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Evaluation of Crestal Bone Height Post-Implant Placement: A Comparative In-Vivo Analysis Between Calcium Phosphate Coating and Alumina Oxide Blasting: An Original Research Study

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KEYWORDS
Alumino Oxide Blasted Implants; Calcium Phosphate Coated Implants; Crestal Bone Loss; Radiographic Changes

ABSTRACT:

Background: To radiographically evaluate crystal bone height changes around the calcium phosphate coated and alumino oxide blasted implants immediately, one month and three months after placement using a software in radionuclide Ventriculogram (RVG).

Methodology: This experimental randomized controlled clinical trial was conducted for a period 2 year. 30 patients with single posterior edentulous region were selected. These patients were divided into two equal groups with 15 sample size each. 15 patients were rehabilitated using alumino oxide blasted implants & 15 patients with calcium phosphate coated implants. Radiographic evaluation was done immediate after implant placement and follow up evaluation was done at one- and three-month time interval.

Results: Repeated Measure of ANOVA test &Boneferroni Post Hoc analysis were used in the study. The results of the study showed statistically significant difference in the crestal bone loss which was more in alumino oxide blasted implant as compared to calcium phosphate coated implants when measured in mm. It was 3.67±0.51 and 3.05±0.50 immediately after insertion, 3.26±0.50 & 2.77±0.56 at 1 month after placement and 3.08±0.45& 2.68±0.58 at 3-month interval after placement for alumino oxide blasted and calcium phosphate coated implants respectively.

Conclusion: Calcium phosphate coated implants were superior to alumino oxide blasted implants as measured and compared radiographically upto 3 months.

Introduction

The biological response to artificial biomaterials is heavily influenced by the composition and qualities of the surface of the implant. Therefore, altering the surface features of implants aids in the regulation of biological reactions. Primary stability, a crucial factor for successful implant integration and early healing, is primarily determined by the endosseous design of the implant (including length, diameter, shape, and threads). Other factors that influence primary stability include the surgical technique, volume, and mechanical quality of the surrounding bone. The osteoconductive qualities of the implant surface are parameters that influence the primary and secondary stability of the implant, as well as the quality of the bone-implant interface [1]. Various methods can be used to alter the surface of an implant, including acid etching, electrolysis, particle blasting, or

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applying a coating of crystalline minerals like Hydroxyapatite (HA)[2,3]. The issue of crystal bone loss associated with dental implants is a clinically relevant occurrence [4]. Radiographic techniques have been extensively employed to assess the extent of alveolar bone loss that has occurred around teeth and/or implants [5]. The presence of surface irregularities on the implant is beneficial for osseointegration and bone formation because it increases the surface area, which is crucial for promoting the expression of the osteoblast phenotype [6]. Calcium phosphate (CaP) coatings improve the process of bone integration with a dental implant because of their biologically active surface chemistry. The calcium phosphate coatings possess advantageous characteristics, including a thin coating thickness ranging from 20-30µm, a substantial active surface area, and a high capillarity of blood that promotes the body's natural osteosynthesis[7,8]. The use of alumina oxide blasted implants led to notable enhancements in bone tissue reactivity through the alteration of the surface oxide characteristics of titanium implants. The tissue reactions to oxidized titanium implants, which were oxidized by alumina oxide blasting, were significantly strengthened. This led to a more robust connection between the implant and the bone, as found in previous studies [2,9]. This study aimed to assess the bone modifications surrounding alumina oxide blasted implants and calcium phosphate coated implants, and to compare the bone alterations around these two distinct coated implants at various time intervals.

Materials and Method

An experimental study design was employed for comparison of the two groups.A total of 30 implantation sites were segregated into 2 groups.Group 1 having 15 patients with alumino oxide blasted implants placement & Group 2 having 15 patients with calcium phosphate coated implant placement. The methodology of the study was divided into following steps-Diagnostic procedure, Implant selection and surgery and Radiographic evaluation of crestal bone heights. Diagnostic procedure: The procedure for this prospective experimental study involved proper screening and selection of patient for implant placement in healed socket. Inclusion criteria comprised of patients who required replacement of their posterior missing teeth and had adequate bone volume to accommodate an implant of appropriate dimensions. Those with good oral hygiene, who were willing for the surgery and proper follow up, with no relevant medical history and no history of previous implants, were selected. Exclusion criteria comprised of medically compromised patients in whom surgery was contraindicated, patient with poor oral hygiene, local inflammation or mucosal diseases and cases where there was need for bone or soft tissue augmentation in the planned surgical site. Patients having any parafunctional habits, suffering from periodontal diseases, treated cases of acute periodontal therapy within 1 year of the onset of study and having temporomandibular joint disorders were also excluded.Physically handicapped patients, heavy smokers and drug users were also not included in the study. Thorough investigations including complete haemogram, bleeding time and clotting time were done to evaluate the fitness of the patient. For surgery pre surgical protocol includes study models were prepared for each patient and occlusal analysis was performed over the study model.IOPAR and panoramic radiographs were taken for radiographic analysis and for 3 dimensional view of bone CBCT was done and based on that implant size selection and its angulations were decided. According to CBCT and diagnostic cast surgical template was fabricated. Oral prophylaxis was done before the planned implant placement. Pre surgical medication protocol was followed for each patient.Before surgery consent form from the patient was also obtained**.** Implant selection and surgery: For group A alumina oxide blasted implant were used and for group B calcium phosphate coated implants were used.Implants were placed using two-stage buried protocol. One week later suture were removed. Radiographic evaluation of crestal bone heights: Digital radiographs were taken with a standardized protocol at the time of placement of dental implant just after surgery. Site was exposed while sensor was supported with its holder, thus ensuring that the plane of the sensor was always parallel to the long axis of implant and thus parallelism was maintained. Sensor was exposed at 70 kilovolts (peak), 10 mA, and 38 impulses with constant focal-sensor distance using a routinely monitored x-ray machine. The landmark used for bone changes determinations was the uppermost limit of the porous-coated segment of each implant, and the bone measurement was recorded for each 0.1 mm above or below this landmark. Bone evaluation was done from

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upper most porous coated segment to bone height from mesial and distal aspect of implant.Suni ray dental imaging software was used to analyse the bone height. Digital radiograph was taken again after one month and three month of implant placement with same above mentioned protocol and bone changes were evaluated.The dimensional changes were nullified by calibrating the radiographic implant length to the original implant length.

Statistics

Data was analysed using SPSS software Version 25.0 (SPSS Inc., Chicago, IL, USA). Comparison of mean crestal bone loss between different time intervals among same group was done with Repeated Measure of ANOVA test. Boneferroni Post Hoc analysis was used for intergroup comparison between different time intervals. Comparison of mean crestal bone loss among alumina oxide & calcium phosphate coated implant at follow up was done with Student 't' test Value. Crestal bone loss was significantly more among alumina oxide blasted implants as compare to calcium phosphate coated implants and it was decreasing among both the groups with the time. There was statistically highly significant difference found in crestal bone height among both the groups.

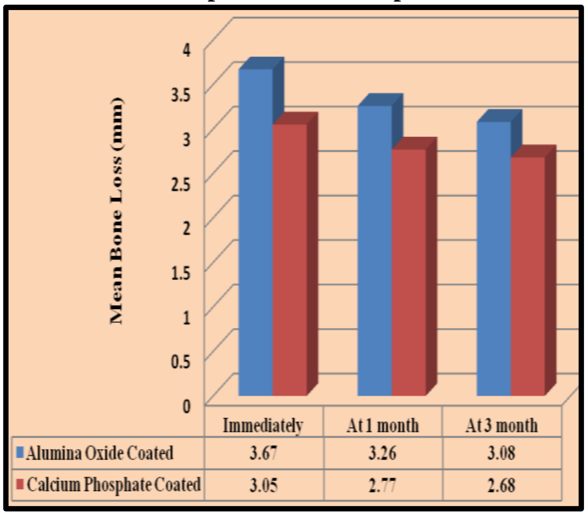
Result

The mean crestal bone loss was 3.67±0.51 and 3.05±0.50 immediately after insertion among both the groups i.e. alumina oxide & calcium phosphate coated implant respectively, which was statistically highly significant (p=0.002). It was 3.26 ± 0.50 & 2.77±0.56 at 1 month interval after placement and was 3.08±0.45 & 2.68±0.58 at 3 months interval. Both these results were statistically significant at (p=0.017) and (p=0.046) respectively. Table 1, Graph 1.

Table 1: Comparison of mean crestal bone loss among alumina oxide & calcium phosphate coated implant at follow up

Groups	Implants	CRESTAL BONE LOSS (mm)		
		Immediately	At 1 month	At 3 month
Group I	Alumina Oxide Coated	3.67±0.51	3.26±0.50	3.08±0.45
Group II	Calcium Phosphate Coated	3.05±0.50	2.77±0.56	2.68±0.58
Student 't' test Value		3.367	2.259	2.087
Significance 'p' Value		0.002(HS)	0.017(S)	0.046(S)

Graph 1: Comparison of mean crestal bone loss among alumina oxide & calcium phosphate coated implant at follow up



The mean crestal bone height for alumina oxide coated implants was significantly decreasing

till 3 month follow up. It was 3.67±0.51 immediately after insertion, 3.26±0.50 at 1 month &

2.33±0.51 at 3month. Table2, Graph 2.

Table 2: Comparison of mean crestal bone loss between different time intervals among alumina oxide blasted implant

Groups	Implants	CRESTAL BONE LOSS (mm)		
		Immediately	At 1 month	At 3 month
Group I	Alumina Oxide blasted	3.67±0.51	3.26±0.50	3.08±0.45
Repeated Measure of ANOVA		39.165		
Significance 'p' Value		0.001(HS)		

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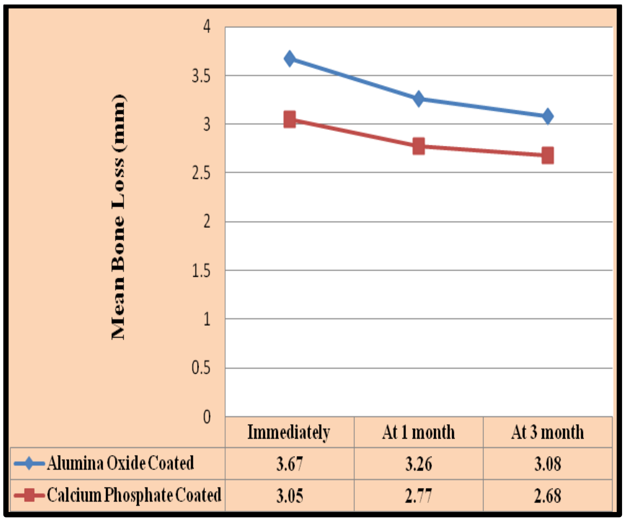
Graph 2: Comparison of mean crestal bone loss between different time intervals among alumina oxide coated & calcium phosphate coated implant



The mean crestal bone height for calcium phosphate coated implant was significantly decreasing till 3 month follow up. It was 3.05±0.50 immediately after insertion, 2.77±0.56 at 1 month & 2.68±0.58 at 3month. Table3.

Table 3: Comparison of mean crestal bone loss between different time intervals among calcium phosphate coated implant

Groups	Implants	CRESTAL BONE LOSS (mm)		
		Immediately	At 1 month	At 3 month
Group I	Calcium Phosphate Coated	3.05±0.50	2.77±0.56	2.68±0.58
Repeated Measure of ANOVA		32.264		
Significance 'p' Value		0.001(HS)		

Discussion

Osseointegration involves a sequence of bone modeling and remodeling processes. The term "osseointegration" refers to the direct physical and functional attachment between biological bone and a load-bearing artificial implant [10]. Osteoblast adhesion, attachment, spreading, and metabolism can be directly affected by surface roughness, which in turn modifies and regulates the osseointegration process. The influence of surface properties on cell response may be attributed to surface characteristics and changes caused by protein deposition, which determine the initial cellular processes at the interface between the cell and the substance [11,12]. While the moderately roughened surfaces exhibited a more robust osseous response compared to the other surfaces examined in live subjects, bioactive implants have been reported to yield favourable outcomes due to their ability to provide both chemical and biomechanical anchoring. The bioactive implant consists of a dental implant that is covered with calcium phosphate [10,13]. An effective coating surface should fulfill the following criteria: enhance cell attachment, promote cell differentiation and bone apposition, facilitate bone fixing, control the rate of dissolution in bodily fluids, and exhibit therapeutic properties [14,15]. Cellular adhesion is crucial for establishing a strong and functional connection between the bone and implant, ensuring structural stability. Following the application of smooth surfaced implants, bone resorption begins promptly, leading to the formation of a layer of fibrous connective tissue. In contrast, rough surfaces undergo a process of remodelling [16]. The most commonly utilized blasting media consists of alumina (Al_2O_3) or silica (SiO_2) particles. Utilizing calcium phosphate as a coating material enhances the ability to withstand shear stresses generated during the placement of an implant. Lezzi et colleagues found that there was an absence of inflammatory cells in the tissues around titanium implants coated with calcium phosphate [17,18]. The current investigation involved the radiographic evaluation of titanium implants with identical macroscopic shapes but differing surface characteristics at various time intervals. Initially, a follow-up was conducted one month following the insertion of the implant, and subsequently, another follow-up was done three months after the insertion. All thirty implants that were put successfully integrated with the surrounding tissue for a period of three months after implantation. They showed stable fusion without any signs of infections around the implants. The radiographic

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assessment using standardized periapical radiography confirmed the clinical observations of an implant with functional ankylosis, as none of the thirty implants showed a continuous radiolucent area around the implant. The evaluation of crystal bone loss shown a notable reduction in bone loss for implants coated with calcium phosphate (CPC) compared to implants blasted with alumino oxide (AOB) at one and three months after implant implantation. The observed disparity between CPC and AOB implants can likely be ascribed to variances in surface features, as the CPC surface exhibits superior osteoconductive properties in comparison to the AOB surface. The rate of crestal bone loss was much higher in alumina oxide blasted implants compared to calcium phosphate coated implants. However, over time, the rate of crestal bone loss decreased in both groups. The values recorded immediately after insertion was 3.67±0.51 and 3.05±0.50 for both groups, respectively. A statistically significant difference in crestal bone height was observed between groups A and B, with a p-value of 0.002. There was a substantial difference in bone loss between alumino oxide blasted and calcium phosphate coated implants during the first and third month. The assessed The crestal bone loss observed after one month is likely a result of the surgical trauma. This is because the elevation of a mucoperiosteal flap during the surgery restricts the vascular supply in the crestal areas. Additional crestal bone resorption has occurred three months later, and this resorption is most likely due to the natural remodeling process of the alveolar bone. Due to the oseoconductive feature of calcium phosphate coated implants, there has been observed a production of new bone with reduced bone loss around them. This study has inherent limitations. The primary constraint was the limited duration of the observation period. Another constraint was the reduced sample size. Another constraint was the standardization of subjects. In order to achieve more precise results, it is necessary to standardize criteria such as the location where the implant is placed, the age and sex of the patient, the bone density at the implant site, and the size of the implant. It is recommended to conduct future long-term research with larger sample sizes and improved standardization procedures for patient selection.

Conclusion

In the present study calcium phosphate coated implants were compared radiographically to alumino oxide blasted implants on posterior maxillary and mandibular regions up to 3 months. Radiographic assessment of bone changes in implants was carried out by measuring the distance between reference line (i.e. implant coated part) and most coronal bone implant contact. After both mesial and distal evaluation it was found that calcium phosphate coated implants shows significantly less bone loss as compared alumino oxide blasted implants. It was also found that after placement of both types of implants there was significant bone loss in one and three month.Within limitation of the study, it was concluded that calcium phosphate coated implants are superior to alumino oxide blasted implants as measured and compared radiographically up to 3 months.

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