ORIGINAL ARTICLE

Crestal Bone Remodeling in Polished Collar Implants

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OBJECTIVE: This study aimed to evaluate the amount of crestal bone remodeling in polished collar implants.
METHODOLOGY: Thirty patients with a missing maxillary or mandibular 1st or 2nd premolar tooth requiring simultaneous bone grafting were recruited and implant placed at the level of crest with polished collar placed 1mm apical to the level of bone and bone augmentation was performed to graft the buccal threads. Buccal bone thickness was measure at crestal level as well as 1mm apical to polished collar. The implants were uncovered at 6 months and restored and patients followed up for 12 months from the time of implant placement. Cone beam computed tomography scans were taken at two time points, immediately after implant placement and at 12-month time point.
RESULTS: At clinical re-entry (6 months), there was significant difference in mean buccal bone thickness found between crestal level and 1mm apical to polished collar ($p<0.05$). Radiographically (at 12 months), the mean buccal bone change was -1.82mm 0.57mm at crest and -0.94mm 0.31mm at 1mm apical to crest.
CONCLUSION: Bone regenerative techniques were unable to prevent biologic bone remodeling around the implant platform; therefore, the outcomes of bone augmentation might be affected by the polished collar of implant.
KEY WORDS: Dental implants, polished collar, bone augmentation, bone remodeling, cone beam computed tomography
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INTRODUCTION

Implant surface technologies evolved from machined surface titanium to nano-roughened surface to enhance osseointegration and early loading.[1] The rough surfaces, while beneficial for osseointegration, if exposed, were found to create a conducive environment for bacterial colonization, leading to chronic implant failures from bacterially induced peri-implantitis.[2]

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The design of the implant, presence of polished collar and platform shifting are amongst the reasons that have been linked with marginal bone loss in the first year of loading.[3] Consequently, efforts have been made to develop implants with innovative collar configurations and topographic modifications that aim to promote better integration of soft and hard tissues around the implant.[2] The initial marginal bone loss occurs in the most coronal portion of the bone-implant interface. During the first year of implant function, it's common to observe bone resorption of approximately 1mm to 2 mm, which is generally considered a normal physiological process. Subsequent to this initial loss, an annual bone loss of approximately 0.2 mm occurs in the following years.[4]

Marginal bone loss (MBL) around dental implants can be influenced by various factors. These factors include unfavourable stress distribution, surgical trauma during implant placement, the presence of micro-gaps between the implant and abutment, and the infiltration of bacteria. These factors collectively contribute to the apical migration of the

biologic width, a protective mechanism that shields the underlying bone from further irritation.[5,6]

It is important to note that the existing literature lacks a consensus on the effectiveness of these configurations and their influence on marginal bone loss. Notably, implants with shorter polished smooth collars have shown promise in reducing marginal bone loss.[7] Similarly, implants with coronal retentive grooves may help maintain more stable levels of peri-implant bone.[8]

There is existing evidence in animal study that links the concave implant crest module (BioSeal concept) to a better soft tissue attachment rather than lesser peri-implant marginal bone loss[9], although clinical trials have not specifically examined such an impact of biologic bone remodelling around implants with concave polished collar.[7,8] Therefore, the objective of this study is to evaluate whether concave polished collar has any effect on the marginal bone loss around an implant, concurrently assessing whether bone augmentation exerts any significant influence around a polished collar.

METHODOLOGY

Thirty healthy non-smokers with a single missing maxillary or mandibular pre-molar tooth were recruited in this longitudinal clinical study at University Dental Hospital, University of Lahore between Jan 2019 till Feb 2020. Ethical permission was granted by Institutional review board of University College of Dentistry (UCD/ERCA/19/09a). The sample size was calculated according to the clinical superiority design formula for continuous variables.[8] Sample size of 25 was obtained but extended to 30 participants keeping in view some drop outs/lost to follow up. Participation in the study was obtained after informed consent. Patients were included if they had an edentulous site in any of the premolar region with crestal ridge width of 4-5mm, and adequate bone height of at least 10mm.

Pre-molar teeth were chosen primarily due to higher possibility that implants can be placed with simultaneous bone grafting without necessitating the use of barrier membranes since the bucco-lingual width is favorable in most cases. Patients were excluded if they have untreated oral diseases, e.g., periodontitis, conditions that complicate wound healing, e.g., smoking (even occasional smoking) and uncontrolled diabetes, conditions that affect bone physiology, e.g., osteoporosis, history of drug and alcohol abuse, and on certain medications, e.g., bisphosphonates or steroids. The primary outcome variables analyzed were buccal bone gain at polished collar and 1mm apical to implant polished collar at 6 months, and secondary variable was proximal peri-implant bone loss/remodeling at 12 months post implant placement.

All the patients received 4mm*10mm NeoBiotech IS II active, Korea dental implants which have 0.5mm polished collar with BioSeal Concept (S shaped curve and microgrooves). After raising a full thickness flap, implants were placed with polished collar flushed at crestal level ensuring 3-4mm distance of implant shoulder to future crown margin, calibrated through a surgical guide. Simultaneous bone augmentation was performed using allograft (SureOss, HansBiomed Corp, Korea) to graft the buccal threads (up to 3mm exposure of implant threads) and contour augmentation (3mm from implant shoulder to outer aspect of grafted bone) calibrated and standardized using a customized measuring guide. Flaps were approximated with 5.0 vicryl sutures. Cone beam computed tomography (CBCT) scans were taken at baseline and at 12 months post implant placement. Implant uncovering surgery (2nd stage) was performed 6 months after placement and PFM crown was subsequently installed. Change in buccal bone thickness, reported as mean ± standard deviation, at polished collar and 1mm apical to the polished collar was determined clinically at implant uncovering surgery. CBCT was used to determine the degree of proximal and buccal bone loss at 12-months post implant placement. Student's t-test was used to measure statistical significance. Statistical difference of <0.05 were considered significant.

RESULTS

The mean age of the sample population of 13 males and 17 females was 46.6 ± 9.4 years (range: 28-61 years). At clinical re-entry (6 months), the mean buccal bone thickness was calculated and compared with the 3mm standardized buccal bone width achieved at the time of surgery. Results are shown in Table 1. A significant difference was found when comparing mean buccal bone change at the level of implant polished collar and 1mm apical to it ($p<0.05$).

Table 1: Summary of clinical and radiographic data

ALL CASES						
	Mean Clinical Buccal Bone change* (mm) at 6 months			Mean CBCT Buccal Bone changes* (mm) at 12 months		
N	Polished Collar	1mm Apical to polished collar	P	Polished Collar	1mm Apical to polished collar	P
30	-1.04±0.47	-0.54±0.27	<0.05	-1.82±0.57	-0.94±0.31	<0.05
CASES WITH WOUND EXPOSURE						
	Mean Clinical Buccal Bone change* (mm) at 6 months			Mean CBCT Buccal Bone changes* (mm) at 12 months		
N	Polished Collar	1mm Apical to polished collar	P	Polished Collar	1mm Apical to polished collar	P
5	-2.40±0.44	-1.88±0.24	<0.05	-2.80±0.56	-2.08±0.63	<0.05

**at time of implant placement and bone grafting, 3mm bone thickness was achieved in all cases.*

Five patients had wound exposure in the first week of healing, although all implants had 100% survival, their measurements were done separately to document the influence of wound exposure on bone remodeling. Only 9 patients had full exposure of polished collar on the buccal site at 6 months re-entry, including 5 cases that had flap exposure in the first week. A summary of clinical and radiographic bone changes at 6 and 12 months respectively are shown in Table 1. CBCT measurements of mesial and distal bone loss at 12 months revealed mean bone loss of 0.52 ± 0.27mm and in wound exposed cases a higher mean bone loss was found 1.07± 0.52mm. Hence, grafting the bone to augment the buccal exposed threads did not stop bone remodeling at the polished collar. It marginally prevented significant bone loss at 1mm apical to the polished collar.

DISCUSSION

This study delves into the intricate process of crestal bone remodelling following bone augmentation in an implant with smooth polished collar. Multiple studies have documented various degrees of crestal bone resorption, spanning from 0.04 to 2.7mm, which can be attributed to the use of diverse implant macro- and micro-designs.3,10 The majority of this bone loss typically takes place during the initial year of implant function. In the context of the current study, the observed crestal bone loss is similar to the one reported in previous research.[10]

Various implant collar designs have been suggested to enhance the stability of the bone-implant connection.[11] Polished collar implants have been observed to result in reduced plaque build-up, potentially contributing to the prevention of peri-implantitis.[12] However, several investigations have revealed a significant issue related to these polished collar implants, showing elevated stress in the region of the crestal bone surrounding the polished neck of dental implants. Consequently, the loss of marginal bone levels might, in part, be attributed to the absence of favourable stress distributions at the uppermost part of the implants.[13]

Research has established that the characteristics of titanium surfaces, such as their topography and chemistry, have a significant impact on the process of osseointegration.[13] In particular, moderate surface roughness of titanium implants has been found to play a crucial role in enhancing the bone-implant contact.[12] Enhancing the roughness of an implant increases the surface area creating a more conducive environment for bone cells to adhere to the implant and facilitate their growth, ultimately promoting more effective osseointegration.[14] This explains why a significant buccal bone gain was achieved at 1mm apical to the polished collar. A systematic review conducted by Roodebah and colleagues highlighted that dental implants with rough-surfaced micro-threaded necks exhibit less change in marginal bone levels compared to implants with polished collars.[15] This finding further emphasizes the importance of implant surface characteristics in preserving marginal bone.

Numerous research studies have highlighted that crestal bone remodeling following the placement of implants with a polished collar is significantly influenced by two key factors: the positioning of the rough/smooth interface (RSI) and the micro-gap existing between the abutment and the polished collar.[16] Investigations by Hermann et al have demonstrated a correlation between the coronal displacement of the RSI and reduced bone loss, while a more apical placement of the RSI resulted in increased bone loss.[17] This observation suggests a physiological response to the location of the RSI. The underlying reasons for this reaction to the interface may stem from potential microbial contamination or subtle micromovements occurring at the interface between the implant and the abutment or other secondary implant components.[18] With the advancements in implant dentistry and inclination towards esthetics the original standardized implant design is no longer used. The polished implant collar was made shorter aiming to prevent the sub-crestal placement of the RSI. In this way the RSI was strategically positioned at the level of the bone crest to mitigate the risk of marginal bone loss.[19] A study by Hanggi et al. reaffirmed this by concluding that the implants with the shorter smooth collar showed no significant increase in bone loss, minimizing the likelihood of metal exposure particularly in areas of esthetic concern.[20]

Our study had some notable limitation of having only one group that should be taken into account when interpreting its findings. A randomized trial including a test group of implant design without polished collar will give further insight into the biological phenomenon of bone remodelling. Given these limitations, it is important to acknowledge that the study's findings are preliminary and that further research is needed.

CONCLUSION

This study has demonstrated that bone regenerative techniques, were unable to prevent bone remodeling around a polished collar of dental implant. In addition, exposure of the flap margins did have a negative effect on bone gain as biologic bone remodeling was more in such cases. Therefore, the use of the bone augmentation technique in an implant without a polished collar might offer a more predictable outcome for bone augmentation at the crestal level.

DISCLOSURE

No conflict of interest/commercial interest declared by any author.

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