ORIGINAL RESEARCH

Evaluation of Pre- and Post-loading Peri-implant Crestal Bone Levels Using Cone-beam Computed Tomography: An *In Vivo* Study

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ABSTRACT

Aim: To evaluate the buccal, lingual, mesial, and distal crestal bone around implant using CBCT analysis having buccal crestal bone width of 1 mm after placement of implant and after 3 months of loading.

Materials and methods: Twenty-five patients between 18 and 60 years of age with adequate bone width and height were selected for this *in-vivo* study with single or multiple missing teeth. Surgical stent was fabricated for all of them by using self-cure acrylic resin for selection of implant according to the availability of bone, and gutta-percha was used as radio-opaque marker to locate the implant site. After proper analysis, in the first stage surgery, implants were placed. After 3 months to this, the second stage surgery was performed followed by elastomeric impression for porcelain fused to metal prosthesis fabrication. The buccal, lingual, mesial, and distal bone width and height were evaluated by using cone-beam computed tomography (CBCT). CBCT was standardized in terms of FOV (field of vision), slice thickness, and interval. After 3 months of loading, CBCT was taken to evaluate the alteration in the crestal bone around implants. Pre- and post-loading, crestal bone on four locations was measured by using CBCT software.

Results: There is significant bone loss at all the locations, buccal, lingual, mesial, and distal, at the time of placement and after 3 months of loading of implant ($p < 0.05$). The mean difference of 0.840, 0.933, 0.840, and 0.380 at buccal, lingual, mesial, and distal locations, respectively, shows statistically significant difference in pre- and post-values of mean bone loss at buccal, lingual, mesial, and distal positions. Pre-loading bone loss was maximum in the distal surface, while post-loading bone loss was maximum in the buccal surface.

Conclusion: From this study, it is concluded that although crestal bone loss was higher before implant placement, there was significant alteration in crestal bone even after loading of implant.

Clinical significance: It is widely accepted that the bone loss around the implant crest module is multidisciplinary in nature. Long-term preservation of the crestal bone is a paramount for successfully functioning of dental implants. Preserving crestal bone will help in dissipating the functional load. With proper treatment planning by the practitioner, this technical contribution to the crestal bone loss can be minimized and long-term survival of dental implants can be achieved.

Keywords: Cone-beam computed tomography, Crestal bone, Dental implant, Marginal bone loss.

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INTRODUCTION

Tooth loss is one of the most important reasons for psychological trauma. What makes dental implantology unique is its ability to overcome this psychological trauma regardless of injury or disease of the stomatognathic system. In the modern era of dentistry, dental implant-supported prostheses have become an accepted form of treatment for functional as well as esthetic point of view. For success of treatment, preservation of peri-implant marginal bone is one of the most important and sensitive criteria as quality and quantity of peri-implant bone play a major role in osseointegration and affect the shape/contour of soft tissue over it. Along with this, the position, size, and also the geometry of the selected implant platform also play a major role in success of dental implants; for example, subcrestal positioning of implant may be responsible for increased marginal bone loss.[1] Currently, one-piece implant (transmucosal component is present that penetrates oral mucous membrane) and two-piece implants (implant placed at bone level) are available. But two-piece implants offer several benefits as compared to one-piece implant, like esthetic enhancement and also less chances of exposure of transmucosal component following gingival recession. As teeth are encased in alveolar bone, dental implants are usually placed in this bone only. To meet the ideal goals of implantology, volume and

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quality of hard as well as soft tissue are necessary. Nowadays, nearly all the implants which are currently being used are of osseointegrated type, which was discovered in 1960; thus, the quantity and quality of peri-implant bone affect the implant osseointegration.[2] As the stability of bone is the key to success of implant, the critical part of determining the success of dental implants is the assessment of peri-implant marginal bone. The position of the implant platform also showed an impact as subcrestal positioning may determine increased marginal bone loss. Occlusal overload often resulted in marginal bone loss or de-osseointegration of successfully osseointegrated implants. The cortical bone is known to be least resistant to shear force, which is significantly increased by bending overload. Most of the time, preoperative planning for placement of dental implant is based on sufficient bone height availability, which cannot be verified because of transverse deficiencies. The main hindrance in determining the dimensions of alveolar bone before and after placement of implant is the routinely used traditional panoramic radiography as it is unable to generate cross-sectional images of the alveolar ridge. For assessment of peri-implant marginal bone, different techniques were discovered in the literature, among which the most widely used method is traditional panoramic radiography. Using panoramic radiography, alveolar bone height around the implant can be evaluated.[3] However, its major limitation is its inability to generate cross-sectional images of the alveolar ridge. The advent of cone-beam computed tomography (CBCT) offers 3D imaging, i.e., evaluation of the height, width, and angulation of the alveolar ridge as well as the distance between the alveolar crest and the mandibular canal, thus overcoming the limitations of panoramic radiography.[4] So, the aim of this study is to compare and analyze crestal bone level circumferentially at the time of placement of implant (Noris system) and changes in crestal bone level after 3 months of loading of implant, by using CBCT analysis.

MATERIALS AND METHODS

In this *in vivo* study, 25 dental patients were selected from the outpatient department of Modern Dental College and Research Centre, Indore, India, who were reported with chief complaint of missing teeth and wanted them to be replaced. The patients who were selected were between the age of 18 and 60 years with adequate bone height and bone width, having one or more missing teeth in mandibular arch only with sufficient amount of space available for implant placement. Patients with poor oral hygiene, psychological disorders, smokers, and diabetic patients were excluded from the study. One implant system (Noris) was selected for study. Commercially packaged two-piece implants and abutments were used. Before starting the study, ethical clearance was obtained from ethical committee. The patients were informed regarding the study, and written informed consent was obtained. Then, surgical stents were fabricated for all the patients by using self-cure acrylic resin after which they were sent for CBCT analysis along with stent for selection of implant according to bone availability. This CBCT measurement was considered as baseline record. Gutta-percha point was used as radio-opaque marker to locate the implant site. CBCT scans were obtained using Kodak care stream machine (CS9300 System) to evaluate adequate width and height for implant placement. Then, first-stage surgery was performed in which implants were placed according to the selected size in their respective sites using Noris surgical kit. After closing the surgical site, the follow-up instructions were given to the patient. After 24 hours, CBCT was again taken to evaluate the amount of crestal bone at buccal, lingual, mesial, and distal locations in the mandibular region. After 3 months of first-stage surgery, second-stage surgery was performed in which gingival former was placed for 1 week and after these elastomeric impressions were made with open-tray transfer. Then, the lab analog was attached and cast was poured. Then, abutments were selected according to the site, and porcelain fused to metal prosthesis was fabricated for patients and cemented over abutment by using glass ionomer cement. Implant protected occlusal scheme was given in these patients. After 3 months of loading, CBCT was taken to evaluate the alteration in the crestal bone around implants in all the aspects. Then, the values of bone loss both before the implant placement and 3 months after loading were recorded.

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Statistical Analysis

The recorded data were analyzed using paired *t*-test, which compares the bone loss at different aspects of bone, i.e., buccal, lingual, mesial, and distal locations before and after loading of implant. The *p*-value was taken significant when it was <0.05.

RESULTS AND OBSERVATION

Patients between the age of 18 and 60 years (without any gender difference) with adequate bone height and bone width in mandibular arch only were selected.

The mean bone loss at the time of placement of implant (pre) and after 3 months of loading (post) was compared at four different locations. In the buccal surface, the mean value of bone loss before placement of implant was 1.187, while after 3 months of implant placement it was 2.027. In the lingual surface bone, mean value of bone loss before treatment was 0.867, while after 3 months post-treatment, it was 1.800. Similarly, in mesial and distal surfaces, values of bone loss before treatment were 0.860 and 1.333, respectively, and after 3 months of implant placement, mean values were 1.140 and 1.713, respectively (Table 1 and Fig. 1). This shows that the post-mean value increases significantly from the pre-mean value in all the four locations. The mean difference of 0.840, 0.933, 0.840, and 0.380 at buccal, lingual, mesial, and distal locations, respectively, shows statistically significant difference in pre- and post-values of mean bone loss at all the four locations ($p < 0.05$).

The obtained results showed that pre-loading bone loss was maximum in distal surface (i.e., 1.333) compared to others followed by buccal (1.187), lingual (0.867), and mesial (0.86). However, when post-loading bone loss values were compared, it was observed that maximum bone loss occurred at buccal surface (2.027), followed by lingual surface (1.8), distal surface (1.713), and mesial surface (1.14).

DISCUSSION

Complete or partial edentulousness, inadequately compensated by dentures or tooth-supported fixed prosthesis, may not only imply impaired oral function and loss of alveolar bone but is also often accompanied by reduced self-confidence. By placing implants with proper planning, a firm, intimate, and lasting connection can be created between the implant and the vital host bone, which remodels in accordance with the masticatory load applied.[3]

Table 1: Pre and post comparison of mean bone loss at different positions

Level	*Duration*	*Mean*	*Standard deviations*	*t-test*	*p value*
Buccal	Pre (placement)	1.187	0.393	8.41	0.000
	Post (after 3 months)	2.027	0.532		
	Difference	0.840	0.387		
Lingual	Pre (placement)	0.867	0.309	7.22	0.000
	Post (after 3 months)	1.800	0.404		
	Difference	0.933	0.501		
Mesial	Pre (placement)	0.860	0.168	3.02	0.009
	Post (after 3 months)	1.140	0.309		
	Difference	0.280	0.359		
Distal	Pre (placement)	1.333	0.255	3.69	0.002
	Post (after 3 months)	1.713	0.261		
	Difference	0.380	0.399		

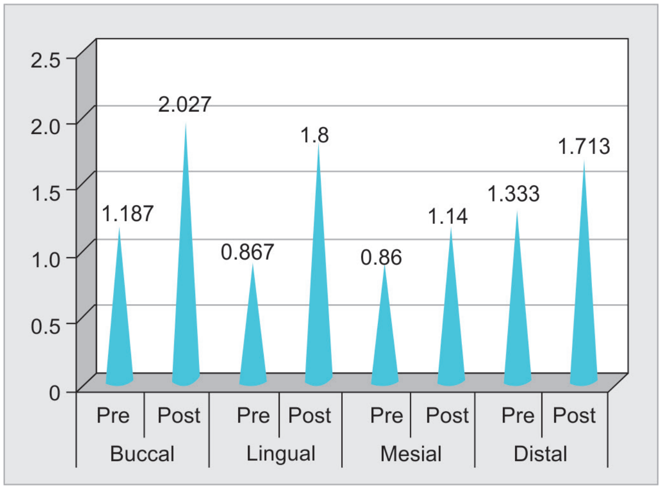

Fig. 1: Pre and post comparison of mean bone loss at different positions

One of the first objective attempts to assess osseointegrated dental implants came from the Swedish National Board of Health and Welfare in 1975. The first National Institutes of Health (NIH) consensus was held in 1978 to establish criteria for the success of implant therapy for all types of implant systems.[5]

The anchorage function depends on both persisting osseointegration and maintaining marginal bone height. Bone loss occurred predominantly during the healing and remodeling periods, i.e., from fixture installation to the end of the first year after loading of implant and amounted to a mean of 1.2 mm.[1] According to Alberktsson et al., a maximum bone loss of 0.2 mm/year including the first year was allowed, so in this present study also, this was considered as criteria for success.[6] In a great number of cases, the residual alveolar crest was extremely thin in the buccolingual direction, a condition that had no apparent relation to the clinical width or height of the gingival crest and that was not always fully revealed by the roentgenographic examination.[7] Diagnostic imaging can play an important role in evaluation of implant site planning.[7] An important aspect of radiologic evaluation of potential implant sites is determining the dimensions of the site on reformatted panoramic and cross-sectional images, the angulation of the alveolar ridge on cross-sectional images, and the quality of the bone present at the site. Successful implant placement and osseointegration normally require 1–1.5 mm of bone on either side of the fixture and 1–2 mm of bone between the base of the fixture and adjacent structures.[6]

Smith et al. suggested that one of the criteria for implant success was that less than 0.2 mm of alveolar bone loss occurred per year after the first year.[8] Adell et al. indicated that alveolar bone loss during the first year after abutment connection averaged 1.2 mm, and annual bone loss thereafter remained at approx. 0.1 mm for both the maxilla and the mandible.[1] According to Bryant et al., peri-implant bone loss is similar in elderly individuals and young adults. This shows that most authors agreed that patient age does not seem to be an important factor in peri-implant bone loss.[9]

Occlusal load applied through the implant prosthesis and components can transmit stress to the bone–implant interface. The amount of bone strain at the bone–implant interface is directly related to the amount of stress applied through the implant prosthesis. Occlusal stresses beyond the physiologic limits of bone may result in strain in the bone significant enough to cause bone resorption. The association between occlusal trauma and bone loss around natural teeth has been debated since Karolyi claimed a relationship in 1901. The bone is less dense and weaker at stage 2 implant surgery than it is 1 year later after prosthetic loading. Bone is 60% mineralized at 4 months and takes 52 weeks to complete its mineralization.[10,11]

In the present study, crestal bone loss was higher before loading of implant as compared to post-loading. Similar results were shown by Albertktsson in 1986 and Chochran et al. in 2009.[6] This may be due to the fact that as the functional forces are placed on an implant, the surrounding bone can adapt to the stress and increase its density, especially in the crestal half of the implant body during the first 6 months to 1 year of loading. As a result, the occlusal load that causes bone loss initially (overload) is not great enough to cause continued bone loss once the bone matures and becomes denser.[13]

Hanggi et al. showed that crestal bone level remodeled down up to the junction of smooth and rough portion of implant.

Hermann et al. reported in their study that peri-implant crestal bone relation is dependent on rough–smooth implant border.[12] On average, the crestal bone loss of 0.6 mm on mesial side and 0.9 mm on distal side of implant was observed. Several authors (Ferraudez et al.) recommended 3–6 months of healing period after implant placement for improved osseointegration of implant with bone; otherwise, implant failure will occur.[15] According to Atwood, there are four main factors that are responsible for bone loss, i.e., (a) anatomic factors, like well-formed ridges, resorb less as compared to narrow and thin ridges, (b) prosthetic factors, like unstable occlusion, patients wearing complete denture, (c) metabolic and systemic factors, like systemic illness like osteoporosis, vitamin D deficiency, (d) periodontal disease, and (e) post-menopausal women.[13] According to the results of the present study, bone height decreases after implant loading. Further researches are necessary for more appropriate findings and for the causes of bone loss.[14,15]

The limitation of this study includes the use of data of crestal bone loss around implants only after 3 months of loading. There was no long-term follow-up of the patients. No discussion on submerged and non-submerged implant, immediate loading, and one-piece implants is done.

CONCLUSION

In the present study, peri-implant crestal bone level changes were compared at the time of placement of implant and after loading of implant. The present study concluded that there was statistically significant difference in pre- and post-values of mean bone loss at buccal, lingual, mesial, and distal positions ($p < 0.05$). Significant loss in crestal bone level was appreciated on all the four locations around implant, at the time of pre- and post-loading of implant. This represents that crestal bone loss was higher before loading of implant as compared to post-loading.

REFERENCES

1. Adell R, Lekholm U, Rockler B, et al. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981;10(6):387–416. DOI: 10.1016/s0300-9785(81)80077-4.
2. Yi JM, Lee JK, Um HS, et al. Marginal bony changes in relation to different vertical positions of dental implants. J Periodontal Implant Sci 2010;40(5):244–248. DOI: 10.5051/jpis.2010.40.5.244.
3. Delbalso AM, Greiner FG, Licata M. Role of diagnostic imaging in evaluation of the dental implant patient. Radiographics 1994;14(4):699–719. DOI: 10.1148/radiographics.14.4.7938761.
4. Mayordomo BR, Martínez GR, Alfaro HF. Volumetric CBCT analysis of the palatine process of the anterior maxilla: a potential source for bone grafts. Int J Oral Maxillofac Surg 2013;42(3):406–410. DOI: 10.1016/j.ijom.2012.09.002.
5. Jung Y, Han C, Lee KW. A 1-year radiographic evaluation of marginal bone around dental implants. Int J Oral Maxillofac Implants 1996;11(6):811–818. PMID: 8990646.
6. Piao CM, Lee JE, Koak JY, et al. Marginal bone loss around three different implant systems: radiographic evaluation after 1 year. J Oral Rehabil 2009;36(10):748–754. DOI: 10.1111/j.1365-2842.2009.01988.x.
7. Annibali S, Bignozzi I, Cristalli MP, et al. Peri-implant marginal bone level: a systematic review and meta-analysis of studies comparing platform switching versus conventionally restored implants. J Clin Periodontal 2012;39(11):1097–1113. DOI: 10.1111/j.1600-051X.2012.01930.x.
8. Ma S, Smith AT, Thomson WM, et al. Marginal bone loss with mandibular two-implant overdentures using different loading protocols and attachment systems: 10-year outcomes. Int J Prosthodont 2010;23(4):321–332. PMID: 20617220.
9. Bryant SR, Zarb GA. Crestal bone loss proximal to oral implants in older and younger adults. J Prosthet Dent 2003;89(6):589–597. DOI: 10.1016/s0022-3913(03)00199-9.
10. Nitzan D, Mamlider A, Levin L, et al. Impact of smoking on marginal bone loss. Int J Oral Maxillofac Implants 2005;20(4):605–609. PMID: 16161745.
11. Misch CE, Suzuki JB, Misch-Dietsh FM, et al. A positive correlation between occlusal trauma and peri-implant bone loss: literature support. Implant dentistry 2005;14(2):108–116. DOI: 10.1097/01.id.0000165033.34294.db.
12. Hanggi MP, Hanggi DC, Schoolfield JD, et al. Crestal bone changes around titanium implants. Part I: A retrospective radiographic evaluation in humans comparing two non-submerged implant designs with different machined collar length. J Periodontol 2005;76(5):791–802. DOI: 10.1902/jop.2005.76.5.791.
13. Maroush MAE, Benhamida SA, Elgendy AA, et al. Residual ridge resorption, the effect on prosthodontics management of edentulous patient: an article review. International Journal of Science and Research Methodology 2019;7(9):260–267. DOI: 10.18535/ijsrm/v7i9.mp04.
14. Koller CD, Cenci TP, Boscato N. Parameters associated with marginal bone loss around implant after prosthetic loading. Braz Dent J 2016;27(3):292–297. DOI: 10.1590/0103-6440201600874.
15. Ahmed KM, Elfatah SA, Katamish MAE. Crestal bone loss of standard implant versus platform switch implant design using minimal invasive technique. Future Dent J 2016;2(2):74–79. DOI: 10.1016/j.fdj.2016.09.001.