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Original Research Article

Radiographic Evaluation of Crestal Bone Loss Following Endosseous Implant Placement

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Abstract:

Background and objectives: The purpose of this clinical and radiological prospective study was to assess "crestal bone loss" surrounding two-piece polished collar implants after a submerged surgical procedure. Crestal bone loss was measured in relation to age, gender, location, implant type and length, soft tissue thickness, and probing pocket depth. Other general characteristics included mobility, pain, bone loss pattern, and the presence or lack of peri-implant radiolucency.

Methods and materials: The trial sample included 30 individuals who received 40 implants. A detailed medical and dental history, current general and oral health status, and inclusion and exclusion criteria were all done as part of the pre-treatment clinical examination and patient selection. The implants were evaluated in the current study based on clinical and digital radiography examination utilising the long cone paralleling technique. The radiograph was taken using the conventional procedure and a stabilising device. The exposure period, distance from the implant to the sensor, and distance from the sensor to the anode are all standardised. Clinical and radiographic evaluations were performed during the first week, three months, six months, and twelve months after surgery.

Results: The mesial and distal sides revealed nearly identical findings (1.9mm and 2.0mm, respectively), with the highest bone loss happening after implant loading. The probing pocket depth scores were statistically significant and linked with radiographic bone loss. Except for one factor, the thickness of the soft tissue prior to implant placement, which had a substantial effect on crestal bone loss, all of the parameters studied were age, gender, site, type, and length of implant. Overall, the success rate was 92%.

Conclusion: Based on the findings of this study, it was determined that there was significant bone loss between 3 and 6 months, which might be attributed to remodelling activities following 2nd stage surgery. The radiographic examination aids in the surgical procedure's prosthetic planning phase as well as the early detection of osseous alterations following loading. A accurate diagnosis of the pathologic aetiology is critical in the management of implant therapy problems.

Keywords: Crestal bone loss**,** Dental implants, Dental radiography, Radiograph.

Introduction

A restoration's aesthetic and retentive ability is as vital for a patient's mental health as its technical and biological approaches are for his dental and physical health.

Teeth loss causes structural imbalance, ineffective oral function, poor aesthetics, and positional changes in the remaining natural teeth. Replacement is required to mitigate the negative effects of tooth loss. Traditional prosthetic therapies, such as removable partial dentures, fixed bridges, or Maryland bridges, all have drawbacks, such as loss of tooth content or vitality. Retention issues may result in serious functional and/or psychological concerns for the patient. [1] Endosseous implants give a dependable strategy for edentulous and partially dentate individuals' oral rehabilitation. [2] With the rising frequency of implant implantation, the number of difficulties is unavoidable.

Endosseous implant osseointegration is defined as "an intimate bone to implant contact around the entire contour with continuous remodelling of the supporting bone and the maintenance over the years of a stable marginal bone height under functional levels and types of loading for the patient's entire life. [3] Recently, the paradigm has shifted, and multiple systematic reviews have been conducted to test the premise that there is no

difference in clinical performance across implants loaded at different times. [4,5] The months following abutment connection appear to be critical for defining the relationship between epithelium, supracrestal connective tissue, and marginal bone - to -implant interface in two stage procedure implant systems, whereas marginal soft and hard tissue adaptations occur concurrently with osseointegration in one stage procedure implants in the first months after surgery. [6] Natural teeth, traditional dental prostheses, and dental implants are all supported by bone. While the mechanisms of such support vary, tracking bone level maintenance provides useful information regarding the longevity of teeth and their replacements. One of the most significant elements to consider in implantology is bone level maintenance. [7]

Peri-implantitis is defined as inflammation of the peri-implant mucosa following osseointegration with concurrent increasing marginal bone loss. [8,9] Periimplant bone loss is typically preceded by periimplant soft tissue inflammation and is assumed to be plaque-induced. This typically results in crater-like bone loss around the implant. Peri-implantitis is assumed to be caused by two major factors: bacterial infection [plaque theory] and mechanical overload. Peri implant bone loss has been observed to occur at a rate ranging from 1% to 19%.

The difficulties associated with continuous bone loss include the establishment of an uncleansableperi-implant sulcus with inflammation, recession leading to loss of interproximal soft tissue, and the possibility of bone loss compromising the implant's stability. [11] Measurements of bone levels are now employed as implant success criteria, and this radiographic criterion is an essential aspect of normal clinical evaluation. [12,13] Within the typical parameters of peri-implant bone loss, two periods have been recognised.

(1)A healing and remodelling period commencing with implant placement and continuing approximately one year, during which bone loss of 0.4 to 2.0 mm may be documented, and (2)A follow-up period following the first year, during which marginal bone loss of 0.005 to 0.15 mm per year may be noted. It is known that functionally loaded dental implants lose roughly 1.0 mm of bone in the first year and at least 0.10 mm per year after that. [2,11]

Clinical evaluation approaches similar to those used in periodontology are now routinely used in implant dentistry. Several approaches have been used to quantify bone changes, including photometric assessment of mineral content changes, stereoscopic or three-dimensional evaluation, two-dimensional evaluation, and linear measures utilising radiographs. [14]

Because of the utilisation of high metal contrast reference points, such as the top of the abutment; implants have an advantage in radiological interpretation over teeth. The implant geometry allows for the evaluation of the projection geometry on the radiographic picture. The current study used clinical and digital radiography examination to assess the crestal bone level around polished collar implants inserted supracrestally.

Material and Methods

Patients who presented to the dental clinic seeking replacement of lost teeth in scenarios suitable for implant insertion were scheduled for surgery. A total of 30 patients (17 male and 13 female) with 40implants of varying widths were enrolled in this study. The implant had diameters ranging from 3.5 to 4.3 mm and a length of 10 and 13 mm.

Criteria for inclusion

1. Subjects who have fully healed the extraction site and implant that will be inserted at least 6 months after extraction.
2. Subjects having sufficient bone height to insert implants in accordance with implant specifications.
3. Subjects having a bone width of at least 6mm
4. Implants with sufficient primary stability of 30-35 N/cm2.

Criteria for exclusion

1. Individuals with any underlying systemic condition.
2. Subjects who are taking any medications that influence bone metabolism.
3. Subjects who should not be radiographed.
4. People who have Para functional behaviors, such as bruxism.
5. All situations that necessitate primary bone grafting
6. Previous radiation to the bone history
7. People with metabolic problems were not allowed to participate.

The patient was given a complete questionnaire and those who were declared fit and healthy after a thorough medical history were invited to participate in the trial. The number of teeth and the health of each surviving tooth were assessed. Prior to implant therapy, any source of infection in the mouth was treated. Prior to implant therapy, periodontal disease and dental cavities were treated. The current states of surgical hygiene, as well as the patient's attitude towards treatment, were essential factors evaluated for a better prognosis of the therapy. For all cases, a case record sheet was created and used. Complete patient data were gathered. The placement, diameter, and length of the implant were all reported. Patients were given a consent form as well as a written explanation of the nature of the

treatment, accompanying procedures, and risks connected with the treatment. A thorough extra oral examination was performed, which included palpation of the temporomandibular joint and the presence of lymphadenopathy. The labial and buccal mucosa, connected gingival, hard and soft palate and tongue were all examined intraorally. Vital indicators such as blood pressure, pulse, temperature, respiration rate, weight, and height were recorded. It was discovered to be within normal limits. A blood test was performed since it could affect the implant operation procedure or long-term success rate. The total blood cell count, haemoglobin level, hematocrit, and platelet count were all measured. Bleeding tests, such as bleeding time and clotting time, were also performed. Serology and random blood sugar levels were studied.

The thickness of the soft tissue was measured using a reamer with a stopper prior to implant insertion after using Lidocaine topical aerosol (15%). The depth of the pocket was tested at various locations using a Williams probe. The implant site was radiographically examined in all patients. The radiographic examination was performed utilising a parallel cone approach with a DentsplyRinn sensor positioning device on an INTRA SKAN digi intraoral X-ray system. Using the INTRA SKAN programme, the image data was retrieved and analysed.

Surgical Technique

Implant kit and physio dispenser were used for implant implantation in a standard technique. Patients were prepared for surgery according to standard dentistry practise norms, and implant surgeries were completed as outpatient procedures. Prior to the procedure, the soft tissue thickness over the region of interest was measured using an endodontic instrument (reamer) after a thorough extra and intraoral inspection. After administering local anaesthetics (2% lidocaine with 1:80,000 epinephrine), full thickness flaps were elevated with a horizontal incision to disclose the bone surface; vertical incisions were employed if visibility was required. A surgical template was employed to verify that the preprosthetic planning was accurately transferred to clinical circumstances. Implant osteotomies were made according to the manufacturer's instructions, and the implants were inserted supracrestally, confirming primary stability by torqueing the implant to 35 N/cm2. The primary flap was closed using resorbable/non-resorbable material. Patients were given antibiotics and painkillers, as well as instructions on how to maintain proper dental hygiene. After three months, the implants were exposed with a full thickness mucoperiosteal flap, and the cover screw was replaced with a healing abutment. After 10 days, impressions were taken and implants were reinstated with prostheses. The materials utilised for prosthesis were chosen based on the patient's preferences. To reduce lateral stresses, occlusion and articulation were carefully adjusted.

Data Collection

This prospective longitudinal study focused on implant success and clinical data on the participants. At 1 week, 3 months, 6 months, and 12 months, clinical and radiologic measures were set to examine hard tissue levels and soft tissue condition. Complications such as indications of infection, evident gingival inflammation, gingivitis, pain during percussion, abscess, and paresthesia were also evaluated at each visit. Probing depth was measured at various time intervals.

Radiographic bone loss on the mesial and distal sides of the implant was measured, as well as RBL in relation to age, gender, location, soft tissue thickness, implant type, and length. As a general metric, peri implant radiolucency, bone loss pattern, and mobility were documented. Radiographic findings were also related to clinical findings. All measurements were tabulated and statistically analysed.

Statistical investigation

The collected data was assembled and input into a spread sheet programme (Microsoft Excel 2007) before being exported to the data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). The confidence level and level of significance for all tests were set at 95% and 5%, respectively.

Results

This study included 30 patients (17 men and 13 women) with a mean age of 31 years who got 40 tapered implants.

Table 1: Distribution of subjects based on age and gender

Variable		Gender		Total
		Male	Female	
Ages	**<25**	4	1	5
	26-30	7	5	12
	31-35	5	5	10
	36-40	1	2	3
Total		17	13	30

Table 1 illustrates the age and gender distribution of respondents. The participants were separated into four groups (quartiles): 25 years, 26-30 years, 31-35 years, and 36-40 years. There were 17 male patients in all, with 4 being 25 years old, 7 being 26-30 years old, 5 being 31-35 years old, and 1 being 36-40 years old. There were thirteen female patients in all, with one being 25 years old, five being between 26-30 years old, five being between 31-35 years old, and two being between 36-40 years old.

Table 2: Distribution of type of implant placed among the study group

Implant Type	Implant No. (10 Mm Length)	Implant No. (13 Mm Length)	Total
Narrow Platform (Np)	8	7	15
Regular Platform (Rp)	12	13	25
Total	20	20	40

Table 2 depicts the implant distribution in the study group, with 15Narrow Platform implants and 25 Regular Platform implants being implanted out of the 40 (100%) total implants placed. The implant length of 8 Narrow Platform and 12 Regular Platform implants was 10 mm each, while the implant length of 7 Narrow Platform and 13 Regular Platform implants was 13 mm each.

Table 3: Comparison of mean mesial Radiographic Bone Loss from baseline to 1 year

Variables		Paired Differences			
		Mean	t value	p value	Significance
Pair 1	**MBLW1 - MBLM3**	-.23	-7.41	.001	Highly significant
Pair 2	**MBLW1 - MBLM6**	-.639	-9.12	.001	Highly significant
Pair 3	**MBLW1 - MBLY1**	-.889	-10.32	.001	Highly significant
Pair 5	**MBLM3 - MBLM6**	-.385	-5.23	.001	Highly significant
Pair 6	**MBLM3 - MBLY1**	-.651	-7.70	.001	Highly significant
Pair 7	**MBLM6 - MBLY1**	-.249	-5.79	.001	Highly significant

Table 4: Comparison of mean distal Radiographic Bone Loss from baseline to 1 year

Variables		Paired Differences			
		Mean	T value	P value	Significance
Pair1	**DBLW1- DBLM3**	-.228	-9.41	.001	Highly significant
Pair2	**DBLW1- DBLM6**	-.576	-12.047	.001	Highly significant
Pair3	**DBLW1- DBLY1**	-.825	-11.62	.001	Highly significant
Pair5	**DBLM3- DBLM6**	-.349	-6.23	.001	Highly significant
Pair6	**DBLM3- DBLY1**	-.597	-7.60	.001	Highly significant
Pair7	**DBLM6- DBLY1**	-.251	-6.07	.001	Highly significant

Tables 3 and 4 provide a comparison of distal Radiographic Bone Loss (RBL) from week 1 to 1 year. The paired t test was used to examine the pair-wise differences between the groups (1 week, 3 months, 6 months, and 1 year). There was a statistically significant difference between the groups, with a p value of 0.001. A comparison of mean radiographic bone loss between the two groups (maxilla and mandible) revealed no statistically significant difference between the groups at week one, three months, six months, and one year.

Discussion

One of the most technologically advanced forms of dentistry available today is the use of endosteal implants for patient dental rehabilitation [14,15]. The clinical long-term success of the implants is dependent on osseointegration and soft tissue and epithelial adherence to the titanium surfaces of the implant. Understanding the causes of marginal bone loss around dental implants is critical for preventing such occurrences, promoting long-term peri implant health, interdental papilla height, and thus influencing aesthetics around implants, particularly in the anterior visible zone, and thus implants prosthesis success. The purpose of this clinical and radiological prospective study was to assess "crestal bone loss" surrounding 2 pieces polished collar implant put supracrestally in 30 patients at 40 sites using a submerged surgical approach. Crestal bone loss was evaluated in relation to age, gender, site, implant type, length, soft tissue thickness, rate of advancement, and probing pocket depth. Other general characteristics included mobility, pain, bone loss pattern, and the presence or lack of peri implant radiolucency. The majority of manufacturers recommend implant placement at the supracrestal level, and studies by Davarapanah et al and Martinez et al have proposed supracrestal placement as a possibility to reduce bone resorption and achieve a better clinical crown/ implant relationship as longer implant placement becomes possible. [16] In the current study, pocket depth was measured using a Williams probe, and the results showed that the mean difference in probing pocket depth at the mesiobuccal, mid buccal, distobuccal, and palatal/lingual sites from 3 months to 6 months was greater than the mean probing pocket depth from 6 months to 1 year,

indicating that the probing pocket depth has increased after implant loading. This rise in PPD was associated with an increase in Radiographic Bone Loss. According to numerous studies, a peri implant probing depth more than 5mm, combined with bleeding on probing and movement, implies a high likelihood of disease progression. [16,17]

In the current investigation, intraoral digital radiographs were acquired utilising paralleling techniques at 1 week, 3 months, 6 months, and 12 months. After statistical analysis, it was discovered that both the mesial and distal sides had similar results (1.8mm and 2.0mm, respectively), which was well within the success criteria and similar to the findings reported by Jung et al [18] and Worthington et al [19], which showed a mean maximum bone loss of 2 mm around the implant at the first year of function, and histological and radiographic studies by Herman et al have proven that the crestal bone

The rate of progression of bone loss from baseline to 3 months was 15%, from 3 months to 6 months was 23%, and from 6 months to 1 year was 6%, indicating that bone loss was greater after implant loading, which was consistent with the findings of Pham et al. [6]

In the current investigation, the link between PPD and radiographic bone height reduction revealed that all values steadily rose from 3 to 6 months. The increase in Probing Pocket Depth was associated with an increase in Radiographic Bone Loss.

At the end of one year, 16 implants exhibited radiographic bone loss of more than 2mm, with 10 implants in the maxilla and 6 in the mandible, indicating that the maxilla had a faster rate of bone loss than the mandible. These findings were predicted or compatible with previous research, which revealed that marginal bone loss was larger in implants placed in the maxilla than in implants placed in the mandible over the first year. [20,21]

In the current study, 91% of the individuals had horizontal bone loss, which could be a symptom of overload. According to a multivariate analysis of crestal bone losses measured in millimetres, radiolucencies at or near implant sites enhance the likelihood of crestal bone loss. Implant locations with radiolucencies may harbour periodontal microorganisms that could infect or contaminate the implant. Infection (bacterial), iatrogenic (heat-induced bone loss), non-rigid fixation (iatrogenic or patient-induced), or local bone healing issues may be the reason. [16]

The failure rate in this trial was 9.09%. Three of the 35 implants failed to osseointegrate. All three were early failures that happened prior to prosthetic loading and manufacture.

Conclusion

Age, gender, location, and the length and diameter of the implant were all considered, but they did not show any significant correlation with crestal bone loss except for one factor, the thickness of the soft tissue prior to implant placement, which had a significant effect, implying that initial soft tissue mucosal thickness can influence crestal bone level around supracrestally placed implants. Both the mesial and distal sides of the implant had comparable findings, with a horizontal pattern of bone loss. The most bone loss was observed between 3 and 6 months, corresponding with the early loading of the implant and associated stress around the crest, resulting in bone remodelling at the local site. After 6 months, the implants showed little changes in bone level, which were well within the success criteria. Concurrently, the clinical findings correlated with the radiological findings. Overall, the success rate was 91%. Because of the small sample size and short length of the study, long-term crestal bone level around the implants and survival rate cannot be assessed, requiring a longer investigation with a larger sample size.

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