Research Article

ASSESSMENT OF CORRELATION OF MANDIBULAR CORTICAL INDEX OF PANORAMIC RADIOGRAPH AND BONE MINERAL DENSITY IN POST MENOPAUSAL FEMALES

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ABSTRACT

Objective: Osteoporosis is a systemic disorder characterized by low bone mass that makes the subjects prone for fractures. It remains undiagnosed in most of the individuals until a fracture occurs. The investigations for osteoporosis are very costly and not easily available. Availability of a simple, quick, easy, inexpensive, non-invasive alternative is desirable.

Methods: The study comprised of thirty postmenopausal females. All the females were subjected to panoramic radiograph and dual energy X-ray absorptiometry (DEXA). The visual analysis was done based on the radiographic appearance of the lower border of the mandible on the right side by two observers who were blinded about DEXA results. The interpretation was repeated after thirty days by both the observers.

Results: It was found that there was statistically significant difference in the three groups of mandibular cortical index of panoramic radiograph as interpreted by the two observers (p value =0.044 and 0.04). The intra-observer reproducibility of this index has moderate agreement (Kappa value of 0.316 & 0.255) and the inter-observer agreement of this index follows fair reproducibility (kappa value of 0.384 & 0.223).

Conclusion: This study concluded that there is a significant correlation between mandibular cortical index (MCI) and bone mineral density (BMD) of the lumbar vertebrae as determined by DEXA. So, visual estimation of the panoramic radiograph can be used as a screening procedure for diagnosis and referral of patients for further evaluation of osteoporosis.

INTRODUCTION

World is moving at a very fast pace and the planet is flooded with inventions, innovations and discoveries. Health sector has made immense progress in the last century and it surpasses the achievements made by other branches of science. In spite of this there are conditions and disorders for which we have no cure. One such condition is osteoporosis.

Osteoporosis is a systemic skeletal disorder characterized by low bone mass and microarchitectural deterioration of the bone scaffold that results in increased bone fragility and susceptibility to fracture [1]. It is a silent disease, reflected only by a low bone density, till a fracture occurs. As hypertension and dyslipidaemia predisposes to stroke and myocardial infarction respectively, a low bone density predisposes to osteoporotic fractures [2].

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There has been a dramatic increase in life expectancy worldwide that has caused a remarkable rise in geriatric population which in turn has increased the incidence of osteoporosis. According to the consensus report it is estimated that 1 in 3 women and 1 in 12 men over the age of 50 worldwide have osteoporosis [3]. At least 40% of these women and 15-30% of men will sustain one or more fragility fractures in their remaining lifetime.

The diagnosis of osteoporosis is based on the physical signs and symptoms, x-rays, bone scans and bone mineral density (BMD) assessment. The gold standard for determining osteoporosis is DEXA (Dual Energy X-ray Absorptiometry), but high cost associated with this advanced imaging technique and unavailability of this equipment at many diagnostic centres limits its usefulness for screening examination.

Panoramic radiograph is widely used for dental examination to detect and scrutinize dental diseases and conditions as it is very cost effective as compared to the other advanced imaging modalities. The use of these radiographs for screening

individuals with low skeletal bone mineral density would be very economical and beneficial as the dentists can refer the patient for further examination if required.

MATERIALS AND METHODS

Ethical clearance was obtained from the institutional review board of KLE VK Institute of Dental Sciences. After obtaining informed consent, thirty post menopausal females in the age group of 50 to 80 years were included in the study. The patients with a history of metabolic bone disease, carcinomas with or without bone metastasis, renal disease, diabetic patients, hypertensive patients, patients on medication, presence of smoking habit were excluded from the study.

Detailed history regarding the post menopausal status of the subjects were recorded. The subjects underwent digital panoramic radiographic examination after taking appropriate measures for radiation protection. Kodak 8000C digital panoramic and cephalometric system was used with 75kV voltage, 12mA current and 13.9 sec exposure. The prints of the radiographs were obtained by using Kodak Dry View 8150 Laser image printer on the film of size 14 X 11 inches.

All the radiographs were analyzed by using the index proposed by Klemetti[48] *et al* by two separate observers who were blinded about the DEXA results. The analysis was repeated by both the observers after one month. The visual analysis was done based on the radiographic appearance of the lower border of the mandible on the right side by Mandibular Cortical Index (MCI). It is a three point index with C1, C2 & C3.(Figure 1)

Figure 1

1. C1: the endosteal margin of the cortex was even and sharp on both sides
2. C2: the endosteal margin showed semilunar defects (lacunar resorption) or seemed to form endosteal cortical residues (one to three layers) on one or both sides.
3. C3: the cortical layer formed heavy endosteal cortical residues and was clearly porous.

Subjects underwent DEXA by Wipro GE Lunar system for estimation of bone mineral density of the lumbar vertebrae (L2- L4) at K.L.E.S. Dr. Prabhakar Kore Hospital and Medical Research Centre. The lumbar spine was taken for comparison with panoramic radiograph because assessment of bone mineral density at the spine and femur is considered as the gold standard for diagnosis of osteoporosis. The result obtained from DEXA examination was interpreted using WHO criteria. Both T score and Z scores were analysed. The radiographic interpretation of OPG was compared with bone mineral density results of DEXA.

The study comprised of thirty post menopausal female subjects. The mean age of the subjects included in this study

was 59.3 years (± 7.53 years) with the age range of 50 to 72 years. The present study has assessed the correlation between the bone mineral density obtained by DEXA and mandibular cortical index of the panoramic radiograph. The intraobserver and the interobserver reproducibility in the assessment of the grading of the mandibular cortical index were also assessed in the present study.

The T score obtained from DEXA showed that 12 patients had normal BMD, 11 had osteopenia and 7 patients were osteoporotic (Table 1).

Table 1 Bone mineral density measured by dexa

DEXA Diagnosis	n	BMD	SD	Range
Normal	12	1.138.	0.208	0.773-1.387
Osteopenia	11	0.978	0.016	0.889-1.064
Osteoporosis	7	0.812	0.078	0.714-0.964

Bone Mineral Density in each of the three groups according to the panoramic index was calculated. The classification was based on the observation made by two observers who were blinded about DEXA results (Table 2, 3).

Table 2 Corelation between OPG index and BMD of DEXA (1st observer)

Grade	n	Mean BMD	SD	Range
C1	8	1.097	0.213	0.773- 1.386
C2	15	1.021	0.172	0.768-1.387
C3	7	0.864	0.113	0.714-1.012

Table 3 Corelation between OPG index and BMD of DEXA (2nd observer)

Grade	n	Mean BMD	SD	Range
C1	10	1.074	0.192	0.773-1386
C2	12	1.035	0.195	0.714-1.387
C3	8	0.871	1.101	0.768-1.027

It was observed that the bone mineral density of the subjects in the C3 group was minimum followed by the C2 and C1 groups respectively. Significant difference was observed between the bone mineral densities of the three groups (p value = 0.016) as graded by the first observer. Assessment of the BMD according to the second observer also showed that there is a progressive decline in the mean BMD values from C1 to C3 groups. It was also observed that there was a significant difference (p value =0.042) in the values of the BMD between the three groups.

The intraobserver reproducibility of MCI as assessed by the first observer was found to have fair agreement according to the guidelines of Landin and Koch (Kappa value was 0.316) The intraobserver agreement of MCI as assessed by the second observer was also found to be fair according to the guidelines of Landin and Koch with the kappa value of 0.255.

The interobserver agreement for the visual analysis of the lower border of mandible as seen in the panoramic radiograph was also assessed. The agreement shown in the first observation according to the guidelines of Landin and Koch showed fair agreement with the Kappa value of 0.384.s The agreement shown by the observers in the second observation showed fair reproducibility with a kappa value of 0.223±0.123. Spearman's Rank correlation coefficient was calculated (Table 4) between the various grades according to the classification of

mandibular cortical index and bone mineral density. The value was found to be significantly correlated for the Ist observer (p value 0.006 and 0.014) but it was not very significant for the second observer (p value 0.024 and 0.170).

Table 4 Spearsmans rank correlation coefficient between Mandibular cortoical index and BMD

	1st observer		2nd observer	
	Spearmans correlation coefficient	Probability	Spearmans correlation coefficient	Probability
1st observation	-0.487	p =0.006	-0.412	p= 0.024
2nd observation	-0.443	p= 0.014	-0.257	p=0.170

DISCUSSION

Panoramic radiograph is widely used for dental examination as it is easily available and cost effective as compared to the other advanced imaging modalities Indices using panoramic radiographs have been proposed as an indicator of the bone mineral density [4, 5, 6 & 7]. These indices can be of two types - radiomorphometric indices and densitometric indices. Radiomorphometric index is based on the morphological or visual analysis of the panoramic radiograph [8 &9]. Densitometric analysis involves quantitative measurements and analysis. Klemetti *et al* had proposed a radiomorphometric index based on the visual appearance of the lower border of mandible. This was called as mandibular cortical index (MCI). The present study evaluated the relation between this index and the bone mineral density of the lumbar spine.

Thirty post –menopausal females were included in this study with the age range of 50 to 80 years. There is a high risk of osteoporosis associated with the post menopausal females [9, 10,11&12] because of which the present study was done on female subjects whose post-menopausal status was confirmed by detailed history. In the present study 40% patients had normal bone mineral density and the rest 60% of patients had reduced bone mineral density (Table I). This is consistent with other studies that also showed the irrefutable evidence of higher incidence of osteoporosis associated with elderly patients. [13,14&15]. The study conducted by Estera *et al* [15] reported 73.8% females between 30 to 80 years had altered BMD. A study carried out by Kaoru [16] *et al* has reported 44% of the postmenopausal females above 50 years have altered bone mineral density.

In the present study the correlation between an OPG index has been made with the DEXA of the lumbar spine region. Several other studies have revealed this beyond doubt that the lumbar and hip DEXA are the best for diagnosing osteoporosis. So in the present study the correlation between the bone mineral density of the lumbar spine (L2 to L4) and different grades of mandibular cortical index was assessed.

Few studies have tried to correlate the m- DEXA (Mandibular DEXA) with panoramic indices but the reliability of m-DEXA has not yet been proved. The study done by B Cakur[5] *et al* to check the reliability of mandibular cortical index and mandibular bone mineral density in the detection of the osteoporotic women has made use of m-DEXA and has concluded that no significant correlations were found between skeletal BMD and m-DEXA and mandibular cortical indices. Another study done by Horner and Devlin [15] has also considered m-DEXA and has calculated the mean BMD. Variations in the results obtained raises serious doubt about the use of mandibular DEXA for determination of bone mineral

density. Hence the present study utilizes DEXA of lumbar spine for determination of bone mineral density.

In the present study panoramic radiographs of all the subjects were interpreted according to the mandibular cortical index (MCI) by two observers who were blinded about the DEXA results. The bone mineral density in each group was assessed. It was found that there was statistically significant difference in the bone mineral density of three groups (p value = 0.044) as interpreted by the first observer. Similar results were obtained by the interpretation made by the second observer (p value=0.04). The mean BMD value of C1 was highest followed by C2 and least in C3 as interpreted by both the observers in the present study. Thus it confirms that patients with C2 and C3 type of mandibular cortex are more prone for fracture due to osteoporotic changes. Similar study carried out by Horner *et al* [15] had assessed the relation between two indices of Mandibular bone quality and bone mineral density. The two indices interpreted by them were bone quality index (BQI) and mandibular cortical index (MCI). They assessed the relation between these indices and the bone mineral density of the mandible obtained by DEXA (m-DEXA). MCI interpretation revealed mean BMD of 1.305, 1.094 & 0.861 by first observer and 1.243, 0.964 & 0.797 by second observer in three groups respectively. This is consistent with the present study. The study by Estera [15] *et al* and SC White [17] has calculated the T score in three groups has also shown comparable results.

Intra-observer reproducibility of both the observers was calculated in the present study. It was found to have fair agreement according to the guidelines of Landin and Koch. The kappa statistics score was 0.316 for the first observer and 0.255 for the second observer. The intra-observer agreement can vary from poor to almost perfect. Another study done to assess the relation between the mandibular cortex on panoramic radiograph and bone mineral density was carried out by Kaoru *et al* [16]The intra-observer agreement in their study was almost perfect (kappa score = 0.89, 0.92)for the first observer and that for second observer was substantial (kappa score = 0.77). Similar study done by Horner *et al* [14] is consistent with the present study and had revealed moderate agreement in the reproducibility of MCI. The Kappa score for the first observer was 0.54 and it was 0.38 for the second observer.

Inter-observer agreement was also calculated in the present study. The inter-observer agreement in the first observation was found to be 0.384±0.138 and in the second observation was found to be 0.223±0.123. Both the observations showed fair agreement. Similar study carried out by Kaoru *et al* [16] had showed fair to substantial agreement in first reading (0.30 to 0.80) with a mean of moderate agreement (0.59). The second reading showed fair to moderate agreement (0.38 to 0.89) with a mean of moderate agreement (0.60). The variation in the interobserver agreement between this study and the present study can be attributed to the smaller sample size. Another study carried out by Horner and Devlin [14] assessed the inter-observer agreement in grading of mandibular cortical index by two observers. Their study is consistent with the present study and had concluded that there are limitations in the agreement shown by the two observers (Kappa value was 0.30±0.12).

In the present study an attempt was made to calculate the correlation between the various groups according to the classification of mandibular cortical index and bone mineral density. The value was found to be significantly correlated for the Ist observer (p value 0.006 and 0.014) but it was not very significant for the second observer (p value 0.024 and 0.170). This study also evaluated the individual T scores of the DEXA and the three grades of MCI according to the two observers. The kappa correlation showed a score of 0.492 for first observer and a score of 0.544 for the second observer. Both the scores showed moderate agreement according to the Landis and Koch guidelines.

Hence the present study shows that mandibular cortical index i.e. a simple three graded classification of radiographic changes in the lower border of mandible can be used to distinguish normal subjects & subjects with altered bone mineral density. Thus postmenopausal females with significant thinning of mandibular cortex should be referred for further evaluation of osteoporosis by the dentists. This will aid in the early diagnosis of vast number of cases of altered bone mineral density that gets detected only after a fracture occurs.

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