Mandibular cortical index as a predictor of skeletal osteoporosis - a panoramic radiographic study

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Abstract

Objectives: The objective of our study was to measure Radiomorphometric Indice of mandible on hundred Dental Panoramic Radiographs (DPR) taking into account, age and gender of participants and comparing with Ultrasonometry of heel bone mineral density (Calscan) measurements. Also to establish a precise technique for measuring bone mineral density (BMD) in elderly using DPR so as to recommend DPR as a simple screening aid in osteoporotic risk individual in order to prevent and for better management of osteoporosis.

Methods: The study group consisted of hundred subjects with sixty female and forty male subjects who were apparently healthy without any systemic medication. BMD of the heel was assessed by Quantitative ultrasound. Mandibular Cortical Index [MCI] was calculated from measurements obtained from DPR by two examiners. Both inter and intra examiner's reliability & results of variables such as age and sex were statistically analysed and correlated with Calscan readings.

Results: Results of our study indicated age related bone loss as indicated by calscan. Chi-square analysis for the correlation of MCI with Calscan was found to be 12.41 with significant P value. MCI had sensitivity of 88%, specificity of 39%, positive predictive value of 91%, and negative predictive value of 33% with an overall efficiency of 82% in detecting osteoporosis. But there was no significant correlation found between MCI with age and sex of subjects.

Conclusion: It can be concluded that MCI aids in early diagnosis of osteoporotic patients in the dental office as being at risk for osteoporosis.

Keywords: DPR, MCI, Calscan, BMD.

Introduction

The loss of bone mass in human beings with increasing age is a universally observed phenomenon.[1,2] Osteopenia and Osteoporosis are two terminologies to describe the decrease in bone mass. Osteopenia can be identified radiographically by a reduction in radiopacity of bone and by observation of thinned cortices, porosity of cortices, or changes in trabecular pattern on panoramic radiographs.[2] Osteoporosis is a disease of bone that leads to an increased risk of fracture.[3] Radiographic assessment of 'bone quality' has applications in implantology and in research, assessing the relationship between oral bone loss and osteoporosis. This aids in early prevention and better management of osteoporosis.[4]

Access to screening for osteopenia or osteoporosis is often limited and the dentist is often the most regularly visited doctor in the elderly population and DPRs are the most frequently used imaging modalities for these patients.[5] Bone mass has been measured by several techniques.[3] DXA including central and peripheral devices, offers the best means of obtaining information on bone mineral density.[6,7] Quantitative Ultrasound (QUS) has recently been used to assess skeletal status in osteoporosis. QUS has the advantage in that they do not involve ionizing radiation, economical, safe[8,9] and may provide information on the structural organization of bone in addition to bone mass.[7,10] Thus QUS serves as an excellent aid for screening osteoporosis.[7] QUS techniques have been evaluated in a large number of studies. Their use has been best established for calcaneal systems.[6] It's low cost and portability make QUS more attractive for use in assessing the risk of fractures in larger populations than may be appropriate for bone DXA.[9]

Various studies have demonstrated that osteoporotic individuals have altered morphology of the mandible and also there exists a good correlation between mandibular and skeletal bone mineral densities.[11] Dental radiographs, and especially panoramic images, have been used to predict patients with low BMD.[12,13] By using various indices, it is possible to measure bone mineral density of mandible.[3] Most studies have focused on thickness and integrity of the inferior border of the mandible.

Hence our study is intended to know the efficacy of Dental Panoramic radiographs in predicting osteoporotic risk individuals as compared with bone mineral density of the heel (calscan).

Methodology

This study was conducted on outpatients in the Department of Oral Medicine and Radiology. Hundred normal individuals with female patient's age ranging from forty five to sixty five years and male patient's age ranging from fifty to sixty five years who fulfilled

the criteria of our study were selected. Taking the consent of the patient, relevant information regarding habits, family history, medical history and drug history; the gender and age of the patient were recorded before subjecting them to panoramic radiographs and bone densitometry. Depending on the age, sex and built of the patient, the exposure parameters were kept between 70kv-80kv, current of 10 mA with exposure time of 12 sec.

Measurements of parameters

All processed panoramic radiographs were viewed for inferior cortical border of mandible. Radiographs were traced for inferior cortical border of mandible (Photograph 1).

Two sets of measurements were made by two examiners, 'A' and 'B'.

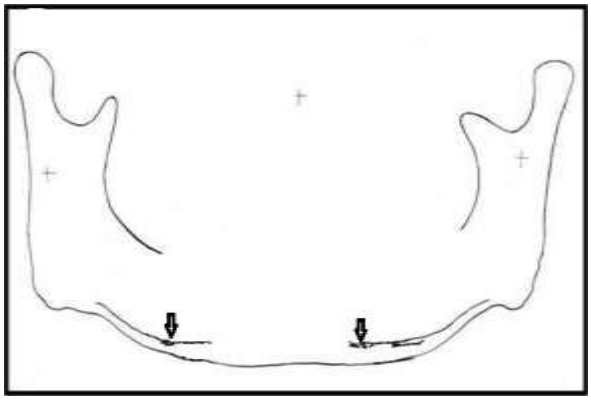
Measurements of mandibular cortical index (MCI)

Classification of MCI (Klemetti's index) was based on the changes in the inferior cortex on panoramic radiographs as C1, C2, and C3 by using Klemetti's classification (Photograph 1) as follows.[3,4]

C1- the endosteal margin of the inferior cortex is smooth on both ends.

C2 - the endosteal margin shows semilunar defects or appears to form endosteal cortical residues.

C3- the cortex is obviously porous with dense endosteal residues.



Photograph 1: Reveals a traced panoramic radiograph with endosteal residues in the lower cortical border of mandible

Calscan (Ultrasonometry of Heel)

In order to measure the skeletal BMD, Calscan was done by Densitometer CM100, a peripheral ultrasound bone densitometer with electric power 100vac to 60 VA, mean frequency of 500 kHz and measuring time approximately 10 sec. The attenuation of this sound was recorded by the densitometer which gives printed T score reading (Photograph 2). The name, age and sex of the subjects were filled in the proforma and entered in Microsoft EXCEL spread sheet which was further subjected to statistical analysis using one way ANOVA, students "t" test, Pearson's correlation and Kappa measure of agreement.

Photograph 2: Reveals a female patient with calscan procedure

Results

According to Calscan, among the study subjects, 13% subjects had normal BMD, 38% subjects were osteopenic and 49% subjects were osteoporotic [Pie diagram 1; Table 1]. The chi-square analysis (X^2) was carried out to find correlation between Calscan and age and was found to be 13.06 and $P<0.05$ [Tables 2]. The chi-square analysis (X^2) was also carried out to find correlation between Calscan and sex, which was found to be 9.19 and $P<0.05$. There was a significant correlation observed between Calscan measurements with both age and sex [Tables 3]. MCI had found 15% subjects as C1 (normal), 18% subjects as C2 (osteopenic) and 67% subjects as C3 (osteoporotic) [Table1]. The chi-square analysis (X^2) was carried out to find correlation between MCI and age and was found to be 5.69 and $P=0.46$. Hence no positive correlation found between MCI and age of the subjects [Tables 2; Bar diagram 1]. The chi-square analysis (X^2) was carried out to find correlation between MCI and sex and was found to be 3.33 and $P=0.19$. There was no positive correlation found between MCI and sex of the subjects [Tables 3; Bar diagram 2].

Table 1: Classification of subjects based on Calscan findings

Calscan findings	T score	Number of patients	Range
Normal	> - 1	13 (13%)	2.1 to -0.9
Osteopenia	-1 to -	38 (38%)	-1.1 to -2.4
Osteoporosis	< - 2.5	49 (49%)	-2.5 to -5.0
Total	100		

Table 2: Calscan and MCI in relation to Age

Age (years)	Number	Calscan			MCI		
		Normal	Osteopenia	Osteoporosis	C1	C2	C3
45-49	20	2 (10%)	12 (60%)	6 (30%)	4 (20%)	3 (15.0%)	13 (65.0%)
50-54	29	6 (20.7%)	8 (27.6%)	15 (51.7%)	7 (24.1%)	3 (10.3%)	19 (65.5%)
55-59	22	4 (18.2%)	10 (45.5%)	8 (36.4%)	2 (19.1%)	5 (22.7%)	15 (68.2%)
60-65	29	1 (3.4%)	8 (27.6%)	20 (69%)	2 (6.5%)	7 (4.1%)	20 (69.0%)
Total	100	13 (13.0%)	38 (38.0%)	49 (49.0%)	15 (15%)	18 (18%)	67 (67.0%)
		$X^2 = 13.06$ P < 0.05, significant			$X^2 = 5.69$ P= 0.46, not significant		

Table 3: Calscan and MCI in relation to Sex

Sex	Number	Calscan			MCI		
		Normal	Osteopenia	Osteoporosis	C1	C2	C3
Male	40	10 (25%)	15 (37.5%)	15 (37.5%)	4 (10%)	5 (12.5%)	31 (77.5%)
Female	60	3 (5%)	23 (38.3%)	34 (56.7%)	11 (18.3%)	13 (21.7%)	36 (60%)
Total	100	13	38	49	15	18	67
		$X^2 = 9.19$ P < 0.05, significant			$X^2 = 3.33$ P= 0.19, not significant		

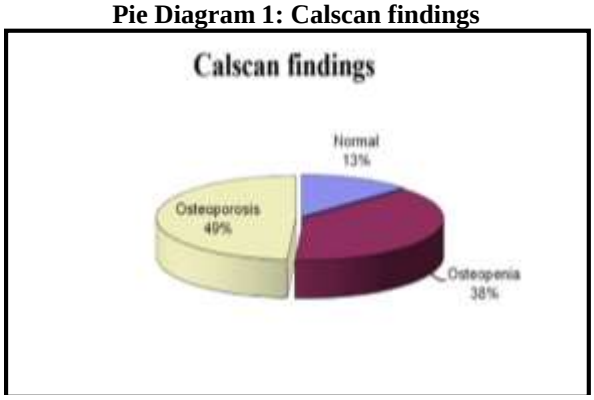
Table 4: MCI in relation to Calscan findings

Calscan findings	Number	MCI		
		C1	C2	C3
Normal	13	5(38.5%)	2(15.4%)	6(46.2%)
Osteopenia	38	1(2.6%)	10(26.3%)	27(71.1%)
Osteoporosis	49	9(18.4%)	6(12.2%)	34(69.4%)
Total	100	15	18	67
		$X^2 = 12.41$ P < 0.05 Significant		

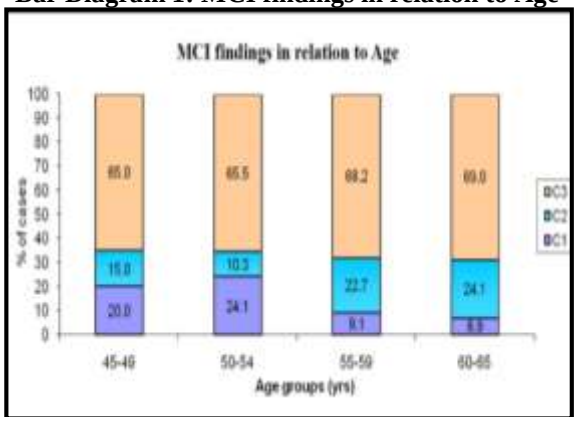
Table 5: Diagnostic efficiency of MCI for Osteoporosis

MCI	CALSCAN		
	Osteoporosis	Normal	
C2+C3	77	8	85
C1	10	5	15
Total	87	13	100

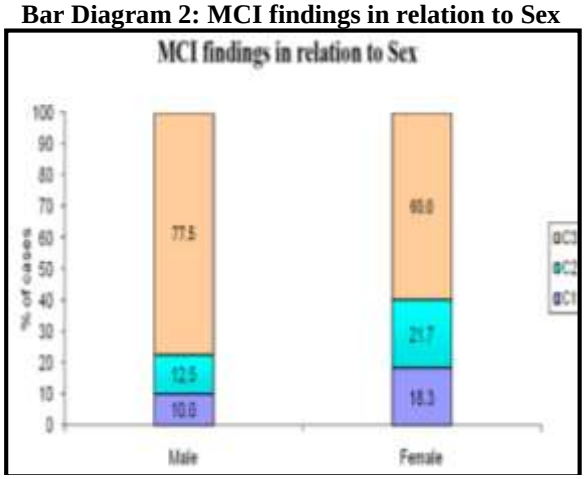
Pie Diagram 1: Calscan findings



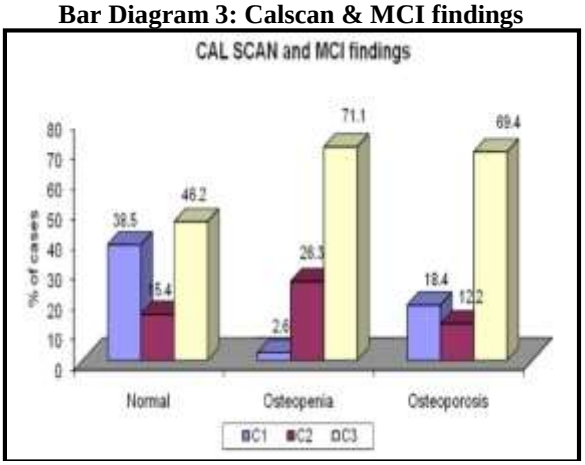
Bar Diagram 1: MCI findings in relation to Age



Bar Diagram 2: MCI findings in relation to Sex



Bar Diagram 3: Calscan & MCI findings



MCI in relation to calscan findings

MCI had detected 38.5% of subjects in normal group, 2.6% of subjects in osteopenic group and 18.4% of subjects in osteoporotic group as C1. It had also found 15.4% of subjects in normal group, 26.3% of subjects in osteopenic group and 12.2% of subjects in osteoporotic group as C2. MCI had detected 46.2% of subjects in normal group, 71.1% of subjects in osteopenic group and 69.4% of subjects in osteoporotic group as C3. Chi-square analysis was found to be 12.41 whereas P<0.05. There was a highly significant correlation found between MCI and Calscan [Table 4; Bar diagram 3].

Diagnostic efficiency of MCI for osteoporosis

Out of 100 subjects, MCI had detected 85 subjects as diseased (C2+C3) that is osteoporotic and 15 subjects as normal (C1). Over all Calscan had detected 87 subjects as osteoporotic and 13 subjects as normal subjects. The sensitivity of MCI in detecting osteoporosis was 88% whereas it had specificity of 39% with positive predictive value of 91%, negative predictive value of 33% and overall efficiency of 82% [Table 5].

Discussion

In our study, it was observed that with increasing age (69%) of the subjects and also in female subjects (56.7%); there was increase in occurrence of osteoporosis. However the disease was less common in males (37.5%), and also in younger age group (30%). This was comparable to the reports of various studies that are available in the literature.[14,15,16,17] Our results were in accordance with the results of Nan-Ping Yang et al.[18]

Also in our study, there was an increase in the MCI (C3) as age advances and also in male subjects (77.5%), it was more prevalent as compared to females (60%) which was in contrary to other reports. There was positive correlation (X^2 = 12.41) between Calscan and MCI with significant P value. The sensitivity of MCI in our study in detecting osteoporosis was 88% where as it had specificity of 39% with positive predictive value of 91%, negative predictive value of 33% and overall efficiency of 82%. Results of our study were comparable to studies [5,12,19,20,21] and were in contradiction to studies reported in literature.[3,4,22,23,24]

As observed in our study, there was more number of C1 subjects in normal group than in osteoporotic group and more number of C2 subjects in normal group than in osteoporotic group. Interestingly there was less number of C3 subjects in normal group than in osteoporotic group. Calscan was able to detect the presence of disease in the study group. There was very good correlation found between MCI with Calscan with highly significant P value.

Our results were in accordance with the results of Klemetti E[25] who reported that reproducibility of mandibular cortical index was 98% and observed a significant correlation between their classification and vertebral bone mineral density (BMD) as assessed dual energy xray absorptiometry (DXA). Similar results were observed in our study also. Author also reported that sensitivity and specificity of the combination of mandibular cortical width and their classification of mandibular cortical morphology (MCI) in the identification of osteoporosis was 0.13 and 0.99. Similar findings were observed in our study also where

there was a significant correlation found between MCI and Calscan.

A study was conducted in which short-term precision and long-term precision of ultrasound parameters were studied and also relationships between ultrasound parameters and BMD at various sites were examined in 42 subjects. BMD at the heel was assessed at the location corresponding to that of the ultrasound measurements (BMD heel/calscan). It was concluded that ultrasound measurements at the heel correlate well to BMD at the same site.[26] Hence we too used calscan for assessing BMD of heel, as it is easily accessible and correlates well with the central bone mineral density (femoral neck).

Conclusion

Results of our study indicated age related bone loss (osteoporosis) as MCI was showing significant correlation with Calscan. It was also observed that the MCI was not correlating with age and sex of the subjects. But there was positive trend of values towards osteoporosis. This is suggesting the need for larger sample size and the more precise technique of measuring skeletal mineral density by using central DXA.

Careful examination of the lower cortical border of mandible in panoramic radiographs helps to classify subjects based on Klemetti's classification as C1, C2 and C3. Wherein C3 being osteoporotic, needs treatment at the earliest there by making individual less susceptible to fractures. Hence Mandibular Cortical Index (MCI) aids in early diagnosis of osteoporotic patients in the dental office as being at risk of osteoporosis, so that they can be referred to a physician for appropriate evaluation.

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