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Detection of osteoporosis using CBCT mandibular indices in Egyptian Females

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Abstract:
Objective*: This study aims to evaluate the significance of using the CBCT mandibular indices in diagnosis of osteoporosis.*
Materials and Methods*: Fifty CBCT (Cone-Beam Computed Tomography) scans were collected from a picture archiving and communications system. All scans were taken using CRANEX 3D (Soredex, Tuusula, Finland) the total 50 subjects were divided into two groups based on DEXA scan Control group of normal healthy females (T score > -1) and study group with osteoporotic females (T score ≤ - 2.5). The computed tomography mandibular index (CTMI), the computed tomography index (superior) (CTIS) and Mandibular Computed Tomography Index (Inferior) MCTI (I) were measured using linear measurement in coronal view. The correlation between these indices and bone mineral density (BMD) measured by DEXA were assessed.*
Results*: Regarding (CTMIS), (CTMII) and (CTMI), the mean ± standard deviation of normal group (I) was (0.37±0.08), (0.49±0.11) and (4.46±0.78). While for osteoporotic group (II), it was revealed that that mean ± standard deviation was (0.240.01), (0.27±0.02) and (3.95±0.44). for significance assessment of both groups, there was significant difference between both groups as P-value < 0.05.*
Conclusion: *CBCT indices are a valuable tool in detection of osteoporosis.*
Key Word*: Osteoporosis, Bone, Mandible, Cone Beam Computed Tomography.*

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I. Introduction

Osteoporosis is a skeletal bone disease distinguished by a loss of bone mass and weakening of the cancellous architecture, which can lead to vertebral, hip, or forearm fractures. Osteoporotic fractures are linked to significant morbidity, medical costs, and a high mortality risk, which is why they are a serious public health issue around the world [(1)]. Osteoporosis is a serious public health issue with personal and financial impacts that will grow progressively more severe as the population ages. Due to limited mobility, hospitalization, and nursing home requirements, osteoporotic fragility fractures place a significant financial strain on health systems. (2)

The current method for diagnosing osteoporosis is to assess bone mineral density (BMD) in the hip or lumbar spine using dual energy X-ray absorptiometry (DEXA). The "T-score" is a comparison of an individual's BMD value to the mean of a healthy young population in units of standard deviations (SD). Osteoporosis is reported by the World Health Organization (WHO) as a T-score of less than -2.5 SD [(3)].

As well as the low cost, convenience of use, and speed of measurement, DEXA has the added benefit of exposing the patient to less radiation than a normal chest radiograph. DEXA measures, on the other hand, have limits. This two-dimensional method cannot distinguish between cortical and trabecular bone, nor can it distinguish between changes induced by bone geometry vs. those directly caused by increased bone density. Inaccuracies can be caused by differences in soft tissue density in the spine and osteoarthritis [(4)].

Studies conducted over the last few decades have proven a relationship between mandibular bone mineral densities, alveolar bone height, tooth loss, and changes in general skeletal BMD [(5, 6)]. Meanwhile dentists utilize radiographs on a daily basis, it's important to assess the possibilities of detecting decreasing bone mineral density (BMD) on dental radiographs, especially in menopausal and postmenopausal women. [(7, 8)]. Cone beam computed tomography (CBCT) can be helpful in identifying people with low BMD. Without overlapping, magnification, or distortion, CBCT provides three-dimensional imaging of structure [(9)]. Based on quantitative and qualitative criteria used in the evaluation of panoramic radiographs as low-BMD predictors, Koh and Kim presented the first study to analyze CBCT and BMD in postmenopausal women [(10)].

CBCT images were used to evaluate mandibular bone quality through obtaining several methods including the computed tomography indices, radiographic density (RD), histogram analysis (HA) and Fractal dimension (FD) analysis. Due to its 2D properties, landmarks such as fossa cannot be seen on panoramic radiographs, and landmarks such as foramen, nasal cavity, maxillary sinus, tooth roots, and mandibular canal were considered to affect the measurement of CT, HA and FD values. The aforementioned limitations of panoramic images, geometric distortions and the magnification machining the cross-sectional CBCT images with a thickness of 2-3 mm show a significant advantage of panoramic images regarding bone density evaluation. [(11)]

II. Material and Methods

Patient selection: Fifty CBCT images from postmenopausal females aged 45-60 was selected from available clinical and radiographical records of patients who had attended from 2019-2021 at the department of oral medicine and periodontology, faculty of dentistry, Mansoura university and approved by the Committee of Research Ethics of Mansoura University under protocol no.05131118.

Study Design: Retrospective study

Study Location: This study was done in department of oral medicine and periodontology, faculty of dentistry, Mansoura university.

Study Duration: September 2019 to July 2021.

Sample size: 50 patients.

Sample size calculation: The total subjects were divided into two groups based on DXA scan: Control group of normal healthy females (T score > -1) and study group with osteoporotic females (T score ≤ - 2.5).

Subjects & selection method: Fifty CBCT images from postmenopausal females aged 45-60 was selected from available clinical and radiographical records of patients who had attended from 2019-2021 at the department of oral medicine and periodontology, faculty of dentistry, Mansoura university.

Inclusion criteria:

1. Female patient
2. aged 45-60
3. osteoporotic patient with previous DEXA scan

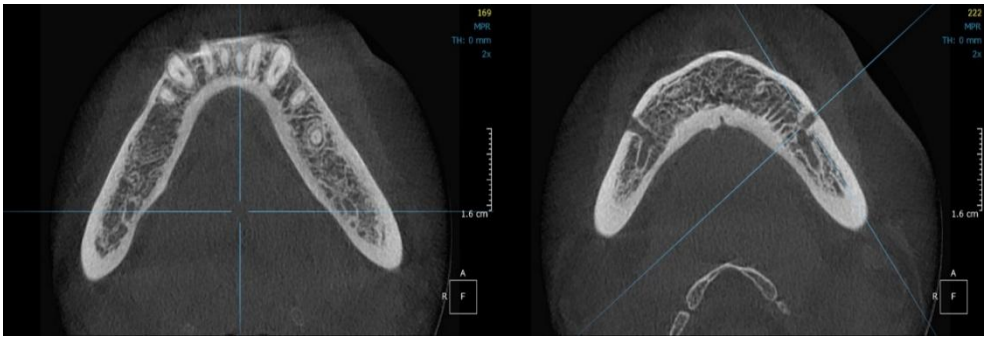
Exclusion criteria:

Patients with systemic diseases affecting bone metabolism such as diabetes mellitus, cancer, osteomalacia, hypo, hyperparathyroidism thyrotoxicosis, liver failure and renal diseases. Patients using medications interfering with bone turnover and those taking corticosteroid or hormone therapy also excluded.

Procedure methodology

Image acquisition: CBCT data was acquired using CRANEX 3D (Soredex, Tuusula, Finland) using the scanning protocol for the whole mandible with the field of view (5×10 cm) and the tube voltage was 90 KPV, tube current 8 MAs. These images, with isotropic voxel size of 125 µm, were exported in Digital Imaging and Communication in Medicine (DICOM) format. Slice selection: using the multiplanar reformation screen (MPR) using OnDemand software (Cyber med Inc., Korea) axial images with a slice thickness of 0.1mm were selected and the mental foramen was detected by scrolling through sequential slices.

Fig (1): axial views showing slice adjustment at mandibular foramen level



We made the following measurements according to modified Ledgerton's classification for panoramic image:

1) Mandibular Computed Tomography Index (Superior) MCTI(S)

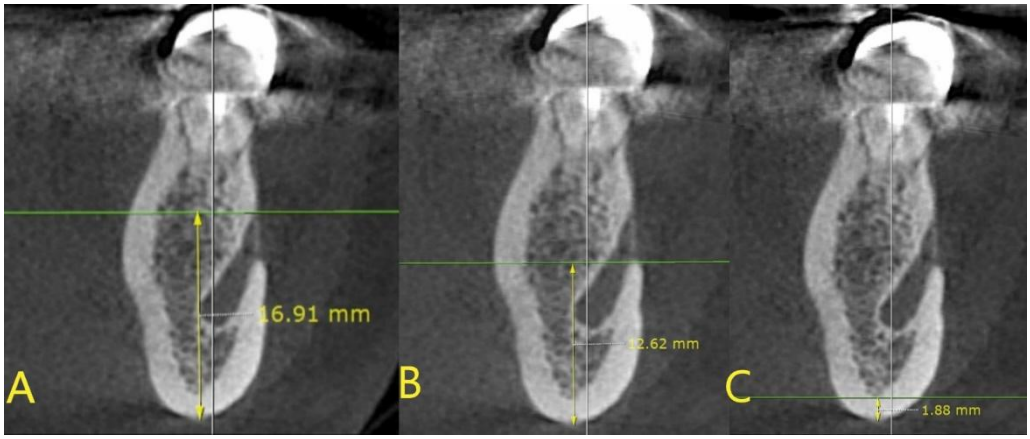
It represents the ratio of the width of inferior cortex to the distance from the superior margin of the mental foramen to the inferior border of the mandible. MCTI(S) =W/S Fig (2, A)

2) Mandibular Computed Tomography Index (Inferior) MCTI (I)

It represents the ratio of the width of inferior cortex to the distance from the inferior margin of the mental foramen to the inferior border of the mandible. MCTI (I) =W/I Fig (2, B)

3)Mandibular Computed Tomography Index (MCTI): It represents the width of inferior cortical of the mandible at the mental foramen region. MCTI =W Fig (2, C)

Fig (2): Coronal views showing CBCT Indices A-MCTI(S), B- MCTI(I), C- MCTI(S)



Statistical Analysis: The collected data were obtained from selected patients according to selected eligibility criteria. Data were statistically analyzed by Microsoft Excel ® 2016[1], Statistical Package for Social Science (SPSS) ® Ver. 24[2]and Minitab[3] ® statistical software Ver. 16.

III. Result

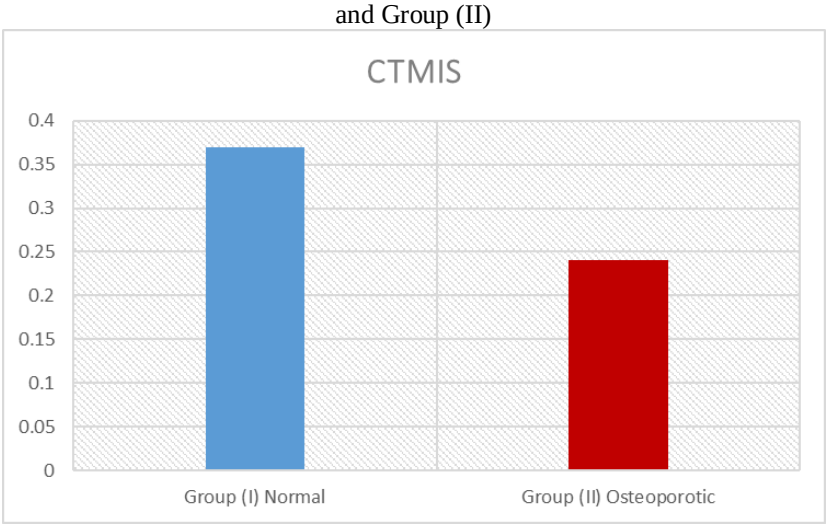
Data were revealed as means and standard deviations for further analysis using independent t test for parametric data and Mann-Whitney test for non-parametric data between group (I) and group (II). The level of significance was calculated at $P \leq 0.05$**.**

Computed Tomography Mental Index Superior (CTMIS):

Regarding Computed Tomography Mental Index Superior (CTMIS), the mean ± standard deviation of normal group (I) was (37±0.08). While for osteoporotic group (II), the mean ± standard deviation was (0.24±0.01), as showed in figure (3). Performing independent t test for significance assessment of both groups, there was significant difference between both groups as P-value < 0.05.

1. Microsoft Cooperation, USA.
2. IBM Product, USA.
3. Minitab LLC, USA.

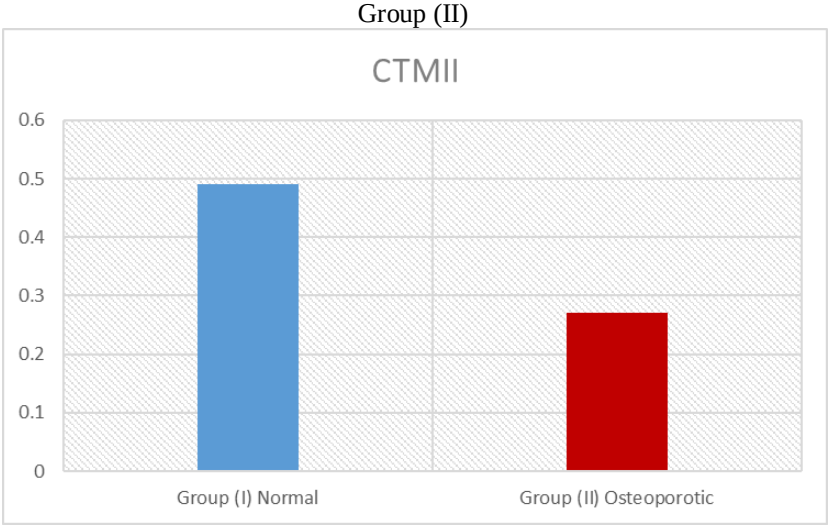
Figure (3): Bar Chart revealing Computed Tomography Mental Index Superior (CTMIS) between Group (I) and Group (II)



I. Computed Tomography Mental Index Inferior (CTMII):

Regarding Computed Tomography Mental Index Inferior (CTMII), it was revealed that mean ± standard deviation of normal group (I) was (0.49±0.11). While for osteoporotic group (II), the mean ± standard deviation was (0.27±0.02), as showed in figure (4). Performing independent t test for significance assessment of both groups, there was significant difference between both groups as P-value < 0.05.

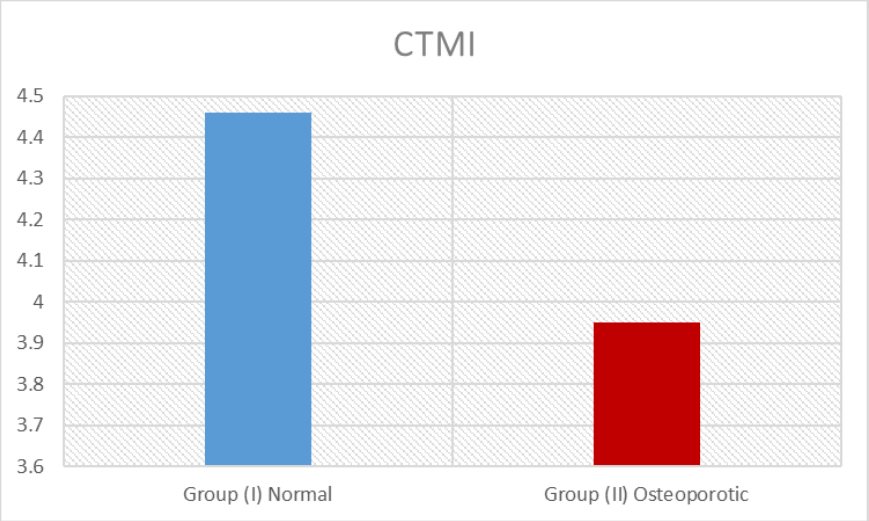
Figure (4*):* Bar Chart revealing Computed Tomography Mental Index Inferior (CTMII) between Group (I) and Group (II)



II. Computed Tomography Mental Index (CTMI):

Regarding Computed Tomography Mental Index (CTMI), it was that mean ± standard deviation of normal group (I) was (4.46±0.78). While for osteoporotic group (II), it was revealed that that mean ± standard deviation was (3.95±0.44), as showed in figure (5). Performing independent t test for significance assessment of both groups, there was significant difference between both groups as P-value < 0.05.

Figure (5): Bar Chart revealing Computed Tomography Mental Index (CTMI) between Group (I) and Group (II).



III. Overall Indices Comparisons:

Regarding (CTMIS), (CTMII) and (CTMI), the mean ± standard deviation of normal group (I) was (0.37±0.08), (0.49±0.11) and (4.46±0.78). While for osteoporotic group (II), it was revealed that that mean ± standard deviation was (0.240.01), (0.27±0.02) and (3.95±0.44), as listed in table (1). Performing independent t test for significance assessment of both groups, there was significant difference between both groups as P-value < 0.05.

Table (1): Significance Evaluation of Overall Indices between Group (I) and Group (II):

	N each group	Group (I) Normal		Group (II) Osteoporotic		P-value
		M	SD	M	SD	
CTMIS	25	0.37	0.08	0.24	0.01	**0.0001****
CTMII	25	0.49	0.11	0.27	0.02	**0.0001****
CTMI	25	4.46	0.78	3.95	0.44	**0.015****

N; Number, M; Mean, SD; Standard Deviation, P; Probability Level
*****significant Difference***

IV. Discussion

In this study we focused on our role as dentists to use CBCT scans from our patients seeking various dental treatments for early detection of osteoporotic patients. We excluded patients with systemic diseases affecting bone metabolism such as diabetes mellitus, cancer, osteomalacia, hypo, hyperparathyroidism thyrotoxicosis, liver failure and renal diseases also Patients using medications interfering with bone turnover and those taking corticosteroid or hormone therapy also excluded [(12)].

We selected female patients aged from 45:60 years old because there is a close relation between osteoporosis and age [(13)] and the diagnosis should be done early for patients at risk of osteoporosis.

We used CBCT as a useful tool in identifying patients with low BMD as CBCT scan provides structure images without overlapping, magnification, or distortion and allows viewing in three dimensions. We made our study on the mandible as it has a semblance with skeletal osteoporosis like the femur neck [(14)]. The bone structure of the mandible composed of compact and trabecular structure which needed to understand the sequence of osteoporosis in jaws bone [(15)].

The other important point for selection of the mandible for this study, is that the mandible has many reference points important for standardization sites like the mental foramen that considered by many researchers as the most probable and reasonable point for BMD measurements [(16).] We also want a region not to interfere with masticatory stress or affect the alveolar bone density as periodontal diseases and edentulous areas.

In our study we used CBCT (CTMIS, CTMII and CTMI) indices to compare between osteoporotic and normal groups as they have been found useful in identifying postmenopausal women with low BMD and as a screening tool for osteoporosis.

Regarding CTMIS, CTMII and CTMI, our results reveal a significant difference between the normal and the osteoporotic group. The results of the present study on the CBCT images showed that the CTI(S) and CTI (I) was significantly different between the normal and osteoporotic groups. This result was in harmony with the study done by Koh and Kim who evaluate CBCT index as a low-BMD predictor in osteoporotic patients [(17)].

Moreover, our study was in concise with studies done by Güngör et al. who concluded that a significant difference for all mandibular indices so the changes in the jawbone associated with osteoporosis can be defined by radio morphometric CBCT index measurements [(18)].

Regarding the CT mental index, our results are in agreement with the study made by NM Elkersh et al who showed significant differences for the CT mental index (CTMI) between the control and osteoporotic groups were found [(19)].

V. Conclusion

CBCT mandibular indices are a valuable tool in detection of low BMD females. So, our study suggests this method for diagnosis of osteoporosis.

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