482

Can Cone Beam Computer Tomography predict the bone density expected at the implant surgical site? exploratory study

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Topic: Material research

Abstract

Background: High success rate of implant rehabilitation depends on different characteristics related either to the implants, to the surgical protocol as well as to the bone conditions. The type of bone should be considered for a correct rehabilitation planning. Development of new imagiologic exams brought more information about the bone volume and density.

Aim: To evaluate the Hounsfield Unit (HU) expected at implant site trough the readings of the dental scan, and to compare them with the operator clinical findings at the moment of surgery.

Material and methods: A comprehensive review of the literature was completed to define the actual bone classification and the impact of this information on the clinical outcomes in implant rehabilitations. The bone density placement site of 90 NobelSpeedyTM Groovy Implants (NobelBiocare AB, Gothemburg, Sweden) were evaluated, by the reading of the HU using the Cone Beam Computer Tomography dental scan (CBCT) (Kodak 9500, Carestream, Rochester, New York, U.S.A). The bone density values were then converted into a scale of "soft, medium, and dense", according to the numerical values found in the literature, and then compared with the clinician´s observation at the surgery moment during the insertion torque (clinical classification: CC).

Results: The correlations between CBCT and CC, axial implants and tilted implants and between residual bone and post-extraction were analyzed using the gamma test. The correlation coefficient between CBCT and CC was strong and statistically significant (R=0.570; p=0.000). Analyzing according to the axis of the implants, the correlation coefficient, for axial implants, was R=0.567 (p=0.000) and for tilted implants R=0.615 (p=0.049). When comparing the results according to post-extraction or residual bone implants, the correlation coefficient was R=0.401 (p=0.101) and R=0.653 (p=0.000) respectively.

Conclusions and clinical implications: Within the limits of this exploratory study, it is possible to predict the bone density, using the HU evaluation of CBCT. Highest correlations were found in implants placed in residual bone either for axial or tilted implant placement. Correlations between the expected values of bone density when placing post-extraction implants were found to be not significant. More studies are needed in this area of research, with higher samples and different operators, so that bone density may be predictable and therefore use as information when planning implant rehabilitations.

Background and Aim

The morphology, volume and quality of the bone are important factors determining the success of dental implant surgery (1-4). Most techniques previously proposed to determine bone density and quality are generally performed during or after surgery (1), providing reliable quantitative measure of bone density, but impractical for the implant surgeon (1, 5-7). Based on the Schwartz et al. concept, Norton and Gamble introduced a method for an objective quantitative classification of bone density that can be applied pre-operatively (7): images provide X-ray attenuation information for specific sized image pixels/voxels in terms of Hounsfield units (HU), which are related to the grayscale (1, 7, 8). The units are based on density values for air (-1000 HU) and pure water (0 HU), with cortical bone ranging from +1,000 to +1,600 HU values (1, 7, 8).

Presently, since Cone Beam Computer Tomography (CBCT) scan has been introduced at dental offices, with compact imaging equipment, and with the use of less radiation dosage and costs for patients (9). The possibility of predicting bone density using this radiologic exam as been object of several studies (9, 10, 11), with inconclusive results among the literature regarding the accuracy of the voxel values when compared with the HU using the traditional CT scan, but is nevertheless considered a procedure with promising outcomes (9, 12-14).

Methods and Materials

This exploratory study was performed at a private practice (MALO CLINIC Lisbon, Portugal) between April and July 2011. CBCT (Kodak 9500, Carestream, Rochester, New York, U.S.A) was used to assess the pre-operative density of the bone at each surgical site before the placing of the implants. An experienced radiologist registered the values of the HU of the bone 3 mm under the cortical bone and 3mm before the most apical location considered possible for the implant. In the case of the axial implant technique, one axial image was read, and in the tilted implants technique, three axial images were read also measuring the HU following the same pattern as to the straight implants. The average value for each implant site (two measurements in a straight implant and six in a tilted one) was then converted into a scale of soft, medium, and dense, according to the numerical values found in the literature (Figure 1 and Table 1). At the day of surgery, the clinicians opinion (CC) about the type of bone was also registered according to the predetermined scale (Table 1). The clinician was kept blind for the results of the CBCT evaluation. For this exploratory study, 90 NobelSpeedyTM Groovy Implants (NobelBiocare AB, Gothemburg, Sweden), 64 of witch were in post-extraction sockets and 26 in residual bone. 22 implants were inserted in a tilted position (distal to mesial) and 68 in an axial position. The correlation between CBCT and CC in axial and tilted implants on residual bone and post-extraction sites were analyzed using the Gamma test.

Houndsfield units	Bone
0-500	*Soft*
500-850	*Medium*
+850	*Dense*

Table 1 –Norton and Gamble (7)

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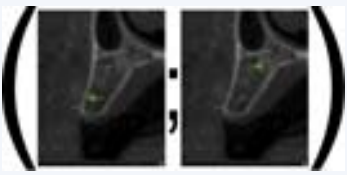

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Figure 1- (The study´s work flow) ; does the mean between the 2 CBCT measurements equals the surgeons evaluation?

Results

The correlation coefficient between CBCT and CC was strong and statistically significant (R=0.570; p=0.000). The correlation coefficient analysis according to the axis of the implants was R=0.567 (p=0.000) and R=0.615 (p=0.049) for axial and for tilted implants. When comparing the results according to post-extraction or residual bone implants, the correlation coefficient was R=0.401 (p=0.101, non significant) and R=0.653 (p=0.000) respectively (Figure 2).

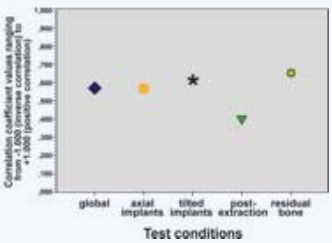

Figure 2- Graphic representing the correlation values between CBCT and CC in the global sample, for axial implants, for tilted implants, on post-extraction sockets and on residual bone.

Conclusions

Within the limits of this exploratory study, the authors conclude that predicting bone density using the HU evaluation of CBCT is possible. High correlations were found in implants placed in residual bone irrespective of the axis of implant (axial or tilted). Correlations between the expected values of bone density for implants placed in post-extraction sockets were not significant. More studies are needed in this area of research, with larger samples and different operators, so to increase the predictability of bone density and therefore provide valuable information when planning implant rehabilitations.

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