Radiographic Evaluation of Crestal Bone Loss in Pre-loading and Post-loading States of Endosteal Implants in Maxilla and Mandible- A prospective study

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ABSTRACT

Background

Peri-implant tissue integrity depends upon healthy peri-implant mucosa and bone. The crestal bone is one of the governing factors for successful implant therapy both functionally and esthetically. There are limited radiographic studies in Nepalese population for determination of crestal bone loss around peri-implant area comparing the bone loss at pre- and post-loading state.

Objective

To evaluate the bone loss in mesial and distal, maxilla and mandible before and after the implant supported prosthesis delivery.

Method

A 6-months prospective study was planned and conducted in 26 endosteal implants (13 maxillary and 13 mandibular) which were placed in 20 patients fulfilling the inclusion criteria. The crestal bone loss was measured and compared using digital radiography images using the designated software. The differences among the crestal bone loss in mesial and distal, maxilla and mandible in pre- (3 months of implant placement) and post-loading states (3 months of prosthesis delivery) were evaluated using the appropriate statistical tests.

Result

The crestal bone loss was more pronounced in the pre-loading stage (1.12 mm) compared to post-loading (0.48 mm). Initially, the bone remodelling was higher in the distal aspect whereas there was no significant difference between mesial and distal aspect in post-loading phase. Comparing maxilla with mandible, there were no significant differences in bone loss in both phases.

Conclusion

Within the limitations of this study, the crestal bone loss was found upto the physiological limit of bone remodelling provided the implants placed in strict, aseptic condition with proper case selection and planning.

KEY WORDS

Crestal bone loss, Dental implants, Implant supported dental prosthesis, Osseointegration

INTRODUCTION

Tooth loss has become a prominent problem all where around the world. A closest simulation to lost natural tooth is dental implant which can provide function and esthetics at the same time. The success of implant therapy is dependent on the preservation of crestal bone level.[1] Albrektsson et al. in 1986 gave the criteria for success of implant therapy based on crestal bone level.[2] The crestal bone loss around implant in first year should not surpass 1.5 mm and less than 0.2 mm annually thereafter as per the guideline provided.[2]

The above-mentioned criteria for success were given according to traditional implant procedures. The current implantology trend however has changed a lot. There are different implant placement and loading protocols commonly followed in modern days implant practice.[3]

The crestal bone loss in both pre- and post-load stage around dental implants hasn't been performed in Nepalese population previously. Therefore, the study was conducted to evaluate the crestal bone level changes pre-loading (after 3 months of dental implant installation) and post-loading (after 3 months of implant supported prosthesis delivery). This study intends to facilitate clinicians to provide a baseline reference about the crestal bone remodelling in our population.

METHODS

An observational prospective radiographic study was planned in partially edentulous patients seeking for the dental implant therapy for replacement of missing teeth from October 2022 to March 2023. Patients were recruited in the study and followed up for six months' time from the day of implant placement. The study protocol was approved by institutional review committee of Kathmandu University School of Medical Sciences (164/22). All the two-dimensional intra-oral periapical radiographs were taken as per standard protocol:

- X-ray receptor- fCE 0297 size 2 PSP plate
- X-ray source- CS2100 (Carestream)
- Technique employed- Paralleling technique (XcpRinn Device)
- Digital analysis software- Vistasoft 2.0.1 image viewer software.

Inclusion criteria[4]

- Systemically healthy subjects of age 18-60 years with adequate bone height and width for implant placement.
- Partially edentulous with one or more teeth missing
- Edentulous area with sufficient crown height space > 7 mm.

Exclusion criteria[4]

- Poor oral hygiene
- Uncontrolled diabetes mellitus
- History of medications
- Smokers
- Psychological disorders

Root form endo-osseous implants (Dentium NR line series-Dentium Co., South Korea) were placed after proper clinical and radiographic evaluation in a completely aseptic, sterile surgical conditions. Sequential drilling protocol according to manufacturer instuctions were implied and overheating was prevented using implant physiodispensor with proper water coolant system.[5] The implants were left for healing till three months time period for osseointegration. Second stage surgery was carried out only in case of submerged implants. Implant supported metal-ceramic prosthesis were delivered to the patients and were recalled for assessment of bone loss post loading after three months (Fig. 1a-d). Two dimensional intra-oral periapical radiographs were taken whenever required during the surgical and prosthetic phase.

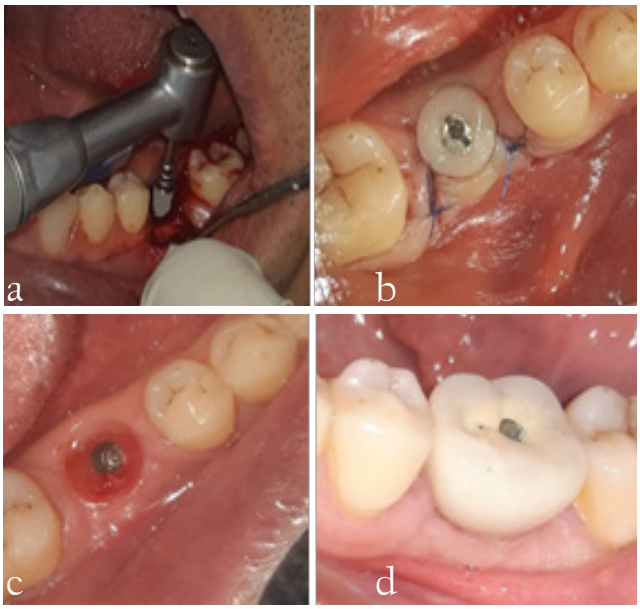

Figure 1 (a-b). Clinical pictures from implant placement till prosthesis delivery

The descriptive analysis was done for bone loss in mesial and distal aspects and in maxilla and mandible. Data were expressed as mean, standard deviation and range values. The statistical difference was set at p value < 0.05 and appropriate tests were applied after checking for the skewed or normal distribution values using IBM SPSS Statistics for Windows, version 22 (IBM Corp., USA).

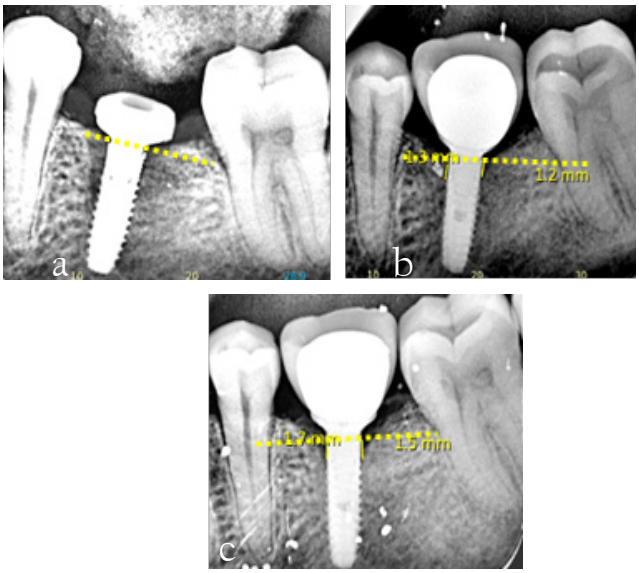

Figure 2 (a-c). Bone loss measurement using the digital Vistasoft 2.0.1 image viewer software at baseline (a), pre-load (b) and post-load (c).

RESULTS

A total of 26 endo-osseous implants were included in this study from 20 patients (13 male and 7 female). Thirteen implants each were placed in maxilla and mandible and were compared for the bone loss in mesial and distal aspect before and after the prosthetic loading.

All mesial and distal sites of 26 implants (n=26) were evaluated. The bone loss was more pronounced in distal aspect at pre-load and post-load state and was statistically significant. The bone loss during an early healing phase before prosthetic loading was higher in comparison to the bone loss occurred after the delivery of prosthesis but was not statistically significant (Table 1 and Fig. 3).

Table 1. Comparison among mesial side, distal side and overall, at pre-load and post-load states

	Descriptive statistics			Test statistics	
Parameters	Mean	Standard deviation	Range	Z-value	Asymptomatic Significance (2-tailed)
Preload Mesial	0.47	0.67	0.00-2.37	-0.98	0.33
Preload Distal	0.74	0.71	0.00-2.49		
Postload Mesial	0.27	0.52	-0.90-1.50	-2.62	0.009
Postload Distal	0.21	0.51	-0.80-1.4		
Preload total	1.12	1.22	0.00-4.00	-1.81	0.07
Postload total	0.47	0.81	-1.10-2.20		

*Asymptomatic sig. (2-tailed) <0.05= statistically significant
*n=26

The total bone loss in maxilla and mandible were also compared which were not statistically significant with a mean bone loss of around 1.47 mm in maxilla and 1.78 mm in mandible (Table 2).

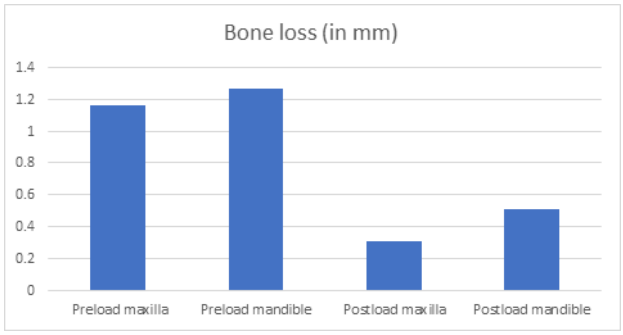

Figure 3. Bone loss in maxilla and mandible at pre- and post-loading states

Table 2. Comparison between total bone loss in maxilla and mandible

	Descriptive statistics			Test statistics	
Parameters	Mean	Standard deviation	Standard error of mean	Z-value	Asymptomatic Significance (2-tailed)
Maxilla	1.47	1.51	0.42	-0.57	0.57
Mandible	1.78	1.57	0.44		

*Asymptomatic sig. (2-tailed) <0.05= statistically significant
*n=13

DISCUSSION

There are different timings of implant placement and prosthetic loading from immediate to delayed. Immediate implant placement with immediate loading is commonly a first choice in current implantology trend for both patient and clinicians but major issue is the peri-implant soft tissue dehiscence which might require further interventions.[6] Early implant is usually done with soft tissue healing in 4-8 weeks from day of extraction of tooth or with partial bone healing in 12-16 weeks of tooth extraction. Early implant with soft tissue healing permits for resolution of the initial infection present at the potential site of implant placement and offers greater amount of keratinized tissue to minimize chances of recession as with immediate implant placement. On the other hand, early implant with partial bone healing it allows clinicians to place implant in a site where there was a huge peri-apical lesion around the tooth which would have hindered the chance of initial implant stability by apical engagement of bone necessary for immediate implant placement. Thus, clinicians prefer to early and delayed implants in many instances due to the more sustainable results.[7]

CBCT (cone beam computed tomography) is generally preferable over conventional radiography to study the available bone height, width and density without superimposition, minimal distortion, good resolution and low dosages of radiations.[8] The peri-implant bone loss is generally circumferential.[9] Also, the value of the interproximal attachment level has been highly emphasized for classifying the disease state as well as in

anticipation of successful periodontal therapy.[10,11] The cost factor for evaluating the bone loss with CBCT also has to be considered. Thus, evaluating the mesial and distal bone loss can provide valuable information regarding the amount of bone loss occurring around the dental implants.

In our current study, the average bone loss after function 0.47 mm in average in a three months' time frame can be judged as a part of normal bone remodeling. Few implants demonstrated positive bone gain after prosthetic loading which has been depicted by Puisys et al. from a famous Tomas Linkevicius zero bone loss concept group. They have also emphasized that "crestal bone loss appears can be remineralized apart from its actual prevention".[12]

Recently published World workshop classification of periodontal and peri-implant health and disease 2017 has also enlightened us about the clear protocol to claim whether the mere 1 or 2 mm of bone loss around implant should be considered as disease or health. Peri-implantitis for both clinical practice and epidemiological surveys is a condition when a distance from implant crest to bone contact is ≥ 3 mm.[13]

The results of our study showed the higher amount of bone loss distally in a pre-loading state which is similar to CBCT based study conducted by Trivedi et al.[1] The above-mentioned study evaluated all four surfaces of the implant i.e., buccal, lingual, mesial and distal. But within our limitation wherein we evaluated only mesial and distal surface, the distal surface bone loss in post-loading state similar to our study was reported.[1] The bone loss in the first six months using the equicrestal or sub-crestal implant were found to be contrasting where the reported bone loss was more in mesial compared to distal aspect.[14] Furthermore, the total crestal bone loss around implants in our study is 1.6 mm in average which is similar to the classical studies measuring the amount of crestal bone loss during the end of first year of implant therapy.[15]

This study in Nepalese population suggests that the implant therapy is a predictable alternative for replacement of missing teeth. The initial bone remodeling in inevitable and is greater at the early stages of healing but the bone remodeling appears to be at a declining phase thereafter. The meticulous pre-surgical planning, surgical and prosthetic execution only can ensure the successful results. In addition, hand driven implantology to technology assisted prosthetically driven implantology is a need of hour.

There are certain limitations in this study as we evaluated the bone level changes in a shorter time period. The various factor that could change the results like submerged or non-submerged implants, implants placed crestal or sub-crestal, different heights of prosthetic abutments, etc. were not a part of the current study. Thus, a large-scale study addressing the limitations are to be carried out in future.

CONCLUSION

The peri-implant hard and soft tissue integrity is a paramount for long term implant success. Implants with ISO (International organization for standardization) standards and FDA (Food and Drug Administration) approval behave similarly. Implant success are dependent upon surgical hands of an oral implantologists and oral hygiene maintenance by the patients. Within the limitations of this study, the crestal bone loss was found upto the physiological limit of bone remodelling provided the implants placed in strict, aseptic condition with proper case selection and planning.

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