ACCURACY OF MANDIBULAR PANORAMIC INDICES IN THE ASSESSMENT OF BONE MINERAL DENSITY IN COMPARISON WITH DEXA SCANS AMONG POST MENOPAUSE WOMEN

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ORAL MEDICINE AND RADIOLOGY

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"ACCURACY OF MANDIBULAR PANORAMIC INDICES IN THE ASSESSMENT OF BONE MINERAL DENSITY IN COMPARISON WITH DEXA SCANS AMONG POST MENOPAUSE WOMEN"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. S.KAILASAM, B.Sc., M.D.S.**, Professor and Head, Department of Oral Medicine and Radiology, Ragas Dental College and Hospital, Chennai.

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CERTIFICATE

This is to certify that this dissertation titled **"ACCURACY OF MANDIBULAR PANORAMIC INDICES IN THE ASSESSMENT OF BONE MINERAL DENSITY IN COMPARISON WITH DEXA SCANS AMONG POST MENOPAUSE WOMEN"** is a bonafide and genuine research work done by **Dr.R.Rajprabha,** under my guidance during her postgraduate study period 2017-2020.

This dissertation is submitted to **THE TAMILNADU Dr.M.G.R. MEDICAL UNIVERSITY,** in partial fulfilment for the degree of **MASTER OF DENTAL SURGERY, BRANCH IX -ORAL MEDICINE AND RADIOLOGY.**

It has not been submitted (partial or full) for the award of any other degree or diploma.

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*Thank you, **Lord**, for I have experienced your guidance day by day. I will keep on trusting you.*

LIST OF ABBREVIATIONS

S.NO	ABBREVIATION	EXPANSION
1.	WHO	World health organisation
2.	DEXA	Dual energy X- ray absorptiometry
3.	OPG	Orthopantomogram
4.	BMI	Body mass index
5.	BMD	Bone mineral density
6.	MI	Mental index
7.	MCI	Mandibular cortical index

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Introduction

INTRODUCTION

Osteoporosis is a silent, complex, multifactorial, chronic disease characterised by the progressive loss of bone density, which leads to the risk of impending fractures. It is considered a public health problem by the world health organisation (WHO) and is therefore important to identify asymptomatic individuals in the early stages of bone mass reduction because this disease has relevant social and economic impacts.

Postmenopausal women have altered endogenous cortisol's and sex steroid levels, which are responsible for the reduced bone mineral density of the spine.

One of the characteristic changes accompanying postmenopausal women with low bone density is atrophy of the dermal structures, a change that is dramatically illustrated both by the increased visibility of cutaneous veins in hands and forearms and by frequent intracutanious bleeding in these areas. A similar change in epithelial surfaces inside the mouth might well potentiate the development of periodontitis with alveolar bone loss.

Bone mineral density evaluation by dual energy x-ray absorptiometry (DXA) testing is considered the gold standard for fracture risk prediction. However, in addition to not being recommended by the WHO as a triage screening tool for osteoporosis, it has a high financial cost.

By contrast, the dentist is often the most regularly visited doctor in the elderly population whom are also under the risk of osteoporosis and associated fractures and panoramic radiograph are the most frequently used imaging modalities in planning prosthetic and implant treatment for these elderly postmenopausal patients.

Because the bones of the oral cavity are similar in structure and physiology to various other bones in the skeleton, several research studies have been conducted with the object of detecting whether these skeletal changes in the mandible are specific to the osteoporotic stage.

In various studies, it has been shown that the decreased bone mineral density (BMD) affects the morphometric, densitometry and architectural properties of mandibular bone in the osteoporotic patients on radiographs. Recent studies have demonstrated significant correlation between bone mineral densities in mandible or maxilla and that in the axial skeleton such as the spine and hip. Researchers have developed a number of panoramic based mandibular indices, image processing and analysing techniques for quantification of mandibular bone mass and trabecular architecture to discriminate osteoporotic patients from non-osteoporotic patients. Only two panoramic indices have been found to be significant in evaluating the morphology of mandibular cortex. They are mandibular cortex index (MCI) which is a qualitative measure and mental index (MI) which is a quantitative measure.

These panoramic radiographic indices have made it possible to establish a data base of the mandibular skeletal characteristics of these patients. Panoramic radiographs are economically feasible and result in low patient exposure to radiation.

In this study, mandibular cortical index (MCI) and mental index (MI) are obtained on digital radiography to evaluate the mandibular bone density and correlate with the bone density evaluated using DXA scan in postmenopausal females, **to project dentist as a potentially valuable resource to identify patients with asymptomatic low bone density and to guide the dentist in proper case selection of postmenopausal patients for implant placement.**

Aims and objectives

AIMS AND OBJECTIVES

AIM:

The present study aims to evaluate the accuracy of mandibular panoramic indices in assessing bone mineral density among postmenopausal women.

OBJECTIVES:

- To assess the mandibular panoramic indices using digital panoramic radiograph.
- To estimate and confirm bone mineral density by DXA scan.
- To compare with DXA scan the reliability of mandibular panoramic indices in detecting low mineral density
- To project dentist as potentially valuable resource to identify patients with asymptomatic low bone density
- To use mandibular panoramic indices as a guide in case selection for implant placement in postmenopausal women.

Review of literature

REVIEW OF LITERATURE

This thesis is about projecting dentists as potentially valuable resource in identifying asymptomatic postmenopausal women in the early stages of bone mass reduction using panoramic indices. A detailed literature review will high lighten the accuracy of panoramic indices in measuring bone mineral density in comparison with DEXA scan and its role as a valuable guide in case selection for implant placement among postmenopausal women.

Osteoporosis is considered a public health problem by World Health Organization (WHO). It is seldom recognized before the occurrence of fractures. It is therefore important to identify asymptomatic individuals in the early stages of bone mass reduction, because this disease has relevant social and economic impacts.

"Osteoporosis is a silent, complex, multifactorial, chronic disease characterized by progressive loss of bone mineral density and micro architectural deterioration in bone tissues leading to fracture". The clinical diagnosis of osteoporosis is done in the following ways,

- The occurrence of osteoporotic fracture
- The World Health Organization bone mineral density criteria

The WHO has established diagnostic criteria for osteoporosis based on bone density measurements determined by Dual Energy Absorptiometry (DEXA).

The earliest bone loss in osteoporosis patient occurs in areas of trabecular bone. The metabolic turnover of trabecular bone is eight times greater than that of cortical bone. This is the reason for preferring areas of predominantly trabecular bone such as vertebral body as sites for measuring bone mineral density.

The mandible is a site consisting predominantly of trabecular bone. Trabecular bone is clearly visible on dental radiographs, thus lending itself to quantitative analysis of bone mineral density. Recent studies have demonstrated a significant correlation between bone mineral density in the mandible and that in the axial skeleton such as spine and hip.

The dentist is often the most regularly visited doctor in the elderly population whom are also under the risk of osteoporosis and associated fractures and dental radiographs are the most frequently used imaging modalities for these patients.

Osteogenesis imperfect foundation has proposed that bone mass refers to the weight of the skeleton. Bone density refers to the ratio of weight to the volume or area of the bones. The basic idea is that heavier bones will be stronger bones. When information about bone mineral density is combined with personal and family medical history, findings on physical examination, x-rays and biochemical testing, doctors can get a more complete picture of the child or adult’s bone health.

Bert J Davidson et al (1983) concluded that endogenous cortisol's and sex steroid levels present in postmenopausal women were responsible for the reduced bone mineral density of the spine observed in the fracture patients.

Harry W. Daniell (1983) noted that one of the characteristic changes accompanying postmenopausal women with low bone density is atropy of the dermal structures, a change that is dramatically illustrated both by the increased visibility of cutaneous veins in hands and forearms and by frequent intracutanious bleeding in these areas. A similar change in epithelial surfaces inside the mouth might well potentiate the development of periodontitis, particularly in the presence of periodontal abnormalities associated with alveolar bone loss.

Patricia J. Kribbs (1983) concluded that there appears to be a multitude of interesting factors contributing to bone loss of the residual ridge and alveolar bone, including age, nutritional history, body mass index (BMI), frequency of dental care sought in the past and severity of generalized skeletal osteopenia.

Barbara L. Drink Water et al (1984) concluded that amenorrhea which is observed in female athelets may be accompanied by a decrease in mineral density of the lumbar vertebra.

B.E.C.Nordin et al (1985) concluded that malabsorptionof calcium is a significant risk factor for postmenopausal osteoporosis, may be because of secondary increase in bone resorption to maintain serum calcium.

Robert S. Gordon (1985) suggested that postmenopausal women have excessive and dispropriate trabecular bone loss and is mainly associated with spinal vertebral collapse and the classic dowagers hump. It also involves the loss of both cortical and trabecular bone.

Shafer et al (1997) suggested that the etiology of osteoporosis was once thought to be a lack of adequate bone matrix. But evidence indicates that it may be due to long term negative calcium balance and Estrogen deficiency appears to be important in the pathogenesis of bone loss after menopause.

Peck WA et al (1993)[41] found that osteoporotic bone is histologically normal in its composition, but has less bone. This results in weakened bones that are more prone to fractures with even minor trauma.

Jan J. Stepan(2002)[34] stated that bone mineral density (BMD) is an accurate and reproducible, non-invasive way of measurement used to diagnose the low bone mass before the first fracture occurs, and as a surrogate for the bone strength to predict an individual’s future fracture risk. In addition, it assists in intervention decisions, and in monitoring the progression or regression of osteoporosis. Techniques for measuring BMD are based on the differential absorption of the ionizing radiation, namely the dual energy X-ray absorptiometry (DXA).

Peck et al (1993)[41] coined the term dual energy x-ray absorptiometry (DEXA), currently, the gold standard technique for determining bone density. It is simple, painless and takes 2 to 4 minutes.

Ethel S. Siris et al(2011)[21] stated that low bone mineral density (BMD)is the single best predictor of fracture risk in asymptomatic postmenopausal women and dual energy absorptiometry (DXA) of the hip and spine is currently the gold standard for the measurement of BMD.

According to WHO The categories for diagnosis of low bone mineral density are:

- Normal (T-score -1.0 and above)
- Osteopenia (T-score between -1.0 and -2.5)
- Osteoporosis (T-score -2.5 and below)
- Severe osteoporosis (T-score -2.5 and below with history of a fracture)

FDA (1998) approved indications for BMD test. Those are

- Estrogen deficient women
- Vertebral abnormalities on x-ray suggestive of low bone density (osteopenia, vertebral fracture)

- Glucocorticoid treatment equivalent to 7.5mg of prednisone or duration of therapy more than 3 months
- Primary hyperparathyroidism
- Monitoring response to FDA approved medications

National osteoporosis foundation in 2006 formulated the guidelines for BMD measurements as

- All women greater than 65 years regardless of risk factors
- Younger postmenopausal women with one or more risk factor
- Postmenopausal women who present with fractures
- Estrogen deficient women at clinical risk for osteoporosis
- Individuals with vertebral abnormalities
- Individuals receiving long term glucocorticoid therapy
- Individuals with primary hyperparathyroidism
- Individuals being monitored to assess response to osteoporosis drug therapy.

J Bras (1982)[9] suggested that the relatively constant thickness of cortical bone at the mandibular angle following the adolescent growth sprut and the decrease in cortical thickness in postmenopausal women suggest that cortical thickness may be useful as a parameter to evaluate in determining metabolic bone loss.

J.J. Groen et al (1984)[31] concluded that diagnosis of osteoporosis was made after an routine x-ray examination of the skeleton. Almost all of the patients had severe back pain and osteoporosis of the dorsal and lumbar spine.

Bollen et al (2000) suggested that dental panoramic radiography measures may be useful tool in identifying postmenopausal women with low skeletal BMD, high bone turn over or high risk for osteoporotic fractures.

Byron W. Benson et al(1991)[10] initiated a study to establish the basis of a preliminary diagnostic modality that may be useful to dental practitioners caring for patients at high risk for osteoporosis, because osteoporosis has been associated with tooth loss, excessive residual ridge resorption, delayed healing after tooth removal, referred dental pain caused by thinned walls of the maxillary sinus, and periodontal disease and suggested that PM1 as a mandibular cortical bone mass indicator is certainly needed. This index represents the ratio between the mandibular cortical width at the mental foramen region and the distance from the lower border to the inferior edge of the mental foramen.

B Drozdzowska et al (2002)[5] conducted studies on panoramic-based indices (Mandibular Cortical Index-MCI, the height of mandibular inferior cortex-IC (mm), Panoramic Mandibular Index-PMI, Mandibular Ratio- MR) to evaluate their diagnostic efficacy and to determine whether they correlate with bone mineral density (BMD (g/cm2)) of the mandible and hip, and with ultrasound parameters of the calcaneus and hand phalanges in postmenopausal women and stated that the efficacy of the panoramic-based mandibular indices in diagnosing osteopenia/osteoporosis is low to moderate.

Devlin and Horner (2002)[18] suggested that a diagnostic threshold for cortical width of 3 mm or less may be most appropriate threshold for referral for bone densitometry in Caucasian postmenopausal women.

Ardakani FE et al (2004) suggested that dental panoramic radiography measures may be useful tool in identifying postmenopausal women with low skeletal BMD, high bone turn over and risk of osteoporotic fractures. They also suggested that relatively constant thickness of cortical bone at the mandibular angle following the adolescent growth spurt and the decrease in cortical thickness in postmenopausal women suggest that cortical thickness may be useful as a parameter to evaluate in determining metabolic bone loss and that a diagnostic threshold for cortical width of 3mm or less may be the most appropriate threshold for referral for bone densitometry in postmenopausal women.

Estera Balcikonyte et al (2004)[25] studied the diagnostic efficacy of MCI, CI in 130 orthopantomograms in determining low bone density in correlation with BMD at lumbar area. MCI was found to have positive correlation. But CI was found to have high degree of significance ($p<0.01$).

F Yasar and F Akgunlu (2006)[26] conducted study to evaluate the relationship between oral signs, body mass index and age; and to assess the possibility of using these parameters as an indicator of post-menopausal osteoporosis. The panoramic-based mandibular indices, such as cortical width, cortical index, panoramic mandibular index and mandibular crest resorption degree; the number of teeth and fractal dimension analysis were used to demonstrated that osteoporotic patients were more likely to have altered inferior cortex morphology than non-osteoporotic patients and age is an important risk factor for osteoporosis.

Esin Hastar et al (2011)[24] evaluated the influence of gender and dental status on the mental index, mandibular cortical index and panoramic mandibular index from dental panoramic radiographs in elderly who had osteoporosis or did not have osteoporosis and concluded a statistically significant result between mandibular cortical width and panoramic mandibular index values in patients with osteoporosis and without osteoporosis ($P<.05$)

D Ledgerton et al (1997)[16] evaluated the intra-observer repeatability and inter-observer reproducibility of the measurements used in deriving the Panoramic Mandibular Index (PMI) and had difficulties in obtaining consistency in repeated measurements. So in order to improve the validity of the PMI as a measure of local bone loss, three measurements were therefore made on both the left (L) and right (R) sides using the following technique: 1- the mental foramen was identified; 2- a line (b) was drawn which passed perpendicular to the tangent to the lower border of the mandible (a) and through the centre of the mental foramen; 3 - measurements were made along this line of cortical width (C); the distance between the lower border of the mandible and the inferior margin of the mental foramen (inferior foraminal distance, I); the distance between the lower border of the mandible and the superior margin of the mental foramen (superior foraminal distance, S).

S Dagistan and OM Bilge (2010)[44] compared 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 and found MI, PMI and AI values, as radiomorphometric indices to be smaller among male patients with osteoporosis, compared with normal patients in this study.

Esa Klemetti et al (1993)[23] used panoramic mandibular Index in a group of postmenopausal women to determine whether it correlates with bone mineral densities of the femoral neck, lumbar area, and the trabecular and cortical parts of the mandible. He measured the bone mineral density values by dual-energy x-ray absorptiometry of the femoral neck and lumbar area and by quantitative computed tomography of the mandible and found the linear correlation of the panoramic mandibular Index with all bone mineral density values was weak. However, the low and high index subgroup means were clearly dependent on the bone mineral density variables.

In this technique, the inferior cortex on both sides of the mandible, distal to the mental foramen is classified into three groups according to the following criteria:

- **Cl 1:** The endosteal margin of the cortex is even and sharp on both sides of the mandible.
- **Cl 2:** The endosteal margin has resorptive cavities with cortical residues one to three layers thick on one or both sides.
- **Cl 3:** The endosteal margin consists of thick cortical residues and is clearly porous.

B.K. Yashoda Devi et al (2011)[6] compared and assessed the accuracy of panoramic mandibular index (PMI) and antegonial index (AI) in the panoramic radiographs of postmenopausal women with normal and low skeletal bone mineral densities (BMD) diagnosed by using dual energy x-ray absorptiometry (DXA) and found a statistically difference between the PMI values in the osteoporotic group and normal group ($t = 13.280$, $p < 0.001$); however, AI showed no significant difference between the groups.

Ah-Young Kwon et al (2017)[2] determined whether the panoramic mandibular index (PMI) is useful for assessing bone mineral density and found that PMI had limited usability when the margin of the mental foramen was not clear. In contrast, MCW, a parameter used for determining the PMI, had fewer drawbacks than the PMI with respect to bone mineral density measurements.

Ioana Duncea et all (2013)[32] did research on the possible correlations between: PMI and the presence or absence of osteoporosis in post-menopausal women; Bone mineral density (BMD) at levels L1-L4, femoral head, hip, mandible and PMI in post-menopausal women, with or without osteoporosis and identified a statistically significant correlations between L1-L4, femoral head and total hip bone mineral densities and the panoramic mandibular index; the lower the bone mineral density the more the panoramic mandibular index is decreasing.

C R W Mai (2008)[15] compared indices obtained from dental panoramic radiographs with bone densitometry results in the identification of individuals affected by osteoporosis/osteopenia and found that the indices evaluated were reproducible; panoramic mandibular and mental indices presented the highest sensitivity in the detection of osteopenia/osteoporosis, however the panoramic mandibular index specificity was low and said although all the indices evaluated could identify low bone density, only the panoramic mandibular and mental indices could differentiate patients affected by osteopenia/osteoporosis.

Gargi Saran et al (2017)[29] aimed to examine the mandibular cortical index (MCI) and panoramic mandibular index (PMI) on panoramic radiograph and to establish a relationship between the two indices (MCI and PMI) with the bone mineral density (BMD) in postmenopausal women and found that he Pearson correlation analysis revealed a significant correlation between age and T-score ($r = -0.59$, $P < 0.05$), i.e., as age increased the T-score decreased. They compared the T-score of two MCI groups, t-test revealed MCI was 69.1% lower in C2 as compared to C1. The value of $P < 0.001$ and t-test revealed significantly different and lowered (32.4%) inferior cortex level in C2 as compared to C1 ($t = 4.76$, $P < 0.001$). Thus they suggested that panoramic radiography could be a reliable tool in screening for BMD.

L. Khojastehpour et al (2009)[36] studied the usefulness of Panoramic Mandibular Index (PMI) on panoramic radiographs in diagnosis of osteoporosis and its correlation with bone mineral density (BMD) of the neck of femur and spine and determined a weak correlation between PMI and spinal BMD ($r=0.23, P<0.05$) and a moderate negative one between age and mean PMI ($r=0.45$, $P<0.0001$). But concluded that dental panoramic radiographs can be used in clinical practice to assist identifying individuals with low bone mass.

Soad Mansour et al (2013)[49] evaluated the significance of panoramic radiomorphometric indices (mandibular cortical index [MCI], mental index [MI] and panoramic mandibular index [PMI]) as useful tools for identifying osteoporosis. Panoramic indices (MI, PMI and MCI) were positively correlated with the t score and BMD of the lumbar spines. The MCI was found to be the most reproducible index.

Taguchi et al (2004)[51] showed that the diagnostic performance of dental panoramic radiography measures for identifying postmenopausal women with suspected spinal osteoporosis was similar to that of the osteoporosis self-assessment tool. From these results, panoramic radiography seems to be a cost-effective means for screening latent osteoporosis in undiagnosed individuals.

E. Calciolari et al (2015)[20] suggested that the mandibular cortical width, panoramic mandibular index, and Klemetti index are overall useful tools that potentially could be used by dentists to screen for low BMD and their limitations are mainly related to the experience/agreement between different operators and the different image quality and magnification of the panoramic radiographs by systematically reviewing the literature on linear and qualitative panoramic measures, to assess the accuracy of these indices by performing a meta-analysis of their sensitivity and specificity (Are linear and qualitative panoramic indices an accurate tool to diagnose osteopenia / osteoporosis?). They found nine studies which considered the panoramic mandibular index (PMI). This index represents the ratio between the mandibular cortical width at the mental foramen region and the distance from the lower border to the inferior edge of the mental foramen (Benson et al. 1991). Most of the studies reported a cutoff value of 0.3, with levels of sensitivity and specificity in detecting individuals with reduced bone density (T score <–1) ranging from 40.8% to 100% and from 47% to 88%, respectively ,Twenty-seven studies considered the Klemetti index (KI) as a tool for prediction of reduced BMD. This index, also known as the mandibular cortical index, produced a sensitivity in detecting reduced BMD (T score <–1) ranging from 48.7% to 100% and a specificity ranging from 31% to 88.89%. The M/M ratio was used in 4 studies (Drozdzowska et al. 2002; Ishii et al. 2007; Damilakis and Vlasiadis 2011; Passos et al. 2012), but only 2 reported data on sensitivity and specificity (Drozdzowska et al. 2002; Passos et al. 2012).

Egle Jagelaviciene et al (2010)[22] determined the relationship between bone mineral density in the calcaneus measured using the dual x-ray and laser osteodensitometry technique and bone mineral density in the mandible calculated using the panoramic radiomorphometric indices obtained by applying linear measurements in panoramic radiograms of postmenopausal women and found a statistically significant correlation in the general group between the mental index and bone mineral density in the calcaneus ($r=0.356$, $P<0.001$), and between the panoramic mandibular index and bone mineral density in the calcaneus ($r=0.397$, $P<0.001$). Thus they concluded that bone mineral density in the calcaneus and the mandible measured using dual energy x-ray and laser osteodensitometer DXLCalscan and by applying panoramic radiography reflect general changes in the mineralization of these bones, characteristic of the postmenopausal period.

Somayeh Nemati et al (2016-29)[50] conducted study to evaluate the diagnostic value of the mandibular radiomorphometric indices of panoramic radiographs to predict the status of bone mineral density (BMD) in postmenopausal women and concluded that the MCW, PMI, and MCI have a high diagnostic value to predict low BMD.

C S Valerio et al (2013-31)[11] correlated the radiomorphometric indices obtained using digital panoramic radiography (DPR) with bone mineral densities evaluated by the dual-energy X-ray absorptiometry test, in a population of post-menopausal females to identify patients with asymptomatic low bone mineral densities and found significant differences between the normal and lower bone mineral density groups (osteopaenia and osteoporosis) for MCI (p,0.01). They suggested that the MCI, MI, MPI1, MPI2, and MPI3 radiomorphometric indices evaluated using DPR can be used to identify post-menopausal females with low bone densities and to provide adequate medical treatment for them.

Ishil K et al (2007)[33] assessed the diagnostic efficacy of mandibular alveolar bone loss in diagnosing postmenopausal femoral osteoporosis and found that lower femoral BMD was associated with increased alveolar bone resorption, however with less accuracy and mandibular cortical width was found to be more accurate in identifying subjects with osteoporosis at the femur. They concluded that mandibular cortical width to be more accurate measure than measure of alveolar bone resorption in identifying osteoporosis.

Cakur B et al (2008)[14] studied the efficacy of panoramic radiography in diagnosing osteoporosis. Mandibular bone density was assessed with the help of aluminum step wedge. DEXA was used to evaluvate the density. The study showed MCI and BMD of lumbar spine had significant correlation.

Grethe Jonasson and Annika Billhult (2013-32)[30] suggested that clinical and oral bone variables using mandibular trabeculation evaluation methods, may identify individuals at greatest risk of fracture. They used mandibular trabeculation evaluation methods, clinical variables, and osteoporosis as fracture predictors in women.

Marina melescanu-imre(2009-33)[38] concluded that there is possible association between osteoporosis and oral bone loss, with an emphasis on radiological studies and dentists are a potentially valuable resource for initial patient screening for signs of osteoporosis, as individuals with osteoporosis have altered architecture of the inferior border of the mandible as seen on panoramic radiographs.

Poornima Govindraju, Poornima Chandra (2014)[42] evaluated the influences of gender and age on the radiomorphometric indices and to assessed the differences in the various indices, if any, between digital and analog radiographs**.** Showed that MCI, MI and PMI indices were useful for identifying patients with low skeletal bone mineral densities (BMD) or osteoporosis and digital panoramic radiographs were better than analog radiographs for measuring the indices.

S. Marandi et al (2010)[45] Compared the mean BMD in the femoral neck in women between C1 and C3 subgroups of MCI, a significant difference was detected (P=0.04) and concluded that Using radiomorphometric indices of the mandible (MCI-MI) may be useful in determining the skeletal status of the patients, but is not sufficient for precise evaluation.

Shefali Waghray et al (2016)[48] evaluated the precision of a radiomorphometric index [mental index (MI)] measured on a panoramic radiograph in early diagnosis of osteoporosis and found its correlation with bone mineral density (BMD) measured by digital X-ray radiogrammetry method to be statistically significant. They concluded that a simple radiomorphometric index (MI) which is relatively easier to measure on a panoramic radiograph can be an indicator of osteoporosis and may aid in early detection and treatment planning of one of the most prevalent metabolic bone diseases.

Mine Tezal et al (2000)[39] assessed the relationship between systemic bone mineral density and periodontal disease and conclude that skeletal BMD is related to interproximal alveolar bone loss and, to a lesser extent, to clinical attachment loss, implicating postmenopausal osteopenia as a risk indicator for periodontal disease in postmenopausal Caucasian women.

Bathla S et al (2015)[7] examined the age and gender related variations associated with the panoramic mandibular index and their effect in a group of North-Indian population of Haryana and found Panoramic mandibular index showed significant negative correlation with age in both the sexes. Inter-age group comparisons showed statistically significant differences between the youngest and eldest age-groups in both the genders. Female values were lower than male values in all age groups, but sexual dimorphism was not observed. Thus concluded that panoramic mandibular index was influenced significantly by the variations in age but minimally by the gender related variations.

C. C. Gomes et al (2014)[12] compared the assessment of mandibular indices on panoramic and cross-sectional images and found that Wilcoxon statistical test ($p > 0.01$), the data showed no statistically significant difference between the exams. Thus Concluded that the mandibular index assigned in tomographic images is comparable to that obtained in panoramic images, indicating a valid use of the index in CBCT images, which can lead to the identification of patients with bone mass loss and a premature referral to further exams and treatment.

Alexandru Georgescu et al (2012)[4] studied the correlation between assessments of age in women patients with the presence of osteoporosis and impaired level of osseous edge at mandible and found mandible cortical thickness measurements (MCT) for each patient in their study showed an average of 3.5 mm for control group (group 1) and thickness average at 2.3 mm for the group with osteoporosis (group 2), and each group could be classified in one of the erosion categories C1 - C3 in infraosseous mandible basal bone. He thus concluded that determination for MCT can be used as a method in patients' selection with postmenopausal osteoporosis or prone to osteopenia.

Savic Pavicin et al (2014)[46] determined the correlation of skeletal bone mineral density (BMD) with mandibular density and mandibular radiographic indices estimated on digital panoramic radiographs and found mandibular density and visual index MCI are significant predictors of hip and spine BMD. Mandibular density was marked by a significant square trend: it decreased until the age of 54 years and remained constant until the age of 64 years when it started to increase. They also found significant correlations between MI, AI and PMI values and BMD in the hip but not in the lumbar spine region. The GI and M/M values did not show statistically significant correlations with BMD of either region. Thus they concluded that Mandibular bone density and mandibular radiographic indices are useful in detecting patients with decreased BMD. The applicability of orthopantomograms in diagnosing osteoporosis/osteopenia should be recognized as the potential greatest benefit of this everyday diagnostic method in dental practice.

Materials & methods

MATERIALS AND METHODS

STUDY TOPIC

Accuracy of mandibular panoramic indices in the assessment of bone mineral density in comparison with DEXA scans among post menopause women.

STUDY DESIGN

The present study is an observational study.

STUDY DURATION

The study was conducted between January 2019 to August 2019 in the department of oral medicine, Ragas dental college and hospital and RGGGH, Chennai.

STUDY POPULATION

20 postmenopausal women who were seeking dental treatment in Ragas dental college and hospital.

OBTAINING APPROVAL FROM THE AUTHORITIES

Before starting the study, permission from the ethical committee of Ragas dental college and hospital was obtained. Due consent letter format was obtained from the participants of the study both in Tamil and English.

MATERIALS USED

1. Digital x- ray machine
2. Unicorn DICOM viewer
3. Discovery Wi DXA (S/N 88272)
4. Lead apron
5. Thyroid collar

METHODOLOGY

SELECTION CRITERIA

INCLUSION CRITERIA

- Postmenopausal women who have not been previously diagnosed with osteoporosis.

EXCLUSION CRITERIA

- Patients who use medication that affect bone metabolism
- Patient who had history of metabolic bone disease, cancer, renal compromise, liver disease
- Patients who had destructive bone lesion in the mandible, previous history of surgery in the mandible
- Patients who were non cooperative and who did not want to participate in the study.

GENERAL PROCEDURE

A proper case history was taken. The patients included in this study were subjected to DEXA scan and digital OPG.

GENERAL INSTRUCTIONS BEFORE PROCEDURE

The patients were instructed to remove all kinds of metal object including jewellery, eye glasses, hair pins, safety pins and denture.

BONE MINERAL ASSESSMENT USING DEXA SCAN

After automated calibration and quality control by automatic internal reference system scan, the scans were performed for these 20 patients. The patients were made to lie on the Discovery WI DXA examination table. The patient's correct position was noted and immobilised with the help of sponge neck pads and straps.

The Discovery WI DXA machine was used for measuring bone density covering lumbar spine and proximal femur regions and the T- Score calculated based on the National health and nutritional examination survey III, as recommended by the International Osteoporosis Foundation.

Normal : T- Score of ≥ - 1.0

Osteopenia : T- Score of -2.5 to -1.0

Osteoporosis : T- Score of ≤ -2.5

ORTHOPANTOMOGRAM

Digital panoramic radiographs were taken in compliance with the specifications by the manufacturer at 80 Kvp, 140 KHz and 8 ma. The measurements were made using Unicorn Dental Imaging Software.

IMAGE ANALYSIS

The following indices were measured on both right and left side of the mandible and the average was recorded.

MANDIBULAR CORTICAL INDEX (MCI):

The inferior mandibular cortex shapes were categorised in to 3 groups based on the criteria described by Klemetti et al[23].

C_1: a normal cortex, in which the endosteal margin of the cortex is even and sharp on both sides. (Figure 1)

C_2: a mild to moderately eroded cortex, in which the endosteal margin shows semilunar defects (lacunar resorption) or seems to form endosteal cortical residue 9one to three layers) on either or both sides. (Figure 2)

C_3: a severely eroded cortex, in which the cortical layer forms heavy endosteal cortical residues and is clearly porous. (Figure 3)

Figure 1- C_1 cortex

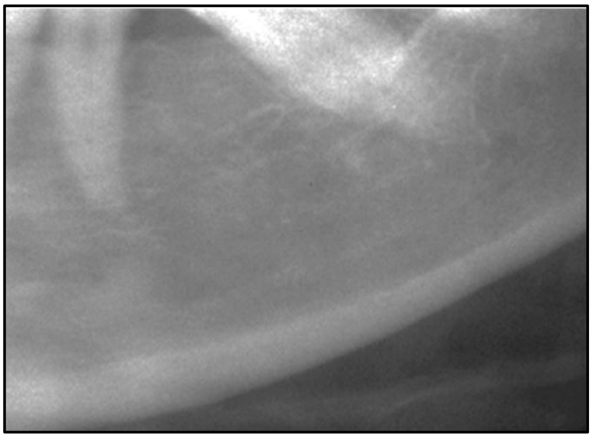


Figure 2 – C_2 cortex

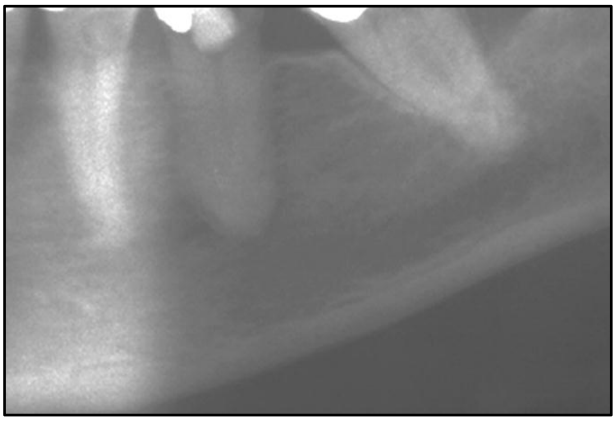
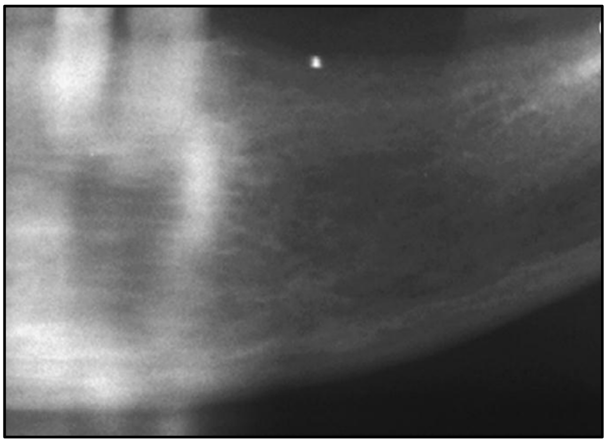


Figure 3 – C_3 cortex



MENTAL INDEX (MI):

The inferior mandibular cortical width was analysed using a quantitative index called the Mental Index. It is the measure of the cortical width in the mental foramen region and is assessed according to the technique described by Ledgerton et al[16]. In this technique the mental foramen is identified, a line parallel to the long axis of the mandible and tangential to the inferior border of the mandible is drawn. A line is traced perpendicular to the tangent intersecting the inferior border of the mental foramen is constructed, along which the cortical width was measured.

Normal : 3.90 ± 0.66

Osteopenic : 3.51 ± 0.51

Osteoporosis : 2.5 ± 0.66

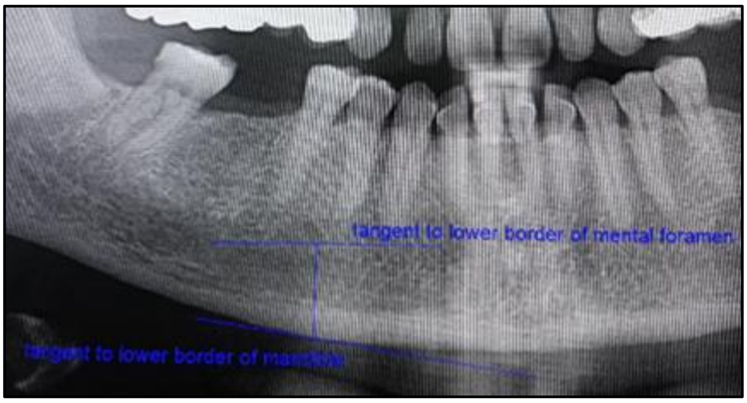


Figure 4 – Mental Index

The reliability of mandibular panoramic indices in detecting low mineral density was assessed by comparing with the gold standard DEXA scan.

STATISTICAL ANALYSIS:

All the data were entered in Microsoft excel sheets. Statistical analysis was done using SPSS software version 20.0. Chi-Square Tests were used for comparison of data.

Detailed budget plan: Rs. 40000

Figures

Figure 5: **Discovery Wi DXA Machine**

Figure 6: **Patient Positioned in DXA**

Figure 7: Patient Positioned in Orthopantomogram

Results

RESULTS

In this study a total of 20 post-menopausal women, who reported to the Outpatient Department of Oral Medicine and Radiology, Ragas Dental College and Hospital, seeking dental treatment were evaluated. Each of these individuals were subjected to digital panoramic radiographs and the mandibular panoramic indices assessed and these values were compared with gold standard DEXA scan, as an attempt to evaluate the accuracy of mandibular panoramic indices in assessing bone mineral density. The study was conducted from January 2019 to August 2019. The data obtained from the study were statistically analysed. The software used for this comparison was SPSS, Version 20.0. The results are presented below.

Demographic analysis

The mean age group of the subjects who participated in this study was 55.7 years. The mean height of the subjects was 152.5cms. The mean weight of the subjects was 60.8 kg's. The mean body mass index of the subjects was 27.06.

Frequency table 1: Bone mineral density (BMD)

Based on the skeletal bone mineral density measurements obtained using DEXA scan, these 20 subjects were grouped into 3 categories – normal subjects, osteopenia subjects, osteoporosis subjects. Among the 20 (100%)

subject, 7(35%) were identified as Group A - normal subjects, 6(30%) were identified as Group B - osteopenic subjects and 7(35%) were identified as Group C - osteoporotic subjects.

Frequency table 2: Mandibular cortex index (MCI)

Based on the MCI criteria described by Klemetti et al[23], these 20 subjects were categorised into 3 groups – $C_{1,}$ C_2, and C3. Among the 20(100%) subjects, 7(35%) were identified to had normal C_1 cortex, 6(30%) were identified to have mild to moderately eroded C_2 cortex, 7(35%) were identified to have severely eroded C_3 cortex.

Table 3: Tukey HSD Test for Pairwise Comparisons of the Groups

On comparing the MCI values between C1, C2, C3 there was significant difference in MCI between C_1 and C_2 (P ~ 0.000), C_1 and C_3 (P ~ 0.00) and between C_2 and C_3 (P~0.001).

Table 4: Shows distribution of subject according to age between BMD categories.

Among the 7(100%) subjects in Group A, 3(42.9%) subjects were below or equal to 50 years, 3(42.9%) subjects were between 50 to 60 years and 1(14.3%) subject was above 60 years. Among the 6(100%) subjects in Group B, 2(33.3%) subjects were below or equal to50 years, 3(50%) subjects were between 50 to 60 years and 1(16.7%) subject was above 60 years. Among the 7(100%) subjects in Group C, 3(42.9%) subjects were below or equal to 50 years, 2(28.6%) subjects were between 50 to 60 years and 2(28.65) subjects were above 60 years.

The distribution of subjects according to age shows significance * at level 5 with P value ~ 0.025.

Table 5: Shows distribution of subjects according to BMI between BMD categories.

Among the 7(100%) subjects in Group A, 1(14.3%) subject was normal, 4(57.1%) subjects were overweight and 2(28.6%) subjects were obese. Among the 6(100%) subjects in Group B, 1(16.7%) subject was normal, 4(66.7%) subjects were overweight and 1(16.7%) subject was obese. Among the 7(100%) subjects in Group C, 1(14.3%) subject was underweight, 2(28.6%) subjects were normal and 4(57.1%) subjects were overweight.

The distribution of subjects according to BMI shows no significance with P value ~0.643.

Table 6: Shows association of MCI with BMD at lumbar spine.

Among the 7(100%) subjects who were identified as having C_1 normal cortex under mandibular cortical index, all 7(100%) subjects were identified as normal subjects based on BMD values obtained in spine using DEXA scan. Among the 6(100%) subjects who were identified as having mild to moderately eroded C_2 cortex under MCI, all 6(100%) subjects were identified as osteopenia individuals based on BMD values obtained in spine using

DEXA scan. Among the 7(100%) subjects who were identified as having severely eroded C_3 cortex under MCI, all 7(100%) subjects were identified as osteoporotic individuals based on BMD values obtained in spine using DEXA scan.

Hence, the association between the three categories of MCI and BMD at spine using DEXA scan was highly significant ** with P value ~ 0.001.

Table 7: Shows association of MCI with BMD at hip – right femur

Among the 7(100%) subjects who were identified as having normal C_1 cortex under MCI, all 7(100%) subjects were identified as normal individuals based on BMD values obtained in right femur using DEXA scan. Among the 6(100%) subjects identified as having mild to moderately eroded C_2 cortex under MCI, 5(83.3%) subjects were identified as normal and 1(16.7%) subject was identified as osteopenic based on the BMD values obtained in the right femur using DEXA scan. Among the 7(100%) subjects identified as having severely eroded C_3 cortex under MCI, 2(28.6%) subjects were identified as normal, 3(42.9%) subjects were identified as osteopenic, 2 (28.6%) subjects were identified as osteoporotic individuals based on the BMD values obtained in right femur using DEXA scan.

The association of MCI between the 3 BMD groups at hip – right femur was significant * at level 5 with P value of~ 0.045.

Table 8: Shows association of MCI with BMD at hip – left femur

Among the 7(100%) subjects who were identified as having normal C_1 cortex under MCI, all 7(100%) subjects were identified as normal individuals based on the BMD values obtained in femur left using DEXA scan. Among the 6(100%) subjects identified as having mild to moderately eroded C_2 cortex under MCI, 3(50%) subjects were identified as normal individuals and 3(50%) subjects were identified as osteopenia individuals based on BMD obtained using DEXA scan at femur left. Among the 7(100%) subjects identified as having severely eroded C3 cortex under MCI, 2(28.6%) subjects were identified as normal individuals, 3(42.9%) subjects were identified as osteopenia individuals and 2(28.6%) subjects were identified as osteoporosis individuals based on the BMD obtained using DEXA scans at femur left.

There was a significant* correlation at level 5 between MCI and the 3 BMD groups obtained using DEXA scan at femur left with a P value of ~0.038.

Table 9: Shows association of MI with BMD at lumbar spine

Among the 12(100%) subjects identified as normal individuals based on the mental index (MI) score obtained from digital panoramic radiographs, 7(58.3%) individuals were identified as normal and 5(41.7%) individuals were identified as osteopenic individuals based on the values obtained using DEXA scan at lumbar spine. 1(100%) subject was identified as osteopenia individuals based on the MI score and that 1(100%) subject was identified as osteopenic individual according to the BMD values obtained using DEXA scan at lumbar spine. Among the 7(100%) subjects identified as osteoporosis individual based on MI score, all 7(100%) individuals were identified as osteoporotic individuals based on BMD values obtained using DEXA scan at lumbar spine.

Hence a significant* correlation exists between MI and the 3 BMD groups obtained using DEXA scan at lumbar spine with P value~ 0.001.

Table 10: Shows association of MI with BMD at hip – right femur

Among the 13(100%) subjects identified as normal individuals based on the MI score obtained from digital panoramic radiograph, 12(92.3%) individuals were identified as normal individuals and 1(7.7%) individual was identified as osteopenic based on the BMD values obtained using DEXA scan at femur right. Among the 7(100%) subjects identified as osteoporotic individuals based on MI score, 2(28.6%) individuals were identified as normal individuals, 3(42.9%) individuals were identified as osteopenic individuals and 2(28.6%) individuals were identified as osteoporotic individuals based on the BMD values obtained using DEXA scan at right femur.

This shows a significant * correlation between MI and the 3 BMD groups obtained using DEXA scan at right femur with a P value of ~0.010

Table 11: Shows association of MI with BMD at hip – femur left

Among the 13(100%) subjects identified as normal individuals based on the MI score obtained from digital radiograph, 10(76.9%) individuals were identified as normal and 3(23.1%) individuals were identified as osteopenic based on the BMD values obtained using DEXA scan at left femur. Among the 7(100%) subjects identified as osteoporotic individuals based on the MI score obtained from digital panoramic radiographs, 2(28.6%) individuals were identified as normal, 3(42.9%) individuals were identified as osteopenic and 2(28.6%) individuals were identified as osteoporotic individuals based on the BMD values obtained using DEXA scan at left femur.

This shows a significant * correlation between MI and the 3 BMD groups obtained using DEXA scan at left femur with a P value of ~0.048.

Tables & graphs

TABLES

Table 1: Bone Mineral Density (BMD)

		Frequency	Percent	Valid Percent
Valid	Group A	7	35%	35.0
	Group B	6	30%	30.0
	Group C	7	35%	35.0
	Total	20	100.0	100.0

Table 2: Mandibular Cortex Index (MCI)

		Frequency	Percent	Valid Percent
Valid	C_1 cortex	7	35%	35.0
	C_2 cortex	6	30%	30.0
	C_3 cortex	7	35%	35.0
	Total	20	100.0	100.0

Table 3: Tukey HSD test for inter group comparison of MCI

Multiple Comparisons						
Dependent Variable: BMD				Tukey HSD		
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval	
					Lower Bound	Upper Bound
C_1 Cortex	C_2	.24452*	.03812	.000	.1467	.3423
	C_3	.40857*	.03662	.000	.3146	.5025
C_2 cortex	C_1	-.24452*	.03812	.000	-.3423	-.1467
	C_3	.16405*	.03812	.001	.0663	.2618
C_3 cortex	C_1	-.40857*	.03662	.000	-.5025	-.3146
	C_2	-.16405*	.03812	.001	-.2618	-.0663
*. The mean difference is significant at the 0.05 level.						

Table 4: Shows distribution of subjects according to age between BMD categories.

			Age Group in years			Total	P value
			<= 50	51-60	> 60		
BMD	Group A	Count	3	3	1	7	0.025
		% within Group	42.9%	42.9%	14.3%	100.0%	
	Group B	Count	2	3	1	6	
		% within Group	33.3%	50.0%	16.7%	100.0%	
	Group C	Count	3	2	2	7	
		% within Group	42.9%	28.6%	28.6%	100.0%	

Table 5: Shows distribution of subjects according to BMI between BMD categories.

			BMI				Total	P value
			Under weight	Normal	Over weight	Obese		
BMD	Group A	Count	0	1	4	2	7	0.643
		% within Group	0.0%	14.3%	57.1%	28.6%	100.0%	
	Group B	Count	0	1	4	1	6	
		% within Group	0.0%	16.7%	66.7%	16.7%	100.0%	
	Group C	Count	1	2	4	0	7	
		% within Group	14.3%	28.6%	57.1%	0.0%	100.0%	

Table 6: Shows association of MCI with BMD at lumbar spine.

			Spine			Total	P Value
			Normal	Osteopenia	Osteoporosis		
MCI	C_1 Cortex	Count	7	0	0	7	0.000
		% within Group	100.0%	0.0%	0.0%	100.0%	
	C_2 cortex	Count	0	6	0	6	
		% within Group	0.0%	100.0%	0.0%	100.0%	
	C_3 cortex	Count	0	0	7	7	
		% within Group	0.0%	0.0%	100.0%	100.0%	
Total		count	7	6	7	20	
		% within group	35.0%	30.0%	35.0%	100.0%	

Table 7: Shows association of MCI with BMD at hip - femur right

			Hip - Femur Right			Total	P value
			Normal	Osteopenia	Osteoporosis		
MCI	C_1 Cortex	Count	7	0	0	7	0.045
		% within Group	100.0%	0.0%	0.0%	100.0%	
	C_2 cortex	Count	5	1	0	6	
		% within Group	83.3%	16.7%	0.0%	100.0%	
	C_3 cortex	Count	2	3	2	7	
		% within Group	28.6%	42.9%	28.6%	100.0%	
Total		count	14	4	2	20	
		% within group	70.0%	20.0%	1.0%	100.0%	

Table 8: Shows association of MCI with BMD at hip - femur left

			Hip - Femur Left			Total	P Value
			Normal	Osteopenia	Osteoporosis		
MCI	C_1 Cortex	Count	7	0	0	7	0.038
		% within Group	100.0%	0.0%	0.0%	100.0%	
	C_2 cortex	Count	3	3	0	6	
		% within Group	50.0%	50.0%	0.0%	100.0%	
	C_3 cortex	Count	2	3	2	7	
		% within Group	28.6%	42.9%	28.6%	100.0%	
Total		Count	12	6	2	20	
		% within group	60.0%	30.0%	10.0%	100.0%	

Table 9: Shows association of MI with BMD at lumbar spine

		Spine						Total		P Value
		Normal		Osteopenia		Osteoporosis				
		Count	% within Group	Count	% within Group	Count	% within Group	Count	% within Group	
Mental Index	Normal	7	58.3%	5	41.7%	0	0.0%	12	100.0%	0.000
	Osteopenia	0	0.0%	1	100.0%	0	0.0%	1	100.0%	
	Osteoporosis	0	0.0%	0	0.0%	7	100.0%	7	100.0%	
Total		7	35.0%	6	30.0%	7	35.0%	20	100.0%	

Table 10: Shows association of MI with BMD at hip – femur right

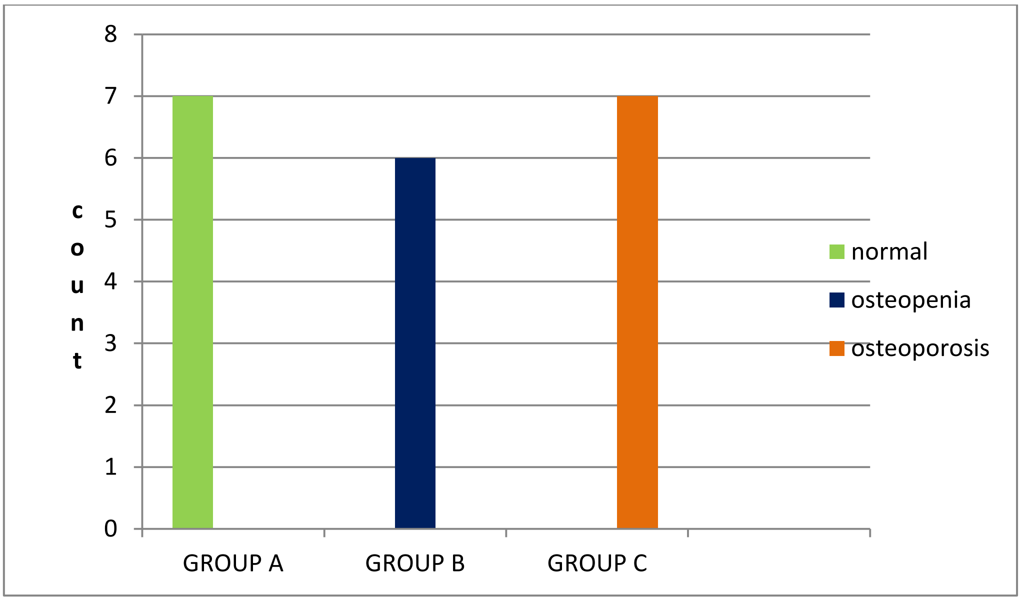
		Hip - femur right						Total		P Value
		Normal		Osteopenia		Osteoporosis				
		Count	% within Group	Count	% within Group	Count	% within Group	Count	% within Group	
Mental Index	Normal	12	92.3%	1	7.7%	0	0.0%	13	100.0%	0.010
	Osteopenia	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Osteoporosis	2	28.6%	3	42.9%	2	28.6%	7	100.0%	
Total		14	70.0%	4	20.0%	2	10.0%	20	100.0%	

Table 11: shows association of MI with BMD at hip – femur left

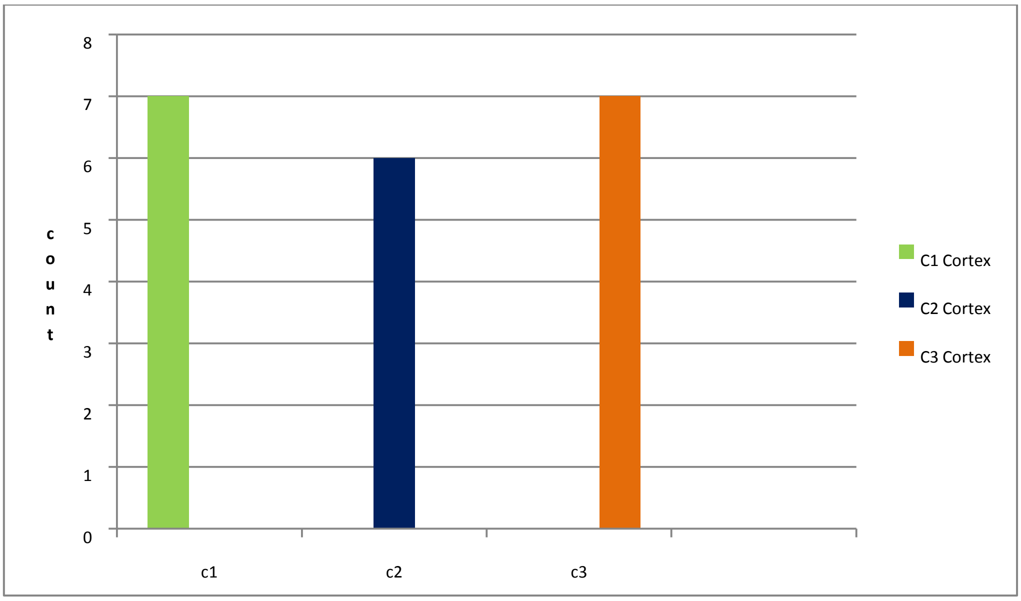
		Hip - femur left						Total		P Value
		Normal		Osteopenia		Osteoporosis				
		Count	% within Group	Count	% within Group	Count	% within Group	Count	% within Group	
Mental Index	Normal	10	76.9%	3	23.1%	0	0.0%	13	100.0%	0.048
	Osteopenia	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	Osteoporosis	2	28.6%	3	42.9%	2	28.6%	7	100.0%	
Total		12	60.0%	6	30.0%	2	10.0%	20	100.0%	

GRAPHS

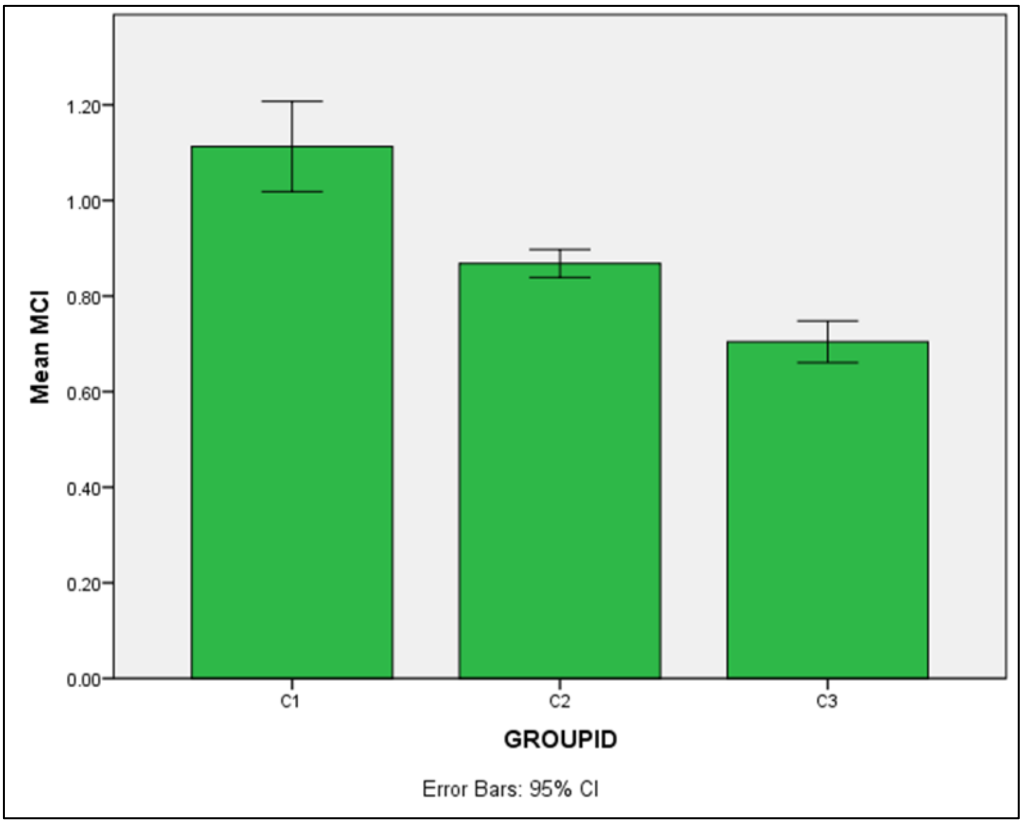
Graph 1: Bone Mineral Density (BMD)



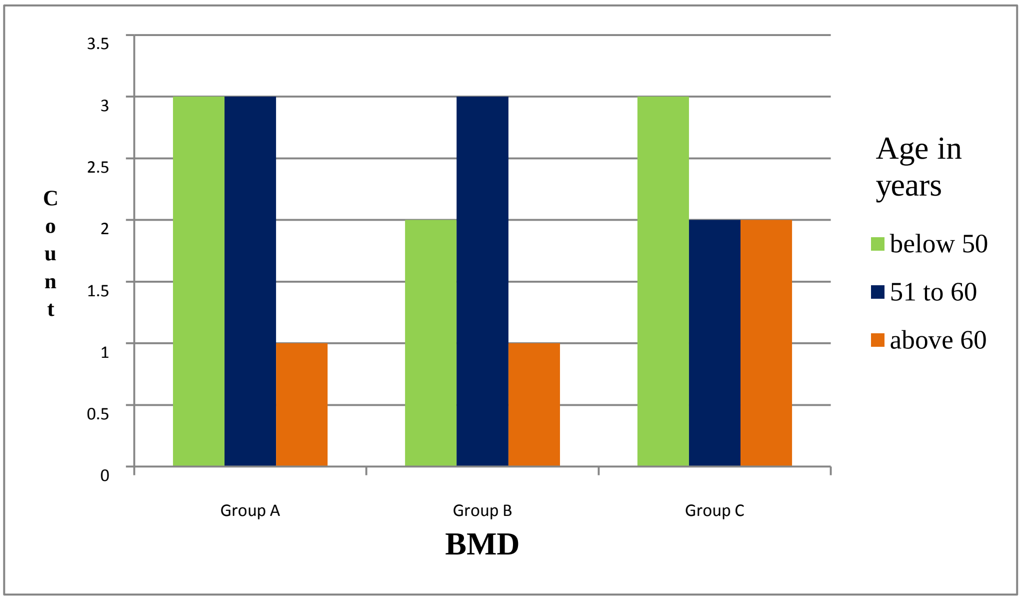
Graph 2: Mandibular Cortex Index (MCI)



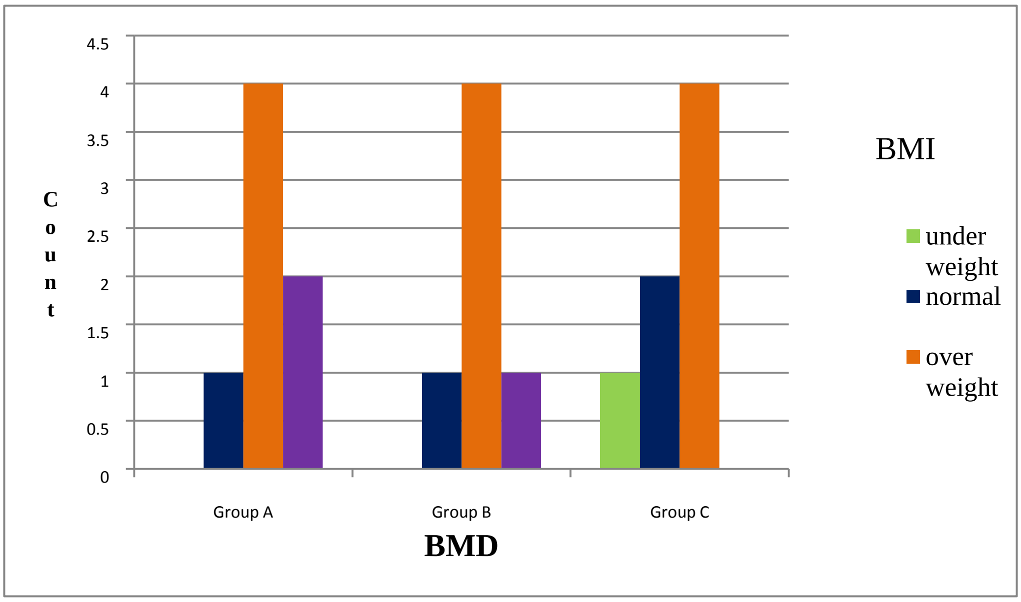
Graph 3: Mean MCI



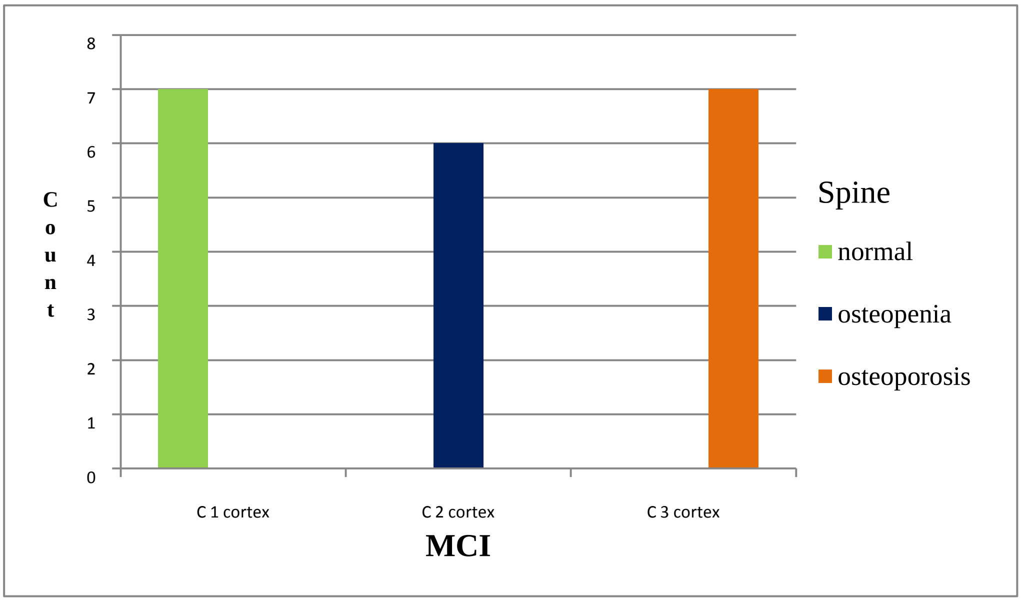
Graph 4: Shows distribution of subjects according to age between BMD categories.



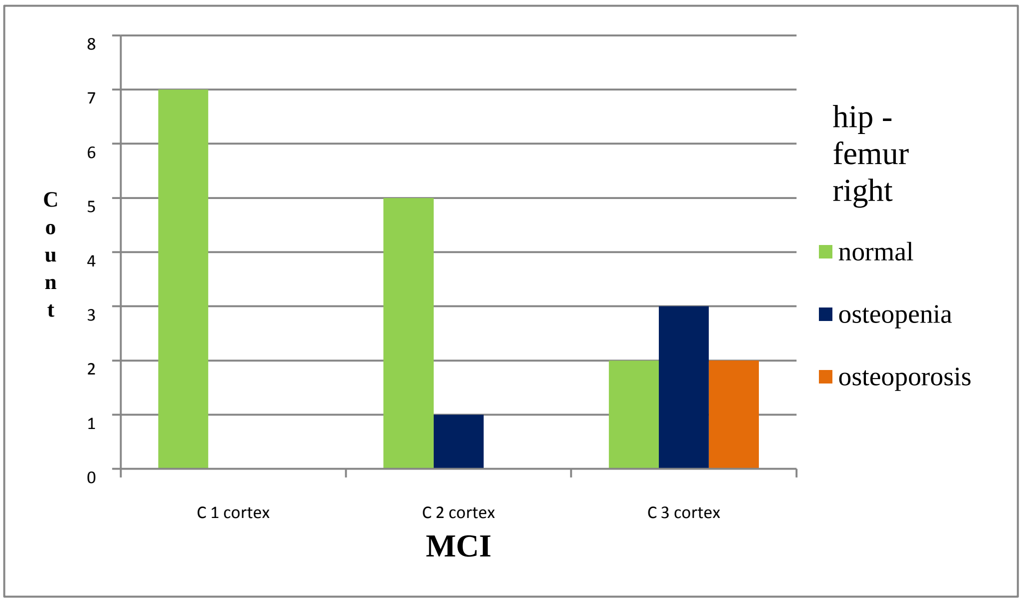
Graph 5: Shows distribution of subjects according to BMI between BMD categories.



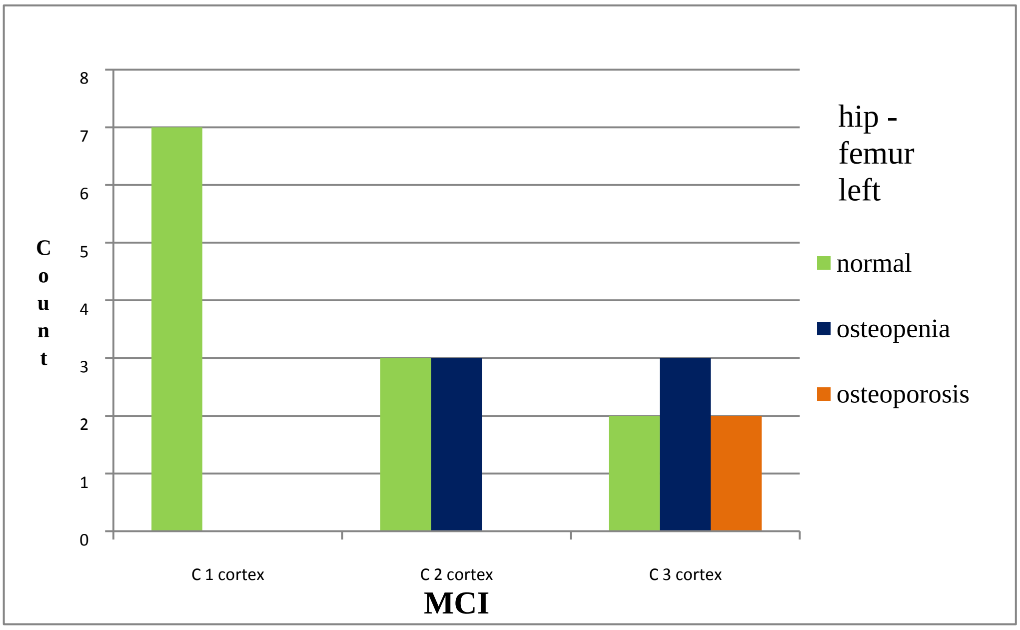
Graph 6: Shows association of MCI with BMD at lumbar spine.



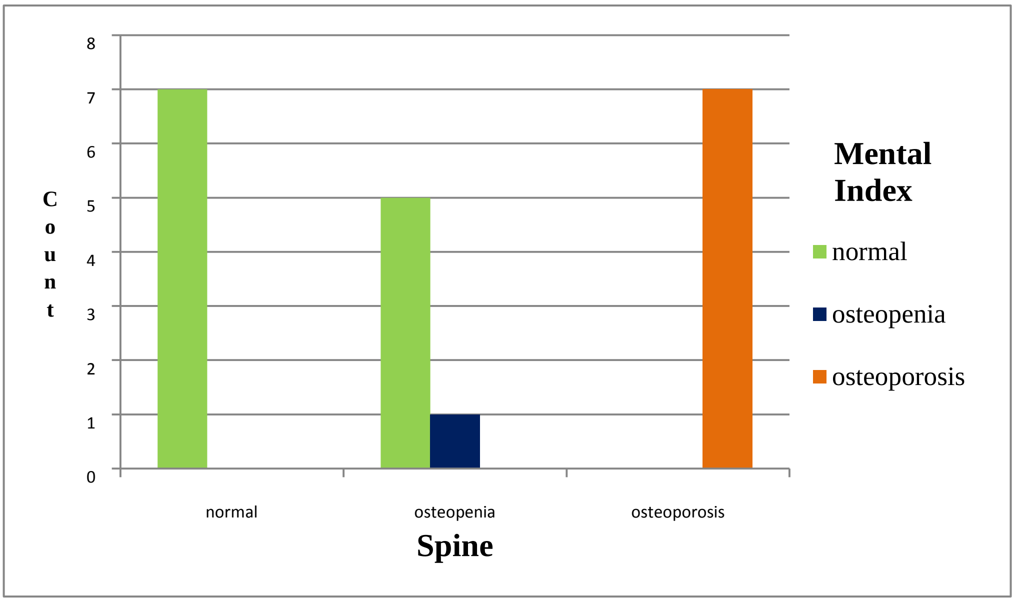
Graph 7: Shows association of MCI with BMD at hip - femur right



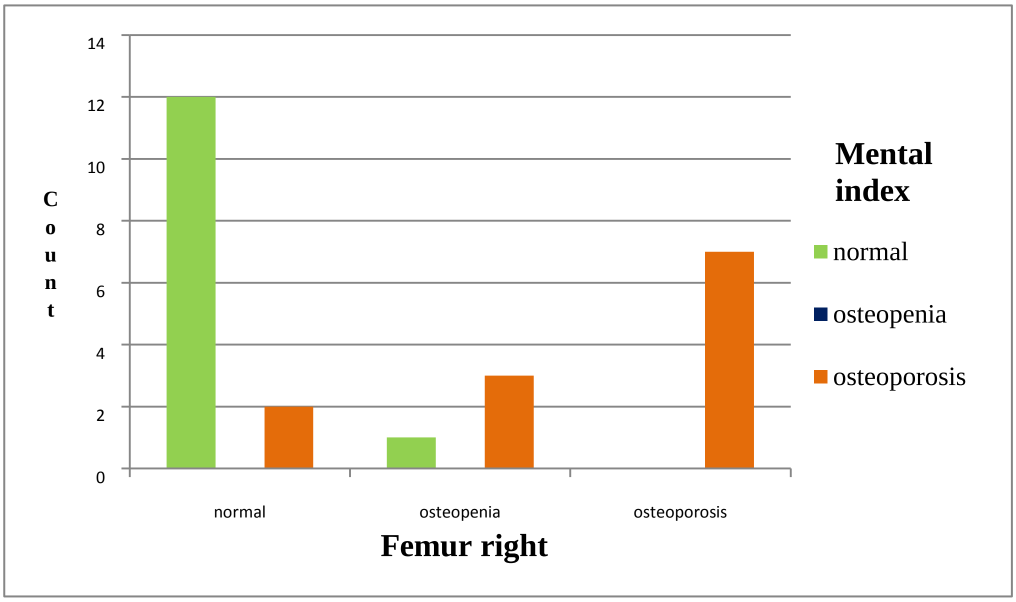
Graph 8: Shows association of MCI with BMD at hip - femur left



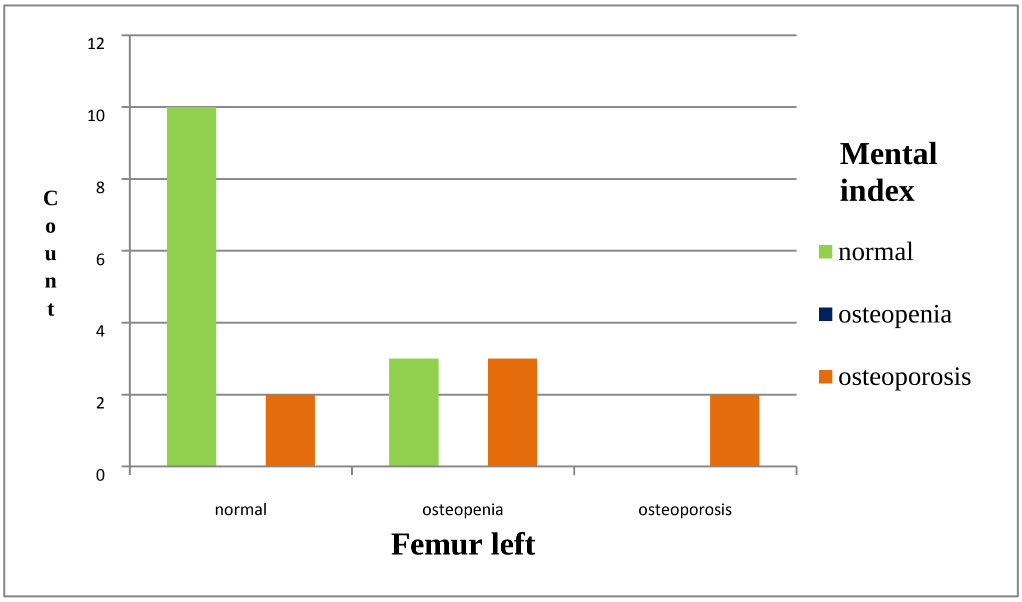
Graph 9: Shows association of MI with BMD at lumbar spine



Graph 10: Shows association of MI with BMD at hip – femur right



Graph 11: shows association of MI with BMD at hip – femur left



Discussion

DISCUSSION

In this study, the data evaluated from the digital panoramic radiograph were compared with those from the BMD evaluation by DXA scanning. The WHO classification of BMD for the diagnosis of osteoporosis is based on extensive cross-sectional data in post-menopausal females, showing consistent correlation between BMD measured using DXA and lifetime fracture risk. So, it is considered as the gold standard method for the non-invasive diagnosis of osteoporosis.

Osteoporosis is considered a public health problem by World Health Organization (WHO). It is seldom recognized before the occurrence of fractures. It is therefore important to identify asymptomatic individuals in the early stages of bone mass reduction, because this disease has relevant social and economic impacts.

"Osteoporosis is a silent, complex, multifactorial, chronic disease characterized by progressive loss of bone mineral density and micro architectural deterioration in bone tissues leading to fracture".

Bone quality relates to bone turnover rate, architecture of the bone, damage accumulation in the bone and degree of matrix mineralization occurring in the bone. Bone is continuously remodelled throughout life. There is a gradual age related decrease in the amount of bone formed in the resorption cavities and the bone mass begins to decline as age advances.

Higher rate of bone remodelling or bone turnover is seen in post-menopausal females and is the primary cause of structural fragility. Increased bone loss occurs following decline in oestrogen production, which accentuates the uncoupling of bone formation and resorption and increased bone turnover rate. Thus disruptions in the normal formation and function of either cell type or imbalance in secreted signalling proteins may have profound effects for the maintenance of bone density and thus resulting in osteopenia or osteoporosis in post-menopausal women.

The fact that impaired bone metabolism affects the mandible or maxilla in a manner similar to its effects on other bones is controversial and it is actually not easy to assess whether bone quality or quantity in the mandible or maxilla parallels those in the rest of the skeleton. This problem is due to the fact,

- That reported studies in literature have been preliminary, most often involving small numbers of subjects, biased sample selection and differing definitions and measurements of bone loss (i.e.,) interchangeable use of terms “bone mass” and “bone density”.
- The peak BMD and rate of change of BMD vary at different skeletal sites depending on the ratio of trabecular to cortical bone and on the average use of the bone.
- Numerous factors can affect the BMD and the development of osteoporosis, including extrinsic factors such as nutrition, medication

use, amount of physical activity, lifestyle factors (e.g., smoking and alcohol abuse) and intrinsic factors (e.g., adrenal and gonadal hormone).

- The process of bone remodelling is a non-uniform process, it differs from one bone to another, between cortical and trabecular bone and from one trabecular bone site to another.

The decrease in the trabecular bone density after menopause exceeds that of cortical bone. The earliest bone loss in osteoporosis patient occurs in areas of trabecular bone. The metabolic turnover of trabecular bone is eight times greater than that of cortical bone. This is the reason why areas of predominantly trabecular bone such as the vertebral body have been preferred sites for measuring bone mineral density.

The mandible consists predominantly of trabecular bone. Trabecular bone is clearly visible on dental radiographs thus rendering itself to quantitative analysis of bone mineral density.

Magnification of the mandible in panoramic radiograph is a known phenomenon, but it occurs unevenly through its structure. According to some authors, the vertical and horizontal magnification measurements obtained in a digital radiograph show greater magnification in anterior region and smaller magnification in posterior region. Vertical measurements are made reliable when the patient is properly positioned. In this study the indices use landmarks on the posterior of the mental foramen in a digital radiograph. The advantage of digital technique is lower radiation, faster communication of images, smaller storage space. Observers can use changes in brightness, contrast and magnification to improve the repeatability and reproducibility of this study.

In various studies, it has been shown that the decreased bone mineral density (BMD) affects the morphometric, densitometry and architectural properties of mandibular bone. Recent studies have demonstrated a significant correlation between bone mineral density in the mandible or maxilla and that in the axial skeleton such as the spine and hip.

Since the study by Klemetti et al[23], several studies have demonstrated a significant correlation between MCI and DEXA assessments, showing that the MCI morphological index has the potential to identify post-menopausal females with lower BMD values. This present study also showed a highly significant correlation between MCI and BMD values in the spine, hip – right and left femur (P ~ 0.000). The results of the study are in accordance to the results of the study conducted by **L. Khojastehpour et al[36], C.S. Valero et al[11] and Gargi Saran et al[29]. L. Khojastehpour et al[36] in 2008** studied 119 patients and found that MCI can be used to distinguish between normal and osteopenic / osteoporotic patients**.** This study is also in accordance with **C.S. Valero et al[11] in 2013** who studied 64 post-menopausal women and found a statistically significant association between BMD and MCI (P~0.0003) and said that the width and shape of mandibular cortex showed significant difference between normal and osteopenic /osteoporosis individuals. But the highest significance was found between MCI and BMD value of spine**. Gargi Saran et al[29] in 2015** found that as BMD decreased, the mandibular cortex exhibited a loss of sharpness and became porous.

The advantage of MCI is that it does not involve any measurements. It is an index of porosity, which is not affected by minor changes in magnification between x-ray machines.

The cortical thickness was analysed by means of MI. In this study, the measurements were determined using a software program which facilitated the reproducibility. The present study statistical analysis showed that a patient with osteoporosis had MI values that were significantly lower than those in a patient with normal BMD or osteopenia (P ~ 0.000). This study suggests that evaluating the mandibular cortex to identify patients at risk for osteoporosis is valid and is in accordance to the findings of **B.K. Yasodha devi et al[6]** and **Somayeh Nemati et al[50]. B.K. Yasodha devi et al[6]** in 2011 analysed 40 postmenopausal women and found a statistically significant difference in MI values between osteoporotic and normal group (P ~ 0.001) and concluded MI is low in subjects with lower BMD levels**.** This study is also in accordance with **Somayeh Nemati et al[50] in 2016** who studied 90 postmenopausal women and found a significant correlation between MI and BMD (P ~ 0.001) and concluded that MI can be used as a screening tool to identify patients with osteoporosis. There are difficulties in measuring the mental index in the mental region due to changes in cortical morphology and identification or recognition of accurate position of mental foramen can differ among different examiners.

From this study we infer that, assessment of the mandibular panoramic indices using digital panoramic radiograph is easy to perform and cost effective technique. The findings of the current study suggest that the, mandibular panoramic indices are reliable in detecting low mineral density as compared with DEXA scan. Since dentists are often the most regularly visited doctor in the elderly population seeking dental rehabilitation and other age related changes, whom are also under the risk of osteoporosis and associated fractures and dental radiographs are the most frequently used imaging modalities for these patients, dentist can be potentially valuable resource to identify patients with asymptomatic low bone density and mandibular panoramic indices can also be used as a guide in case selection for implant placement in postmenopausal women and elderly individuals seeking dental rehabilitation.

Summary & conclusion

SUMMARY AND CONCLUSION

The present study titled "ACCURACY OF MANDIBULAR PANORAMIC INDICES IN THE ASSESSMENT OF BONE MINERAL DENSITY IN COMPARISON WITH DEXA SCAN AMONG POSTMENOPAUSAL WOMEN" was conducted in the Department of Oral Medicine And Radiology, Ragas Dental College and Hospital, Uthandi, Chennai and RGGGH, Chennai to evaluate the accuracy of panoramic indices in assessing bone mineral density among postmenopausal women and compare with DXA scan.

A total of 20 postmenopausal women were selected for the study. Out of the 20 postmenopausal women, 7 individuals were normal (group A), 6 individuals were osteopenic (group B) and 7 individuals were osteoporotic (group C).

The study documented the following data:

- ❖ The mean age group of individuals participated in this study was 55.7 years. The mean height of the subjects was 152.5cms. The mean weight of the subjects was 60.8 kg's. The mean body mass index of the subjects was 27.06
- ❖ Mandibular cortical index was evaluated for each patient and were grouped under 3 categories C_1, C_2 and $C_{3.}$ MCI was compared with

BMD values obtained from DEXA scans of spine, right and left femur of respective patients and showed highest significance ** with P value ~ 0.001 when compared at lumbar spine.

- ❖ Mental index was evaluated for each patient and the values were compared with BMD values obtained from DEXA scan of spine, right and left femur of respective patients and showed highest significance ** with P value ~ 0.001 when compared at lumbar spine .
- ❖ This present study revealed a statistically significant correlation between mandibular panoramic indices (MI, MCI) in assessing bone mineral density in comparison with DEXA scan among post-menopausal women.

In conclusion, the thickness and shape of the mandibular cortex reflects the systemic condition of bone mass and digital panoramic radiograph could be used to identify individuals at the risk for low BMD. Using the MCI, patients with normal bone mass could be differentiated from those with reduced bone mass (osteopenia /osteoporosis). MI identified females at high risk of osteoporosis but did not provide any distinction between normal and osteopenia patients. The evaluating panoramic radiographs showed that only those patients with the thinnest mandibular cortices should be referred for further osteoporosis investigation.

The clinical use of this tool in tracking osteoporosis individuals, particularly by untrained clinical dentist will improve the selection of females at high risk for osteoporosis for further investigation, as well as aid in proper case selection for implant placement among postmenopausal and elderly edentulous patients seeking oral rehabilitation with implant therapy.

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Annexures

ANNEXURE – I

CASE SHEET

RAGAS DENTAL COLLEGE & HOSPITAL

2/102, EAST COAST ROAD, UTHANDI, CHENNAI – 600119.

DEPARTMENT OF ORAL MEDICINE & RADIOLOGY

ACCURACY OF MANDIBULAR PANORAMIC INDICES IN THE ASSESSMENT OF BONE MINERAL DENSITY IN COMPARISON WITH DEXA SCANS AMONG POST MENOPAUSE WOMEN.

Date:

S.No :

OP.No :

Name :

Age/Sex :

Address :

Phone number :

Occupation :

Monthly income :

Past medical /surgical/dental /history :

Personal history :

Provisional Diagnosis :

Investigation & Reports :

Final Diagnosis :

GROUP A/ GROUP B/ GROUP C

S.NO	NAME	AGE	WT	HT	BMI	BMD	SPINE	FEMUR RIGHT	FEMUR LEFT	MCI	MI

ANNEXURE - II

RAGAS DENTAL COLLEGE AND HOSPITAL

DEPARTMENT OF ORAL MEDICINE AND RADIOLOGY

CONSENT LETTER

I…………....……………………., the undersigned hereby give my consent for the performance of radiographic study "ACCURACY OF MANDIBULAR PANORAMIC INDICES IN THE ASSESSMENT OF BONE MINERAL DENSITY IN COMPARISON WITH DEXA SCANS AMONG POST MENOPAUSE WOMEN" by R.RAJPRABHA under the able guidance of Dr S. Kailasam, M.D.S., Professor and Head of the Department, Department of Oral Medicine and Radiology, Ragas Dental College and Hospital, Chennai-600119. I have been informed and explained the procedure and the purpose of the study. I also understand and accept this as a part of the study protocol there by voluntarily, unconditionally and freely give my consent without any fear or pressure in a mentally sound and conscious state to participate in the study.

Witness/Representative: Patient's signature:

Date:

ANNEXURE – II A

RAGAS DENTAL COLLEGE AND HOSPITAL

DEPARTMENT OF ORAL MEDICINE AND RADIOLOGY

நான்__________________________ என்னுடைய முழு ஒத்துழைப்பை மருத்துவர் R.ராஜ்பிரபா, அவர்கள் மற்றும் மருத்துவர் திரு.சு.கைலாசம், தலைமை பேராசிரியர் அவர்களுக்கும், வாய் மருத்துவம் மற்றும் வாய்நோய் அறிதல் கதிர் வீச்சுத்துறை ராகாஸ் பல் மருத்துவகல்லூரி மற்றும் மருத்துவமனை, முதுநிலை படிப்பிற்கான அவர்களுடைய "இறுதி மாதவிடாய் தாண்டிய பெண்களின் எலும்பிலுள்ள தாது பொருள்களின் அடர்த்தியை டெக்சா வரைபடம் மற்றும் ஊடுகதிர்விச்சு ஒளிப்பட வரைவியில் மண்டிபுலர் பனோராமிக் இன்டிக்சின் துல்லியம் கண்டறிதல் ” குறித்த ஆய்வில் மருத்துவர் சொல்ல நான் என் முழு சுயநினைவில் யாருடைய வற்புறுத்தல் இல்லாமல், யாருடைய கட்டுப்பாட்டிற்க்கு கீழ்பணியாமலும் என்னுடைய முழு ஒத்துழைப்பையும் இந்த மருத்துவ ஆராய்ச்சிக்காக ஒப்புதலையும் அளிக்கின்றேன்.

சாட்சிகள் கையொப்பம்

1.

2. தேதி:

ANNEXURE – III

RAGAS DENTAL COLLEGE & HOSPITAL

(Unit of Ragas Educational Society)

Recognized by the Dental Council of India, New Delhi

Affiliated to The Tamilnadu Dr. M.G.R. Medical University, Chennai - 600 032

2/102, East Coast Road, Uthandi, Chennai - 600 119. INDIA

Tele : (044) 2453 0002 - 06. Principal (Dir) 2453 0001 Fax : (044) 24530009

TO WHOM SO EVER IT MAY CONCERN

Date: 20.12.2019

Place: Chennai

From

The Institutional Review Board

Ragas Dental College and Hospital

Uthandi, Chennai – 119

The Project titled **"ACCURACY OF MANDIBULAR PANORAMIC INDICES IN THE ASSESSMENT OF BONE MINERAL DENSITY IN COMPARISON WITH DEXA SCANS AMONG POST MENOPAUSE WOMEN"** submitted by **Dr.R.Rajprabha** has been approved by the Institutional Review Board of Ragas Dental College and Hospital.

Dr.N.S .Azhagarasan,MDS

Member secretary,

The Institutional Review Board

Ragas Dental College and Hospital

Uthandi, Chennai – 119

ANNEXURE – IV

URKUND

Urkund Analysis Result

Analysed Document: New - plag.docx (D62122172)
Submitted: 1/10/2020 8:17:00 AM
Submitted By: rajprabha_r@yahoo.com
Significance: 4 %

Sources included in the report:

dr prasanna thesis.docx (D34514351)
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3853514/
https://go.gale.com/ps/i.do?id=GALE%7CA187327538&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=07179367&p=AONE&sw=w
https://www.chsjournal.org/CHSJ/papers/CHSJ.35.04.02.pdf

Instances where selected sources appear:

8

ANNEXURE - V

S. No	Name	Age	Sex	Height (cm)	Wt (kg)	BMI	BMD	Spine	Hip		Mandibular Cortical Index	Mental Index
								T score	Femur Right T score	Femur Left T score		
	GROUP A - NORMAL											
1	Maadana saraswathi	52	F	150	66	29.3	1.05	0.1	1.5	1.6	C1	3.9
2	Rajeshwari	58	F	144	70	33.8	1.04	0	0.7	0.5	C1	3.87
3	Ramadevi	57	F	153	65	27.8	1	-0.4	0	0.1	C1	3.95
4	Samudeswari	49	F	145	55	26.8	1.22	1.6	2.2	2.2	C1	4.12
5	Geetha	68	F	157	60	24.3	1.04	0	1	1.3	C1	3.85
6	Jayalaksmi	49	F	146	55	25.8	1.2	-0.2	1.2	1	C1	3.9
7	Vishweshwari	48	F	176	123	39.7	1.24	1.4	2.3	2.1	C1	4.2
	GROUP B - OSTEOPENIA											
1	Kanchana	62	F	149	65	29.3	0.83	-2	0.2	0.6	C2	3.58
2	Dhanala radha	62	F	155	55	22.9	0.9	-1.3	2.1	2.6	C2	3.62
3	Saraswathi	55	F	156	75	30.8	0.86	-1.6	0.4	-1.6	C2	3.3
4	Ambika	49	F	153	65	27.8	0.9	-1.8	-0.1	-0.3	C2	3.5
5	Uma rani	56	F	159	66	26.1	0.87	-1.9	-0.8	-1.3	C2	3.5
6	Vijaya	51	F	150	65	28.9	0.85	-1.7	-1.1	-1.5	C2	3.6
	GROUP C - OSTEOPOROSIS											
1	Devagi	67	F	147	50	23.1	0.75	-2.6	-2.3	-3	C3	2.5
2	Kondammal	49	F	147	50	23.1	0.71	-3.1	-1.6	-1.3	C3	2.31
3	Muthammal	70	F	144	60	28.9	0.63	-3.8	-0.7	-0.2	C3	2.6
4	Krishnaveni	50	F	146	57	26.7	0.73	-2.8	-0.2	-0.2	C3	2.5
5	Poonkodi	50	F	158	46	18.4	0.65	-2.6	-2.8	-2.4	C3	2.9
6	Lakshmi	57	F	169	75	26.3	0.71	-2.6	-2.5	-2.5	C3	2.66
7	Poomathi	56	F	151	65	28.5	0.75	-2.8	-1.8	-1.9	C3	2.87