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Research Paper: Comparing panoramic mandibular radiomorphometric indices between osteoporotic and healthy women in Rafsanjan, Iran, 2018

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ABSTRACT

Introduction: Radiomorphometric indices obtained from panoramic radiography are used to quantitatively and qualitatively evaluate osteoporosis. Given the importance of early diagnosing osteoporosis. The present study was conducted to compare osteoporotic and healthy women in Rafsanjan, Iran in terms of mandibular radiomorphometric indices obtained from their panoramic radiographs.

Materials and Methods: This descriptive cross-sectional study examined 212 subjects, including 53 osteoporotic women and a control group comprising 159 women presenting to the Department of Oral and Maxillofacial Radiology, School of Dentistry, Rafsanjan University of Medical Sciences, Rafsanjan, Iran .The participants were investigated by performing radiographic imaging using a digital panoramic system (Planmeca Promax, Helsinki, Finland). The radiographic data recorded on each image included radiomorphometric indices such as mandibular cortical index(MCI), antegonial index (AI) and gonial index(GI). The data collected from the checklists were analyzed in SPSS-22.

Results: The osteoporotic patients were not significantly different from the controls in terms of AI. The mean GI was significantly higher in the osteoporotic women than in the women in the control group. Investigating MCI showed that category C1 was significantly higher in the controls than in the osteoporotic women, whereas category C2 was higher in the osteoporotic group than in the controls.

Conclusion: The present findings revealed that GI and MCI obtained from panoramic radiographs can be used to diagnose osteoporosis and differentiate osteoporotic patients from healthy individuals. Although the indices were affected by age in both groups, differences in the indices between the patients and controls were insignificant in the same age group.

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Introduction

Osteoporosis is a disease that decreases bone density and causes the microstructure loss of the bone, which increases its fragility and fracture risk .(1) Osteoporosis is categorized as primary and secondary in type. Lack of formation of primary bone density during adolescence and youth and gradual reductions in bone density with age can cause osteoporosis.(2) Bone fracture is asymptomatic, and pain and disability occur after bone fracture.(3) At all ages, bone density is markedly less in women than in men of the same age and race. In both genders, bone density begins to decrease with age after being maximized at 30 years of age. (2) Research suggests this reduction is below 1% per year after the age of forty, 2% in postmenopausal women (4) and 3-9% six years after menopause, and 50% of the trabecular bone and 30% of the cancellous bone are lost 20 years after menopause.(5,6) The costs imposed by this disease include hospitalization, outpatient care, nursing services, medicinal therapies and working days lost. Moreover, this disease increases the risks of mortality, bone fractures, back pain, reduced height and disability and its secondary complications threaten the health of older adults.(7) In addition to genetic and hereditary factors, which contribute to the incidence of osteoporosis in 50-80% of the cases, physical activity, the environment, nutrition and the onset age of puberty are effective.(2)

The main radiographic changes in osteoporosis include reductions in bone density and mandibular cortical thickness.(7) Osteoporosis has been well found to reduce the mandibular bone density and structurally change the mandible, especially its lower border.(8) Reduced bone density in the skeleton, e.g. the vertebrae, metacarpus and radius, can be associated with progressive periodontal diseases, severely-atrophic mandibular ridge and postmenopausal tooth loss.(9-11) Research suggests the density of the mandibular buccal cortex correlates with the density of the femur and lumbar vertebrae.(12)

As the main radiographic techniques for diagnosing osteoporosis, quantitative computed tomography and dual-energy x-ray absorptiometry (DXA) are highly expensive, not always available and require specialized skills. These technological obstacles therefore restrict screening for osteoporosis. Panoramic radiography is usually prescribed for treatment planning in dentistry due to its acceptable quality, low dose and cost effectiveness.(13) The panoramic radiomorphometric indices used to quantitatively and qualitatively assess osteoporosis include mandibular cortical index (MCI), antegonial index (AI) and gonial index (GI), whose interpretations can help dentists diagnose osteoporosis in its early stages.(8)

Given the importance of the early diagnosis of osteoporosis and that different factors affect the disease and its geographical distribution (14-17), the present study compared panoramic mandibular radiomorphometric indices between osteoporotic and healthy women in Rafsanjan and determined the abnormal indices that suggested osteoporosis. It is recommended that future meta-analyses be conducted to specify the normal and abnormal values of these indices in Iranian populations.

Materials and Method:

This descriptive cross-sectional study examined a control group comprising 159 women presenting in 2018 to the Department of Oral and Maxillofacial Radiology, School of Dentistry, Rafsanjan University of Medical Sciences, Rafsanjan, Iran to receive dental services such as panoramic radiography. The osteoporotic group investigated comprised 53 women diagnosed with osteoporosis through the DXA of the femur, the spine and the wrist, with at least two radiographs of these regions prescribed. These women, whose health records were held in Ali ibn Abi Talib Hospital of Rafsanjan, were investigated after taking their panoramic radiographs. The radiomorphometric data were collected after obtaining the informed consent of the patients. The Ethics Committee of Rafsanjan University of Medical Sciences approved the present research.

The inclusion criteria comprised being from

Rafsanjan, an age of over 20 years (given that calcification of the cortical periphery is not completed before 20, absence of diseases affecting bone metabolism, e.g. osteomalacia and hyperparathyroidism, avoiding medications that affect bone metabolism, e.g. heparin and corticosteroids (in the control group), the panoramic radiographs without technical errors and absence of lesions or special local conditions that affect the lower border of the mandible. Patients with a toothless mandible were excluded from the study.

Radiographic images of the participants were obtained using a digital panoramic system (Planmeca Promax, Helsinki, Finland) with an exposure factor proportionate to the patient build.

The radiographic data extracted from every image by an oral and maxillofacial radiologist included radiomorphometric indices such as MCI, AI and GI. The results of investigating these data as described in the following were recorded in the checklist attached.

According to figure 1, the MCI-based morphological categories of the cortex at the lower border of the mandible in the distal part of the mental foramen in panoramic radiography include:

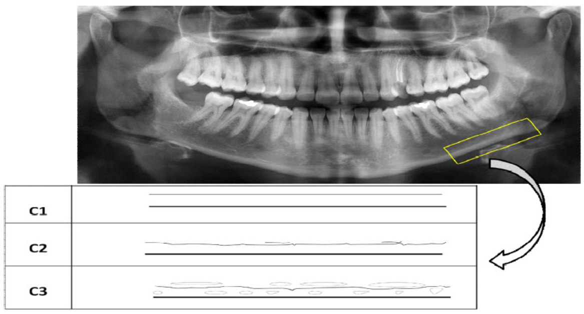

Figure 1: MCI classification; C1: The endosteal margin of the cortex is even and smooth on both sides. C2: The endosteal margin of the cortex shows semilunar defects or a layered form (1-3 layers) on one or both sides. C3: The cortical layer is completely layered and clearly porous on one or both sides.

C1: The endosteal margin of the cortex is even and smooth on both sides.

C2: The endosteal margin of the cortex shows semilunar defects or a layered form (1-3 layers) on one or both sides.

C3: The cortical layer is completely layered and clearly porous on one or both sides.

AI: To determine the thickness of the mandibular cortex, a line is drawn in the antegonial region parallel to the anterior border of the ramus and another parallel to the lower border of the mandible. From the intersection of the two lines, a perpendicular line is drawn to the lower cortex of the mandible, and mandibular

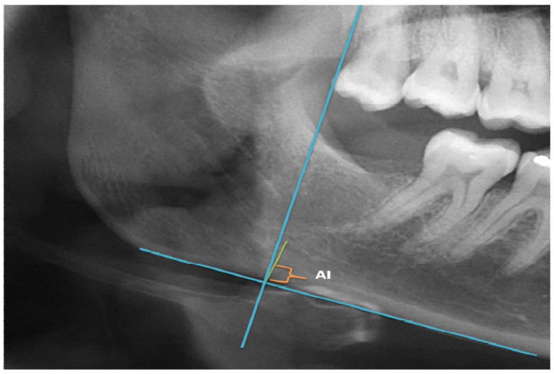

Figure 2: AI measurement method; A line is drawn in the antegonial region parallel to the anterior border of the ramus and another parallel to the lower border of the mandible. From the intersection of the two lines, a perpendicular line is drawn to the lower cortex of the mandible, and mandibular thickness is measured in that region

According to figure 3, to determine the mandibular cortical thickness, a line is drawn in the gonial region parallel to the posterior border of the ramus and another parallel to the lower border of the mandible. An angle bisector is drawn at the intersection of the two lines and the cortical thickness measu 8)

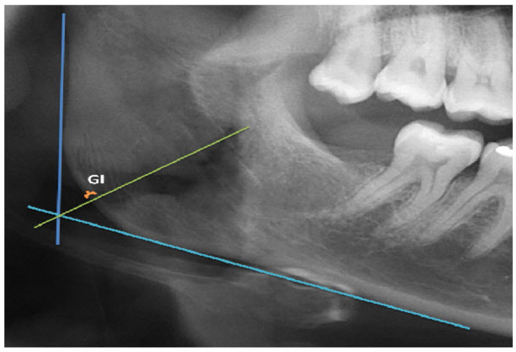

Figure 3: GI measurement method; A line is drawn in the gonial region parallel to the posterior border of the ramus and another parallel to the lower border of the mandible. An angle bisector is drawn at the intersection

An oral and maxillofacial radiologist performed linear measurements in Planmeca Romexis 3.8.3 on the digital panoramic radiographs. Intraobserver agreement was evaluated by randomly selecting and re-examining approximately 10% of all the radiographs at least 2 weeks later and comparing the results with the initial investigation results.

These radiomorphometric indices were ultimately compared between the control and osteoporotic groups. After performing statistical analyses, patients in the control group whose radiomorphometric indices lay in the osteoporotic range were advised to visit a doctor.

The results of analyzing the data collected from the checklists in SPSS-22 were reported as mean values for the quantitative data and frequency (relative frequency) for the qualitative data.

A two independent samples t-test was performed to compare the radiomorphometric indices of the mandible (AI and GI) between the osteoporotic women and the control group by age. The Chi-squared test and Fisher's exact test were also conducted to compare the frequency of categories C1 and C2 between the women with and without osteoporosis by age. Moreover, the Kolmogorov-Smirnov test confirmed the normality hypothesis of the frequency distribution of AI and GI in the two groups (P>0.05). The level of statistical significance of the tests was adjusted at P<0.05.

Results :

In 2018, this descriptive cross-sectional study examined 53 osteoporotic women aged 33-75 years and a control group comprising 159 women aged 37-74 years presenting to the Department of Oral and Maxillofacial Radiology, School of Dentistry, Rafsanjan University of Medical Sciences, Rafsanjan to receive dental services such as panoramic radiography.

The mean age of the participants was 46.23±8.32 years in the control group and 46.74±12.70 in the osteoporotic group, suggesting a statistically-insignificant difference based on the independent two sample t-test (P=0.786). The two groups were matched in terms of age and gender. Table 1 statistically compares the radiomorphometric indices between the patients and controls.

The data in table 1 were reported as mean±SD or frequency (relative frequency) and parentheses for AI and GI show the variation range, i.e. minimum and maximum.

According to table 1 and the independent two sample t-test, although no statistically-significant differences were observed between the two groups in terms of the mean AI (P=0.738), the mean GI was significantly lower in the osteoporotic women than in the controls (P=0.003). The Chi-squared test respectively revealed the significantly-higher and significantly-lower frequencies of categories C1 and C2 in the controls compared to in the osteoporotic women (P< 0.001). This study reported category C3 in neither the control nor the osteoporotic groups.

To investigate the effect of age on the radiomorphometric indices, the patients and controls were categorized into age groups of below 35 years, 35-49 and at least 50. A total of 65 (40.9%) and 20 (37.7%) subjects were below 35 years old, 71 (44.7%) and 23 (43.4%) were 35-49 and 23 (14.5%) and 10 (18.9%) at least 50 in the control and osteoporotic groups, respectively. The Chi-squared test showed insignificant differences in the frequency distribution of age between the patients and controls (P=0.738).

Table 1: Comparing panoramic mandibular radiomorphometric indices between the osteoporotic patients and the controls in Rafsanjan, 2018

Group / Index	Control (N=159)	Osteoprsis (N=53)	Statistical Index	P
AI (mm)	2.14±0.53 (1-3.4)	2.11±0.53 (1.1-4)	-0.335	0.738
GI (mm)	0.94±0.33 (0.5-1.6)	0.79±0.28 (0.2-1.7)	-2.971	0.003
MCI C1 C2	 138 (86.8%) 21 (13.2%)	 33 (62.3%) 20 (37.7%)	15.331	<0.001

Table 2 statistically compares the radiomorphometric indices between the patients and controls by age.

The data in table 2 were reported as mean±SD or frequency (relative frequency) and parentheses for AI and GI show the variation range, i.e. minimum and maximum.

According to table 2 and the two independent samples t-test, the mean GI was significantly lower in the osteoporotic women than in the controls (P=0.012) in the age group of below 35 years, whereas no statistically-significant differences were observed between the two groups in terms of the mean GI in the other age groups (P>0.05). No significant differences were observed in the mean AI between the patients and controls at any age groups (P > 0.05). Furthermore, Fisher's exact test respectively revealed the significantly-higher and significantly-lower frequencies of categories C1 (P=0.022) and C2 (P=0.037) in the controls compared to in the osteoporotic women in the age groups of below 35 and 35-49. In the age group of at least 50, no statistically-significant differences were observed between the osteoporotic women and control in terms of these frequencies (P=0.215).

Table 2: Age-based comparison of panoramic mandibular radiomorphometric indices between the osteoporotic patients and controls in Rafsanjan, 2018

Group / Index	Control	Osteoporosis	Statistical Index	P
<35 years	(N=65)	(N=20)		
AI (mm)	2.18±0.51 (1.2-3.4)	2.29±0.68 (1.4-4)	0.769	0.444
GI (mm)	0.96±0.34(0.5-1.6)	0.76±0.28 (0.3-1.5)	-2.649	0.012
MCI			---	0.022
C1	56 (86.2%)	12 (60%)		
C2	9 (13.8%)	8 (40%)		
35-49 years	(N=71)	(N=23)		
AI (mm)	2.11±0.54 (1-3.1)	1.97±0.33 (1.1-2.4)	-1.582	0.119
GI (mm)	0.94±0.32(0.5-1.6)	0.80±0.28(0.3-1.7)	-2.010	0.051
MCI			---	0.037
C1	64 (90.1%)	16 (69.6%)		
C2	7 (9.9%)	7 (30.4%)		
≥50 years	(N=23)	(N=10)		
AI (mm)	2.10±0.59(1.2-3.3)	2.09±0.51(1.1-2.9)	-0.047	0.963
GI (mm)	0.87±0.34(0.5-1.6)	0.84±0.32(0.2-1.6)	-0.243	0.811
MCI			---	0.215
C1	18 (78.3%)	5 (50%)		
C2	5 (21.7%)	5 (50%)		

Discussion:

Osteoporosis is a systemic skeletal disease that reduces bone density, microscopically destructs the bone tissue and increases the risk of bone fracture. Osteoporotic fractures cause illness, impose medical costs and increase the risk of mortality. (1, 19) Given the importance of the early diagnosis of osteoporosis and that different factors affect the disease and its geographical distribution, (14-17) the present study compared panoramic mandibular radiomorphometric indices between osteoporotic and healthy women in Rafsanjan and obtained the abnormal indices that suggested osteoporosis.

The mean AI was obtained as 2.11±0.53 mm in the osteoporotic patients and 2.14±0.53 mm in the controls (P = 0.738). Similarly, J Bras et al. and Knezovic Zlataric et al. found AI not to constitute an appropriate criterion for diagnosing osteoporosis. (20, 21) In contrast, a significant difference was reported by Devlin et al. (22) in the mean AI between an osteoporotic group and a healthy group in England, which is consistent with and the mean AI was lower in people with lower bone density than the normal group. Some other studies have reported contradictory findings. (23, 24, 25) This discrepancy in results can be explained by differences in ethnicity and the size of control group between the present study and that conducted by Delvin et al., with 19 individuals in their control group .(22)

The mean GI was significantly lower in the osteoporotic patients (0.79±0.28 mm) than in the controls (0.94±0.33 mm) (P=0.003). GI was therefore found to constitute an acceptable criterion for diagnosing osteoporosis although there is yet no consensus among researchers on the applicability of GI to diagnosing osteoporosis. In line with the present research, studies such as one by Taguchi et al. reported GI as a significant index for osteoporosis evaluation .(8,26,29) In contrast, Devlin et al. (22) reported no significant differences in GI between osteoporotic and control groups, which can be explained by the different severity of osteoporosis in their study population. They reported a mean GI of 0.386 in the osteoporotic group, which was significantly lower than that reported in the present study. GI was also considered an ineffective index in diagnosing osteoporosis elsewhere. (22, 23) Taguchi attributed these contradictory findings to the significant effects of the errors occurring during performing the procedure on the outcome as a result of GI being small. (26)

Investigating MCI showed the frequency of category C1 in the control group (138, 86.8%) to be significantly higher than in the osteoporotic group (33, 62.3%) and the frequency of category C2 to be 20 (37.7%) in the osteoporotic group and 21 (13.2%) in the control group. The present findings suggested MCI can be an acceptable index for diagnosing osteoporosis. Similarly, Leite et al. (25) found MCI applicable to differentiating osteoporotic from healthy individuals, and numerous studies reported MCI as a reliable index for diagnosing osteoporosis. (23, 28, 29, 30) The findings obtained by Dagistan et al. (24) were, however, inconsistent with the present results, which can be explained by the male gender of the population they investigated.

The present study revealed insignificant differences in the mean age between the two groups. The mean AI also decreased with an age of up to 50 years and increased at ages over 50 in the osteoporotic patients. This increase in older ages was not reported in any other studies, which can be explained by their small number of subjects investigated at an age of over 50. Moreover, the mean GI respectively decreased and increased with age in the control and osteoporotic groups. In all the age groups, the frequency of category C1 was higher in the control group than in the patients, and the effect of age variations on MCI was significant in the participants aged at most 49 years.

Studies such as one by Bojaria et al. (23) reported reductions in the mean values of AI and GI with age (24, 25, 28, 31, 32), which is consistent with the present findings. However, Devlin et al. observed no reductions with age in GI in contrast to the age-dependent decrease in AI (22). This contradiction can be associated with the difference in the mean age of the study participants, which was 62 years in their study. Despite reporting insignificant changes in GI with age in individuals aged at most 50, Gavindraju et al. observed significant negative correlations between GI and age in those aged over 50 (33). Neves et al. reported significant changes in MCI with age, which is inconsistent with the present research and similar studies (8,23,35) owing to their selection of a study population from patients with sickle cell disease. (34)

The present study limitations included its small sample and failing to examine all radiomorphometric indices. It is recommended that similar studies be conducted in other Iranian cities and the results be summarized in review articles and meta-analyses to help obtain the values of radiomorphometric indices in Iranian populations.

Conclusion:

According to the findings obtained from the present research, GI and MCI obtained from panoramic radiographs can be employed to diagnose osteoporosis and differentiate the patients from healthy individuals.

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Conflict of interest:

All the authors declare that they have no conflict of interest.

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