An In Vivo Assessment of Effect of three Different Implant Abutment Materials on the Crestal Bone Levels: One Year Observational (Original Research) Study

Dr. Hemant Ramesh Chourasia[1], Dr. Uma H. Chourasia[2], Dr. Kulashekar Reddy Nandalur[3], Dr. Juhi Jaiswal[4], Dr. Pinki Bankoti[5], Dr. Margee Desai Sharma[6]

[1]Associate Professor, Department of Restorative Dental Sciences, College of Dentistry, Jazan University, Jazan, Saudi Arabia
[2]Assistant Professor, Department of Obstetrics and Gynaecology, College of Medicine, Jazan University, Jazan, Saudi Arabia
[3]Assistant Professor, Prosthetic Dental Sciences, Jazan University, Jazan, Saudi Arabia
[4]Reader, Department of Prosthodontics and Crown & Bridge, Institute of Dental Sciences, Bareilly, Uttar Pradesh, India
[5]Reader, Department of Prosthodontics and Crown & Bridge, Institute of Dental Sciences, Bareilly, Uttar Pradesh, India
[6]Reader, Department of Oral Medicine and Radiology, Pacific Dental College and Hospital, Udaipur, Rajasthan, India

Corresponding Author: Dr. Hemant Ramesh Chourasia,
Email: drhemantrchourasia@gmail.com

Abstract

Background and Aim: Implant abutment plays an important role in overall implant success and longevity. Different abutment materials have been experimented to see associated crestal bone losses around implants. Since crestal bone loss is directly related to the implant stability, it is highly significant to explore these clinical factors. Therefore this (one year observational) in vivo study was conducted to assess the effect of three different abutment materials on the crestal bone levels.

Materials & Methods: Total three different and popular implant abutment materials were selected for this study. PEEK (Polyether Ether Ketone), surgical grade stainless steel and Titanium have been studied in total 24 patients in which maxillary central incisor was restored by implant. Both male and female patients were included in the study in the age range of 28 to 42 years. Group 1 included 8 patients in which PEEK (Polyether Ether Ketone) based abutment was used. In group 2 total 8 patients were studied in which abutment of Surgical grade stainless steel was used. In group 3 total 8 patients were studied in which Titanium abutment was used. Patients were recalled after 6 months and 12 months periods and means of all four surfaces were taken in to account (for assessing crestal bone levels). P value less than 0.05 was considered significant ($p< 0.05$).

Statistical Analysis and Results: Out of 24 patients, males were 15 and females were 9. For group 1; assessments were made after 6 months and 12 months post operative periods. In 6 months post operative period the mean bone level was 0.29 and in 12 months post operative period the mean bone level was 0.34. The p value was highly significant for 6 months post operative period. For group 2: assessments were made after 6 months and 12 months post operative periods. In 6 months post operative period the mean bone level was 0.32 and in 12 months post operative period the mean bone level was 0.42. The p value was highly significant for 6 months post operative period. Comparison among the 3 study groups was attempted by using one-way ANOVA [for group I, II, III]. Here the estimated p value was highly significant (0.001).

Conclusion: Authors concluded that among the all three studied abutment materials, PEEK (Polyether Ether Ketone) and Titanium showed almost similar bone heights in their post operative phases. Moreover, Surgical Grade Stainless Steel showed maximum heights of crestal bone in 6 and 12 months post operative phase therefore stated best among all three. Furthermore, other long term studied are also expected to be performed to validate these outcomes and results.

Key Words: Implant Abutment, Dental Implant, Prosthodontics, Bone Loss, PEEK, Titanium
DOI Number: 10.48047/Nq.2022.20.17.Nq880280 **Neuroquantology 2022; 20(17):2161-2167**

Introduction

Many of the researchers in the literature have searched about different aspects of crestal bone loss around dental implants. Mostly, the studies suggested that this event is multi-factorial in nature and can be minimized by various measures and cautions.[1,2] Bone loss around implants is a negative sign for longevity of the prosthesis. This event of bone loss is typically initiated by biological activities around the implant and implant abutment junctions. Many of such processes are related to bacterial growth and development.[3,4] Clinicians have also stated that abutment material has also significant role in peri-implant health. Therefore, considering all these factors this study was designed and executed. In literature many abutment materials have been exercised. PEEK is somewhat newer material to be used as abutment material. Similarly surgical grade stainless steel is also novel abutment material which are used these days.[5,6] All these materials have their own advantages and disadvantages but none of the material guarantee about bone loss. As per clinical reports and other studies, crestal bone loss is seen almost with all these three tested materials. However their magnitude and patterns may be different depending upon clinical materials and host responses.[7] Therefore this (one year observational) in vivo study was conducted to assess the effect of three different implant abutment materials on the crestal bone levels.

Materials & Methods

The study was abstracted and performed with the sole aim to assess the best abutment material which exhibit minimum crestal bone loss. This observation based study was performed completed and drafted in October 2022. We have studied three different and popular implant abutment materials for this purpose. Presently, titanium based implant abutments are being utilized worldwide. However, experiments are also going on the exploration of best abutment material which could minimize the associated bone loss. PEEK (Polyether Ether Ketone), Surgical Grade Stainless Steel and Titanium have been studied in detail in our study. Total 24 patients were included in the study in which maxillary central incisor was missing due to miscellaneous

reasons. Rehabilitation was planned by dental implant and related prosthesis. After all radiological and laboratory investigations, the suitable dimensions and size of implant was decided. Standard osteotomy procedure was followed for the placement of single implant in all cases. Additionally, all implant surgeries were performed by single operator to avoid any operational bias and related differences. Both male and female patients were included in the study in the age range of 28 to 42 years. Systemic sampling was used for the study. The study design and procedure was explained to all participating patients and informed signed consent was obtained from all patients individually. Each patient was called after three month of their respective stage one surgery to initiate stage to surgery. Therefore, patients with any kind of follow up issue were strictly excluded from the study. Patients with any serious systemic complications were also excluded from the study. In second phase, stage two surgeries were performed and gingival former placed accordingly. All impressions and laboratory procedures were also completed. Here, patients were decided into three study groups as per the material of their respective abutments. Group 1 included 8 patients in which PEEK (Polyether Ether Ketone) based abutment was used. In group 2 total 8 patients were studied in which abutment of Surgical grade stainless steel was used. In group 3 total 8 patients were studied in which Titanium abutment was used. Final rehabilitations were completed by crown placements. Patients were recalled in their follow up phases to assess the crestal bone levels and estimate any pertinent bone loss. Patients were recalled after 6 months and 12 months periods and means of all four surfaces were taken in to account (for assessing crestal bone levels). For all participants, privacy and other rights were kept completely confidential. Results hence received was entered in table and sent for basic statistical analysis. P value less than 0.05 was considered significant ($p< 0.05$).

Statistical Analysis and Results

Statistical analysis was conducted by statistical software Statistical Package for the Social Sciences version 22 (NY, United States of America). We calculated p values, mean, standard deviation, chi- square test, standard error and 95% CI. Table 2 and Graph 1 confirmed that out of 24 patients, males were 15 and females were 9. Total 5 age based groups were recognized in the range of 28-42 years. In age range of 34-36 years, total 6 patients were present and p value was highly significant here (0.01). Table 1 shows about material based allocations and related groupings of implant studied abutments. Table 3 depicts about basic statistical description with level of significance assessment using pearson chi-square test [for group I: PEEK Abutments: n=8]. Assessments were made after 6 months and 12 months post operative periods. Mean crestal bone levels were estimated on radiographs and compared as and when needed. In 6 months post operative period the mean bone level was 0.29 and in 12 months post operative period the mean bone level was 0.34. The p value was highly significant for 6 months post operative period. Table 4 depicts about basic statistical description with level of significance assessment using pearson chi-square test [for group II: Surgical grade stainless steel Abutments: n=8]. Assessments were made after 6 months and 12 months post operative periods. Mean crestal bone levels were estimated on radiographs and compared as and when needed. In 6 months post operative period the mean bone level was 0.32 and in 12 months post operative period the mean bone level was 0.42. The p value was highly significant for 6 months post operative period. Table 5 depicts about basic statistical description with level of significance

assessment using pearson chi-square test [for group II: Titanium Abutments: n=8]. Assessments were made after 6 months and 12 months post operative periods. Mean crestal bone levels were estimated on radiographs and compared as and when needed. In 6 months post operative period the mean bone level was 0.27 and in 12 months post operative period the mean bone level was 0.32. The p value was highly significant for 6 months post operative period. Table 6 shows about comparison among the 3 study groups using one-way ANOVA [for group I, II, III]. Here the estimated p value was highly significant (0.001).

Table 1: Material based allocations and related groupings of implant studied abutments

Materials	**Group**	**n**	**Component**
PEEK (Polyether Ether Ketone)	I	8	Abutment
Surgical Grade Stainless Steel	II	8	Abutment
Titanium	III	8	Abutment
Total	-	24	-

Table 2: Age & gender wise distribution of patients

Age Group (Yrs)	**Male**	**Female**	**Total**	**P value**
28-30	5	1	6	0.30
31-33	4	2	6	0.10
34-36	2	4	6	0.01*
37-39	3	1	4	0.30
40-42	1	1	2	0.08
Total	15	9	24	***Significant**

Table 3: Basic statistical description with level of significance assessment using pearson chi-square test [for group I: PEEK Abutments: n=8]

Time	**Crestal Bone Level (Mean)**	**Std. Dev.**	**Std. Error**	**95% CI**	**Pearson Chi-Square Value**	**df**	**Level of Significance (p value)**
6 Months	0.29	0.938	0.830	1.23	1.653	1.0	0.01*
12 Months	0.34	0.412	0.561	1.93	1.537	2.0	0.50
***p<0.05 significant**							

Table 4: Basic statistical description with level of significance assessment using pearson chi-square test [for group II: Surgical grade stainless steel Abutments: n=8]

Time	**Crestal Bone Level (Mean)**	**Std. Dev.**	**Std. Error**	**95% CI**	**Pearson Chi-Square Value**	**df**	**Level of Significance (p value)**

6 Months	0.32	0.420	0.430	1.15	1.842	1.0	0.02*
12 Months	0.42	0.243	0.039	1.93	1.783	1.0	0.80
***p<0.05 significant**							

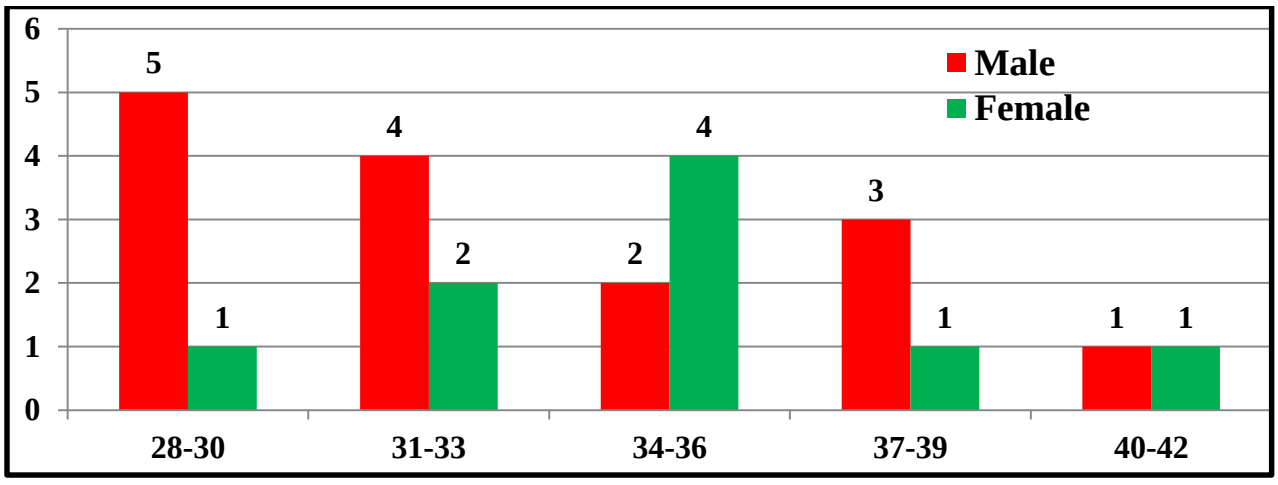
Table 5: Basic statistical description with level of significance assessment using pearson chi-square test [for group III: Titanium Abutments: n=8]

Time	**Crestal Bone Level (Mean)**	**Std. Dev.**	**Std. Error**	**95% CI**	**Pearson Chi-Square Value**	**df**	**Level of Significance (p value)**
6 Months	0.27	0.637	0.232	1.64	1.463	1.0	0.02*
12 Months	0.32	0.223	0.036	1.93	2.527	1.0	0.10
***p<0.05 significant**							

Table 6: Comparison among the 3 study groups using one-way ANOVA [for group I, II, III]

Variables	**Degree of Freedom**	**Sum of Squares ∑**	**Mean Sum of Squares m∑**	**F**	**Level of Significance (p)**
Between Groups	4	3.736	1.383	4.1	0.001*
Within Groups	23	9.639	0.732	-	
Cumulative	192.12	14.932	***p<0.05 significant**		

Graph 1: Age & gender wise distribution of patients



Discussion

Initially, Albrektsson and other fellows have studied the long-term efficacy of currently used dental implants. They also concluded with some recommendations and guidelines for implant success. Their implant success criteria were highly popular and being used these days also.[8] Friberg and Jemt did a study on Rehabilitation of edentulous mandibles by means of five TiUnite implants after one‐stage surgery. It was a 1‐year retrospective study performed on 90 patients. They stated that edentulous situations also behave similarly as in dentulous situation.[9] Al‐Thobity and others studied about Microthreaded implants and crestal bone loss. They have explored the effect of change of thread design on the implant bone loss.[10] Goswami studied and compared crestal bone loss along two implant crest module designs. They stated that bone loss is an unavoidable event and can only be minimized.[11] Similar recommendations and inferences were also noticed in the studies conducted by other pioneer workers.[12,13,14,15] Mortazavi explored about bone loss-related factors in tissue and bone level dental implants.[16] Other researchers have also experimented and explored about the mechanisms and etiology of the crestal bone loss around the implants. Wilson TG has seen bone loss around implants. They aimed to find that is it metallosis or something else. They noticed that its behaviors are somewhat similar to metallosis however underling mechanism and progression patterns were totally different.[17] Sargolzaie and other colleagues have studied about marginal bone loss around crestal or subcrestal dental implants: prospective clinical study. They clearly mentioned that this event diereses the longevity and stability of dental implants.[18]

Conclusion

Within the limitations of the study authors concluded that crestal bone loss is apparently predictable in almost all clinical situations in implantology. Different abutment material exhibits different behavior and reactions to the biological milieu of the surroundings. These events eventually concentrated around the implant abutment junctions. Among the all three tested abutment materials, PEEK (Polyether Ether Ketone) and Titanium showed almost similar bone heights in their post operative phases. However, Surgical Grade Stainless Steel showed maximum heights of crestal bone in 6 and 12 months post operative phases. Therefore Surgical Grade Stainless Steel must be the material of choice for minimizing bone loss around implants. However, these outcomes must not be directly applied to other similar circumstances. Clinician should correlate and consider other imperative factors also like implant material, biocompatibility, host responses, deleterious habits of patients and systemic factors/diseases.

References

1. Misch, CE. Contemporary Implant Dentistry. 3th ed, CV. Mosby Co., St. Louis, Boston, Chicago, London, Philadelphia, Sydney, Toronto, 2008.
2. Albrektsson T, Zarb G, Worthington P & Eriksson R. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11–25.
3. Albrektsson T, Zarb G, Worthington P & Eriksson R. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants 1986;1:11–25.
4. Quoc JB, Vang A, Evrard L. Peri‐implant bone loss at implants placed in preserved alveolar bone versus implants placed in native bone: A retrospective radiographic study. Open Dent J 2018;12:529‐45.
5. Jovanovic SA. Diagnosis and treatment of peri implant complications. In: Newman MG, Takei HH, Carranza FA, editors. Carranza's Clinical Periodontology. 9th ed.

Philadelphia: WB Saunders; 2003. p. 931‑42.
6. Vaillancourt H, Pilliar RM, McCammond D. Factors affecting crestal bone loss with dental implants partially covered with porous coating: A finite element analysis. Int J Oral Maxillofac Implants 1996;11:351‑9.
7. Wiskott HW, Belser UC. Lack of integration of smooth titanium surface: A working hypothesis based on strains generated in the surrounding bone. Clin Oral Implants Res 1999;10:429‑44.
8. Albrektsson T, Zarb G, Worthington P, Eriksson RA. The long‑term efficacy of currently used dental implants: A review and proposed criteria for success. Int J Oral Maxillofac Implants 1986;1:11‑25.
9. Friberg B, Jemt T. Rehabilitation of edentulous mandibles by means of five TiUnite implants after one‑stage surgery: A 1‑year retrospective study of 90 patients. Clin Implant Dent Relat Res 2008;10:47‑54.
10. Al‑Thobity AM, Kutkut A, Almas K. Microthreaded implants and crestal bone loss: A systematic review. J Oral Implantol 2017;8:157‑66.
11. Goswami MM. Comparison of crestal bone loss along two implant crest module designs. MJAFI 2009;65:319‑22.
12. Aparna IN, Dhanasekar B, Lingeshwar D, Gupta L. Implant crest module: A review of biomechanical considerations. Indian J Dent Res 2012;23:257‑63.
13. Barone A, Orlando B, Cingano L, Marconcini S, Derchi G, Covani U. A randomized clinical trial to evaluate and compare implants placed in augmented versus non‑augmented extraction sockets: 3‑year results. J Periodontol 2012;83:836‑46.
14. Kumar P, Dammani B, Mahajani M, et al. (September 11, 2022) A Two-Year Follow-Up Assessment of Decreasing Crestal Bone Levels Around Dental Implants in Patients Rehabilitated With Mandibular Implant Overdentures . Cureus 14(9): e29044.
15. Shokouhi B, Cerajewska T: Radiotherapy and the survival of dental implants: a systematic review . Br J Oral Maxillofac Surg. 2022, 60:422-9.
16. Mortazavi H, Khodadoustan A, Kheiri A, Kheiri L: Bone loss-related factors in tissue and bone level dental implants: a systematic review of clinical trials. J Korean Assoc Oral Maxillofac Surg. 2021, 47:153-74.
17. Wilson TG Jr: Bone loss around implants-is it metallosis? . J Periodontol. 2021, 92:181-5.
18. Sargolzaie N, Zarch HH, Arab H, Koohestani T, Ramandi MF: Marginal bone loss around crestal or subcrestal dental implants: prospective clinical study. J Korean Assoc Oral Maxillofac Surg. 2022, 48:159-66.