Research Article

Evaluating Change in Radiographic Bone Density via Cone-Beam Computed Tomography before and after Surgery to Patients with Chronic Periodontitis

Alshaer.S., ALhaffar.I, KHattab.R.
Faculty of Dentistry, Damascus University, Syria.
*Corresponding author's E-mail: dr.samiaalshaer@gmail.com

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ABSTRACT

This research aims at identifying changes in the minute internal structure of the mandibular bone that result from periodontitis. It is to investigate clinical attachment loss and recession in the radiographic bone density. The clinical study leads to establish a nexus between the quality of bone in frontal mandible of patients who suffer periodontitis and the clinical indices before surgical treatment and after it in six months. The quality of bone is imaged using the recent modality in radiology, which is known as cone-beam computed tomography (CBCT). The sample consists of nineteen patients who are infected with chronic periodontitis of two hit stages, intermediate level and later developed levels. The mean of participants' ages is 43.53 ± 7.52 years. Each subject has admitted cone-beam computed tomography before treatment that implemented unified full thickness flaps. Six months later, the clinical indices have been recorded: plaque, probing depth, and clinical attachment loss. As for the statistical part, Pearson Correlation Coefficient and *t*-Test of paired two samples have been utilized at the value of $p<0.05$. All clinical indices of the periodontitis-infected group of patients have decreased equating the statistical value of $p<0.05$ after administering therapy in six months. Further, the radiographic bone density has increased after observation to reach the significant value of $p<0.05$. Correlation between radiographic bone density increases with the improvement of clinical indices after surgical interference reflects improvement in the quality of bone that reflects levels of mechanical bone support.

Keywords: Radiographic Bone Density, CBCT, Periodontitis.

INTRODUCTION

Chronic Periodontitis is a septic disease associated with plaque and characterized by inflammation of the adjacent gingiva; this inflammation extends to the deep supporting tissues resulting in a loss of periodontal ligament and alveolar bone. Prognosis of the infected tooth with such disease is subjacent to the periodontal osseous defects that recount their degree, spread, and site[1]. Along the disease course, the alveolar bone is featured by osseous recession; morphological alterations; miniscule internal structure deforms in metallic osseous density, radiographic osseous density, and bone thickness and architecture. These manifestations are reflected clinically on teeth, specifically in rapid surface bone loss of the lower incisors that leads to gomphiasis and extraction[2,3].

Trabecular bone is affected to a large extent with metabolism and inflammation factors which are reflected on bone density. This introduces TB as a vital locus for investigating early osseous loss and examining responses to medical interaction[4].

Radiographic bone density is dependent on the principle of connecting increased density in a radiograph to actual increase in density to an imaged region; it reflects the density of the radiographed tissues, and it is one of the most important factors delineating bone quality; according to previous study[5], good bone density entails good quality. It is an excellent pointer to mechanical properties of bone: strength, toughness and resistance. More with the development of digital techniques, representing this density in numbers derived from Hounsfield Units has become available via implementing specific software. So has become evaluating bone quality digitally[6 7]. Hounsfield Units values range between (-1000 for air to +1000 for enamel/dentin); this scale has been devised after denoting Hounsfield Units for water as equating zero, so the value of 339.5 HU connotes an "outstanding" bone density[8].

Panoramic radiography is considered one of the 2-D imaging modalities in radiological diagnosis of bone levels where the type of bone resorption is revealed, yet its capability to analyze trabeculae and osseous nets has proven inadequate. For example, the panoramic image has its multifaceted limitations such as misrepresentation of the actual size, distortion, and superimposition of imaged structures. The thing that renders it less accurate in identifying osteology than 3-D imaging, specifically in frontal maxilla and mandible[9].

Computed tomography has heralded a paradigm shift in studying alveolar bone through 3-D imaging using computing software with multi reconstruction planar, screening dimensions radiographically to any site overcoming the disadvantage of superimposition, and distinguishing tissues of multi density with 1% rate. However, of most spotted disadvantages of computed tomography are the high radio-active dosage, the much higher cost of equipment, and the distortions resultant from metallic usage of restorations and implants and from patient ongoing motion while radiographing[10 11].

Recently, Cone-Beam Computed Tomography (CBCT) has been introduced to clinical dentistry since 2000 to expand the role of imaging from diagnosing alveolar bone to guidance of operative and surgical procedures[11]. In addition, the new generation of CBCT equipment has commenced high accuracy in graphs, with dimensional frames of less than 100 cubic microns, aided by logarithmic slices reconstruction software to magnify the jaws region clearly. This new generation has the capability of offering detailed knowledge of osseous structures taking into consideration the limitation of such method: detector-based rays scatter, artifacts resultant from metallic restoration, for instance, and recorded pixels of a large portion of photons engaged in interactions with dense objects that leads to attenuation. Then, the three orthogonal planes (pyramidal, sagittal, coronal) are of paramount significance in the transition of planed voxels[12 13].

Aim of the study

This study aims at utilizing CBCT to evaluate the change in bone density in the frontal mandible site of patients infected with periodontitis; thus, result comparison is implemented as to detect potential variations in pre- and post-surgery stages. This is annexed to clinic-based data to determine suitable diagnosis and treatment of cases where evaluating the alveolar bone quality is essential to efficacious therapy. Examples are bound in plans for dental implants, regenerative periodontal therapy; these, it is assumed, suffice for positive effects on three levels of patient's life: psychological, social, and economical. Henceforward, benefits are extended to include society as a whole.

MATERIALS AND METHODS

Sample

114 frontal mandible teeth of 19 participants whose mean of ages is 43.53 years with standard deviation of ± 7.52. Subjects are 11 males and 8 females with the percentage of 57.89% and 42.11% respectively; they are recurrent patients to the Faculty of Dentistry, Damascus University, in the period of 2012 - 2013. All are infected with chronic periodontitis of the degree intermediate to advance hit; this hit infection is scaled according to the American Academy of Periodontology with the existence of 4 teeth or more each of which containing one periodontal site or more with probing depth ≥ 4mm and/or lost ligament ≥ 3mm[14]. A written consent and agreement of the scientific committee at Damascus University have been obtained on 2012/2/27 issue-numbered (1448) to conduct the research which has been carried out in the oral and periodontal sections of the Faculty.

Periodontal Clinical Diagnosis

Clinical indices to patients have been recorded: plaque index (PI) [15], clinical attachment loss (CAL), and pocket probing depth[16] using UNC15-Medsey by measuring the distance from the free gingival edge to the deepest probe-reached point in the gingival sulcus for four sites to each tooth: vestibular, medial-vestibular, lateral-vestibular, and lingual. The researcher has repeatedly taken the sample measures to achieve authenticity.

Cone-Beam Computed Tomography

38 CBCT images have been taken to the whole set of regional periodontitis. 19 have been obtained in the pre-surgical phase whilst the remaining have been reserved to the post-surgery stage after 6 months of surgical periodontal therapy via Witefox CBCT (va Italia deGotzen®s.r.lViaRoma, 4521057 OlgiateOloma). The radiography locale has been in Al-Abasyyeen Hospital, Secured Radiography Department, in Damascus.

Periodontal Treatment

Periodontal treatment has been administered to patients to establish oral hygiene, scaling and cleaning formed plaque, and delivering orthodontic treatment of the roots using manual tools. After 7 - 10 days, full thickness mucoperiosteal flaps have been exposed, defects have been debrided of granulomatous tissues in the trabeculae, and roots have been scaled and polished. Consequent to these procedures, the region has been cleaned by the physiologic serum, and surgical suture using non-absorbable silk threads of the size (0-3); stitches have been removed after one week. The recommendations, then, have been directed to patients specifically rinsing with chlorhexidine 0.12% twice a day for one week. No antibiotics or non-steroid anti-inflammatory drugs have been subscribed.

Follow-Up

Three months later, Follow-up surgical procedures have been administered to participants. These are to emphasize how essential oral hygiene is by raising the patients' awareness towards this measure.

Radiological Study to CBCT Images

114 radiographs have been examined. These planes form the 38 CBCT images taken to the frontal mandible. Regions are specified according to orthogonal Axial horizontal section; axes are moved accordingly to inter-cross a certain tooth. Unlike transposition, measurement has been altered on sagittal focus which has been unified to achieve fixed thickness all over the study; sagittal reconstruction has been 1.5 mm. Sagittal screened window, the base of measures, has been enlarged to a rectangle sized 1 x 2 mm. This rectangular selection has been in the third apex medial-rooted region starting from vertex in cervix direction of each tooth of the sample; associated measures have been distributed in apt tables.

Adobe Photoshop Creative Suite 4, CBCT-optimal image processing software, is used. It allows pixel-based modifications of radiographs using filters to improve the image and to offer values of the required dimensions.

Statistical Study

Means and standard deviations to the variables have been obtained by using two-sample paired t-test. This is to compare differences between the values of measuring bony density pre- and post-surgery. Moreover, Pearson Correlation Coefficient is used to measure the co-relation amongst the investigated variables. The accuracy of the tests are equalized to the p-value of 0.05. Statistics have been calculated automatically via SPSS v.18.

RESULTS

Clinical Study Results

The following clinical indices have been studied: probing depth, attachment loss, and plaque before and after the surgical treatment. Throughout the previous table 1 there is evident decrease in the probing depth mean. It is also observable in the plaque index. Further, a clear improvement in attachment loss is conceivable after treatment.

Table 1: Means of Probing Depth, CAL, and Plaque before and after Treatment

	Probing Depth Index		Plaque Index		CAL Index	
	Before Rx	After Rx	Before Rx	After Rx	Before Rx	After Rx*
Mean	4.58	2.96	0.67	0.65	11.19	9.65
Std Deviation	0.59	0.26	0.45	0.91	1.77	1.36
***p*-Value**	0.00		0.00		0.00	

*Rx = Treatment

Radiological Study Results

It is observed that bone density mean in the experimental group exceeds that before treatment. This is empowered statistically by the group numbers before and after treatment with the p-value of 0.01.

Table 2: Bone Density Mean before and after Treatment with Significance

Bone Density	N	Mean	Std Deviation	*p*-Value
before Rx	19	43.46	1.3	0.01
after Rx	19	44.88	1.4	

This attachment relation of bone density before and after radiological treatment can be measured using Pearson Correlation Coefficient. As can be seen, table 3 displays Pearson Correlation Coefficient in bone density before and after radiological therapy. Where the value has been 82% in 33rd tooth, it taps the borders of 95% in the 41st one. This, exigently, is significant as evidence piles direct proportional positive nexus.

Table 3: Pearson Coefficient of Radiographic Bone Density before and after Rx

N	Pearson's Correlation	*p*-Value	ROI*
19	0.90	0.00	ROI^{43}
19	0.91	0.00	ROI^{42}
19	0.95	0.00	ROI^{41}
19	0.86	0.00	ROI^{31}
19	0.82	0.00	ROI^{32}
19	0.82	0.00	ROI^{33}

*ROI = Region of Interest

Clinical Indices Results

AS can be seen, table 4 clarifies the importance of coefficiency between periodontal indices and bone density across the subjects of the sample. This is significant at p= 0.05.

Table 4: Pearson Correlation Coefficient of Clinical Improvement

Bone Density	Level of Significance	Periodontal Index
0.62	Pearson Correlation	Plaque Index
0.01	*p*-Value	
0.48	Pearson Correlation	Probing Depth Index
0.02	*p*-Value	
0.46	Pearson Correlation	CAL Index
0.03	*p*-Value	

Plaque index: there is strong correlation between the improvement of clinical index and bone density of statistical value where the coefficient r equalizing 62% and a p-value of 0.01. ***Probing depth index:*** there is a moderate correlation between the improvement of clinical index and bone density where the coefficient r equalizing 48% and a p-value of 0.02.

CAL index: there is a moderate correlation between the improvement of clinical index and bone density of statistical value where the coefficient r equalizing 46% and a p-value of 0.03.

DISCUSSION

Discussing the results of the clinical study before and after treatment

All examined periodontal clinical indices have decreased in the number of p=0.00 where the significance level is less than the statistical one; sig. level matching 0.05. Hence, the mean of probing depth has declined after surgery interference at the value of (2.96 to reach 4.58) as compared to that in the pre-therapy phase. It might refer to supposed improvement in the health of periodontal tissues. Adding, attachment loss mean has decreased after surgery represented by a value of 9.65 accumulating the limits of 11.19 as, also, compared to numbers abiding the pre-treatment stage. This gaining in

higher indexed values of attachment is evident to recession od diseased periodontal tissues. The finding, per se, comes in accordance with what has been reviewed in the literature. 589 scientific articles postulate that after surgical or scaling interference, there is an acclaimed probability of improvement in the periodontal ligaments and recession in the probing depth (see for example[17].

Discussing the results of the radiological study of bone density before and after Rx

An increase in the mean of radiographic bone density has been observed. This is extended to cover all of the 114 examined teeth at the value of $p<0.05$ after surgery in six months with the significance level of p-value equaling 0.00.

When measuring the correlation between radiographic bone density before and after treatment, via calculating Pearson Correlation Coefficient of the relation amongst variables, it has been noted that PCC ranges between 82% for 32nd teeth whilst it taps 95% in 41st. This is significant as a direct proportional positive link. Simply put, the principle governing this correlation is the increase of radiographic bone density before treatment leads to an increase in density after this interference.

Brägger et al., evaluate the digital radiographs of the changes of alveolar bone density at the interdental alveoli apex after the surgical interference on the periodontal region. Their results maintain a loss of density after 4 - 6 weeks from performing the surgery to the sites, which have admitted periodontal operation as compared to the status quo. This negates the findings of this study. The reason behind such a fact might be ascribed to the locus of surgery: studying changes in alveolar bone density in Brägger et al's research has been conducted at the vertex of alveoli; it is a sound fact that this region is vulnerable to destruction and resorption when undergoes any surgical interference, henceforth, osteo-loss becomes abundant. This, in turn, leads to reduction on osseous density[18]. As for my study, density changes have been measure at the third apex of the examined teeth distant from the surgery locus.

The same results are found in Fourmousis et al., where they have evaluated changes in bone density via studying the digital radiographs before and after gingival treatment in three months. Findings second these of the afore-mentioned study where loss in alveolar bone density appears at the alveoli apex that is exposed to curettage and resorption in the post-treatment phase[19].

Finally, Morea et al., aim at evaluating the quantitative change of bone density in laboratory[20]. This is accomplished by analyzing the digital radiographs directly after imaging. Their findings unfold increase in density along with the bone mass increase.

Discussing the correlation between the periodontal indices and the radiographic density

Throughout the course of studying Pearson Correlation Coefficient amongst the studied periodontal indices and the radiographic bone density, all disease periodontal indices have decreased after surgical interference in a period of 6 months. It has, moreover, been noted that whenever an improvement appears in the probing depth, attachment loss, and plaque (this necessarily conveys low rates), bone density records refer to high rates. As a result, there is established correlation between the clinical improvement in the examined periodontal indices and increase in radiographic bone density at the statistical value of $p<0.05$ with a strong remarkable correlation. This illustrates the improvement of plaque index and that of radiographic bone density where the correlation coefficient r=62% at a significant level of p-value matching 0.01. The thing that comes in accordance to the principle that the improvement of clinical indices is reflected positively on bone restoration after treatment and on the radiological evaluation[21].Findings, also, amount for the increase in inflammatory effects that hinder the bone response to mechanical stimulation; with the existence of untreated periodontal inflammation causes biological cell changes, which result in a delay in bone re-formulation. In addition, Misch (2005) pinpoints the direct linkage between bone density and toughness, and stresses the fact that the increase in bone density is a reliable referent to mechanical bone support and its satisfactory quality[5].

CONCLUSION

The increase in radiographic bone density after surgical treatment, in six months, to those who suffer periodontitis along with clinical improvement could reflect improvement of bone quality after treatment. Furthermore, CBCT might prove reliable in evaluating the minute bone structure and changes associate to it with patient exposition to minor amounts of rays.

Suggestion

It is recommended that the same study be re-conducted using other radiology-dependent variables such as the number of osseous nets and their distribution, and density of trabeculae. In addition, it is a prime suggestion to carry out a study of a long-termed observation to continue investigating the changes of bone structures on an extended period.

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