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Short vs Long Implants - Comparison of Crestal Bone Loss: A Clinical Study

G. Ramaswamy Reddy[1] Anam Chandrasekar[2] N. Sandeep[3] Syed Sameer[4] G. Prabhandh Reddy[5*] M.D. Khadeer[6]

[1]Professor and Dean, Department of Prosthodontics, SVS Institute of Dental Sciences, Mahabubnagar, Telangana, India.
[2]Professor and Head, Department of Prosthodontics, SVS Institute of Dental Sciences, Mahabubnagar, Telangana, India.
[3]Reader, Department of Prosthodontics, SVS Institute of Dental Sciences, Mahabubnagar, Telangana, India.
[4]MDS, Department of Prosthodontics, SVS Institute of Dental Sciences, Mahabubnagar, Telangana, India.
[5]MDS, Department of Periodontology, SVS Institute of Dental Sciences, Mahabubnagar, Telangana, India.
[6]PG Student, Department of Prosthodontics, SVS Institute of Dental Sciences, Mahabubnagar, Telangana, India.

ABSTRACT

Background: Dental implants aid in improving both function and aesthetics. It is widely accepted as an efficacious method of the prosthetic restoration. The aim of this article is to correlate crestal bone levels from the time of implant placement till the second stage surgery and 6 months after the placement of the crowns between short and long implants in the posterior mandible. A total of 40 partially edentulous patients with an age ranging from 18-60 years who were willing for implant therapy were considered. Patients were divided into two groups, each group consisting 20 patients. One group received short implants (<10mm) and the other group received long implants (>10mm). Radiological evaluation was performed to inscribe the bone levels using digital images (RVG) at the time of implant placement, second stage surgery and after 6 months. Radiological analysis revealed the mean bone loss in long implants and short implants as $\pm$ 0.12mm and $\pm$ 0.21mm respectively. The results show that the mean crestal bone loss was more around the short implants when compared to the long implants, but statistically it was not significant.

Keywords: Dental implants, Crestal bone loss, Short implants, Long implants, Two-piece implants, Posterior mandible, Delayed loading.

INTRODUCTION

The introduction of improved implant designs and surface topographic modifications[1] are aimed chiefly to enhance the primary stability and osseointegration. One of the Albrektsson et al.[2] criteria for a better success rate of an implant states that the bone loss should be less than 0.2mm annually after the implant's first year of service. In addition, primary and secondary implant stability are also important factor for the success of an implant. Primary stability of an implant comes from mechanical engagement with cortical bone which play a key role in successful osseointegration[3], furthermore, it was described as essential in Brånemark's original protocol[4]. Secondary stability propounds biological stability through bone regeneration and remodelling.

Crestal bone loss around dental implants is more during the first year after placement because of a variety of reasons such as surgical trauma, occlusal overload, peri-implantitis, the influence of the implant abutment microgap, biologic width, reverse torque testing and the implant crest module design. Longer implants have always been considered more reliable as they have better crown-to-implant ratio and a greater surface area which is available for osseointegration, thus dissipates the imposed occlusal forces well[5]. Placement of long endosseous dental implants is subject to anatomic limitations,

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***Correspondence Dr. G. Prabhandh Reddy.**
Department of Periodontics, SVS Institute of Dental Sciences, Mahabubnagar, Telangana, India.
Email: drprabhandhreddy@gmail.com

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such as the position of the inferior alveolar nerve in the posterior mandible.

In the past, short implants have been associated with lower survival rates[6]. But, at present the short implants with improved macro-topography, micro-topography and nano-topography[7] have increased the implant surface which results in higher survival rates[8].

Ergo, this research article was aimed to correlate crestal bone levels between short and long implants in the posterior mandible from the time of implant placement; second stage surgery and till 6 months after the placement of the crowns.

MATERIALS & METHODS:

The prospective study constitutes implants, Aquasil soft putty, digital intraoral sensor, holder for intraoral sensor of RVG and the armamentarium for dental implant surgery.

Total 40 patients were selected for this study within an age group out of 18-60 years; 20 patients were given short implants (≤10mm) and another 20 patients long implants (>10mm).

INCLUSION CRITERIA:

Patients with missing mandibular posterior teeth willing for implant therapy and for clinical

follow up from prosthetic department, S.V.S. Institute of Dental Sciences, Mahabubnagar.

EXCLUSION CRITERIA:

- Implants which are not osseointegrated during second stage surgery.
- Grafted implant sites.

A) Surgical Protocol- Full-thickness flap was raised, osteotomy performed (Fig 1) and implant placed. A two-stage delayed loading protocol was chosen for all implants. Implants were placed upto the crestal bone level, followed by cover screw placement (Fig 2) and flap approximation with sutures.

C) Clinical Radiographic Evaluation and Data Collection-

Fig 1: Osteotomy.

Fig 2: Implant placed.

Fig 3: Placement of the crown 2 weeks after the 2nd stage surgery.

Recording the base line bone levels: The first digital intraoral radiograph using paralleling cone technique was exposed which serves as a base line for recording initial bone level. An index was made with polyvinylsiloxane putty material (Fig 4), which was used to standardize the position of sensor as well as the distance between the focal spot and the sensor. This index was adapted onto the bite plate of the holder and patient was asked to bite, so that it had imprints of the teeth adjacent to and opposing the missing tooth. After the radiograph was taken, this index was separated from the holder and preserved for the subsequent radiographs.

Fig 4: Putty index of the patient placed in rvg sensor holder.

Recording the crestal bone levels at the time of second stage surgery: This was done at the second stage surgery prior to the reflection of surgical flap and placement of the gingival former. These radiographs were taken 3 months after placement of implant in the mandible by using the same putty index.

Recording the crestal bone levels after 6 months of placement of the crowns: This was done after 6 months of placement of the crowns. The crowns were unscrewed and the same putty index was used to take the radiograph.

Measurement of crestal bone levels on the radiographs taken: All These radiographs were uploaded onto the software (AUTO-CAD) and the bone levels were measured in milli-meters (Fig 5). In the first radiograph, for every implant, two measurements were made, which are denoted as M1 and D1. M1 denotes the distance between the crest of the bone and the implant shoulder on the mesial side. D1 denotes the distance between the crest of the bone and the implant shoulder on the distal side. Similarly, M2 and D2 represents bone levels at second stage surgery, M3 and D3 represents bone levels after 6 months of placement of the crowns.

Calculation of the bone loss: For both the long and short implants, bone loss that occurred on the mesial side of the implant was denoted as the mesial bone loss (M) which was calculated as M2-M1 which was classified as bone loss during the surgical phase (M_S) and M3-M1 which was classified as the total mesial bone loss (M_T).

Bone loss that occurred on the distal side of the implant was denoted as distal bone loss (D) which was calculated as D2-D1 which was classified as bone loss during the surgical phase (D_S) and D3-D1 which was classified as the total distal bone loss (D_T).

In most cases, where bone was lost after placement of implant, the bone loss values i.e., M and D were positive, while, in cases where bone had formed after implant placement, the bone loss values i.e., M and D obtained were taken as negative.

The bone loss for each implant was denoted as mean bone loss, which was calculated as the average of bone loss that had occurred on the mesial and distal sides of the implant, i.e., M+D/2. The data thus obtained for all 40 implants was tabulated and analysed statistically. The following table represents the various measurements and how they are denoted.

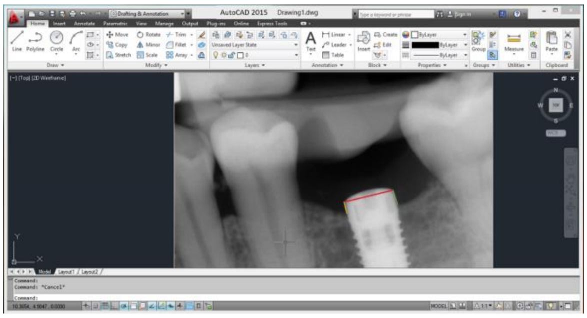


Fig 5: Crestal bone levels measurement using AUTOCAD software

Fig 5: CRESTAL BONE LEVEL MEASUREMENT USING AUTO-CAD SOFTWARE.

RESULTS: The comparison between long and short implants was done by unpaired t-tests/ Mann-Whitney U test for continuous data. The comparison between long and short implants for two groups was done by Two-Way Analysis of Variance Test (ANOVA)

All the P- values less than 0.05 were considered as statistically significant.

Table 1: Comparison of mesial (MB) and distal (DB) bone loss from the time of implant placement (1) till the second stage surgery (2) between long and short implants

Group	Bone loss (mm)	N	Mean	SD	P-value
	MB2-MB1	20	0.07	0.49	
Long	DB2-DB1	20	-0.10	0.46	P > 0.05
	MB2-MB1	20	0.08	0.31	
Short	DB2-DB1	20	0.04	0.36	

The mean bone loss in long implants; MB2-MB1 = 0.07 mm; DB2-DB1 = -0.10, In short implants; MB2-MB1 = 1.03 mm; DB2-DB1 = 0.04, P-value > 0.05 indicating no statistically significant difference

Graph 1: Showing the mean value

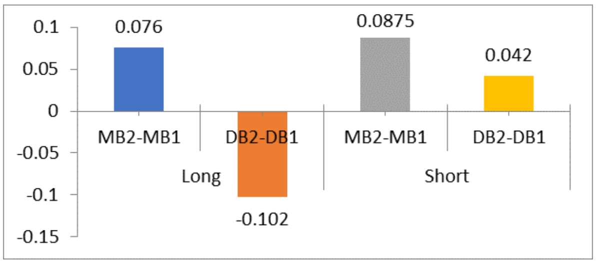
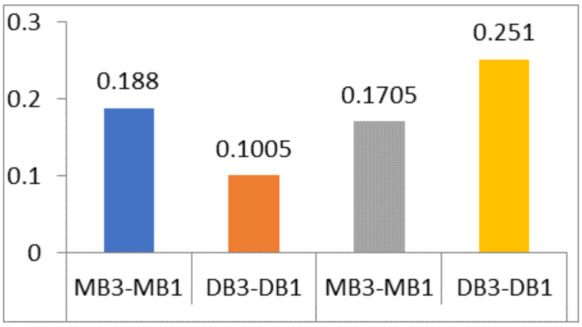


Table 2: Comparison of mesial (MB) and distal (DB) bone loss from the time of implant placement (1) till 6 months after the placement of crowns (3) between long and short implants

Group	Bone loss (mm)	Number of values	Mean	SD	P-value
	MB3-MB1	20	0.18	0.50	
Long	DB3-DB1	20	0.10	0.59	P > 0.05
	MB3-MB1	20	0.17	0.58	
Short	DB3-DB1	20	0.25	0.42	

The mean bone loss in long implants; MB3-MB1 = 0.18 mm, DB3-DB1 = 0.10, In short implants; MB3-MB1 = 0.17 mm, DB3-DB1 = 0.25, P-value > 0.05 indicating statistically no significant difference



Graph 2: Showing the mean value

Table 3: Comparison of mean bone loss between long and short implants

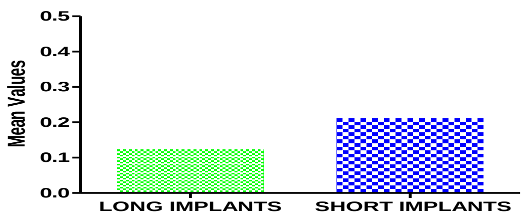
Group	N	Mean	SD	P-value
LONG IMPLANTS	20	0.12	0.47	0.55
SHORT IMPLANTS	20	0.21	0.46	

The mean bone loss in long implants = 0.12 mm

In short implants = 0.21 mm

P-value = 0.55, indicating statistically no significant difference

Graph 3: Showing mean value of long implant and short implants.



DISCUSSION

In 1965, Branemark was the first to place dental implants in edentulous patients, which gradually led to the use of implants in dentistry[13]. Adell et al.[9] in 1969 introduced for the first time the concept of osseointegration and later redefined it in 1981 as a direct functional and structural connection between living bone and the surface of a load-carrying implant. Bone resorption is known to take place mainly during the first year after the placement of the implant, decreasing considerably after the prosthesis is stabilized[14]. However, Kim, J.H., and Kim, Y. K.[15] conducted a clinical study and stated that there was no significant difference in bone resorption either 1, 2, or 3 years after the surgery between patients with or without systemic diseases. In this clinical study, a total of 40 implants were placed out of which 20 were long implants and other 20 were short. All the implants placed were restricted to posterior mandible only so as to standardize the bone density.

A study was conducted by Grant et al.[10] in which 335 short implants were placed in 124 patients of 8 mm length and they found 99% survival rate of short implants after a follow up period of 2 years. Also Al- Hashedi et al.[16] found that short implants have excellent survival rate when implants are placed in the posterior mandible.

Kempainen et al.[17], Peñarrocha et al.[18] and Danza et al.[19] found marginal bone loss during the first year to be greater in implants located in the maxilla than in implants placed in the mandible. This increased maxillary bone loss could be due to possible differences in bone remodelling capacity between the mandibular and maxillary bone, the latter being more vascularized and with a greater remodelling potential during the healing phase after implant placement.

As of this current study, a similar way of standardizing the radiographs was done by Shikha et al.[20] but instead of using polyvinyl siloxane, the occlusal bite jig was fabricated by using modelling wax which was then acrylized in heat cure acrylic and used for further visits. Al-Hasedhi et al.[16] standardized the radiographs by fabricating template made up of self-cured acrylic resin to ensure reproducibility of radiographic positioning.

In the present study, imaging software AUTOCAD 2015 was used for measuring the crestal bone loss in the radiographs. In a study by Ajanovic et al.[21] the measurements for the crestal bone loss were performed using software Kodak dental software. Ko-Ning et al.[22] used EZ-Dental professional image recombination software for the measurement of mesial and distal peri-implant bone heights.

Short implants are considerably placed in resorbed regions to avoid further grafting/surgical procedures, and thus the clinical crown height may be greater than the implant length, an increase in lever arm may result in bending movements exerted on the implants, thus resulting in more marginal bone loss[23]. But Blanes demonstrated in a systematic review that a large crown/implant ratio did not have any effect upon the marginal bone loss[24].

The rapid bone loss in the initial months after implant placement may be because the fixtures are not loaded, so there is lack of physiologic stimulation and also there may be activities of remodeling which is a physiological change independent of loading and starts as soon as the implant is placed in bone. Pham et al.[25] found that significantly more crestal bone loss was noted before functional loading than after the prosthesis was connected.

According to Cochran et al.[26], peri-implant bone remodeling after implant placement is more accentuated in the first 6 months after surgery. These authors found 86% of the bone loss to take place in the first 6 months between the initial implant insertion control and the control at final placement of the prosthesis.

Short implants splinted with fixed dental prosthesis in the posterior area of the jaws have shown to give better results than unsplinted crowns. Gulje et al.[12] conducted a study in which he placed 6mm and 11mm implants and followed for a period of 1 year. The results shown to have less bone loss when the crowns were splinted together. In the present study, delayed loading protocol was followed. In a study by Rossi et al.[11] early loading of single crowns on 6 mm short implants were done and it resulted in high implant survival rates and moderate loss of bone after 2 years of loading.

The average bone loss of long implants was 0.12 mm and short implants showed average bone loss of about 0.21 mm. Thus, the bone loss was found to be more in short implants than in long implants which is similar to the study done by Felice et al.[27] who found that short implants even after 5 years after loading, have more marginal bone loss than long implants. In contrast, studies by Deporter et al.[28] and Rokn et al.[29] found similar results for both short as well as long implants.

The differences in the mean bone loss values reported by different authors may be attributed to the different implant designs, the surgeons experience, the number of studied implants, the oral hygiene status and practice in patients undergoing implant restorations, the time past from implant reception, the bone quality at the implant sites, or different measures to assess implant treatments.

All the implants used in the present study were tapered implants. Tapered implants induce more compression than parallel implants as they are inserted in the bone[30]. They have continuously increasing insertion torque because of lateral bone compression from the entire length of implant during insertion.

The present study found no significant correlation between long and short implants but slightly more bone loss was observed in relation with short implants.

The limitation of this study are:

- Radiographic measurements were done using Digital Periapical Radiographs (RVG) which gave only two-dimensional data. Precise CT scan (3 dimensional) analysis of bone levels could have given more accurate and undistorted interpretations, however it carries risk of radiation overexposure.
- Small sample size- the results of this study can be corroborated with increased sample size and conducting randomized control trials in future.
- A short follow up study period of 9 months only.
- The study is restricted to posterior mandibular region only.
- Parameters like age, gender and sex were not standardized.

CONCLUSION

Within the limitations of the study following conclusions were drawn:

- The crestal bone loss from the time of implant placement till the second stage surgery was found to be more around short implants compared to long implants but statistically no significant difference was observed.
- The crestal bone loss from the time of implant placement till 6 months after the placement of the prosthesis around short implants compared to long implants but statistically no significant difference was observed.
- The mean crestal bone loss was found to be more around short implants when compared with the long implants but statistically it was not significant.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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