RESEARCH

Comparison of antegonial index, mental index, panoramic mandibular index and mandibular cortical index values in the panoramic radiographs of normal males and male patients with osteoporosis

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Objective: The aim of the study was to compare the values of the antegonial index (AI), mental index (MI), panoramic mandibular index (PMI) and mandibular cortical index (MCI) in the panoramic radiographs of normal males and male patients with osteoporosis.

Methods: In panoramic radiographs obtained from 40 male individuals (20 normal and 20 with osteoporosis), the mean was calculated for MI, AI, PMI and MCI index values measured in the right and left mandibles. The MI, AI and PMI index values were evaluated using the paired *t*-test, and MCI values were analysed using the χ^2 test.

Results: MI ($P < 0.001$), AI ($P < 0.01$) and PMI ($P < 0.05$) values were significantly smaller in the group with osteoporosis; however, MCI ($P > 0.05$) was not significantly different.

Conclusion: MI, PMI and AI values, as radiomorphometric indices, were found to be smaller among male patients with osteoporosis, compared with normal patients in this study. It is suggested that these indices, used as an ancillary method in the diagnosis of osteoporosis in women, could also be useful for male patients. Further studies, of larger groups are needed on this subject, including of the MCI, which in this study showed no significant difference. *Dentomaxillofacial Radiology* (2010) **39**, 290–294. doi: 10.1259/dmfr/46589325

Keywords: osteoporosis; dual-energy X-ray absorptiometry; panoramic radiography; mandibular bone

Introduction

Osteoporosis is defined as a systemic disease of the bone that is characterized by reduced bone mass and disrupted bone tissue microstructure, which leads to increased bone fragility and fracture risk. The risk factors for the development of osteoporosis include ageing, menopause, insufficient consumption of food containing calcium, familial education and decreased physical activity.¹ Although women are known to be particularly affected by this condition, the prevalence, socioeconomic effects and studies on the diagnosis and treatment of male osteoporosis have recently increased.

Because of a higher peak bone mass in men than in women, the lack of a menopause-like process and larger bones, the prevalence of osteoporosis is lower among men than in women.² However, the loss of bone in the spine and proximal femur with ageing is similar in both sexes at advanced age. Such an age-related decrease in bone mineral density (BMD) occurring in both sexes is associated with an increase in fracture prevalence.^{3,4} 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.⁵ With rising average life expectancy, this issue is becoming increasingly important for public health.

Single- or dual-photon absorptiometry, quantitative CT, single- or dual-energy X-ray absorptiometry (DXA) and quantitative ultrasound are among the techniques

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Table 1 Bone mineral density (BMD) values of the osteoporosis and control groups (vertebrae lumbar 1–4 g cm⁻²)

	Mean	Standard deviation	Minimum	Maximum	<i>t</i>	<i>P</i>
Osteoporosis vertebrae BMD	0.75	0.47	0.65	0.81	28.06	0.000
Control vertebrae BMD	1.05	0.26	1.01	1.08		

developed to identify individuals with osteoporosis.^{6,7} DXA is used extensively around the world as it has a high reliability in identifying individuals with low BMD and delivers a low radiation dose.⁸ Dental panoramic radiographs have a long history of examining current dentition, the temporomandibular joint, jawbones and related structures, and have been shown in recent clinical studies to play a critical role in the identification and evaluation of osteoporotic patients or those with low BMD by dentists.^{9–12} The present study aims to perform radiomorphometric measurements of the mandibular bone on panoramic radiographs. This has been used as an ancillary technique for the diagnosis of osteoporosis in female patients,¹² on the panoramic radiographs of osteoporotic male individuals and to compare them with the measurements of healthy males.

Materials and methods

The study group consisted of 40 male individuals. The BMD was measured at the lumbar region (L1–L4) and the proximal femur (femur neck, Ward's triangle, trochanter, intertrochanteric region) by DXA at the Nuclear Medical Center, Faculty of Medicine, Ataturk University. All individuals in this study were referred to the service for bone densitometry owing to a variety of medical problems and suspected osteoporosis. Of the 40 males, 20 were osteoporosis patients aged between 30 and 73 years (mean 51.6 years) with T-scores below the standard deviation of -2.5 (T-score < -2.5) in at least one region, and 20 were healthy males aged between 45 and 72 years (mean 56.9 years) with T-score values greater than -1 (T-score > -1) (Tables 1 and 2) who formed the control group. This study was approved by the ethics committee and patients were informed about the study.

Conventional panoramic radiographs of these individuals were obtained with the PM 2002 CC Proline (Planmeca, Helsinki, Finland) at the Department of Oral Diagnosis and Radiology, Faculty of Dentistry, Ataturk University. In order to achieve a standard, the panoramic radiographs were obtained by a single dentomaxillofacial radiologist and in full compliance with the reference points specified by the manufacturer of the device. The antegonial index (AI) (Figure 1), mental index (MI) (Figure 2) and panoramic mandibular

index (PMI) (Figure 3) measurements were made separately on the right and left mandibular sides and their means were calculated. Statistical analyses were performed using the paired *t*-test. The mean AI values (Table 3), mean MI values (Table 4) and mean PMI values (Table 5) were calculated for all 40 male individuals, both in the osteoporosis group and the control group.

The mandibular cortical index (MCI), also known as the Klemetti index, was evaluated in individuals with osteoporosis and in the control group as either Class I (clear cortical bone boundaries), Class II (fragmented cortical bone boundaries with crescent-shaped defects) or Class III (pronounced porosity of the cortical bone with cortex damage in the foreground) (Figure 4).

Results

A statistically significant difference was shown between the MI values in the osteoporosis group and control group (*t* = 4.76, *P* < 0.001). Similarly, a statistically significant difference was found between values of AI (*t* = 3.68, *P* < 0.01) and PMI (*t* = 3.23, *P* < 0.05) in the osteoporosis group and control group.

The MCI values for the osteoporosis and control groups are presented in Table 6. There was no statistically significant difference between MCI values in the osteoporosis and control groups (χ^2 = 0.96, *P* > 0.05).

Discussion

Early diagnosis of osteoporosis is important to reduce fracture risk and to initiate early treatment. Panoramic radiographs are used extensively in dentistry and allow the study and evaluation of maxillary and mandibular bone structure, along with teeth. Identification of the signs of osteoporosis in dental panoramic radiographs is crucial in the diagnosis of this condition.¹³

As far as the authors are aware, there are no studies comparing the AI, MI and PMI index values in the panoramic radiographs of male patients with osteoporosis and a control group. The present study compares the AI, MI, PMI and MCI index values of

Table 2 Bone mineral density (BMD) values of the osteoporosis and control groups (femur g/cm²)

	Mean	Standard deviation	Minimum	Maximum	<i>t</i>	<i>P</i>
Osteoporosis femur BMD	0.48	0.16	0.46	0.51	33.66	0.000
Control femur BMD	0.73	0.32	0.66	0.78

Figure 1. Measurement of the antegonial index and distances used in the study

male patients with osteoporosis and a control group using panoramic radiography.

Benson et al¹⁴ used the PMI in panoramic radiographs based on cortical bone measurements and also measured the cortical bone thickness in the mental foramen region. They evaluated the MI according to age, race and sex, and observed that mandibular cortical bone thickness decreased with age and the amount of resorption was higher among women and among white individuals when compared with black individuals.

In a study by Horner and Devlin,¹⁵ the PMI values measured in females with osteoporosis on panoramic radiographs were compared with the mandibular bone values measured with DXA, and a significant relationship was found between the two. They concluded that PMI could be used as an indicator of mandibular bone density; however, further studies among larger groups are needed.

Studies measuring PMI values found that the values that decrease with increasing age are smaller among white individuals than among black individuals and among women compared with men. They are also smaller in female patients with osteoporosis than in healthy female individuals; this was found to be statistically significant.^{14,16,17}

In a study of 112 healthy females and females with osteoporosis, Kribbs¹⁸ observed that the MI is smaller in the group with osteoporosis than in healthy individuals. Other studies measuring bone thickness in the mental region demonstrated that MI decreases with increasing age, is lower in white individuals than in black individuals, is lower in women than in men and is

Figure 2. Measurement of the mental index

Figure 3. Measurement of the panoramic mandibular index (a/b)

lower among female patients with osteoporosis compared with healthy female individuals.^{16,19–22}

Our study found that the MI and PMI values in panoramic radiographs of male patients with osteoporosis were statistically significant when compared with the values of the control group; cortical bone thickness in these regions was also lower. These results are in agreement with the results of similar studies of different study groups.^{13,18}

Ledgerton et al²³ evaluated AI in panoramic radiographs. This study, which compared the AI measurements of 500 panoramic radiographs in terms of age, dentition and social class, found a negative relationship with age, and this was interpreted as a possible indicator of skeletal osteopenia.

A study of 52 edentulous females found that AI values measured on panoramic films were lower in the group with osteoporosis, and antegonial region measurements are a useful method to identify osteoporosis risk groups.²⁴

Studies on cortical bone measurements in the antegonial region (AI) have shown that the change in measurement is inversely proportional to age, and the values are smaller in edentulous individuals than in dentate and denture-wearing individuals, and in females than in males. The studies suggested that the decrease in cortical bone thickness in the gonial region, particularly among women, might be associated with osteoporosis.^{25,26}

Dutra et al¹⁹ compared the AI and MI values on 312 panoramic radiographs in terms of sex and age, and reported that there was a notable decrease in antegonial bone thickness among elderly females and that resorption was lower among elderly males.

In this study, AI evaluations of male patients with osteoporosis (mean 4.17 mm) and control group males (mean 5.21 mm) was found to be mathematically and statistically significant at $P < 0.001$. This result is comparable with the results of similar studies conducted with different study groups.

Klemetti et al²⁷ evaluated the MCI, which is also known by the first author's name. They suggested that a thin or eroded inferior cortex of the mandible detected on dental panoramic radiographs, an indicator of alterations of the mandible, is useful for identifying post-menopausal women with undetected low skeletal BMD or osteoporosis.

Table 3 Antegonial index values of the osteoporosis and control groups

	<i>Mean</i>	<i>Standard deviation</i>	<i>Minimum</i>	<i>Maximum</i>	<i>t</i>	<i>P</i>
Osteoporosis	4.17	0.95	2.00	5.70		
Control	5.21	0.85	4.00	7.00	3.68	0.001

Table 4 Mental index values of the osteoporosis and control groups

	<i>Mean</i>	<i>Standard deviation</i>	<i>Minimum</i>	<i>Maximum</i>	<i>t</i>	<i>P</i>
Osteoporosis	5.71	1.00	4.30	8.50		
Control	7.40	1.22	6.00	9.50	4.71	0.000

Table 5 Panoramic mandibular index values of the osteoporosis and control groups

	<i>Mean</i>	<i>Standard deviation</i>	<i>Minimum</i>	<i>Maximum</i>	<i>t</i>	<i>P</i>
Osteoporosis	0.35	0.06	0.25	0.47		
Control	0.43	0.89	0.29	0.64	3.23	0.04

Figure 4 Measurement of the mandibular cortical index (a) normal mandibular cortex and (b) porous mandibular cortex**Table 6** Mandibular cortical index values of the osteoporosis and control groups

	<i>Class I</i>		<i>Class II</i>		<i>Class III</i>	
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>
Osteoporosis	6	30	9	45	5	25
Control	9	45	7	35	4	20
Total	15	37.5	16	40	9	22.5

n, number; Class I, clear cortical bone boundaries; Class II, fragmented cortical bone boundaries with crescent-shaped defects; Class III, pronounced porosity of the cortical bone with cortex damage in the foreground

Ledgerton et al²³ reported that among the radiomorphometric analyses, the MCI has an excellent reliability and repeatability.

As a result of the evaluation of 30 panoramic films by 4 specialist dentists and 45 senior students following minimal training, one study concluded that the MCI is a useful method in evaluating bone quality; however, minimal training is required.²⁸

In a study on osteoporosis and control groups, Amorim et al²⁹ found that MCI was statistically insignificant in this group.

Our study evaluated the MCI in male patients with osteoporosis and normal male individuals using the χ^2 test. The χ^2 values were found to be 0.96 and insignificant at $P > 0.05$. Our results are comparable with those of Amorim et al;²⁹ however, they are not in

agreement with other studies.^{20,23} The different results may be due to the different patient group selected.

In conclusion, our results demonstrate that although radiomorphometric indices are regarded as an ancillary method for the diagnosis of osteoporosis on panoramic

radiographs, they should be a routine procedure in dental examination. Now they are used generally in female patients with osteoporosis, but also in healthy individuals, and could potentially be used to evaluate male patients with osteoporosis.

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