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ORIGINAL RESEARCH ARTICLE

Evaluation of the effect of osteoporosis on mandible with mandibular indexes using panoramic radiography and cone beam computed tomography

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Abstract

Purpose: The purpose of the study is to evaluate the effects of osteoporosis (OP) using panoramic mandibular index (PMI) and mandibular cortical index (MCI) in panoramic radiographic and cone-beam computed tomographic (CBCT) images and to demonstrate any advantages of CBCT versus panoramic imaging in those indexes.
Materials & Methods: 36 female patients (18 with osteoporosis and 18 with no systemic disease) who had panoramic radiographic and CBCT indication due to dental problems were involved in the study. PMI and MCI are evaluated on both panoramic and CBCT images. Differences between patient groups are analyzed by the Kruskal Wallis test, and differences between imaging techniques are analyzed by impaired t-tests ignoring patient groups in confidence interval 95%.
Results: In CBCT images, PMIs were significantly lower in patients with osteoporosis than in the control group (p=0.004), and there was no significant difference between the patient and control group in panoramic images (p=0.085). In both imaging techniques, MCIs were significantly higher in the osteoporosis group than in the control group (p=0.000). CBCT showed a significant advantage on PMI to panoramic images (p=0.05).
Conclusion: Systemic diseases affect bone tissue in different levels, and to evaluate these effects, cortical and trabecular bone parts must be investigated separately, and findings must be combined with patients' clinical symptoms. CBCT has advantages in PMI evaluations to panoramic radiography.

Key words: Computed Tomography; Dentistry; Osteoporosis; Mandible; Panoramic Radiography.

Introduction

Osteoporosis is characterized by low bone mass and microstructural degeneration.[1]Osteoporosis is one of the major causes of senile immobility, morbidity, and mortality.[1,2] Osteoporosis frequently occurs in postmenopausal Caucasian women. Osteoporosis is usually an asymptomatic disorder till a spontaneous fracture occurs and a bone investigation of the high-risk individuals is substantial.[1–3]Aging, past bone fractures, long-term used drugs affecting bone metabolism (corticosteroids, diuretic agents, anticonvulsants, methotrexate, anticoagulants) determine that risk.[4] Osteoporosis is classified as general osteoporosis and local osteoporosis by location[5] and primary and secondary osteoporosis etiologically.[6,7]

The gold standard in the osteoporosis diagnosis is bone mineral density (BMD) measurement using dual-energy X-ray absorptiometry (DXA). According to the World Health Organization (WHO), osteoporosis is described as a loss in bone mineral density compared with young adults (the T score) and adults of the same age (the Z score).[8] Researchers describe the role of dentists in the diagnosis of osteoporosis and effects on mandible are investigated using mental index (MI), panoramic mandibular index (PMI), and mandibular cortical index (MCI) on panoramic images and had various correlated results from low to high with DXA scores[9–11] The MI shows the cortical thickness of the mandibular basis in the mandibular mental foramen region. However, it has limited knowledge about other parts. PMI is characterized as the evaluation of cortical and whole bone structure vertically in the mental foramen region. The ratio of vertical measurement of basis mandible in mental foramen region to the vertical height of mental foramen's inferior border to basis gives PMI. Patients with osteoporosis have lower PMI than those who are healthy.

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PMI can be used as an indicator of osteoporosis.[12] MCI shows the on porosity in the cortex of the basis mandible. Porosity leads to the prediction of osteopenia and osteoporosis as MCI=1 refers to no porosity in cortical bone, MCI=2 refers to 1-3 resorbed small cavities in cortical bone (Predicting Osteopenia) and MCI=3 refers to porous and several resorbed cavities in cortical bone (Predicting Osteoporosis).[13] The purpose of the study is to evaluate the effects of osteoporosis (OP) using panoramic mandibular index (PMI) and mandibular cortical index (MCI) in panoramic radiographic and cone-beam computed tomographic (CBCT) images and to demonstrate any advantages of CBCT versus panoramic imaging in those indexes.

Materials and Methods

This study has ethical approval from Non-invasive Clinical Studies Ethical Commitee of Yüzüncü Yıl University Faculty of Medicine in Turkey in 18/12/2015 with decision number 01.

Patient Selection

36 female patients (18 with osteoporosis and 18 with no systemic diseases) were included in the study. Patients involved indicated panoramic radiographic and cone-beam computed tomographic images for dental reasons like impacted teeth and dental implant need.

Osteoporosis diagnoses of patients were constant with DXA results. The mean age of patients was 53.4±10.5. Patients who are pregnant, had radiotherapy on the head/neck region, and with a history of trauma, fracture, local osteomyelitis, cystic or tumoral lesions were not involved in the study.

Implementation of Methods

Panoramic radiographs were taken with Vatech PAX-400C device (Vatech Co, Gyeonggi-South Korea) using specific settings depending on jaw width with exposure parameters of 68 kV, and 8mA 13 seconds. The CBCT images were taken with KaVo 3D eXam (KaVo Dental, Biberach-Germany) with 16×8 cm of FOV and 0,2 mm/Vx section thickness and the exposure time of 14.7 seconds, 120 kV, and 5mA. Measurements were made with devices' software due to consideration of magnific calibration in panoramic radiographs.

PMI and MCI were analyzed on both panoramic and CBCT images. Vertical measurements of basis mandible in both mental foramen regions (left and right) of each patient saved as basis mandible height (BMH) and vertical measurements of each mental foramen inferior border to basis mandible of patients were mental foramen height (MFH). BMH/MFH ratio saved as PMI values (Figures 1, 2 and 3).

The MCI analyzed on panoramic radiographs and CBCT images according to the original scale (Figures 4 and 5). Measurements were performed by one dentomaxillofacial radiologist with five years of expertise. Differences between patient groups for both imaging techniques are analyzed using Kruskal Wallis test and ignoring patient groups, imaging techniques are evaluated using the impaired t-test in another analysis of software SPSS 21 (IBM co, New York, USA) software in 95% interval.

Results

MCI and PMI of patients with osteoporosis and the control group were saved (Table 1). Results showed that PMI of the osteoporosis group was lower than the control group in both

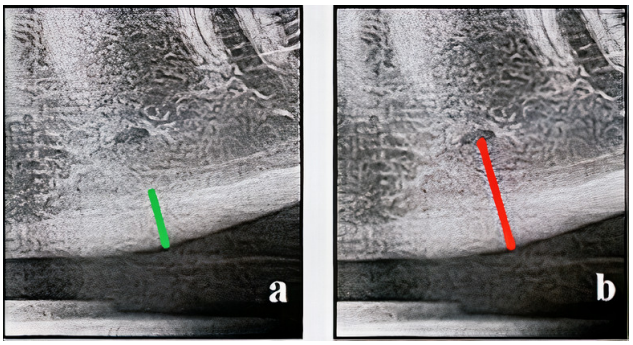

Figure 1. BMH(a) and MFH(b) measurements of a patient in control group on panoramic radiographs.

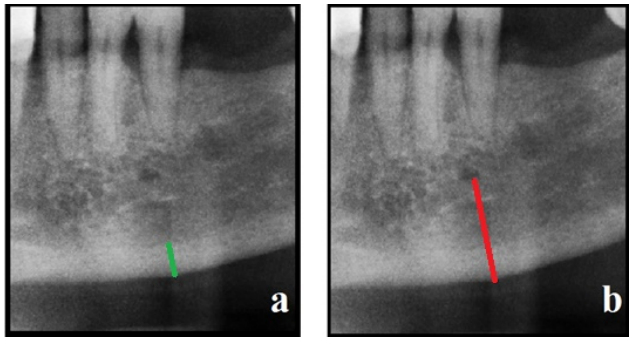

Figure 2. BMH (a) and MFH (b) measurements of a patient with osteoporosis on panoramic radiographs.

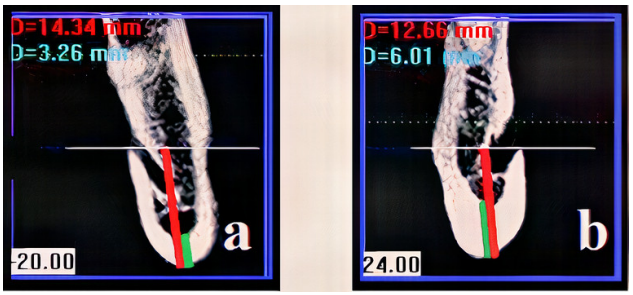

Figure 3. BMH (green) and MFH (red) measurements of patients with osteoporosis (a) and in control group (b) on CBCT.

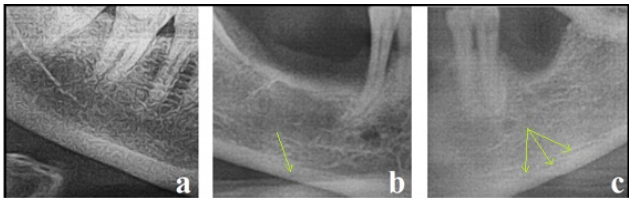

Figure 4. Panoramic radiographs of patients with MCI scores 1 (a), 2 (b) and 3 (c) respectively. Defects in basis mandible are demonstrated by green arrows.

imaging methods. Statistically, these difference was significant in CBCT images (p=0.04), and insignificant in panoramic images (p=0.85) (Table 2).

There was a significant difference between patient groups with or without osteoporosis in MCI measurement in panoramic and CBCT images. PMI analysis with CBCT showed a significant difference between patient groups, and PMI analysis with panoramic radiographs did not. Results demonstrated a significant difference for PMI analysis between panoramic

Table 1. PMI ve MCI values of both patient groups and imaging methods.

	Patient Group and Imaging Method	n	Minimum Value	Maximum Value	Standard Error	Mean Value
PMI	Osteoporosis (Panoramic)	18	0.158	0.553	0.02	0.324
	Control Group (Panoramic)	18	0.267	0.644	0.024	0.38
	Osteoporosis (CBCT)	18	0.180	0.405	0.015	0.29
	Control Group (CBCT)	18	0.242	0.495	0.015	0.336
MCI	Osteoporosis (Panoramic)	18	1	3	0.164	2.278
	Control Group (Panoramic)	18	1	3	0.135	1.389
	Osteoporosis (CBCT)	18	1	3	0.180	2.333
	Control Group (CBCT)	18	1	2	0.090	1.167

Table 2. Statistically evaluated PMI and MCI values of patient groups calculated on panoramic radiographs and CBCT images.

Imaging Technique	Index	Patient Group	n	Mean Value	Kruskal-Wallis Value	P *(p≤0,05)
Panoramic	MCI	Osteoporosis	18	2.278	24.75	0.000*
		Control Group	18	1.389	12.75	
	PMI	Osteoporosis	18	0.324	15.47	0.085
		Control Group	18	0.38	21.53	
CBCT	MCI	Osteoporosis	18	2.333	25.25	0.000*
		Control Group	18	1.167	11.75	
	PMI	Osteoporosis	18	0.29	13.5	0.004*
		Control Group	18	0.336	23.5	

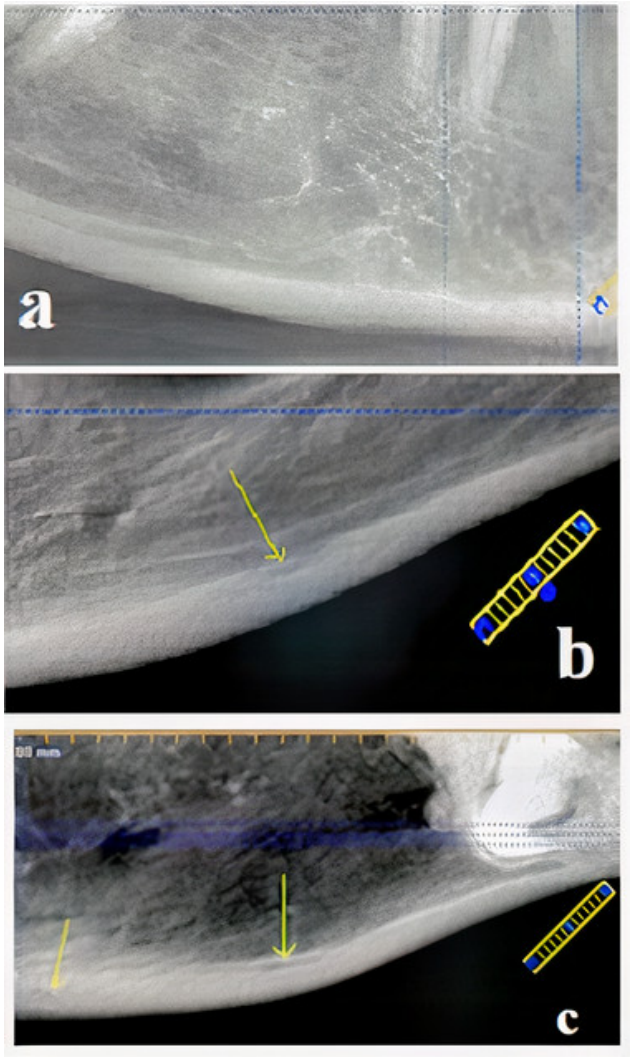

Figure 5. CBCT images of patients with MCI scores 1 (a), 2 (b) and 3(c) respectively. Defects in basis mandible are demonstrated with green arrows.

and CBCT imaging techniques (p=0.05). The difference in MCI between panoramic and CBCT imaging techniques was insignificant (p=0.663) (Table 3).

Discussion

Usage of mandibular basis cortex as an early diagnosis mark of osteoporosis is possible with several methods. Essential methods are MI, MCI, and PMI.[11–14] Mohajeri and Brooks found a low correlation between MI and DXA scores of the patients.[15] Taguchi et al.[16] found a high correlation between MCI and DXA and a low correlation between MI and DXA scores and stated that MI alone is not a fracture risk analyzer for osteoporosis. The MI was not involved in the present study. Grocholewicz et al.[17] described high correlation between bone status assessed with quantiative ultrasound (QUS) and MCI and low correlation with PMI and MI. Whereas Bayrak et al.[18] described opposite results in correlation with fractal dimension (FD). Some authors described 0.4 as a critical value for PMI score, and individuals below that score should be investigated for osteoporosis,[10,11] while Hastar et al.[19] found mean PMI score in patients with osteoporosis as 0.27 and 0.32 in healthy individuals. This study had similar results with Hastar et al.[19] Bayrak et al.[18] researched osteoporotic effects of Thalassemia Major and pointed out the availability of PMI and MCI Several authors studied PMI, MI, and MCI scores on panoramic images agreeing that MI and PMI are affected by patients' positions. The MCI had higher correlations with DXA scores and was found more useful to evaluate osteoporotic effects on mandible parallel to this study.[20–22] According to the present study, the mean PMI value in the control group on panoramic radiographs was 0.38 ±0.102. This value was 0.324 ±0.086 in patients with osteoporosis. These values were 0.336 ±0.064 and 0.29 ±0.065, respectively on CBCT images. These results show similarity with previous studies.[19,23] MCI values were higher in patients with osteoporosis than in the control group in both imaging techniques. MCI values showed similarity with previous researches.[19,24] Close values of panoramic and CBCT images for MCI analysis demonstrate the minimum effect of the imaging technique in MCI analysis.[19,21,24,25] Mostafa et al.[26] and Koh and Kim[27] evaluated PMI and MI on CBCT images of patients with and without osteoporosis and found high corre-

Table 3. Statistically evaluated differences in PMI and MCI values for imaging techniques

Index	Imaging Technique	n	Mean Value	Standard Error	p *(p≤0,05)
PMI	Panoramic	36	0.352	0.016	0.05*
	CBCT	36	0.313	0.011	
MCI	Panoramic	36	1.83	0.13	0.663
	CBCT	36	1.75	0.14	

lated results with BMD values in separate studies. However, panoramic images were not involved. PMI was significantly higher in the control group than the osteoporosis group in CBCT images while panoramic images did not have a significant difference. This result is thought to be caused by the low vision and resolution quality of the panoramic images than CBCT images. The main limitation of this study was the number of patients included. This limitation was caused because of patient selection that patients with no indication of both panoramic and CBCT images for any reason were not involved. For that reason, studies with large patient groups could enlight the results of the present study better.

Conclusion

PMI was lower in patients with osteoporosis than in healthy individuals. PMI analysis in both CBCT and panoramic radiographs showed the difference between healthy individuals and patients with osteoporosis. Low correlation between imaging techniques shows that PMI analysis is more effective in CBCT images, and analysis in panoramic radiographs could be misleading. MCI values in healthy individuals were found lower than those with osteoporosis in the current study. The high correlation between panoramic radiographs and CBCT images shows that both imaging techniques are suitable for that analysis.

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Author Contributions

The author contributed all stages of the manuscript.

Conflict of Interest

The author declares that he has no conflict of interest.

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