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Original Research

Influence of implant length on crestal bone loss & survival rates- An in vivo study

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ABSTRACT:
Background: The crestal bone area is a significant indicator of implant health. Early loss of crestal bone is usually a result of excess stress at the permucosal site. It is an indicator for the clinician to review the causes of possible stress for the implant. The biomechanical rationale behind the use of short implants is that the crestal portion of the implant body is the most involved in load-bearing, whereas very little stress is transferred to the apical portion**. Material and method:** The study was conducted on patients divided into two groups: A total of 20 implants were placed (10 implants per group) in subjects requiring placement of mandibular and maxillary implants.All implants placed in both study groups were of same diameter. Follow up for radiographic and clinical evaluation which was made at 1 week, 3 months and 6 months after implant loading for evaluation of crestal bone changes with help of radiographs**. Results**: Crestal bone loss on mesial side of short implants show significantly lesser as compared to conventional implants. Short and long implants showed comparable survival rates and success both clinically and radiographically.

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INTRODUCTION

Short implants have been proposed as an alternative choice for the prosthetic treatment of alveolar ridges, which may provide surgical advantages including reducing morbidity, treatment time, and costs[1]. Primary stability depends mainly on the endosseous design of the conventional implant including the functional length, besides surgical technique and properties of local bone. The loss of teeth leads to bone resorption limiting the use of regular length implants of 10 mm or above[2]. Its use may be restricted in the presence of limitations related to the morphology and volume of the bone ridge. These limitations are usually more common in the posterior maxillary and mandibular regions. Longer implants have always been considered more reliable due to both an improved crown-to-implant ratio and a greater surface area available for osseointegration, which dissipates the imposed occlusal forces. However, the biomechanical rationale behind the use of short implants is that the crestal portion of the implant body is the most involved in load-bearing, whereas very little stress is transferred to the apical portion[1]. Thus our study intends to evaluate clinically and radiographically short implants versus conventional implants of same diameter.

MATERIAL AND METHOD

The study was conducted on patients divided into two groups: A total of 20 implants were placed (10 implants per group) in subjects requiring placement of mandibular and maxillary implants.All implants placed in both study groups are 3.8mm in diameter. Selected groups were grouped on the basis of length of implant used.

Group I Short length implants(<10mm).

Group II Conventional length implants(>10mm).

The selection criteria was as follows:

INCLUSION CRITERIA

- All partially dentate patients requiring dental implants.
- All subjects should be 18 or greater than 18 years of age.
- All patients should be periodontally healthy.

EXCLUSION CRITERIA

- Irradiation in the head and neck area less than 1 year.
- Unsatisfactory oral hygiene and motivation.
- Untreated periodontal disease.
- Severe systemic disease that would not allow a short surgical intervention.
- Active infection or severe inflammation in the area.
- Drug abuse.
- Psychologic disorder.

PRESURGICAL ASSESSMENT

IOPA and Orthopantomogram (OPG), 3D CBCT was done to determine position of bony walls (buccal and lingual/palatal), their height and width and accordingly the position and orientation of implant in relationship to critical structures was analyzed. Final planning for the size of implant was done.

SURGICAL PREPARATION

The patients were pre-medicated with antibiotics(Amclaid 625mg) 1 hour prior to surgery. Local anesthesia was then administered at the surgical site using lignocaine with adrenalin in the ratio of 1:100,000 at the involved site.

IMPLANT PLACEMENT IN BOTH GROUPS

Crestal incision was given for full thickness flap reflection, to expose the implant site. Surgical stent was then placed over the crest to mark the implant site. Implant site was marked to create bleeding point and initially osteotomy. After marking the implant site pilot drill was used, followed by subsequent drills of increasing diameter , and final drill up to the decided depth in order to create an osteotomy site of required dimensions for each patient. The implants were then inserted into this osteotomy site. Once the cover screw were placed,the surgical site was thoroughly irrigated and flap was closed with tight non-resorbable 3-0 silk sutures and the patients were prescribed with antibiotics and analgesics for 1 week, post operatively. Second stage surgery was performed after 4 weeks and gingival former was placed. After 2 weeks abutment were placed and the impression was made by polyvinylsiloxane material using indirect impression technique. Impression was then poured in die stone to fabricate the cast. After cast fabrication die cutting was done and wax pattern fabricated, metal casting was then fabricated from investing and casting of this wax pattern. Metal try in was then made followed by shade selection. Final prosthesis was fabricated and then tried in patient's mouth and occlusion adjusted, after final trial the prosthesis was cemented with the help of type1 glass ionomer cement (Luting).

FOLLOW UP

The patient was then recalled for follow up for radiographic and clinical evaluation which was made at 1 week, 3 months and 6 months after implant loading for evaluation of crestal bone changes with help of radiographs.The standardised periapical radiographs were digitized using digitized image analysis ,Med Calc Software version 4.3.5.0. The known implant length was used to calibrate the images in the computer software.

The results obtained were subjected to statistical analysis paired T-test.

RESULTS

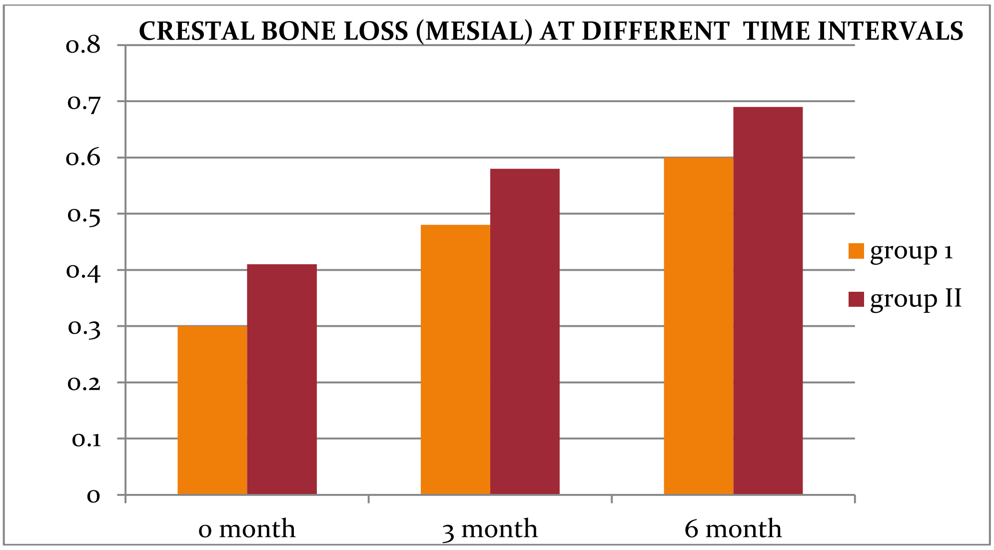
Table 1 Mean Crestal Bone Loss (Mesial) in two groups at different time intervals

Variable	Group 1		Group 11		p value
	Mean	± SD	Mean	± SD	
At 0th Month	-0.2980	0.06893	-0.4080	0.13003	0.030
At 3rd Month	-0.4800	0.05869	-0.5760	0.11027	0.026
At 6th month	-0.6020	0.06070	-0.6860	0.09204	0.027

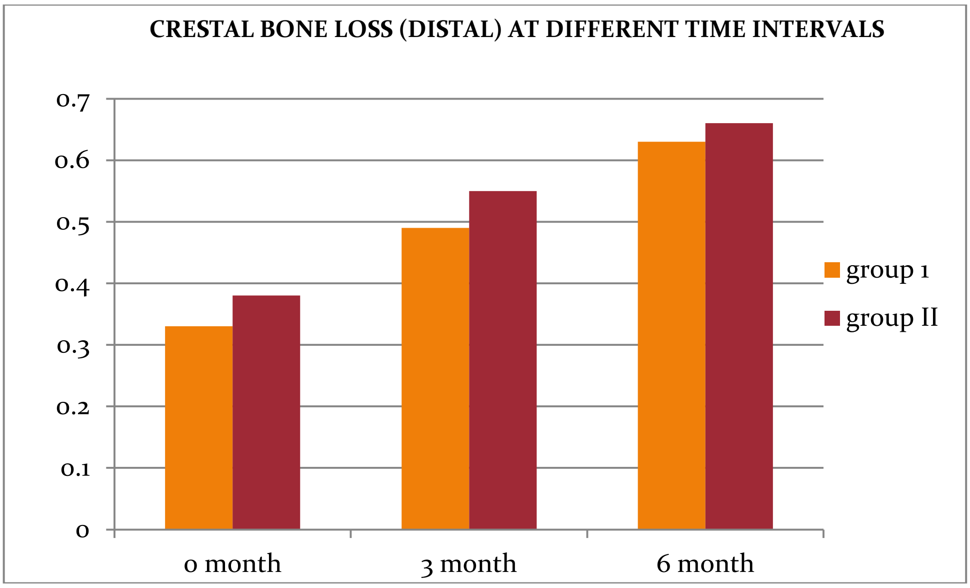
Table 2 Mean Crestal Bone Loss (Distal) in two groups at different time intervals

Variable	Group 1		Group 11		p value
	Mean	± SD	Mean	± SD	
At 0th Month	-0.3280	0.09762	-0.3820	0.08135	0.196
At 3rd Month	-0.4900	0.10424	-0.5480	0.06795	0.158
At 6th month	-0.6280	0.09531	-0.6630	0.06881	0.359

Graph 1



Graph 2



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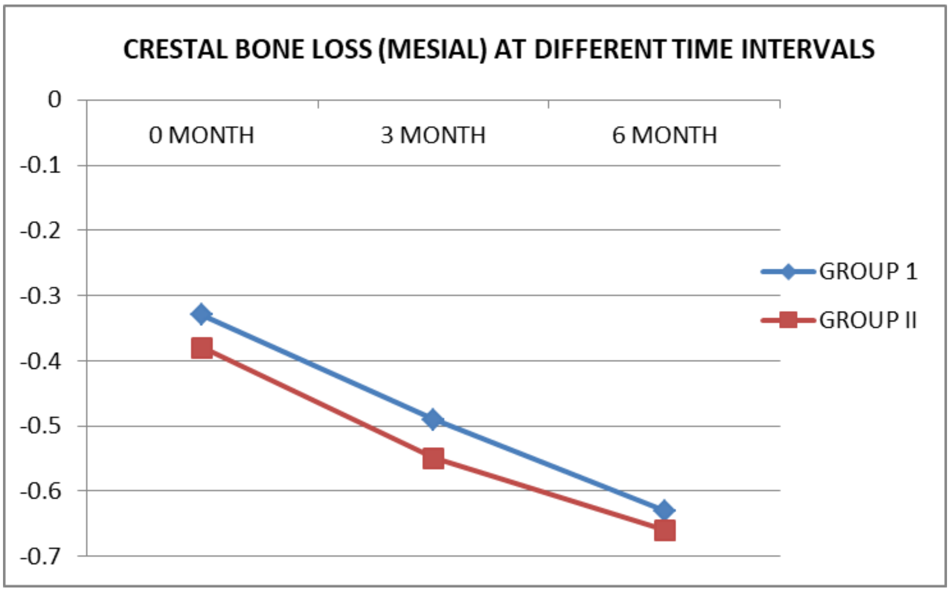
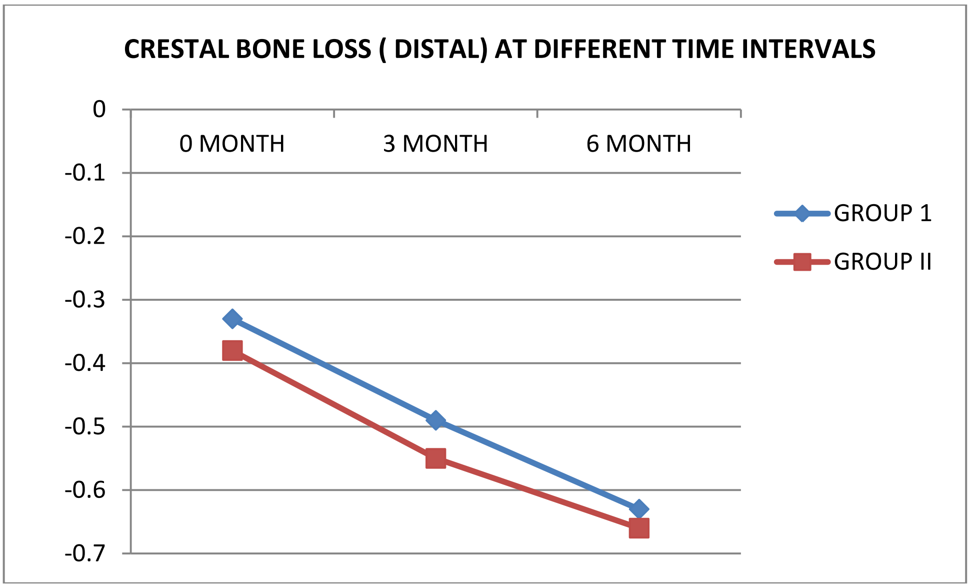


Graph 4



DISCUSSION

Short dental implants were introduced for simplified placement in compromised alveolar situations to avoid interference with vital anatomical structures, minimize surgical trauma and associated risks, and consequently reduce the morbidity of advanced surgical procedures. Finite element analysis reveals that highest strains to a bone stimulant occur in crestal region of implant and little stress transferred to apical portion[3]. It was demonstrated that increasing the implant diameter resulted in a 3.5-fold reduction in crestal strain. On the contrary,increasing the implant length resulted in a 1.65-fold reduction in crestal strain[4]. However, other studies showed that increasing implant diameter did not compensate for the reduction in length[5,6]. In this study, a short implant is defined as a dental implant that is <10 mm long whereas a standard length dental implant is ≥10 mm[7]. Accordingly, in clinical situations with little bone availability, short implants are a viable, simple, and predictable alternative.The biomechanical rationale for use of short implants is that osseointegrated bone-implant interface distribute most prosthetic loads to crestal portion of an implant body. All implants placed in both study groups are 3.8mm in diameter placed in mandibular posterior region . Implant length is generally selected according to maximum amount of bone height at recipient site. Functional surface area of implant is considered important as it transfers the compressive & tensile loads to bone and does not includes passive portion of the implant[8].

We have conducted a prospective clinical study with the purpose of evaluating the treatment outcomes of 20 early loaded short implants and standard implants. We have selected and included patients (10 implants per group) in our study, based on certain inclusion and exclusion criteria. Patients were excluded if they provided a positive history of smoking, bruxism, or presence of any medically compromising conditions which prohibit implant surgery, such as stroke, recent infarction, severe bleeding disorders, diabetes, osteoporosis, and cancer.The surgery was performed by same operator under standard conditions. Intra-operatively, those patients in whom a minimum torque of 35-40Ncm was not achieved were also excluded from the study, as that amount is a pre-requisite for early loading.Pre-operative OPG and CBCT was obtained to evaluate detailed visualization and measurement of vital structures from the surgical site. This 3D visualisation of the features of implant recipient sites and neighbouring anatomy may enhance the surgical and prosthetic decision making, increasing the reliability of the overall implant treatment while at the same time reducing postoperative morbidity[11].At the time of insertion, the exact location of implant osteotomy was decided based on regional topography, keeping in mind to provide at least 2mm of healthy bone between implant and tooth[6].After early loading with the prosthesis, the implant was closely followed up for a period of six months.In few studies, [13,14] there was tendency of short implants to fail before loading. However, no implant failed during initial phase . This was comparable to prospective clinical study by Rossi [9,10] et al on early loading of 6mm short implants.

As far as sex distribution was concerned, 35% of the cases were females and 65 % males, for which no authentic reason could be given. Interestingly, mean age was 47.75±16.43 years. With regard to age, it was observed during screening for potential candidates that middle age patients were more interested in conserving adjacent teeth structure, therefore opting for implant therapy over fixed partial dentures.

The crestal bone area is a significant indicator of implant health. Early loss of crestal bone is usually a result of excess stress at the permucosal site. It is an indicator for the clinician to review the causes of possible stress for the implant, such as occlusal factors, cantilever length, and parafunction. Under ideal conditions, an implant should lose minimum bone. In our study, mean marginal bone levels were assessed radiographically using the standard Intra-oral Periapical Radiographs. The radiographs were taken immediately after early loading, 3 months and 6 months post-operatively to assess the vertical height of peri-implantal surface marginal bone changes. The changes in the crestal bone level around peri-implantal surface was radiographically evaluated by measuring the proximal distance between the implant shoulder to most coronal aspect of the alveolar crest was measured at mesial and distal aspects. The difference between the bone loss from the initial and final radiograph at 6 month for each implant was calculated for total bone loss of that implant. Present study aimed to compare the radiologic changes in peri-implant bone level in implants placed with the short implants and conventional implants. The mean of the mesial crestal bone loss at 3 months after loading for the short implant was 0.48 mm while it was 0.57mm for the conventional implants. The p-value was 0.026 which is considered to be significant (Table 1).The mean of the mesial crestal bone loss at 6 months after loading for the short implants was 0.60 mm while it was 0.69 for the conventional implants. The p-value was 0.027 which is considered to be significant (Table 1).The mean of the distal crestal bone loss at 3 months after loading for the short implants was 0.49 mm while it was 0.55 for the conventional implants. The p-value was 0.158 which is considered to be insignificant (Table 2).The mean of the distal crestal bone loss at 6 months after loading for the short implants was 0.63 mm while it was 0.66 for the conventional implants. The p-value was 0.359 which is considered to be insignificant (Table 2).Thus the present study shows that crestal bone loss in short implants is less than than conventional implants but were insignificant .Only crestal bone loss on mesial side of short implants show significantly lesser as compared to conventional implants. The results of this study are in accordance with studies done by Rokni S[12] et al in which 199 implants placed and followed for 4 years which concludes long implants had greater crestal bone loss(0.2mm more) than short implants.These effects might be related to "stress-shielding" effects on crestal bone and resultant disuse atrophy.

The survival rates of implants shorter than 10mm seem to comparable to longer implants(Anitua & Gorka 2010;Annibali et al 2012; Brocard et al 1997; Buser et al 1997;Fugazzotto etal 2004, Pommer et al 2011;Renouard and Nisand 2005;Telleman et al 2011)[18]. The results of this study are in accordance with the studies[18,19,20,21,22,23,24] which states that length does not appear to influence the survival rates of the implants. Similar overall outcomes are seen in short & long implants[9,13,25,26,27,28,29].However few studies,Wyatt & Zarb(1998),Winkler(2000),Herrmann(2005) shows short implants have less survival rate compared to conventional implants[16]. These differences in the studies may be due to other variables affecting implant survival, including the implant surface,surgeons learning curve,bone quality and quantity,implant primary stability,prosthodontics protocol, and the lack of a common definition of short implant[15]. When an implant is loaded, the majority of stress is distributed at level of first few threads to crestal cortical bone;therefore once a minimum implant height is osseointegrated, implant width is more important than additional length[15].Effective implant length or Effective bone-to-implant surface which satisfies the functional needs of the prosthesis,is the key to ensure the long-term outcomes of the short implants supporting single crowns[17].

The drawbacks of this study included the fact that in this study, intra-oral radiography was used to evaluate the radiologic changes in peri implant bone level, which is quite a sensitive method. However, it should be noted that this technique could only record bone level in two dimensions (mesial and distal). Therefore, it is highly likely that some information (bone loss in the buccal and lingual dimensions) might be missing.Other limitations of the study were the small sample size consisting 10 patients in each group and 6 months post-operative follow-up is a short duration,hence a study with a large sample with longer follow up time period is required to analyse the results.

CONCLUSION

An analysis of the data obtained in course of this study, coupled and compared with data obtained while reviewing literature, directs us to the conclusion that early loading of dental implants are highly predictable modality for replacing missing teeth in the atrophic alveolar ridge. It must however be noted that patient selection and primary stability of implants plays a crucial role in the success of early loaded short dental implants. A few conclusions drawn from this study were: - Short implants with early loading must gain sufficient primary (mechanical) stability for successful outcome. Short and long implants showed comparable survival rates and success both clinically and radiographically.However, further trials involving a larger sample size, longer follow-up periods and other sites of maxilla and mandible are necessary before declaring short implant placement with early loading protocol as reliable procedure.

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