To assess the ability of CBCT in evaluating osteoporotic bone changes in type 2 diabetes mellitus patients in comparison to bone mineral density using DEXA scan.

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Abstract

Purpose: This study assessed the ability of CBCT in evaluating osteoporotic bone changes in comparison to bone mineral density by using DEXA scan in type 2 diabetes mellitus patients.

Materials and methods: Thirty diabetic patients and thirty healthy control subjects were included in this study. The CBCT images were obtained from the left mental foramen region using New Tom GIANO (CEFLA)-SC Dental CBCT system. The axial, sagittal and coronal sections had prepared. The T-value was taken as a gold standard to determined BMD (Bone Mineral Density) of the lumbar vertebrae by Dual Energy X-ray Absorptiometry (DEXA) using a DEXA scanner LUNAR DPX NT (GE, USA). The intra-observer agreement and relationship between the CBCT measurements and BMDs relationship had assessed.

Results: The result of the study showed statistically significant difference in the mean values of CTIS, CTII, CTMI indices measured on CBCT in the diabetic group and control group. Mean t- scores in both diabetic males and females is lesser as compared to the mean T score in the control group. A positive correlation has observed between T-score and CTIS, CTII and CTMI indices. The intra-observer variability between CTIS, CTII, CTMI and CTCI reveal strong agreement among various radio morphometric indices.

Conclusion: The various radiomorphometric indices such as computed tomography mandibular index superior, computed tomography mandibular index inferior, and Computed Tomography Cortical Index (CTCI) and Computed Tomography Mental Index (CTMI) on CBCT can be used as an ancillary tool for the early detection of osteoporotic bone changes in type 2 diabetic patients.

Keywords: CBCT, Type 2 diabetes mellitus, DEXA scan, BMD, Radiomorphometric indices.

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Introduction

Diabetes Mellitus (DM) is a metabolic disorder characterized by persistent hyperglycaemia. It may be due to resistance to peripheral actions of insulin, impaired insulin secretion or both. An important complication of type 2 diabetes is osteoporosis, which is characterized by low bone mass and deterioration of bone micro-architecture. According to World Health Organization (WHO) osteoporosis is define as a bone mineral density t-score value of 2.5 or lower at any one location or having a previous fracture [1]. Due to changing of life style and sedentary habits even the males are found to be prone to osteoporotic changes. Dual Energy x-ray Absorptiometry (DEXA scan) is the best non-invasive technique for bone mineral density measurement. But in few cases for instance impaction, implant placement and curved canals 3D imaging such as CBCT is used for better treatment planning as it provides 3-dimensional representation of the maxillofacial skeleton. Therefore, this study was conducted with the purpose to assess the ability of CBCT to evaluate osteoporotic bone changes in type 2 diabetes mellitus patients in comparison to bone mineral density using DEXA scan.

Materials and Methods

The prospective study was performed at the centre for advanced imaging in the department of oral medicine and radiology, its centre for dental studies and research, Ghaziabad, Uttar Pradesh, India from June 2018 to July 2019.The study group involved 30 diabetic patients within age range between 50 to 80 years with known history of type II diabetes, of more than 10 years of duration who had undergone CBCT imaging for various reasons [2]. The control group included 30 healthy subjects aged 50 to 80 years with no history of systemic disease who underwent CBCT scans for different reasons. Patients with other systemic disorders such as hyperparathyroidism, hyperparathyroidism, osteomalacia, thyrotoxicosis, renal disease or any disorder known to cause osteoporosis and with a history of taking any long-term medications for any other systemic problem were excluded. Consent was taken from the participants who had joined in this study. The study was approved by institutional ethical board. All those patients who were suffering from diabetes underwent blood sampling by venipuncture of the antecubital vein to establish fasting and post prandial glucose values in fully automated clinical chemistry analyser [3].

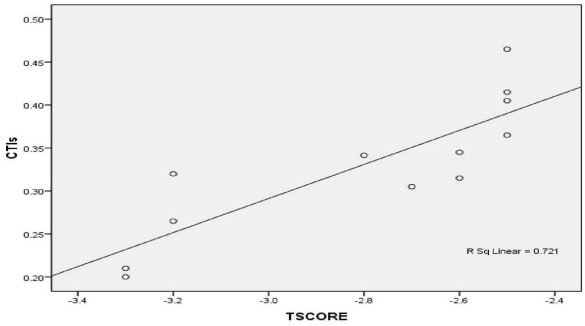

Figure 1: Correlation between T-score and CTI(S) index in osteoporotic group.

Axial, sagittal and coronal images were reconstructed on the multiplanar reformation screen using NNT software version by scrolling through sequential axial slices the mental foramen was identified and the slice with widest mesiodistal dimension of the mental foramen was utilized. Two experienced maxillofacial radiologists recorded the measurements and readings were repeated after 2 weeks.

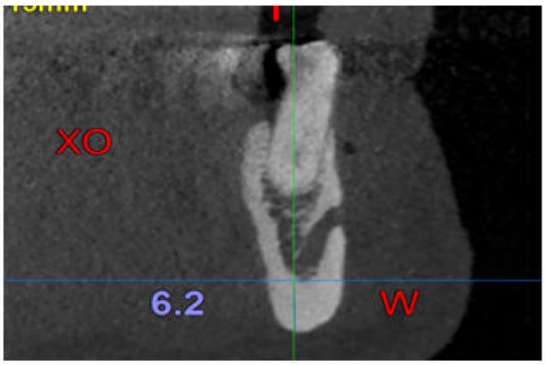

Figure 2: On coronal image Inferior cortical width (W) of the mandible measured.

The radiomorphometric indices, were recorded on the angled coronal sections, the computed tomography mandibular index superior, computed tomography mandibular index inferior, computed tomography mental index and Computed Tomography Cortical Index (CTCI). On angled sagittal sections the CTCI score was measured using a modification of the scoring system.

Statistical Analysis

All the data was analyzed on the statistical software SPSS 16.0 for windows. The descriptive statistics like mean, median, SD and frequency distribution of data was calculated. P-value<0.05 considered as significant. Correlation coefficient between CTI(S), CTI(I), CTMI and CTCI and t-score was calculated by using Spearman's rho correlation coefficient. Intra-observer agreement between various radiomorphometric indices based on Cronbach Alpha was determined.

Results

Group	N	Age	Height	Weight	T-score
Male					
Diabetics	15	63.2 ± -7.4	167.0 ± -9.5	68.7 ± -13.0	-1.0 ± 1.1
Control	15	66.4 ± -4.2	163.5 ± -3.6	67.3 ± -7.8	-1.1 ± -1.4
Female					
Diabetics	15	59.0 ± -6.5	155.7 ± -4.7	65.3 ± -11.1	-0.96 ± -1.5
Control	15	61.0 ± -4.7	151.2 ± -2.1	61.4 ± -9.7	-1.7 ± -0.54

Table 1: The characteristics of the study subjects.

Group	N	CTI(S)	CTI(I)	CTMI
Male				
Diabetics	15	0.29 ± -0.05	0.36 ± -0.07	4.2 ± -0.81
Control	15	0.37 ± -0.14	0.45 ± -0.15	5.4 ± -1.7
Female				
Diabetics	15	0.28 ± -0.05	0.35 ± -0.07	4.1 ± -0.72
Control	15	0.39 ± -0.1	0.46 ± -0.11	5. 4 ± -1.4

Table 2: Analysis of radiomorphometric indices on cone beam computed tomography image.

Table 1 represents the characteristics of the study subjects. The study sample comprised of thirty diabetic patients with known history of type II diabetes, of more than 10 years of duration and thirty healthy control subjects. The mean age of the diabetic population was 63.2 ± -7.4 years in male group and 59.0 ± 6.5 years in the female group. The mean height and weight were 167.0 ± -9.5 cm and 68.7 ± -13.0 kg in the male group and155.7 ± -4.7 cm and 65.3 ± -11.1 kg in the female group. -1.0 ± -1.1 and -.96 ± -1.5 was mean lumbar T-scores in male and female diabetic group respectively. The mean values of CTI(S), CTI(I) and CTMI in T2DM males and females were 0.29 ± -0.05, 0.36 ± -.07, 4.2 ± -.81 and 0.28 ± -.05, 0.35 ± -0.07, 4.1 ± -0.72 as shown in Table 2. The mean values of all the indices were greater in the males as compared to the females and the difference was statistically significant (P-value <0.05) except CTI(S).

Discussion

The study examined the feasibility of CBCT in radiomorphometric analysis to detect osteoporotic changes in type 2 diabetes mellitus patients and compare them with healthy control group and correlate the findings with bone mineral density measured by DEXA scan. Osteoporotic changes in males and females were also assessed as males are often neglected for evaluation of osteoporosis. In the current study, DEXA is considered as a gold standard for the BMD measurements in the lumbar region for diagnosis of

osteoporosis and prediction of fracture risk. BMD is reported as a t-score value, defined as the difference in number of Standard Deviations (SDs) from the mean BMD of a normally distributed, healthy adult reference population, it is expressed as a negative number [4]. Apart from DEXA, conventional radiology such as panoramic radiographs has utilized various quantitative and qualitative indices to evaluate the osteoporosis cases and can be used as an indicator of osteoporosis. Image distortions, magnification, overlapping of the osseous structures are the few drawbacks of panoramic radiographs for the diagnosis of osteoporosis. In the present study, the mean values of CTI(S), CTI(I) and CTMI indices on CBCT images were lower in the diabetic group than in the control group and the difference was found to be statistically significant whereas study showed no significant difference between the mean values of CTI(S), CTI(I) and CTMI indices between diabetic and non-diabetic group. The mean values of all the indices were greater in the diabetic males as compared to the diabetic females and the difference was statistically significant for CTI(I), CTMI except for CTI(S) [5].

Our study is in correlation with the study conducted on CTCI that no significant difference was established between the diabetic groups and control groups. The bone quality and quantity assessment revealed that females are more prone to osteoporotic changes and have poor bone quality. Based on t-score osteoporosis was observed more in type 2 diabetic females as compared to males. Our results are in correlation with the study revealed that large proportion of females had osteoporosis and osteopenia at both spine ($P<0.0001$) and hip ($P<0.0001$) compared to males. Positive correlation between t-score and CTI(S), CTI(I) and CTMI indices was found and it was statistically significant for all the indices. The current study agrees with found highly significant positive correlation between CTMI and CT(I) with lumbar spine BMD measured by DXA (t-score) ($p<0.5$). Negative correlation coefficient was present between t-score and CTCI ($R=-0.642$) in osteoporotic patients which was statistically significant with a p value of . 024. As the t-score reduces, the likelihood of the patients belonging to TYPE III CTCI progressed. The intra-observer variability between CTI(S), CTI(I), CTMI and CTCI indices revealed strong agreement for all the indices.

Conclusion

Our study concluded that diabetic population is more prone to osteoporosis as low bone mineral density was observed in diabetic group in comparison to non diabetic group. The various radiomorphometric indices studied on CBCT can be used as an auxiliary tool to identify patients at risk of osteoporosis and further refer the patient for densitometry analysis. The limitation of the study was a small sample size, thus further studies should be performed with larger sample to evaluate the ability of CBCT to assess the osteoporotic bone changes in type 2 diabetes mellitus patients.

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