QUANTITATIVE AND QUALITATIVE BONE ASSESSMENT OF THE POSTERIOR MANDIBLE IN PATIENTS WITH DIABETES MELLITUS: A CONE BEAM COMPUTED TOMOGRAPHY STUDY

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Diabetes mellitus has been associated with the occurrence of a series of complications involving the skeletal system, such as the reduction of bone mineral density, with an increased risk for occurrence of osteopenia and osteoporosis, poor osseous healing characteristics and impaired bone regeneration potential (1).

However, the influence of systemic diseases, such as diabetes mellitus, on the bone quantity and quality of the jaws has been investigated to a minor extent.

Different oral and maxillofacial imaging techniques used for the assessment of bone quantity and quality, as well as localization of the anatomical structures in the...
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jaws, are indispensable in treatment planning before placement of dental implants.

Cone beam computed tomography (CBCT) become one of the most useful imaging technique for acquiring bone images before performing dental implant surgery and had been increasingly replacing multi slice CT (MSCT), because it provides adequate image quality associated with a lower exposure dose (2 - 4).

Several authors have reported the use of CBCT intensity values as a measurement to assess bone mineral density, which is expressed in Hounsfield units (HU) (5), characteristics that provide important information about the quality of the bone.

The posterior region of mandible may be the implant site requiring the most rigorous assessment of bone quantity and quality because both will directly influence the results of the implant treatment as well as implant stability.

The aim of this study was to evaluate the bone quantity and quality of the posterior region of the mandible using the CBCT technique for implant planning in patients with diabetes mellitus.

MATERIAL AND METHODS

The patients were randomly chosen from the Department of Oral Radiology, Faculty of Dental Medicine, “Grigore T. Popa” University of Medicine and Pharmacy, Iasi, Romania who had received a CBCT examination as part of their dental implant planning. The study protocol was approved by the local Ethics Committee.

Quantitative and qualitative assessment was performed on 50 adult patients (28 male, 22 female) with a mean age of 51.3 years (range 41– 67 years). Of those, 23 patients had diabetes mellitus and 27 were non-diabetic, who served as a control group.

During the preliminary screening, patients had to meet the following entry criteria: (a) absence of second premolars and molars in both sides of the mandible; (b) no history of bone grafting at the implant site; (c) no smoking; (d) absence of systemic disease, infections or illness, except diabetes mellitus for diabetic group and (e) no current use of drugs which could influence the bone quality.

All of the study subjects had blood sampling by venipuncture of the antecubital vein, after a minimum 8 hours of fasting, in order to determine glycated haemoglobin (HbA1c) values. In the study it was used a single standardized commercial laboratory to evaluate the HbA1c levels.

The CBCT device used was the PlanmecaPromax 3D Mid (Planmeca OY, Helsinki, Finland). The scans were carried out under the following exposure conditions: 90 kV, 12 mA, and exposure time of 18.3 seconds. Initial and final reconstructions were carried out by Romexis 2.3.1 software (Planmeca, Helsinki, Finland).

One previously calibrated oral radiologist with CBCT experience measured the distance from mandibular canal to alveolar ridge (bone height) and the distance from bucal to lingual cortical wall (bone width). Quantitative evaluations in each case were made using reconstructed sagital sections of CBCTs images for each potential implant site (fig. 1).

Also, it was assessed the bone quality of each region of interest, by measuring the bone mineral density, which was classified in to four groups: D1, D2, D3 and D4. Qualitative evaluations were made using panoramic reconstructions for each region of interest (ROI) (fig. 2, 3). The measurements were performed bilaterally in the
premolar and molar regions of the mandible.

The evaluation was repeated by the same examiner within an interval of 30 days to ascertain the reproducibility of the HU and the area measurements.

**Fig. 1.** Measurements of bone quantity (height and width) using sagital images

**Fig. 2.** A reconstructed panoramic CBCT image showing the ROI set in the trabecular bone of the posterior mandible for bone density measurement

**Fig. 3.** A reconstructed panoramic CBCT image showing the ROI set in the cortical bone of the posterior mandible for bone density measurement.

The data were analyzed with a statistical software package (*SPSS Version 10.0*; SPSS Inc., Chicago, IL). Mann Whitney U-test was used to measure the differences between bone quantity, quality and those of other parameters (gender, age and HbA1c levels) between diabetes and control groups. The correlation or regression analysis was used
where appropriate. The level of statistical significance was set at P, 0.05.

RESULTS
The patients were stratified on the basis of their HbA1c levels in patients without diabetes (HbA1c level of < 6.0 percent), with well-controlled diabetes mellitus (HbA1c level from 6.0-8.0 percent), with moderately controlled diabetes mellitus (HbA1c level from 8.1-10.0 percent) and with poorly controlled diabetes mellitus (HbA1c level of > 10.0 percent) (tab. I).

The study revealed the presence of significant correlations between bone quality and values of glycosylated hemoglobin (fig. 4).

TABLE I
The distribution of bone quality according to the glycosylated hemoglobin value.

<table>
<thead>
<tr>
<th>HbA1c (%)</th>
<th>Bone quality</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D1</td>
<td>D2</td>
</tr>
<tr>
<td>≤ 6%</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>25.93%</td>
<td>74.07%</td>
</tr>
<tr>
<td>6.1% - 8%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>8.1% - 10%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>&gt;10.1%</td>
<td>0</td>
<td>0</td>
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<td></td>
<td>0.00%</td>
<td>0.00%</td>
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</tbody>
</table>

Fig. 4. The mean value for HbA1c (%) levels according to the type of bone quality.
The evaluation of non-parametric correlation showed a significant association between patient gender and bone type. Thus, female patients held a large share of cases from D2 bone type and male patients are found in high numbers in D2 and D3 bone type.

The age showed significantly higher values in patients from D4 bone type compared with the age of patients from D1, D2 or D3 bone type (fig. 5).

There is a significant inverse correlation between the values of cortical and trabecular bone density in the posterior region of the mandible and HbA1c. This result demonstrates that for high levels of HbA1c are found low levels of bone density.

**DISCUSSION**

Because of the number of patients with diabetes mellitus, this condition cannot be neglected in the daily routine of dental clinics. The aim of the present study was to assess the mandibular bone quantity and quality in a diabetic patient population, because mandibular bone height, width and density gains special importance in some dental procedures such as osseointegrated implants and grafting.

Well known complications of diabetes mellitus include retinopathy, nephropathy, neuropathy, macrovascular diseases and altered wound healing. Currently it is thought that delayed healing and compromised neutrophil functions are associated with the periodontal diseases, periodontal abscess and implant failures (6, 7).

Mechanisms that might account for an association between diabetes mellitus and bone quantity and quality are not clear. In order to solve the mechanism, several studies have focused on sex hormones, hyperglycaemia, obesity and hyperinsulinaemia, but still the pathogenesis is a subject of
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controversy (8). There are few studies evaluating the relationship between diabetes mellitus and mandibular bone quantity and quality. Studies are mostly focused on bone implant problems in diabetic patients. In an experimental study, Nevins et al (9) observed that bone implant contact was significantly reduced for diabetic compared with control animals, but the quantity of bone formation was similar.

Olson et al (10) suggest that the duration of diabetes may be associated with implant failure and their study supports the concept of endosseous dental implant in the mandibular symphysis of type 2 diabetic patients as a predictable procedure.

Recently, the use of CBCT prior to dental implant therapy has contributed to an increasing attention on bone quantity and quality of the jaws.

CBCT has been used in dentistry since 1998 (11). The amount of radiation delivered by this technique is much lower than that used in CT (2 - 4), although the dose of radiation used is at least four times higher than the dose used during panoramic radiography.

Some studies have found that the variable quality of bone is more important to treatment outcome than the quantity of bone in the region of a dental implant. A corrected HU in CBCT data is useful for determining the bone density of ROI prior to implant placement, and this valuable information about bone quality enables better treatment planning by dental practitioners regarding implant positions.

This study clearly demonstrated that patients with diabetes who present poor metabolic control have a low bone density in the posterior region of the mandible.

Bone density of posterior region of the mandible is higher corresponding to premolars are, comparing to molars area. The knowledge of the bone density is very important, the positive outcome for osseointegration depending mainly on it. With this respect, conventional radiographs are not a useful tool.

The mandibular bone quantity and quality clearly reflects the physiological condition of the bone due to systemic diseases of bone degeneration, like diabetes mellitus.

CONCLUSIONS

In conclusion the use of CBCT in preoperative bone measurements will help provide the clinician with a prognostic indicator that not only provides valuable information about the quantity and quality of bone but helps to avoid placement of implants into the very poorest bone, where failure is more likely.

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REFERENCES


**ORAL HEALTH STATUS IN HAEMODIALYSIS PATIENTS**

A study realized by a group of Indian researchers aimed to assess the oral and dental manifestations in non-diabetic and diabetic uremic patients who were undergoing haemodialysis. The study also aimed to estimate and to compare the salivary pH in the two mentioned groups. Were included ninety seven uremic patients who were undergoing maintenance haemodialysis. Subjective and objective findings were evaluated and recorded. Unstimulated whole salivary pH was recorded by using pH-measuring strips. Dental health assessment consisted of DMFT and CPITN indices. A subjective oral manifestation of dysgeusia was found to be more significant in non-diabetic patients (p<0.008). Statistically, a high significance was observed with mucosal petechiae in 31.9% patients of diabetic group. The overall DMFT score was significantly higher in diabetic group. A moderate significance was found with a CPI score of 5 (p<0.015). The pH of saliva was significantly higher among diabetic patients. The conclusions of the study showed that the diabetic subjects who were on haemodialysis were at a high risk for developing periodontal disease and they exhibited a potential threat for dental decay and xerostomia. A lower salivary pH and a poor glycaemic control may affect their oral health. (Swapna LA, Reddy RS, Ramesh T, Reddy RL, Vijayalaxmi N, Karmakar P, Pradeep K. Oral health status in haemodialysis patients. *J Clin Diagn Res*. 2013; 7 (9): 2047-2050).

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