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Assessment of the increased calcification of the jaw bone with CT-Scan after dental implant placement

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ABSTRACT

Purpose : This study was performed to evaluate the changes of jaw bone density around the dental implant after placement using computed tomography scan (CT-Scan).

Materials and Methods : This retrospective study consisted of 30 patients who had lost 1 posterior tooth in maxilla or mandible and installed dental implant. The patients took CT-Scan before and after implant placement. Hounsfield Unit (HU) was measured around the implants and evaluated the difference of HU before and after implant installation.

Results : The mean HU of jaw bone was 542.436 HU and 764.9 HU before and after implant placement, respectively ($p < 0.05$). The means HUs for male were 632.3 HU and 932.2 HU and those for female 478.2 HU and 645.5 HU before and after implant placement, respectively ($p < 0.05$). Also, the jaw bone with lower density needed longer period for implant procedure and the increased change of HU of jaw bone was less in the cases which needed longer period for osseointegration.

Conclusion : CT-Scan could be used to assess the change of bone density around dental implants. Bone density around dental implant was increased after placement. The increased rate of bone density could be determined by the quality of jaw bone before implant placement. (***Imaging Sci Dent 2011; 41 : 59-62***)

KEY WORDS : Tomography, X-Ray Computed; Dental Implants; Bone Density

Introduction

It is important to evaluate the state of jaw bone in surgical procedures for implant placement. Many methods to measure the quantity and quality of bone was introduced for clinicians, however they would hardly reflect the exact bone situation at the planned implantation site for an individual patient. Determination of local bone mineral density (BMD) may offer a comprehensive description of the bone, therefore it would be a helpful information for surgeons. Quantitative computed tomography (Q-CT) (ie, quantitative interpretation of values derived from Hounsfield Unit (HU) with a suitable calibration procedure) is one of the choices to determine BMD.[1]

Quality and quantity of jaw bone are important factors for bony integration in the placement of dental implant. The evaluation of bone quality and quantity is complicated and important for accurate implant placement. Also, good bony quality will ensure the better stability in dental implant placement, therefore the knowledge of the quality and quantity of jaw bone is required for successful implantation. Therefore, computed tomography scanning (CT-Scan) was recommended for implant surgery because of its ability to reconstruct the three dimensional model of jaw bones and to make a treatment plan quickly using the most accurate information.[2-4] CT-Scan is considered as a modern device, with the combining concept of tomography with synthetic imaging. CT-Scan was successfully applied for the first time in dental implantology in 1980s. In CT-Scan, axial slice is obtained from pass through the jaw bone, then the data is converted by the special software for cross-sectional images.[5] This cross-sectional image is recommended for implant surgery because it provides more diagnostic information.[6]

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Since 1995 in Dentistry Faculty, King Saud University, a multidiscipline team of dental implant that consists of maxillofacial surgeon, periodontologist, and clinical radiography still use panoramic radiography to evaluate jaw bone in every case of dental implant.[3] The usage of modern radiographic devices has been very limited in Indonesia. Many implantologists also have only used panoramic radiography to evaluate jaw bone. From a survey in 18 implant practitioners in Jakarta, 44.44% used only periapical radiographs, 94.44% panoramic radiographs, and 38.89% periapical and panoramic radiography. From 109 cases of implant placements on that survey, there were 22 cases (22.18%) that had failed.[7] In Makassar, clinicians commonly use periapical and panoramic radiographs to examine the condition of jaw bone for implant surgery, and there was no report about the usage of high technology devices such as CT-Scan.

The jaw bone density can be assessed using HU value on the implant site on computer monitor. Even though the standard value of jaw bone density might vary for each individual, the density value is commonly over 250 HU on CT-Scan.[8] The interpretation of bone density assessment: D1 bone: $>$1,250 HU (very good density), D2 bone: 850-1,250 HU (good density), D3 bone: 350-850 HU (fair density), D4 bone: 150-350 HU (poor density), D5 bone: $<$150 HU (bad density).[9]

The purpose of this research is to evaluate the changes of jaw bone density around dental implants after placement using HU value on CT-Scan images.

Materials and Methods

This retrospective study was performed in Wahidin Sudirohusodo Hospital, Makassar, from June to December in 2009. Thirty patients who had installed implants and performed CT-Scan were selected. Before dental implant placement, clinical examination was undergone for the patients before anatomical impression was taken for upper and lower jaw. Then CT (HiSpeed Dual, GE Healthcare, Waukesha, WI, USA) examination was performed to assess the volume of the jaw bone; width (mesio-distal) was not less than 6 mm, bucco-lingual was not less than 6 mm, and height (apical-top) was not less than 10 mm. HU on the CT images were measured to assess the density of jaw bone before dental implant placement on the recipient site of implant, and the value of taken sample was HU$>$350. Then the sizes of dental implants were determined considering the state of the jaw bone. The sizes were as follows; 3.8 $\times$ 8-14 mm, 4.5 $\times$ 8-14 mm, 5.3 $\times$ 8-14 mm. The dental implants were installed in the jaw bone. Two months after dental implant placement, CT-Scan was performed and HU was measured again on the jaw bone around the dental implant as the indicator of osseointegration.

Results

Table 1 shows the mean HU of the bone around the implant before and after implant installation. The mean HU of jaw bone before implant placement was 590.7 HU, and increased to 1035.7 HU after dental implant placement, and they showed statistically significant difference ($p<0.05$).

Table 2 shows the mean of HU according to gender before and after implant installation. The mean HU of jaw bone before implant placement on male was 632.3 HU, and increased to 932.2 HU after dental implant placement, and there was statistically significant difference ($p<0.05$). On the other hand, that of the females before implant placement was 478.2 HU, and after implant placement, it increased to 645.5 HU. They also showed statistically significant difference ($p<0.05$). The mean HUs of the males before and after implant placement was higher than those of the females ($p<0.05$).

Table 3 shows the mean HU from the 30 patients. There

Table 1. The mean Hounsfield Unit on the area of implant placement before and after implant installation

	Mean $\pm$ SD
Before implant installation	590.7 $\pm$ 114.5
After implant installation	1035.7 $\pm$ 187.5*

*$p<0.05$ compared with before implant installation

Table 2. The mean Hounsfield Unit according to gender before and after dental implant placement

	Male	Female
Before implant placement	632.3 $\pm$ 96.5	478.2 $\pm$ 134.7 †
After implant placement	932.2 $\pm$ 281.2*	645.5 $\pm$ 296.9* †

*$p<0.05$ compared to before implant placement
† $p<0.05$ compared to male

Table 3. The mean Hounsfield Unit of the jaw bone according to the period between before and after dental implant placement

	Before	After
2 months (n=10)	673.8 $\pm$ 70.2	1218.2 $\pm$ 108.9
3 months (n=16)	577.2 $\pm$ 101.2	986.7 $\pm$ 124.9
4 months (n=4)	436.6 $\pm$ 71.1	775.3 $\pm$ 109.3

were 10 samples that had osseointegration period of two months. The mean HU of the jaw bone before implant placement was 673.8, and after implant placement it increased to 1218.2. In the 16 samples that had osseointegration period of three months, the mean HU was 577.2 and, it increased to 986.7 after implant placement. Only four samples had osseointegration period of four months. The mean HU before implant placement was 436.6, and after dental implant placement, it increased to 775.3. The regression-test statistic showed that there was a significant difference in the differences of HU before and after dental implant placement according to the period for implant placement.

Discussion

This study revealed that the density of the jaw bone around dental implant was increased after implant installation. The density of the jaw bone was increased more in men than in women. Also the increase of the jaw bone density was less in the cases which needed longer period for osseointegration.

Common Q-CT procedure was developed for the measurement of bone mineral density using HU, which could be used for the assessment of osteoporosis, and was applied to lumbar vertebrae. However, Q-CT could not be applied to dental implantology because the region of interest (ROI) for implant installation was too small for the procedure. Therefore, this study tried to assess the jaw bone density using HU measurement on the region of implant installation.

Table 1 shows the difference of bone density around the installed implant before and after the surgery. Mean HU value was increased significantly after implant placement. This result reveals that the density of the jaw bone around the dental implant increased. This is in line with Han and Park that there was calcification tissue around implant surface after implant installation.[10]

The concept of osseointegration was first introduced by Branemark and it was defined as functional ankylosis. Schroeder stated there was no fibrous tissue or non-bone tissue on the interface between implant and bone. The more accurate term is microinterblock, used in orthopedic implantology, where the tissue and implant are close to each other, and cause bioinert fixation with implant porosity, groove on the surface. Another definition of osseointegration is direct contact between bone and implant that could be found with light microscope.[10]

This study was also in line with Turkylmes and McGumphy[9] in 2008. In their study, out of 300 implants placed, 20 implants were lost, meaning a survival rate of 93.3% after three years (average 3.7+/−0.7 years). The mean bone density, insertion torque and RFA recordings of all 300 implants were 620+/−251 HU, 36.1+/−8 Ncm, and 65.7+/−9 ISQ at implant placement respectively; which indicated statistically significant correlations between bone density and insertion torque values ($p < 0.001$), bone density and ISQ values ($p < 0.001$), and insertion torque and ISQ values ($p < 0.001$). The mean bone density, insertion torque and RFA values were 645+/−240 HU, 37.2+/−7 Ncm, and 67.1+/−7 ISQ for 280 successful implants at implant placement, while corresponding values were 267+/−47 HU, 21.8+/−4 Ncm, and 46.5+/−4 ISQ for 20 failed implants; which indicated statistically significant differences for each parameter ($p < 0.001$).[9]

The density of bone is commonly higher in males than in females. There were studies on the clinical evaluation of bone density including using intraoral digital radiography.[11] However, the HU obtained from CT images could be a better tool for assessment of jaw bone density, therefore this study was performed to compare the HU according to the gender. Table 2 indicates that there were significant differences in the changes of jaw bone density between males and females. The amount of the increased density was larger in males than in females.

Table 3 indicates that there was a significant relationship between the density of jaw bone before dental implant placement and the osseointegration period. The jaw bone with lower density needed a longer period for implant procedure and the increased amount of HU of jaw bone was smaller in the cases which needed longer period for osseointegration. This result was in line with Han and Park that “in the two-stage implant system, the surgery ends by suturing the soft tissue over the implant so that it remains excluded from the oral cavity. In the mandible, the implants are left undisturbed for 2 to 3 months, whereas in the maxilla, they remain covered for approximately 4 to 6 months because of the slower healing prcoess due to less dense bone. During this period, the healing bone makes direct contact with the implant surface (osseointegration) and sometimes grows to its occlusal surface, even covering it.”.[10]

In conclusion, CT-Scan could be used to assess the change of bone density around dental implants. Bone density around dental implant was increased after implant placement. The increasing rate of bone density could be determined by the quality of jaw bone before implant placement.

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