion on bone loss is accelerated. Therefore, these indicators can be used to identify and screen for people with reduced bone density. This study is in line with the current study and further strengths of the statistical community can be mentioned (Imani Moghaddam et al. 2005, Soleimani et al. 2020). Overall, this study showed that MIC is directly related to age and sex and is clinically relevant. . MI was inversely correlated with age but was significantly correlated with sex but was not clinically significant. GI was inversely correlated with age and significantly correlated with sex. PMI was inversely correlated with age and has a significant relationship with sex, but it was not clinically significant despite its significance.

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