# Comparative Evaluation of The Correlation Between Crown-Implant Ratios And Marginal Bone Resorption In Short Dental Implants- An In Vivo Study

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## ABSTRACT

A very common challenge encountered in the use of oral implants is the presence of reduced alveolar ridge height. Aggressive treatment options for reduced alveolar ridge height call for bone grafting the area followed by the placement of dental implants. An alternative approach in cases where a limited amount of bone height is available is to use short implants of less than 10 mm of length, instead of the standard range 10 to 16 mm. The purpose of the present study was to evaluate the correlation between crown implant ratios and marginal bone resorption in short implants. Ten implants with length 8 mm and 9.5 mm and diameter 4.5 mm were placed in the mandibular molar region. All the implants had been placed at the crestal level at the time of surgery. Radiographs with grid were obtained at 3, 6 and 12 months after loading and were evaluated by screen calliper software measuring the location of crestal bone level around short implants. The results showed a mean bone loss of 0.76 mm on mesial side and 0.72 on distal side after one year. The findings concluded that the success and survival rates for short implants are comparable to long implants and crown implant ratios are not associated with peri implant bone loss and short implants may extend the boundaries of current implant practice.

**Keywords**: Crown implant ratio, marginal bone loss, reduced bone height, Short implants.

## INTRODUCTION

Over the years, traditional methods of tooth placement are slowly and steadily being replaced by newer modalities. The basis of the increasing popularity of dental implants is the discovery by Per-Ingvar Branemark and his co-workers of the tenacious affinity between living bone and titanium oxides, termed "Osseointegration". An esthetic implant restoration depends on correct implant placement in all the three directions (i.e. in apicocoronally, mesiodistally and faciolingually) and well designed prosthesis that includes the teeth and surrounding matrix. Adjacent anatomical structures are key factors in the planning and placement of dental implants. Anatomical considerations for implant placement are bone height and bone width of residual alveolar ridge, presence of bony undercuts and proximity of proposed site to apices of adjacent roots[1].

A very common challenge encountered in the use of oral implants is the presence of reduced alveolar ridge height.[2] A radiographic study of 431 partially edentulous patients done by Oikarinen *et al*.[3], revealed that the existing posterior bone height was at least 6 mm in only 38% of maxillae and 50% of the mandibles examined. This is of particular concern when observed in the posterior areas of the mandible and the maxilla, where the mandibular nerve and the maxillary sinus, respectively, are to be avoided.[4]

Aggressive treatment options for reduced alveolar ridge height call for bone grafting the area followed by the placement of dental implants.[5,6] Griffin and Cheung[7] listed several surgical interventions often required to develop implant sites including guided bone regeneration with or without tenting screws, distraction osteogenesis, sinus augmentation, and nerve transposition. The authors conceded that while these methods have obtained a level of success, some patients reject multiple surgeries and are discouraged by additional treatment duration and financial burden. Also to date, the evidence relating to the predictability of surgically increasing vertical ridge height (other than sinus augmentation) is inadequate. At the same time, a prosthetic solution sometimes is not applicable because of inadequate interarch space.[7] An alternative approach in cases where a limited amount of bone height is available is to use short implants of less than 10 mm of length, instead of the standard range 10 to 16 mm.[8,9] This strategy avoids the need for bone augmentation procedures and simplifies treatment. Recent clinical studies have demonstrated that short implants may be a viable long term solution for sites with limited bone height.[10] Short implants simplify treatment in the posterior resorbed maxilla and mandible as compared to placement of longer implants[1]. The average crown-implant ratio of a single tooth implant-supported restoration exceeds that which is considered favourable for a natural tooth. The crown to root ratio guidelines used to establish prognosis for natural teeth should not be applied to a single tooth implant supported restoration.[11]

In the last two decades, it became clear that clinical implantology had advanced to the point that this treatment represented a predictable approach to the replacement of lost teeth. These conflicting results suggest the need for additional research efforts aimed at elucidating successful applications and recommendations for the use of short, wide-diameter implants.

In this study, we will evaluate the functionality of short dental implants and peri implant bone loss.

## MATERIALS AND METHODS

Patients were selected from the outpatient department irrespective of socio-economic status, religion, age and sex based on inclusion and exclusion criteria. Ten implants (DentsplyXive system), five each, of length 8 mm and 9.5 mm were placed in the patients.

Prior to the treatment, all the patients were explained about the procedure and an informed consent was obtained from all the patients.Patient with inappropriate bone height, proximity of proposed site to anatomical structures like maxillary sinus, nasal floor, inferior dental canal, proximity of proposed site to apices of adjacent roots, site where fixed prosthesis cannot give esthetic outcome due to bone defects, partially edentulous posterior mandibular arches, good overall health and oral hygiene, no signs of articular disorders. Exclusion criteria were: bruxism, smoker, localized radiation therapy of oral cavity, antitumor chemotherapy, liver, blood and kidney diseases, immunosuppressed patients, patients taking corticosteroids, pregnant woman, inflammatory and autoimmune diseases of the oral cavity and poor oral hygiene.The implant size was predetermined both in width and length and they were selected according to the bone mapping and with the help of radiographic evaluation after taking into account the magnification error with the help of radiographic template having a ball bearing embedded in it **(FIGURE 1)**.

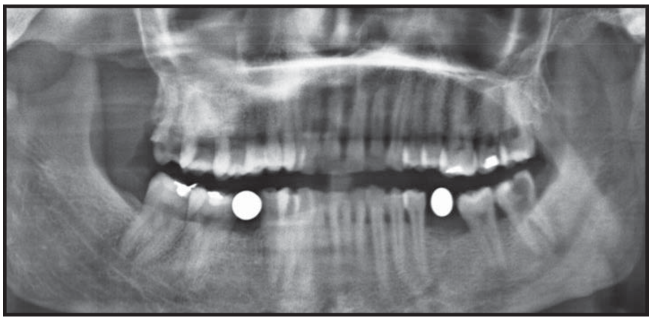


**Figure 1.** Preoperative orthopantomogram with metal ball bearing

The screw type implants (two piece implants) were used. In the present study, specifically mandibular molar sites were chosen and subsequently, the diagnostic wax up of the cast was completed and the surgical template was prepared to guide the implant location and angulation during placement. The second stage surgery was done after healing period of 3 months. The implant was exposed without damaging the surrounding bone and gingival healing cap was placed for 2 weeks. Indirect impression technique was used for making the impression.To evaluate the crestal bone loss the radiographic examination was conducted on a PlanmecaProstyle intraoral X-ray machine using a parallel cone technique with a Dentsply® film positioning device. A size 2 adult film Kodak® Ekta speed film was used, exposure parameters were kept standardized at 70 kVp, 10mA and 0.2 seconds. To allow for magnification and image distortion errors a lead grid with 1 sq mm grid pattern was affixed on to the film for the exposure. **(FIGURE 2)**

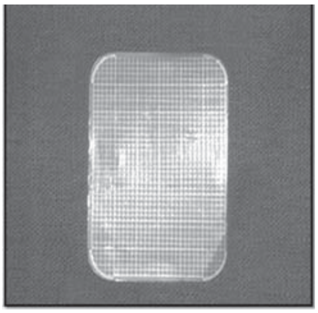


**Figure 2.** Grid used with iopa radiograph

The IOPA with grid were analyzed on the Adobe photoshop® Ver 8 software. Prior to the analysis the image characteristics were enhanced (contrast, density, brightness) to optimal levels by the software itself. Images were resized wherever magnification error was found. A filter tool was used to create an embossed effect on the image to highlight the bone details of the image and minimize errors. Metric analysis was performed on a micrometer scale using the measuring tool available in the Screen Caliper Software. Points were selected as follows:

**Mesial**: Distance from the first thread (coronal) on the implant fixture to the most coronal point on mesial alveolar bone crest.**(FIGURE 3)**

**Distal**: Distance from the first thread (coronal) on the implant fixture to the most coronal point on distal alveolar bone crest.**(FIGURE 3)**

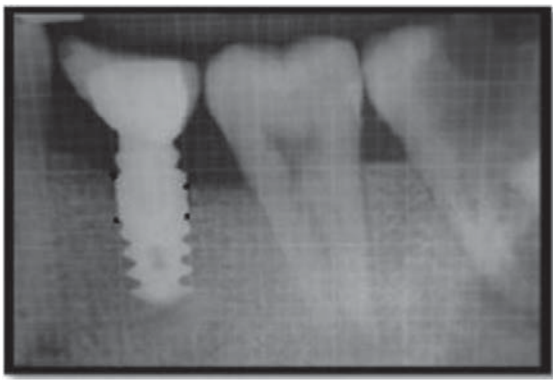


**Figure 3.** Points selected to measure bone loss

The determined values of each fixture was compared over the follow up period separately for the mesial and the distal aspects to arrive at the following results. The radiograhic findings were also co-related with the clinical findings. The criteria both subjective and objective was used to evaluate the success of the implant process.

The collected data was assessed at baseline, 3 months, 6 months and one year and analysed statistically. The values were represented in Number (n), Percentage (%), Mean (X) and Standard Deviation (σ).

## RESULT

### Bone loss

The results obtained from the above study (**Table 1)** shows the **marginal bone loss** that has taken place mesially and distally from baseline to 3rd month postoperatively was 0.46 mm mesially and 0.47mm distally, whereas the marginal bone loss that has occurred at mesial and distal sides from baseline to 6th month was 0.64 mm mesially and 0.58 mm distally, and the marginal bone loss that has occurred mesial and distal sides from baseline to 12th month was 0.76 mm mesially and 0.72 mm distally.

Therefore, table 1 shows significant increase in crestal bone loss in one year. GRAPH 1 & 2 shows average bone loss at distal and mesial side at different time intervals. Bone loss decreases from 3rd month to 6th month, and it further decreases from 6th month to 12th month.

Table 2 and 3 show comparisons of marginal bone loss that has occurred at mesial and distal sides at various intervals. The marginal bone loss that has occurred from baseline to 3rd month was 0.46 mm on the mesial side and 0.47 mm on the distal side hence the marginal bone loss occurred during this period was found to be statistically highly significant, the marginal bone loss that has occurred from 3rd month to 6th month was 0.175 mm on the mesial side and 0.11 mm on the distal side similarly the marginal bone loss that has occurred from 6th month to 12th month was 0.14 mm on the mesial side and 0.12 mm on the distal side here we found that the marginal bone loss occurred during this period decreases with time but still it is significant.

**Table 1.** Mean and S.D. of bone loss at different time points

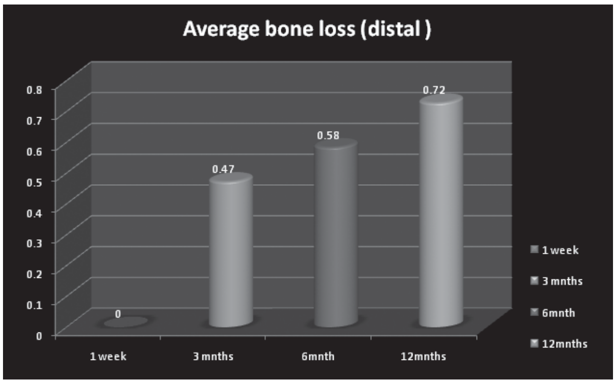
| S. No. | Dental parameters | | At one week | At 3 months | At 6 Months | At 12 months |
|---|---|---|---|---|---|---|
| 1 | Bone loss | Mesial | 0±0 | .465±.1292 | .64±.09667 | .76±.1265 |
| | | Distal | 0±0 | .472±.2108 | .5833±.1620 | .7278±.1481 |

**Table 2.** Comparison between successive time intervals (by paired "t" test), % improvement between time-points for bone loss (mesial side)

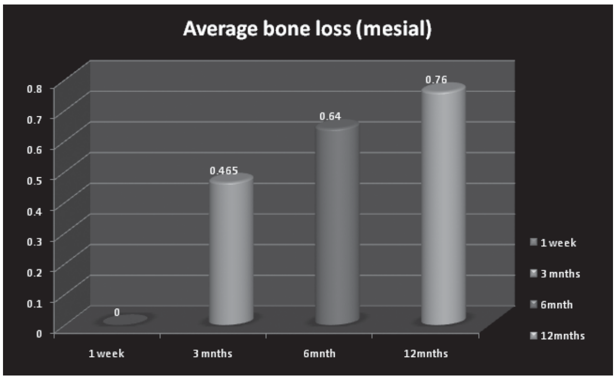
| S. No. | Difference between time Intervals | Mean±S.D. (Differences) | % Improvement between Time Points | Probability OF Paired "t" Test | P-Value / Significance |
|---|---|---|---|---|---|
| 1. | One Week-3 Months | **.465±.1292** | 46.5% | .0000 | P<.05 (SIG.) |
| 2. | 3 Months -6 Months | **.175±.1275** | 37.63% | .0018 | P<.05 (SIG.) |
| 3. | 6 Months- 12 Months | **.12±.0422** | 18.75% | .0000 | P<.05 (SIG.) |

***P<.05** shows a significant difference at **5%** level of significance.

**Graph 1.** Bar diagram of mean values of crestal bone loss (distal) at different time intervals

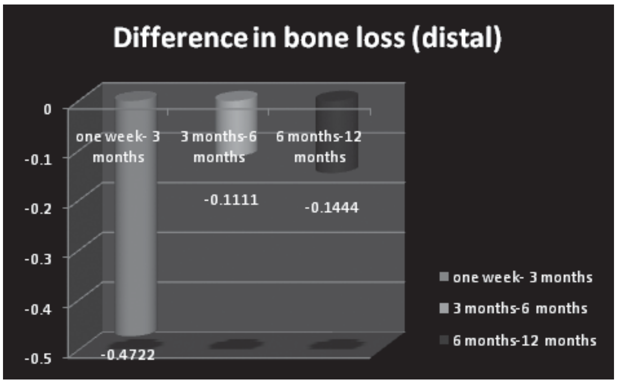



**Graph 2.** Bar diagram of mean values of crestal bone loss (mesial) at different time intervals

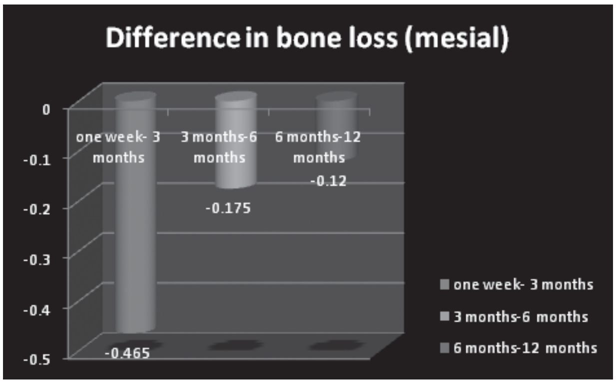



GRAPH 3 and 4 shows difference in bone loss on distal and mesial side at different time intervals.

**Graph 3.** Difference in crestal bone loss (distal) at different time intervals




**Graph 4.** Difference in Crestal Bone loss (Mesial) at different time intervals




## DISCUSSION

The null hypothesis for this study is ($H_0$)- no significant difference observed in bone loss and mobility among different time intervals. Alternative $H_1$- significant bone loss and mobility was present among different time intervals. In the present study, null hypothesis was examined by appropriate test statistics at 5% level of significance. In the study, ten dental implants were placed. DentsplyXive system was used as the test device. Implants used were of 8 mm and 9.5 mm in length and 4.5 mm in diameter. These implants were evaluated radiographically and clinically at time interval of 3, 6 and 12 months following prosthodontic rehabilitation. Periapical raiographs are particularly convenient; the screen caliper software was used to define the two reference points and measure bone loss automatically, thus increasing measurement accuracy. Radiographs were procured using a standardized 1-$mm^2$ grid. Radiographic grids are helpful in the accurate measurement of radiographs because the grid and the anatomic features are exposed at the same time. Even if the radiograph is distorted, grid lines can be counted as the distance between the two grid lines, which is 1 mm even if it is elongated or shortened.This method was chosen because it is easily done on the chair side and later adobe photoshop and screen caliper was used to detect bone loss. It also prevents patient from large radiation exposure of CT scan and cost effective. Although this technique has several advantages but use of 3 dimensional diagnostic tools will provide much accurate results. The sequelae of tooth loss are often associated with compromised masticatory function and unpredictable alveolar ridge resorption[1,12], which may in turn complicate prosthodontic treatment outcomes. Bone resorption presents two serious challenges: absence of sufficient amount of bone for implant placement and a resultant alteration in the vertical dimension of occlusion with esthetic implications.[1,2,4,13] Both considerations may require the use of shorter implants or longer crowns, leading to a crown implant ratio much greater than the crown root ratios associated with naturally healthy teeth.[13] From a simple theoretic point of view, the crown root relationship is the relationship between the length of the anatomical crown of the tooth (from cementoenamel junction CEJ to the most coronal part) and the length of the anatomical root (from CEJ to the radicular apex). However, from a clinical point of view, the crown root relationship is defined as the physical relationship between the portion of the tooth situated within the alveolar bone compared to portion outside the alveolar bone, as seen radiographically.[13] While historically implants were of standard lengths and diameters, implants increasingly became available that were shorter or longer and with wider or narrower diameters, as well as with varying macro-geometric designs[14]. Anatomical considerations may exist that require either adjunctive treatment prior to implant placement or, instead, the placement of short implants. Recent research has found that length, macro-geometric design and diameter influence the amount of bone that osseointegrates due to differences in surface area, as well as the distribution of forces and resulting stresses[15]. With appropriate selection, high success rates can be enjoyed for both long and short implants whereindicated[1,16].The radiographs taken were analyzed for changes in marginal bone loss of each fixture measured mesially and distally by using the fixture threads as an internal dimensional reference. These points were chosen because they were permanently visible and easy to locate on all radiographs.

The results for marginal bone loss were statistically found to be highly significant and was in accordance to the study conducted by Ten Bruggenkate CM *et al* (1998),[17]who stated thatperi-implant bone loss since abutment connection showed no bone loss in 72% of the patients, 1 mm of bone loss in 16%, 2 mm of bone loss in 9%, and more than 3 mm of peri-implant bone loss in 3%.This study is also in accordance with another study conducted by Blanes *et.al*(2007),[18] who assessed crestal bone loss 1 years after loading by conducting a clinical and radiographic evaluation and the average crestal bone loss observed was 0.21± .38 mm. Another study done by Arlin *et al* (2006),[19] stated that 2 year outcome for 8 mm implant short implant was comparable to longer implants in terms of failures and bone loss. Kim HU *et al* (2013),[20] stated mean bone loss 0.34 mm in short implants that is also comparable to bone loss in longer implants.Ten short length implants were placed in this study and necessary statistical analysis were performed for all the parameters. Most of these findings were in accordance with majority of the studies reported so far. Within the limitation of the present study it might be concluded that crown implant ratios are not associated with peri implant bone loss and short implants may extend the boundaries of current implant practice.

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