



An in Vivo Imperative Assessment of Varying Crestal Bone Levels by Peri-Implantitis Staging Around Implants Placed in the Posterior Mandibular Region in Patients with Hyperthyroidism and Vitamin D Deficiency: A Cone Beam Computed TomographyBased Original Research Study

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ABSTRACT:

Aim: This study aimed to assess the varying crestal bone levels by peri-implantitis staging around implants placed in the posterior mandibular region in patients with hyperthyroidism and vitamin D deficiency.

Materials and Methods: This study involved 40 patients with hyperthyroidism or vitamin D deficiency seeking replacements for missing posterior right mandibular first molars, out of 60 patients who initially participated. Informed consent was obtained, and inclusion criteria included patients aged 35 to 60; mentally unstable individuals and smokers were excluded. Cone beam computed tomography (CBCT) was used, and a chlorhexidine mouthwash was administered pre-operatively. Local anaesthesia was provided via an inferior alveolar nerve block. Patients were divided into two groups: 20 with hyperthyroidism and 20 with vitamin D deficiency. The main goal was to assess crestal bone loss at 2 and 4 months post-implant placement to evaluate bone integration and stability between the groups.

Statistical Analysis and Results: This study was analysed by SPSS software and consisted of 40 patients, including both males and females. A Cone Beam Computed Tomography (CBCT) evaluation determined implant size and bone quality, dividing participants into Group 1 (20 with hyperthyroidism) and Group 2 (20 with vitamin D deficiency). Crestal bone levels were assessed at 2- and 4-month post-implant placement. After 2 months, Group 1 showed early-stage peri-implantitis in 14 patients and advanced-stage in 2, while Group 2 had 12 with early-stage and 3 with advanced-stage. After 4 months, Group 1 had 13 with early-stage and 2 with advanced-stage, whereas Group 2 had 14 with early-stage and 2 with advanced-stage. A one-way ANOVA comparison indicated significant differences in crestal bone loss across groups related to peri-implantitis.

Conclusion: This study concluded that patients with thyroid disorders can successfully receive



dental implants, achieving survival rates similar to those without such disorders. Vitamin D supplementation enhances osseointegration, and low serum vitamin D is linked to higher implant failure and greater bone loss. Administering vitamin D supplements a week before surgery may mitigate these risks.

Introduction

"Peri-implant disease" encompasses conditions affecting the tissue around a dental implant, particularly peri-implantitis, characterized by inflammation and bone loss. Peri-implantitis staging is early, moderate, and advanced. It has been indicated that 5% to 8% of individuals with certain implants may develop this condition, often due to specific bacteria that thrive in low-oxygen environments. Additionally, uneven chewing pressure on the implant can lead to loosening or infection, worsening inflammation.¹⁻³ An implant is considered unsuccessful if it becomes loose, is lost, or shows significant bone loss, more than 1.0 mm in the first year and 0.2 mm in subsequent years. If peri-implantitis isn't treated, it can lead to ongoing bone loss and, eventually, the loss of the implant itself.⁴ In general, the best outcome of treating peri-implantitis is the regeneration of the crestal bone loss and soft tissues that support the implant. Historically, a type of implant made from pure titanium with a smooth surface, developed by Per-Ingvar Branemark, showed minimal bone loss, typically about 1.0 mm in the first year and then about 0.2 mm each year after.^{5,6} Many believed that once the bone stabilized between the first and second threads of the implant, it would remain stable for years. However, in cases where bone loss and inflammation occur, the presence of certain bacteria can lead to confusion, making it seem like peri-implant problems are similar to traditional gum disease. When peri-implant bone loss or inflammation is noticed, treating the bacterial infection might help alleviate symptoms, but it won't fix the underlying issues, which often stem from misdiagnosis or poor treatment plans by unaware dental professionals.^{7,8} Cone beam computed tomography (CBCT) is increasingly used to evaluate the success of dental implants. It provides essential information for selecting the size and location of implants by revealing their position, surrounding anatomical structures, and details about bone angulation, contour, and thickness. CBCT also helps identify peri-implant damage accurately, all while offering 3D and multiplanar views without the higher costs and radiation exposure associated with traditional CT scans.^{9,10} Vitamin D is crucial for maintaining healthy bones as it helps the body absorb calcium and phosphate. This raised questions about how a lack of vitamin D might affect the success of dental implants. Similarly, thyroid hormones are important for bone

growth and health.¹⁰ Changes in these hormones can lead to issues like poor bone development, bone loss, and increased risk of fractures. Although it has long been known that thyroid problems can lead to bone diseases, the connection between thyroid hormone levels and conditions like osteoporosis is still not fully understood.¹¹ The goal of this study was to assess the varying crestal bone levels by peri-implantitis staging around implants placed in the posterior mandibular region in patients with hyperthyroidism and vitamin D deficiency.

Materials and Methods

This study encompassed a cohort of 40 patients diagnosed with hyperthyroidism and vitamin D deficiency, all of whom presented with missing posterior right mandibular first molars and expressed a desire for replacement of these teeth. Out of a total of 60 patients with missing posterior right mandibular molars seeking replacement options, 40 patients opted for dental implant placement along with the corresponding implant-supported prosthesis. Before participation in the study, informed consent was obtained from each patient. The inclusion criteria specified that participants would be between the ages of 35 and 60 years and could be of either gender, specifically including both individuals with hyperthyroidism and those with vitamin D deficiency. Conversely, the exclusion criteria disqualified mentally unstable patients and smokers from participating in the study. To ensure accurate assessment and planning, cone beam computed tomography (CBCT) analysis was conducted for implant placements. Additionally, a chlorhexidine mouthwash rinse was administered as part of the pre-operative protocol. For local anesthesia, an inferior alveolar nerve block was performed. The study involved a total of 40 patients who expressed their interest in undergoing implant placement. These patients were divided into two distinct groups based on their health conditions. Group 1 consisted of 20 individuals diagnosed with hyperthyroidism, while Group 2 was made up of 20 patients who were experiencing vitamin D deficiency. The primary objective of the investigation was to assess the levels of crestal bone loss at various stages of periimplantitis, which included early, moderate, and advanced phases. The evaluation of crestal bone levels was conducted for each implant at all four surfaces: mesial,



distal, buccal, and lingual. The mean bone levels across these four surfaces were measured and subsequently analyzed at two distinct time points: 2 months and 4 months following the placement of the implants. This comprehensive assessment aimed to provide a clearer understanding of bone integration and implant stability over time. To achieve this, the data was obtained from cone beam computed tomography (CBCT) analysis, a cutting-edge imaging technique that allows for precise evaluation of bone structure concerning dental implants. Overall, this study aimed to analyze and compare the levels of crestal bone loss at different stages of periimplantitis between the two groups: those with hyperthyroidism and those with vitamin D deficiency.

Statistical Analysis and Results

In this study, all statistical analyses were carried out using the SPSS software, a powerful tool designed for statistical computing and data analysis in the social sciences. To evaluate the significance of our findings, we utilized the chi-square test, which is particularly effective for examining the differences in proportions across various groups. This method allowed us to perform a comprehensive and rigorous comparison of categorical data, ensuring that our results accurately reflect the underlying trends and relationships within the dataset.

Results

This study encompasses a total of 40 patients with an edentulous area in the right mandibular molar region, who are seeking replacement through implant placement and the subsequent use of implant prostheses. The subjects of this study range in age from 35 to 60 years, including both male and female participants. Table 1 presents a statistical description of the age and gender distribution of the contributing patients. Graph 1 illustrates the demographic distribution of the patients and related details, revealing that there are 24 males and 16 females. A Cone Beam Computed Tomography (CBCT) evaluation was conducted to assess the appropriate implant size and bone quality, enabling precise evaluation for implant placement. The 40 participants were divided into two groups: Group 1

(n=20) comprised patients diagnosed with hyperthyroidism, while Group 2 (n=20) consisted of patients with vitamin D deficiency. Crestal bone levels were assessed on all four surfaces (mesial, distal, buccal, and lingual) for each studied tooth. The mean bone levels across all four surfaces were evaluated and further analysed at two different time intervals: 2 months and 4 months post-implant placement. Table 2 details the findings for Group 1, wherein dental implants were placed in patients with hyperthyroidism. The pattern of crestal bone loss was systematically evaluated at various stages of peri-implantitis after the 2-month postoperative phase. Statistical analysis was conducted using the Pearson Chi-Square test to determine the level of significance. Early-stage peri-implantitis was identified in 14 patients, with advanced-stage peri-implantitis observed in 2 patients. Table 3 outlines the results for Group 2, consisting of patients with vitamin D deficiency. Similar assessments for crestal bone loss related to peri-implantitis were performed after the 2-months postoperative phase. Statistical analysis revealed that early-stage peri-implantitis was present in 12 patients, while advanced-stage peri-implantitis was noted in 3 patients within the same time frame. Table 4 explores the outcomes for Group 1 following a 4-month postoperative evaluation. The examination for crestal bone loss related to peri-implantitis continued, and the statistical analysis once again employed the Pearson Chi-Square test. After 4 months, early-stage peri-implantitis was detected in 13 patients, whereas advanced-stage peri-implantitis was found in 2 patients. Table 5 summarizes the findings for Group 2 after 4 months. The assessment of crestal bone loss at various stages of peri-implantitis was conducted, and statistical analysis employed the Pearson Chi-Square test to ascertain the significance. At this 4-month period, early-stage peri-implantitis was observed in 14 patients, with advanced-stage peri-implantitis identified in 2 patients. Table 6 provides a detailed analysis of the estimated results for all the groups examined in the study, employing one-way ANOVA as the statistical method. This table summarizes the outcomes and allows for comparisons between the different groups, highlighting any significant differences observed in the data.

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

Age Group (Yrs)	Male	Female	Total	P value
35-40	4	4	8	0.02*
41-45	6	5	11	0.30
46-50	7	3	10	0.05*
51-55	3	2	5	0.20



56-60	4	2	6	0.30
Total	24	16	40	*Significant
*p<0.05 significant				

Graph 1: Patients demographic distribution and associated details

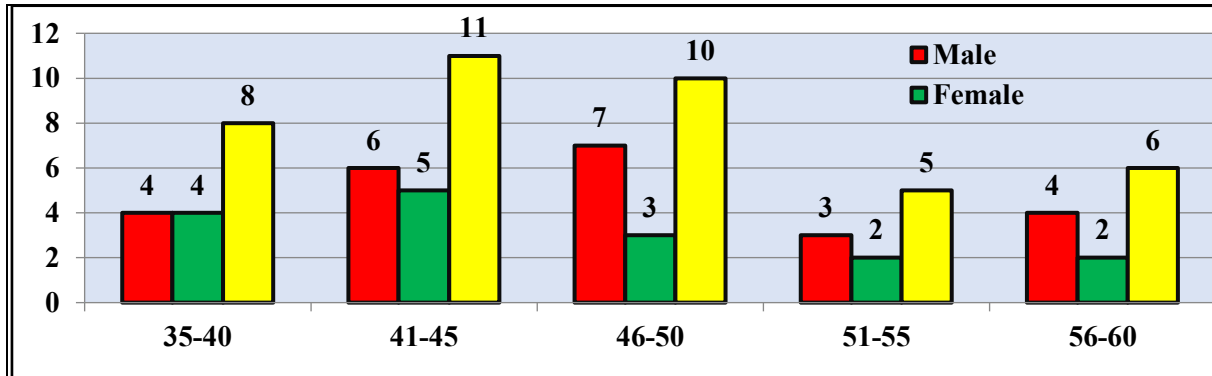


Table 2: Group 1 (n=20), dental implants were placed in patients diagnosed with hyperthyroidism. The pattern of crestal bone loss was systematically evaluated at various stages of peri-implantitis after 2 months of the post-operative phase. Statistical analysis was performed utilizing the Pearson Chi-Square test to ascertain the level of significance

Peri-implantitis Stages	Bone loss criteria	n	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Early Peri-implantitis	Less than 25%	14	2.24	2.695	2.015	2.26	2.316	1.0	0.02*
Moderate Peri-implantitis:	between 25% and 50%	4	2.09	1.106	1.210	2.16	2.132	1.0	0.80
Advanced Peri-implantitis:	More than 50%	2	1.07	1.089	1.040	1.08	1.158	1.0	0.56
*p<0.05 significant									

Table 3: Group 2 (n=20), dental implants were placed in patients diagnosed with vitamin D deficiency. The pattern of crestal bone loss was systematically evaluated at various stages of peri-implantitis after 2 months of the post-operative phase. Statistical analysis was performed utilizing the Pearson Chi-Square test to ascertain the level of significance

Peri-implantitis stages	Bone loss criteria	n	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
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Early Peri-implantitis	Less than 25%	12	2.20	2.667	2.105	2.36	2.306	1.0	0.01*
Moderate Peri-implantitis:	between 25% and 50%	5	2.10	1.116	1.214	2.18	2.134	1.0	0.06
Advanced Peri-implantitis:	More than 50%	3	1.08	1.129	1.145	1.10	1.160	1.0	0.67
*p<0.05 significant									

Table 4: Group 1 (n=20), dental implants were placed in patients diagnosed with hyperthyroidism. The pattern of crestal bone loss was systematically evaluated at various stages of peri-implantitis after 4 months of the post-operative phase. Statistical analysis was performed utilizing the Pearson Chi-Square test to ascertain the level of significance

Peri-implantitis stages	Bone loss criteria	n	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Early Peri-implantitis	Less than 25%	13	2.22	2.633	2.123	2.16	2.212	1.0	0.02*
Moderate Peri-implantitis:	between 25% and 50%	4	2.09	1.106	1.210	2.16	2.132	1.0	0.80
Advanced Peri-implantitis:	More than 50%	2	1.07	1.089	1.040	1.08	1.158	1.0	0.56
*p<0.05 significant									

Table 5: Group 2 (n=20), dental implants were placed in patients diagnosed with vitamin D deficiency. The pattern of crestal bone loss was systematically evaluated at various stages of peri-implantitis after 4 months of the post-operative phase. Statistical analysis was performed utilizing the Pearson Chi-Square test to ascertain the level of significance

Peri-implantitis stages	Bone loss criteria	n	Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square Value	df	p value
Early Peri-implantitis	Less than 25%	14	2.24	2.695	2.015	2.26	2.316	1.0	0.02*
Moderate Peri-implantitis:	between 25% and 50%	5	2.10	1.116	1.214	2.18	2.134	1.0	0.06



Advanced Peri-implantitis:	More than 50%	2	1.07	1.089	1.040	1.08	1.158	1.0	0.56
*p<0.05 significant									

Table 6: Estimation amongst all studied groups using one-way ANOVA

Variables	Degree of Freedom	Sum of Squares Σ	Mean Sum of Squares $m\Sigma$	F	Level of Sig. (p)
Between Groups	2	1.020	1.234	1.2	0.001*
Within Groups	12	1.244	1.564		–
Cumulative	107.10	3.134			*p<0.05 significant

Discussion

Hausmann DW et al reviewed in that study that maintaining healthy bone around dental implants is very important for their success over time. When the bone shrinks or loses height around the implant, it can lead to a buildup of harmful bacteria and a condition called peri-implantitis, which can weaken the bone support and ultimately lead to implant failure. Successful dental implants typically show signs of integration with the jawbone, don't cause pain, remain infection-free, and don't develop visible issues on X-rays.^{12,13} Paolantoni G et al outline in their study that a typical loss of about 1.5 mm of bone height occurs in the first year after the implant is placed, with a smaller loss of about 0.2 mm each year after that. Several factors can cause this loss, including damage during surgery, the presence of bacteria, the way the implant is loaded, and small gaps between the implant and the connecting piece called the abutment.^{14,15} Qian J et al reviewed in their study that the limited amount of bone available around an implant, it is crucial to preserve this bone for the implant's stability and aesthetic result. Some key factors that can help maintain bone levels include avoiding excessive pressure on the implant, addressing reactions to foreign materials, and controlling harmful bacteria related to gum disease.¹⁶ Al-Hamoudi N et al outline in their study that techniques such as platform switching, not exposing the implant fully during surgery, modifying the implant design, placing implants right away after tooth loss, and gradually increasing the load on the implant can be beneficial.¹⁷ Algethmi AS et al included in their study that while traditional X-rays can help assess the bone and roots around implants, they only provide a limited view. Newer 3D imaging methods, like cone beam computed tomography (CBCT), allow

for a clearer and more accurate view of bone levels without overlapping images. This advanced imaging is particularly effective in diagnosing conditions like apical periodontitis (infections at the root tip) and measuring different types of bone loss.^{18,19} Singh S showed in their study that another important aspect is Vitamin D, a hormone we mainly get from sunlight, food, or supplements. Vitamin D helps with bone health and affects our immune system, making it significant in the context of dental implants. Studies show that taking 10 micrograms of Vitamin D3 daily, along with 1000 mg of calcium, can lower bone loss and fractures, while also improving bone density.^{20,21} Attard NJ et al reviewed in their study that additionally, thyroid health can influence how our bones are managed. Research on patients with thyroid issues has shown mixed results regarding the impact of thyroid medicine on bone density. It's evident that monitoring and maintaining both Vitamin D and thyroid health is important for successful dental implant outcomes.²²

Conclusion

This study was to evaluate the variations in crestal bone levels associated with peri-implantitis staging around implants placed in the posterior mandibular right first molar of patients with hyperthyroidism and vitamin D deficiency. The findings indicated that patients with thyroid disorders can successfully receive dental implants, exhibiting comparable survival rates to those without such disorders. Notably, the data show significantly enhanced osseointegration in individuals who receive vitamin D supplementation. Conversely, patients with reduced serum vitamin D levels may face an increased risk of dental implant failure and exhibit moderately greater crestal bone loss as compared to



hyperthyroid patients. The study advocates for administering vitamin D supplements one week before implant surgery to mitigate these risks. To confirm these findings and their clinical relevance, future long-term studies must be conducted to deepen our understanding of the interplay between vitamin D status, thyroid disorders, and dental implant outcomes.

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