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Original Research

Comparison of crestal bone loss around different implant crest module designs: A comparative study

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ABSTRACT:
Background: The success rate of various systems of dental implants is dependent upon the amount of crestal bone surrounding various implants. The crestal module is defined as "the trans-osteal region surrounding an implant which is designed for receiving a prosthesis component. The design of the crestal module strongly influences the loss of crestal bone surrounding implants. **Aim**: The present study aimed to compare crestal bone loss surrounding different designs of crest modules. **Materials and methods**: 300 partially edentulous patients aged between 25-50 years with 1 or 2 missing teeth were selected after obtaining Institutional ethical clearance. Inclusion criteria for the study were a) Age-matching between 25 to 50 years; b) patients with no systemic medical condition and c) those who were unable to visit a dental clinic for follow-ups. Exclusion criteria were a) presence of any pathology; b) those on corticosteroids and c) those diagnosed with any bone disease. 150 smooth-collar designed and 150 micro-threaded roughened collared design implant systems were inserted in equi-crestal position. Post-operative instructions were explained to patients. Assessment of loss of marginal bone on proximal aspects of implants was performed with an OPG at 6 months. Measurement was performed after drawing a horizontal line tangential to the coronal-most position of an implant (reference) till crestal bone surrounding any implant system. Statistical analysis: P-value was calculated using the ANOVA test. **Result**: No statistical significance was found in the comparison between both crest modules. **Conclusion**: Present study represents data that suggests no difference in osseointegration capacity of either smooth collar or micro-thread rough design of implant crest module. Hence, more studies are required for substantiating these findings with uniform baseline measurements.
Keywords: implant, crest module, smooth, rough, collar, design.

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INTRODUCTION

Presently, dental implants are one of the main treatment options among other modalities for the replacement of missing teeth. The ability to undergo osseointegration with host alveolar bone is related to success for withstanding occlusal or masticatory forces on prosthetic crown and bridge during functional movements. The prognosis of the dental implant becomes poor in case of crestal loss of bone. The loss of bone loss could be because of any infection or application of force and stress which act surrounding the collar of an implant. This loss of bone support initiates around the collar area of any dental implant and undergoes progression in an apical direction.[1]

Dental implants with variations in surfaces' designs are currently being used for the replacement of missing teeth. The design of an implant collar surface may affect the loss of bone loss. The most commonly used collar surface design is the "two-piece and submerged" implants with a 2-millimeter smooth surface collar. Those implants with the smooth design of the collar demonstrate significant loss of bone. [2] It has been found that the rough or coated collared

design of dental implants exhibits a reduced loss of bone. Marginal loss of bone associated with both of the designs of the collar must undergo assessment.[3] Endo-sseous implants while being placed result in a close union with surrounding alveolar bone. This process has been termed "osseointegration". The overall prognosis of a dental implant is dependent upon the union between the implant and the osseous as well as soft tissues surrounding it. Thus, the interface between an implant and host tissue usually starts at the crest region in successful osseointegration with endosteal-based implants.[4] It has been seen that following the first year of functioning or loading of the prosthesis, the loss of crestal bone occurs till or beyond the tip of titanium-based implants.

A lack of agreement exists among various researchers as to the reason due to which there is a higher loss of alveolar bone occurring during the first year of functioning of an implant when compared to the following years. There are different reasons pertaining to the early loss of alveolar bone surrounding implants. There are various parameters used for the assessment of rates of success of dental implants such as the absence of mobility, associated discomfort, development of infection, and presence of periapical radiolucency. Different designs of implants have been developed for achieving osseointegration and for reduction of loss of crestal bone. Studies have reported approximately one mm of marginal alveolar bone loss during the initial year of placement of an implant and functional loading. Later, 0.1 millimeters of annual loss of alveolar bone has been reported. The neck of an implant is termed as a 'crest module'. [5] Hence, different designs of neck collar of implants have been proposed for reducing this bone reduction or loss. Few of the implants have been designed with a polished design of the collar for reducing the accumulation of dental plaque and for promotion of sealing between biological tissues. This polished design of implant collar may result in crestal loss of bone. [4]

FACTORS THAT CONTRIBUTE TOWARDS FAILURE AT EARLY AND LATE STAGES

a) **Reasons for an early implant failure**: Micro-motions or lacking primary stability; short-sized implants; narrow-sized implants; early or immediate functional loading; lower-density of bone as seen in osteoporosis; any surgically induced trauma; over-heating of bone; osteonecrosis due to compression; the presence of infection; delay or impairment of healing; habit of smoking; diabetic as well as advanced age. [5]

b) **Causes for implant failure at a late stage**: an infection caused by bacteria; history of periodontal problems; habit of smoking; neck of the implant; whether one-piece or two-piece implant; applying excess load; Insufficient restoration; Short or narrow implants and any trauma. [5]

Thus, based upon existing literature evidence, the aim of the current study was determined as "A comparative study of crestal bone loss around different implant crest module designs

MATERIALS AND METHODS

In this comparative study, 300 partial dentulous subjects who had one or two missing teeth in any of the mandibular posterior quadrants were selected. All study subjects were aged between 25 to 50 years.

Institutional ethical clearance was obtained from the appropriate committee. Patients were well-informed regarding various steps involved in implant placement. Diagnostic study impressions using X IMPRINT alginate impression material, DPI were made. All necessary diagnostic investigations were performed before the placement of implants.

Inclusion criteria for the subject selection were a) Age-matched individuals between 25 to 50 years; b) those without any systemic medical condition and c) those who could visit the clinic for a follow-up examination. Exclusion criteria of the study were a) presence of any pathological condition; b) subjects who were on corticosteroid therapy and c) subjects with any bone disease.

All implant systems were placed in the mandibular posterior region with sufficient bony support. The total duration of this study was 6 months. 150 smooth collared designs and 150 micro-threaded roughened collared design implant systems were placed according to the instruction given by manufacturers. Both types of implants were root-shaped, coated with pure Titanium and two-staged dental implants.

All implants were placed at the equi-crestal location. The site of the implant was approximated using a flap. The selected patient was placed on medication for one week, post-operatively. All follow-up visits, as well as post-operative instructions, were given to the test subjects.

Assessment of loss of marginal bone on both mesial as well as distal aspects (proximal aspect) of placed implants was done using Ortho Pantomograph (OPG) for both the implant systems at 6 months following placement of implants before functional loading using a prosthesis. The loss of crestal bone was then measured upon digital OPG. This measurement was performed after drawing a horizontal line that was tangential to the coronal-most border of an implant which was marked as a 'reference'.

Measurements starting from the reference line till crestal bone surrounding an implant were then done along a line which was then drawn parallel to the long axis of an implant for measuring vertical bone.

The total measurement between the neck of an implant and level of marginal bone along the surface of an implant on either of the proximal aspects were then assessed using an OPG monitor by utilizing Image Plus Software. Measurement values are recorded till a single unit following a decimal.

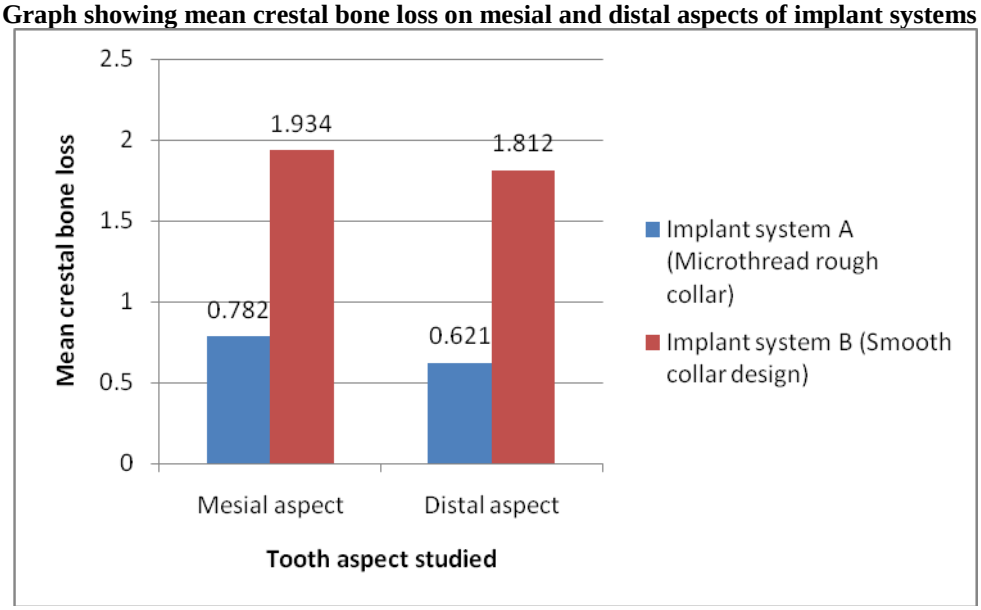
RESULTS AND OBSERVATIONS

In the current study, on performing a radiographic assessment of mesial and distal crestal vertical alveolar bone, mean marginal loss of alveolar bone measuring 0.782 ± 0.23 mm on mesial aspect and 0.621 ± 0.06 mm on the distal aspect of Implant System A (Smooth collar design implants) while mean crestal bone loss of 1.934 ± 1.12 mm on mesial bone and mm on the distal aspect of implant System B (Microthread roughened collar design) was noted on follow-up at 6 months post-operatively before functional loading of both the implant systems (table 1 and graph 1). The success rate of both the implant systems was noted to be 100%. On statistical comparison between both the groups, significant P values were obtained on comparison of crestal bone loss in both the implant systems (table 1 and graph 1).

Table 1: Table showing mean values of crestal bone loss 6 months following placement of two different implant systems

	Mesial aspect	Distal aspect	t value	p-value
Implant system A (Microthread rough collar design)	0.782 ± 0.23	0.621 ± 0.06	1.76	<0.05 (Significant)
Implant system B (Smooth collared design)	1.934 ± 1.12	1.812 ± 0.31	3.25	<0.01 (Significant)

Graph 1: Graph showing mean crestal bone loss on mesial and distal aspects of implant systems studied



DISCUSSION

According to the conventional technique that was proposed by Branemark, complete healing of alveolar bone before implant placement following extraction of a tooth requires an average healing period extending between 6 to 12 months. [6] Panoramic and intra-oral periapical radiographs have been commonly employed as an imaging method in implant-based dentistry. Both of these radiographic techniques have been found equally reliable for assessing loss of peri-implant bone levels after implant placement. [7]

"Crest module" is that particular portion of any two-piece metallic implant system in dentistry that has been designed for holding a prosthetic component in its position and also, for creating a transition area between the prosthesis and the load-bearing body of an implant. The design of a crest module, it's relative positioning with respect to alveolar crestal bone, and between abutment- implant interface leads one to believe in its role in providing integration between both the hard as well as soft tissues. Very importantly, it has been seen in many clinical situations that there might be an early stage of breakdown of tissues starting with soft tissues and later on, involving hard tissues in this region. Early loss of crestal bone is generally highest in the initial year following implant placement and ranges between 0.9 to 1.6 mm with an average bone loss measuring between 0.05 to 0.13 mm in subsequent following years. [8]

The remodeling process of peri-implant crestal bone takes place after implants have been placed.[9] This involves a complicated multi-factorial pathway. This process of remodeling is mostly governed by numerous factors related to surgeons, patients, and implants. [10, 11]

Numerous scientific advances have been introduced recently for the preservation of crestal bone as much as possible coronally for improvement in success for a longer time and for obtaining optimal esthetics following implant placement. [10, 11]

In the present study, greater loss of alveolar bone at implant crest module was found to occur in implant

system manufactured by Nobel BioCare when compared to Life Care implant systems. However, no statistically significant difference was observed in the clinical performance of these implant systems. Our findings are supported by Asalroosta H in 2021 who reported no statistically significant marginal loss of bone in implants in their study owing to the micro-thread design when compared to threaded design in a study observation period lasting for up to five years follow-up. [12]

Similarly, Bagchi et al in 2017 in their comparative study on two implant systems reported mean crestal loss of loss measuring 1.694 mm on mesial aspect and 1.892 mm on the distal aspect of Noble Biocare implant system while the mean bone crest loss of 0.863 mm and 0.792 mm was observed on mesial and distal aspects of life care implant system, respectively by radiographic examination on a digital Orthopantomograph. [13]

Vikhe et al (2016) in their study on crestal loss of bone following implant placement reported a mean loss of crestal bone measuring 1.6 mm on mesial aspect and 1.8 mm on the distal aspect of implant, respectively after approximately following six months of placement of implants on radiographic evaluation.[1]

Singh et al in 2006 reported in their study that before prosthetic functional loading of two-stage implants, an average loss of crestal bone measuring 0.6 to 0.9 mm took place surrounding an implant. They contributed this bone loss to the smooth and polished collared design of implants used. [14]

There is a large difference among various studies due to variability in various systems of radiographic imaging, selection of different points of reference, and subjective variations in baseline observations. A similar reason may be cited for the variation as well as higher levels of resorption of crestal bone which was recorded in the current study and may be attributed to a probable difference in baseline observations. Few published studies have recorded radiographic baseline views following placement of the prosthesis.[15] Hence, they did not record the greatest levels of resorption of crestal bone that did not occur between the timing of placement of an implant and placement of final prosthetics. [15, 16, 17]

CONCLUSION

Clinical success pertaining to rehabilitation using an implant depends upon the successful integration of these implants with hard as well as soft tissue health. Thus, loss of crestal or marginal bone is an important factor that affects clinical results or the outcome of implant placement. A moderate loss of crestal bone measuring less than 0.2 mm each year is usually acceptable within limits of any normal and physiological event while an excess loss of crestal bone, especially during 1st year following insertion of an implant has been associated with an increase in the risk of development of peri-implantitis along with the collapse of soft tissues which can affect the rate of survival of dental implants as well as create esthetic issues, especially in the anterior region.

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