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An In Vivo Comprehensive Assessment of Changing Crestal Bone Levels By IP-CB Distance Around Implants Placed in the Anterior Maxillary Region in Patients with and Without Smoking Habit- A Cone Beam Computed Tomography-Based Original Research Study

Dr. Abhigyan Kumar[1], Dr. Abhishek Kumar Pandey[2], Dr. Preeti Rastogi[3], Dr. Saraswati Sachan[4], Dr. Sonam Pandey[5], Dr. Pratik More[6]

[1]Senior Resident, Department of Oral & Maxillofacial Surgery, Kalyan Singh Super Speciality Cancer Institute, Lucknow, UP, India

[2]MDS (Periodontist), Senior Resident, Department of Dentistry, Kalyan Singh Super Speciality Cancer Institute, Lucknow, UP, India (Corresponding Author)

[3]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental Sciences, Lucknow, UP, India

[4]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Sardar Patel Post Graduate Institute of Dental Sciences, Lucknow, UP, India

[5]Junior Resident (JR-1 in Department of Periodontology & Implantology), Babu Banarasi Das College of Dental Sciences, Lucknow, UP, India

[6]Assistant Professor, Department of Conservative Dentistry and Endodontics, School of Dental Sciences, Krishna Vishwa Vidyapeeth (KVV) Deemed to be University, Karad, India

Corresponding Author: Dr. Abhishek Kumar Pandey

Abstract

Aim: *This study aims to assess the change of crestal bone levels by the IP-CB distance around implants placed in the anterior maxillary region in patients with and without smoking habits.*

Materials and Methods: *A study involving 40 individuals aged 25 to 50 who preferred implant placement. Exclusion criteria included mental instability, systemic diseases. Informed consent was obtained from all participants. Cone beam computed tomography (CBCT) was used for implant placement, and patients rinsed with chlorhexidine mouthwash to reduce infection risk. On surgery day, an infraorbital nerve block was administered for implant surgery. The experienced operator performed an incision, ostectomy, and implant placement using a consistent implant kit. After surgery, the flap was sutured. A healing abutment was placed after a two-month healing period, followed by the implant-supported prosthesis fitting in the third month of surgery. The study compared 20 non-smokers (Group 1) to 20 smokers (Group 2), by measuring distances from the implant platform to the crestal bone level at three, six, and nine months to analyze smoking's impact on implant success.*

Statistical Analysis and Results: *This study caught up 40 individuals, aged 25 to 50, with a missing right maxillary central incisor, comprising 21 males and 19 females. All 40 patients preferred implant placement, and a comprehensive cone beam computed tomography (CBCT) was conducted pre-surgery. Patients rinsed with chlorhexidine mouthwash to reduce infection risk, and on surgery day, an infraorbital nerve block was administered for comfort before implant placement. After two months of healing, a healing abutment was added, and an implant-supported prosthesis was fitted by the third month. Patients were divided into two groups: 20 non-smokers and 20 smokers. CBCT measurements from the implant platform to the crestal bone level were taken at three, six, and nine months. Results indicated that normal ranges for non-smokers decreased from 17 to 15 patients over time, while smokers showed a drop from 15 to 13. A one-way ANOVA was utilized to analyze the results across both groups.*

Conclusion: *This study concluded that smokers experienced a moderate yet significant increase in crestal bone loss compared to non-smokers, highlighting the negative effects of smoking on oral health. Smokers exhibited greater marginal bone loss (MBL), increasing the risk of implant failure in the maxilla. Future research should aim to further explore this critical issue to enhance clinical practices and patient outcomes.*

Keywords: *Crestal Bone Levels, Marginal Bone Loss (MBL), Implant Platform, Smoking, Cone Beam Computer Tomography (CBCT), Marginal Bone Loss*

INTRODUCTION

A dental implant is a highly sought-after solution for replacing missing teeth, renowned for its effectiveness in addressing both complete and partial tooth loss. With an impressive success rate exceeding 97% after a decade, dental implants not only restore function but also enhance aesthetics, allowing individuals to regain confidence in their smiles.[1]These sophisticated devices play a crucial role in oral health by preventing tooth decay, preserving bone density in areas that previously housed teeth, and diminishing sensitivity in nearby natural teeth. Crafted from biocompatible materials, implants are strategically placed within the jawbone or surrounding soft tissues to support either fixed prosthetics, like crowns, or removable dental devices, such as dentures.[2,3] For an implant to thrive, it is essential to ensure there is sufficient bone quality and quantity available. Initial bone loss can pave the way for bacterial proliferation, leading to complications such as peri-implantitis, which can result in further bone deterioration and jeopardize the success of the implant.[4,5] The innovative platform switching concept employs a smaller abutment, effectively reducing stress concentrations and minimizing bacterial exposure at the bone crest. This strategic design is instrumental in limiting bone loss, which is a common issue around dental implant. Factors such as surgical trauma, the quality of the surrounding bone or tissue, chewing stresses, inflammation, and the presence of healthy tissue around the implant significantly influence crestal bone loss and, subsequently, the long-term functionality of the implant.[6,7] Recent advancements in dental X-ray imaging, which now elegantly blend both 2D and 3D techniques, play a crucial role in thoroughly evaluating the health and integrity of dental implants. These sophisticated imaging modalities allow dental professionals to conduct meticulous assessments, ensuring that each implant is positioned optimally and functioning correctly.[8,9] Moreover, lifestyle choices, particularly smoking, significantly elevate the risk of implant failure, reflecting the profound impact of personal habits on dental health.[10] The overall success of dental implants hinges on a myriad of factors, encompassing not only the patient's general health and smoking behaviours but also the quality of the available bone, rigorous oral hygiene practices, and the specific characteristics of the implant itself. Additionally, precise placement of the implant and the experience of the dentist performing the procedure are critical components that contribute to successful outcomes. Importantly, it is often the patient-specific factors that exert a greater influence than the attributes of the implant, highlighting the necessity for a comprehensive, holistic approach to dental care that prioritizes the individual needs and circumstances of each patient.[11,12] This study aimed to assess the change of Crestal Bone Levels by IP-CB distance Around Implants Placed in the anterior Maxillary Region in Patients with and without smoking habits

MATERIALS AND METHODS

Initially, the study involved 50 patients who presented with the common complaint of a missing maxillary right central incisor and expressed a desire for its replacement. Among these 50 individuals, 40 expressed their preference for implant placement and the use of implant-supported prostheses. This research focused on a cohort of 40 patients aged between 25 and 50 years, inclusive of both males and females, specifically targeting those with a missing right maxillary right central incisor. The study's inclusion criteria permitted individuals aged 25 to 50 years and smoking patients, while exclusion criteria ruled out patients who were mentally unstable, suffering from systemic diseases. Informed consent was diligently obtained from all participants who were willing to take part in the study. In order to achieve precise implant placement, comprehensive cone beam computed tomography (CBCT) analyses were meticulously conducted before the surgical intervention. In preparation for the procedure, patients were carefully instructed to rinse with a chlorhexidine mouthwash, a step designed to minimize the risk of infection and enhance oral hygiene. On the day of surgery, around 2-3ml of 2% Lidocaine with epinephrine was used for an infraorbital nerve block and was skillfully administered to ensure the highest level of comfort for the patient during the process. The surgical procedure commenced with a deliberate incision, followed by a careful ostectomy, in which the implant was strategically and expertly positioned. Remarkably, the entire procedure was conducted by a single experienced operator, who utilized a consistent implant kit and system throughout to maintain procedural integrity. After the implant was successfully placed, the surgical flap was meticulously repositioned to cover the area of intervention, and sutures were applied with precision to promote optimal healing. Following a healing period of two months, a healing abutment was placed onto the implant to facilitate proper soft tissue adaptation. By the third month post-surgery, the implant-supported prosthesis was fitted onto the implant, and careful measurements were taken to assess the distance from the implant platform to the crestal bone level for each implant. The study comprised a total

of 40 patients, who were thoughtfully divided into two distinct groups for comparative analysis. Group 1 consisted of 20 non-smoker patients, whose distances from the implant platform to the crestal bone level were evaluated using CBCT at three, six, and nine-month intervals post-implantation. Conversely, Group 2 encompassed 20 patients who were smokers, and their implant platform to crestal bone level distances was measured at the same intervals. All measurements were attempted at all four surfaces (mesial, distal, buccal, lingual) of each implant side. However, combined arithmetic average of all four distances were taken and forwarded for statistical analysis of that particular implant. The implant platform to the crestal bone level usually falls in the normal range of 1.0-1.5mm.[3,5,8,11] Statistical analyses were performed to scrutinize the outcomes between these two groups, yielding invaluable insights into the influence of smoking on the success and longevity of dental implants. This study assesses the change of crestal bone levels by the IP-CB distance around implants placed in the anterior maxillary region in patients with and without smoking habits.

Statistical Analysis and Results

In this study, we used SPSS software version 22.0 for all our data analysis. SPSS is a useful tool for working with statistics in the social sciences. To check the significance of our findings, we used the chi-square test. This test is good for comparing differences in proportions among different groups. It helped us make thorough comparisons of categorical data. This way, our results accurately show the trends and relationships in the data.

RESULTS

A study initially involving 50 patients presented with the common complaint of a missing maxillary right central incisor and expressed a desire for its replacement. Among these individuals, 40 expressed their preference for implant placement and the use of implant-supported prostheses. This research focused on a cohort of 40 patients aged between 25 and 50 years, including both males and females, specifically targeting those with a missing right maxillary central incisor. Table 1 shows the statistical description of age and gender of the contributing patients, while Graph 1 illustrates the demographic distribution and associated details, comprising a total of 21 males and 19 females. To ensure precise implant placement, comprehensive cone beam computed tomography (CBCT) analyses were conducted before the surgery. Patients were instructed to rinse with chlorhexidine mouthwash to reduce the risk of infection. On the day of the procedure, an infraorbital nerve block was administered for patient comfort. The surgery began with an incision and careful ostectomy, during which the implant was expertly positioned by a single operator using a standardized implant kit. After placing the implant, the surgical flap was repositioned and sutured to promote optimal healing. Following a two-month healing period, a healing abutment was added, and by the third month, the implant-supported prosthesis was fitted. The study included 40 patients divided into two groups: Group 1, consisting of 20 non-smokers, and Group 2, comprising 20 smokers. Distance measurements from the implant platform to the crestal bone level were taken at three, six, and nine months post-implantation using CBCT. All measurements were attempted at all four surfaces of each implant side. Table 2 shows the results for Group 1 (n=20) after three months, where the IP-CB distances were assessed to evaluate the diminishing crestal bone levels in non-smokers. All estimations were conducted radiographically using three-dimensional CBCT. A statistical analysis utilizing the Pearson Chi-Square test was performed to determine the significance of the findings, with normal ranges observed in 17 patients. Table 3 presents the results for Group 1 (n=20) after six months, showing that the IP-CB distances were again estimated for non-smokers, with normal ranges observed in 16 patients. Table 4 shows the results for Group 1 (n=20) after nine months, with normal ranges observed in 15 patients. Table 5 illustrates the results for Group 2 (n=20) after three months, where the IP-CB distances were assessed for smokers, revealing normal ranges in 15 patients. Table 6 displays the results for Group 2 (n=20) after six months, with normal ranges seen in 14 patients. Table 7 shows the results for Group 2 (n=20) after nine months, with normal ranges observed in 13 patients. Lastly, Table 8 presents the estimations among all studied groups using one-way ANOVA.

Table 1: Age & gender based statistical description of contributing patients

Age Group (Yrs)	Male	Female	Total	P value
25-30	4	4	8	0.02*
31-35	6	5	11	0.03*
36-40	3	7	10	0.01*

41-45	3	2	5	0.60
46-50	5	1	6	0.50
Total	21	19	40	*Significant
*p<0.05 significant				

Graph 1: Patients demographic distribution and associated details

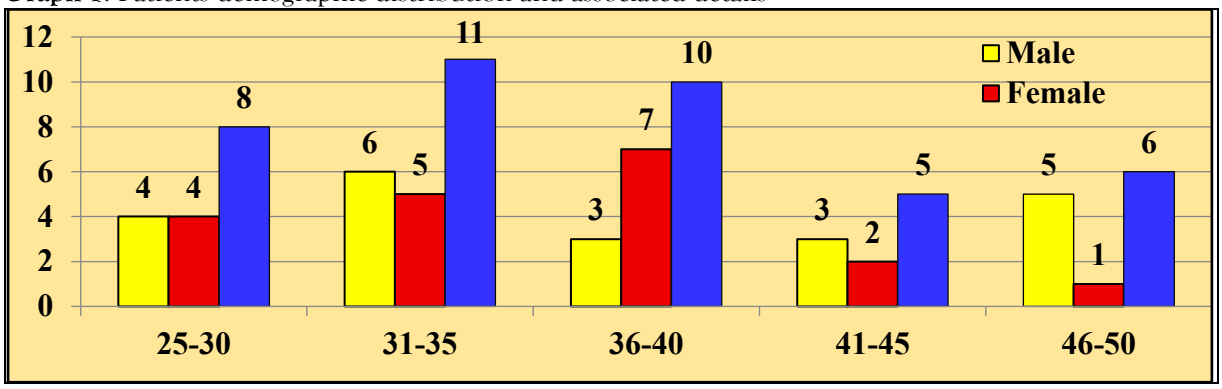

Table 2: Group 1(n=20) Implants were placed and after period of 3 months, the IP-CB distances were estimated to assess the diminishing Crestal Bone Levels in patients without smoking habits. All estimations were performed Radiographically by three-dimensional CBCT. Following this, a statistical analysis was performed utilizing the Pearson Chi-Square test to determine the significance of the findings

Parameters	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Within the normal range (1-1.5mm)	` 17	2.24	2.10	2.167	2.180	2.45	2.232	1.0
Up to 2.5mm	2	1.09	0.08	1.098	1.070	1.10	1.082	1.0
More than 2.5mm	1	1.02	0.03	1.023	0.060	1.09	1.002	0.02*
*p<0.05 significant								

Table 3: Group 1 (n=20) Implants were placed and after period of 6 months, the IP-CB distances were estimated to assess the diminishing Crestal Bone Levels in patients without smoking habits. All estimations were performed Radiographically by three-dimensional CBCT. Following this, a statistical analysis was performed utilizing the Pearson Chi-Square test to determine the significance of the findings

Parameters	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Within the normal range (1-1.5mm)	16	2.20	2.08	2.107	2.110	2.05	2.092	1.0
Up to 2.5mm	3	1.09	1.23	1.09	1.090	1.01	1.020	0.01*
More than 2.5mm	1	1.02	0.03	1.023	0.060	1.09	1.002	0.02*
*p<0.05 significant								

Table 4: Group 1 (n=20) Implants were placed and after period of 9 months, the IP-CB distances were estimated to assess the diminishing Crestal Bone Levels in patients without smoking habits. All estimations were performed Radiographically by three-dimensional CBCT. Following this, a statistical analysis was performed utilizing the Pearson Chi-Square test to determine the significance of the findings

Parameters	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square	df	p value

						Value		
Within the normal range (1-1.5mm)	15	2.14	2.01	2.009	2.098	2.04	2.032	0.03*
Up to 2.5mm	3	1.09	1.23	1.09	1.090	1.01	1.020	0.01*
More than 2.5mm	2	1.04	0.08	1.098	1.070	1.10	1.082	1.0
*p<0.05 significant								

Table 5: Group 1(n=20) Implants were placed and after period of 3 months, the IP-CB distances were estimated to assess the diminishing Crestal Bone Levels in patients with smoking habits. All estimations were performed Radiographically by three-dimensional CBCT. Following this, a statistical analysis was performed utilizing the Pearson Chi-Square test to determine the significance of the findings

Parameters	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Within the normal range (1-1.5mm)	15	2.14	2.01	2.009	2.098	2.04	2.032	0.03*
Up to 2.5mm	3	1.09	1.23	1.09	1.090	1.01	1.020	0.01*
More than 2.5mm	2	1.04	0.08	1.098	1.070	1.10	1.082	1.0
*p<0.05 significant								

Table 6: Group 1(n=20) Implants were placed and after period of 6 months, the IP-CB distances were estimated to assess the diminishing Crestal Bone Levels in patients with smoking habits. All estimations were performed Radiographically by three-dimensional CBCT. Following this, a statistical analysis was performed utilizing the Pearson Chi-Square test to determine the significance of the findings

Parameters	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Within the normal range (1-1.5mm)	14	2.09	2.001	2.007	2.068	2.01	2.012	0.02*
Up to 2.5mm	2	1.09	0.08	1.098	1.070	1.10	1.082	1.0
More than 2.5mm	4	1.10	1.43	1.56	1.130	1.02	1.030	0.01*
*p<0.05 significant								

Table 7: Group 1(n=20) Implants were placed and after period of 9 months, the IP-CB distances were estimated to assess the diminishing Crestal Bone Levels in patients with smoking habits. All estimations were performed Radiographically by three-dimensional CBCT. Following this, a statistical analysis was performed utilizing the Pearson Chi-Square test to determine the significance of the findings

Parameters	N	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Within the normal range (1-1.5mm)	13	2.02	2.01	2.02	2.023	1.01	1.019	0.01*
Up to 2.5mm	2	1.09	0.08	1.098	1.070	1.10	1.082	1.0
More than 2.5mm	5	1.12	1.67	1.76	1.140	1.34	1.035	0.01*
*p<0.05 significant								

Table 8: Estimation amongst all studied groups using one-way ANOVA

Variables	Degree of Freedom	Sum of Squares ∑	Mean Sum of Squares m∑	F	Level of Sig. (p)
Between Groups	2	1.543	1.342	1.2	0.001*

Within Groups	16	2.145	1.452	_
Cumulative	24.16	02.304	*p<0.05 significant	

DISCUSSION

Kwok V et al reviewed in their study that dental implants have emerged as a highly effective solution for addressing the issue of missing teeth, providing a durable and aesthetically pleasing option for individuals seeking restorative dental work. Whether for a single tooth, several adjacent teeth, or even a complete arch of teeth, these implants can restore both function and confidence in one's smile.[13,14] Torof E et al showed in their study that as the popularity of dental implants continues to grow, dental professionals are encountering an increasing number of patients who have opted for these implant-supported restorations. Nevertheless, the journey to a successful implant can sometimes be hampered by complications such as screw loosening or peri-implant diseases, both of which can jeopardize the longevity and reliability of the implant. Proper care and monitoring are essential to ensure the best outcomes for those who choose this transformative dental solution.[15,16] Juan-Montesinos A et al included in their study that crestal bone loss serves as a fundamental indicator of the success of dental implants, with an expected loss in the initial year typically ranging from less than 1 to 1.5 mm. Early failures of implants can arise from various factors, including surgical trauma, improper techniques, and the design of the implant itself. While moderate bone loss shortly after placement may not necessarily jeopardize osseointegration—the natural process through which the implant fuses with the jawbone—it can adversely affect aesthetic outcomes, particularly in cases where patients have thin bone structures.[17,18] Artzi Z et al reviewed in their study that the long-term maintenance of crestal bone is crucial, not only for ensuring the stability of the implant but also for preserving the health of the surrounding soft tissues. Recent advancements in our understanding of the biological processes involved in osseointegration have paved the way for the acceptance and implementation of innovative techniques, such as platform switching, in dental implant design. This method enhances the fit and functionality of implants while playing a vital role in improving long-term success for patients. By redistributing stress around the implant, platform switching fosters better bone preservation and promotes superior aesthetic results, ultimately leading to enhanced patient satisfaction and outcomes.[19,20] Patel S et al included in their study that a revolutionary tool in this field is Cone Beam Computed Tomography (CBCT), which offers exceptional imaging capabilities for maxillofacial structures. By addressing the limitations of traditional imaging methods, CBCT provides a more detailed and accurate three-dimensional representation, allowing for better planning and execution of implant procedures.[21] Mustapha AD et al showed in their study that smoking is a major risk factor for early implant failure, particularly in the maxilla. This type of early failure, which occurs prior to the connection of the abutment, can lead to significant stress and anxiety for patients. Various factors contribute to this issue, including oral hygiene practices, smoking habits, vitamin D levels, the specific characteristics of the implant used, and the administration of antibiotics. Among these, the detrimental impact of smoking on osseointegration is particularly well-documented, underscoring the importance of addressing this habit in patients undergoing implant therapy.[22,23]

CONCLUSION

Within the limitations of the study, authors examined the alteration in crestal bone levels as measured by the distance from the implant platform (IP-CB distance) within the anterior maxillary region, focusing on patients with varying smoking habits. The research uncovered a troubling trend: individuals who engaged in smoking demonstrated a moderate yet significant rise in crestal bone loss when compared to their non-smoking counterparts. This finding reveals the detrimental impact of smoking on oral health, highlighting a clear association between tobacco use and the deterioration of bone structure in the jaw. In particular, smokers demonstrated a pronounced degree of marginal bone loss (MBL), a factor that increases the risk of implant failure, especially in the vulnerable maxillary architecture. As we move forward, it will be essential for future research to be both thorough and expansive to deepen our understanding of this critical issue, ultimately leading to improved clinical practices and patient outcomes.

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