Original Article

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Dentistry Section

Comparison of Clinical and Radiological Parameters around Microthread Implants in Patients with and without History of Treated Periodontitis

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ABSTRACT

Introduction: Maintenance of crestal bone level is crucial for the success of implant-supported prosthetic rehabilitation. Implant neck design plays an important role in maintaining crestal bone levels. The microring neck design is known to counteract the marginal bone loss and improving bone-to-implant contact by providing optimal load distribution as reported by the finite element studies and animal studies.

Aim: The current study aimed to evaluate dental implants' short-term (12 months) clinical and radiographic parameters in periodontally healthy patients versus those with history of treated periodontitis.

Materials and Methods: The current prospective interventional study was performed at AB Shetty Memorial Institute of Dental Sciences, Mangalore, Karnataka, India from 2016 to 2018. In the study, 24 microthreaded implants were placed in periodontally healthy patients (group A, n=12) and patients with a history of treated periodontitis (group B, n=12). Peri-implant radiographic crestal bone loss, clinical measurements like probing pocket depths, bleeding on probing, and soft tissue complications were assessed around implants at time of implant loading, and 3, 6, and 12 months postloading. Statistical Package for the Social Sciences (SPSS) software version 22 was used for statistical analysis. Statistical significance was set at $p<0.05$.

Results: At the end of one-year postloading, peri-implant crestal mean bone loss of 2.317±0.914 mm (mesial), 2.37±1.276 mm (distal) and 2.673±1.178 (mesial), 2.87±1.075 (distal) mm were observed in groups A and B, respectively. The probing pocket depths were 3.729±0.95 mm and 4.017±0.67 mm in groups A and B, respectively at the end of the study period. However, there was no statistical significance for probing depths among both groups. At the end of the study period, soft tissue complications were 16.67% in group B, while no complications were noted in group A. None of the groups showed any technical or mechanical complications.

Conclusion: The results of the study revealed that crestal bone loss and pocket depths around implants are similar in both groups at various follow up periods. However, the incidence of peri-implant soft tissue complications is higher in patients with history of treated periodontitis.

Keywords: Alveolar bone loss, Complications, Dental implants, Edentulous jaw, Periodontal attachment loss

INTRODUCTION

Dental implants are increasingly being accepted as a treatment modality for replacing missing teeth in partially edentulous patients due to their favourable long-term survival and success rate [1]. Despite their high survival rate, adverse events have been reported with soft and hard tissues around the implants, leading to bone loss and peri-implant pocket formation [2].

Maintenance of crestal bone level is crucial for the success of implant-supported prosthetic rehabilitation [3]. The initial crestal remodelling is dependent on the type of implant-abutment interface and interactions/manipulations at the interface [4]. The formation of biological width around implants occurs during the initial six months following the establishment of an implant-abutment interface, which is influenced by numerous factors [5,6]. However, this initial bone remodelling is exaggerated when there is bacterial infiltration along with the micro-leakage at the implant-abutment interface [7]. Besides, implant neck design also plays an important role in maintaining crestal bone levels [8]. The implant designs which distribute lower levels of sheer stress in the peri-implant bone causes less bone loss compared to others. Microrings on the implant neck have been reported to minimise early bone loss, and some authors suggest that microrings limit marginal bone loss in the presence of loading forces. The microring feature counteracts marginal bone loss and improves bone-to-implant contact by providing optimal load distribution [9,10].

The microbiota of the oral cavity influences the peri-implant microbiota. Plaque accumulation at dental implants can trigger an inflammatory response which leads to peri-implant mucositis/peri-implantitis [11,12]. The occurrence of peri-implantitis in periodontally healthy individuals is 10.53%, compared with 37.93% in those with a history of periodontitis [13]. Supportive maintenance therapy helps avoid potential colonisation of peri-implant ecological niches by periodontal pathogens [14]. History of chronic periodontitis is thought to be a risk indicator and not a risk factor, influencing the establishment and progression of peri-implant diseases around dental implants [15]. However, Quirynen et al., in a review, concluded that implant-supported restoration in periodontally compromised patients was successful in those who maintained adequate plaque control and were compliant with regular supportive periodontal therapy [16].

Although the behaviour of the microthreaded implants is reported by finite element analysis [17,18]. and animal studies [19], human studies evaluating the crestal bone loss around these implants are scarce [20-22]. The present study compares the clinical and radiological parameters around microthreaded implants placed in patients with and without a history of periodontitis.

MATERIALS AND METHODS

A prospective comparative interventional study was conducted in AB Shetty Memorial Institute of Dental Sciences, Mangalore, Karnataka, India. The research protocol was approved by the Institutional Human

Ethical Committee (ABSM/EC40/2015) and was performed according to the Helsinki declaration. A written and well-informed consent was obtained from all the participants. The study period was from October 18, 2016 to September 30, 2018.

Sample size calculation: With α=0.05, power of 80%, with standard deviation in group I (1.09 mm) and group B (1.06 mm) a total of 24 implants were required in the study [23].

Formula

$$n=\frac{Z^2_{1-\alpha/2}[2S_p^2]}{d^2}$$

$$\text{Where, } S_p^2=\frac{S_1^2+S_2^2}{2}$$

S_1^2-Standard deviation in the first group

S_2^2-Standard deviation in the second group

S_p^2-Pooled standard deviation

d: Precision

α: Significance level

Systemically healthy patients with healed edentulous sites (after extraction, delayed implant placement) in the posterior mandible were enrolled for the study.

Inclusion criteria: For enrolment of patients for study were; 1) patients aged ≥18 years with missing at least one tooth in the posterior mandible, but the teeth loss is not due to periodontitis. 2) Patients willing for implant-supported restoration, 3) Patients with adequate bone support for inserting a dental implant in a prosthetic driven position without requiring bone regeneration or ridge preservation procedures, 4) Natural teeth present mesial and distal to the implant placement, 5) Sites with opposing teeth are natural or natural or an implant-supported restoration.

Exclusion criteria: Patients with diseases such as diabetes, hypertension, tobacco users (smoke and smokeless), pregnant and lactating women and patients under any form of medication that affects bone metabolism such as osteoporosis. Patients with poor oral hygiene and non-compliance.

After recording the patient history and periodontal examination, they were divided into periodontally healthy patients (group A) and those with history of treated periodontitis (without active periodontal disease) (group B).

GROUP A: **Periodontally healthy patients:** Periodontally healthy patients having probing depth is ≤2 mm, full-mouth bleeding score ≤20% bleeding on probing <10%, loss of clinical attachment level loss <1 mm, and absence of bone loss.

GROUP B: **Periodontally compromised patient:** Subjects with a previous history of moderate chronic periodontitis, with more than 30% of the sites involved and 3-4 mm CAL, but no active disease (full-mouth bleeding score ≤20% bleeding on probing) at the time of implant placement, i.e., patients who have completed their active periodontal therapy at least 6 months prior to implant placement [24].

Study Procedure

1) Evaluation of parameters around natural teeth: After recording the age, gender, and dental and medical history, periodontal examination was undertaken for all the patients. A single-blinded observer recorded all the clinical and radiological parameters at all follow-up times. AUNC-15 probe (Hu-Friedy) was used around natural teeth. The following clinical parameters were evaluated: Width of Keratinised Mucosa (WKG), Gingival Thickness (GT), Probing Pocket Depth (PD), Clinical Attachment Level, and Bleeding on Probing (BOP).

WKG was measured mid facially from the gingival margin to the mucogingival junction. GT was assessed using transparency of UNC 15 periodontal probe through the gingival margin at midfacial level: Patient was categorised into thin gingival biotype when the probe was visible through the gingival margin and into thick gingival biotype when probe was not visible.

PD was measured from the gingiva margin to the base of the pocket/sulcus. CAL was measured from the cemento-enamel junction to the base of the pocket/sulcus.

BOP was assessed as a dichotomous measure (bleeding present or absent) within 15 seconds of probing.

The measurements for PD, CAL, and BOP were performed at six sites around the teeth (mesio-facial, midfacial, distofacial, distolingual, mid-lingual, mesio-lingual).

2) Evaluation of parameters around implant: All clinical measurements were made at the implant site. The WKG and gingival biotype was measured at the implant site. Bone width was measured using bone callipers (BONE CALIPER BC35 (GDC, Hoshiarpur). Bone height and anatomical structures were evaluated using radiographs.

3) Radiographic evaluation: An intraoral periapical radiograph (IOPA) and orthopantomogram (OPG) were obtained for each patient.

Based on the clinical examination and oral radiography, the patients were divided into respective groups.

4) Implant placement: Before implant placement, all patients, received periodontal non-surgical therapy at least 4 weeks prior to surgery using ultrasonic or hand instruments, if indicated and oral hygiene instructions were given.

The patients were asked to rinse pre-operatively with 0.2% chlorhexidine solution to reduce the bacterial load. The implant was placed following a two-stage protocol, with the implant shoulder supracrestally and covered with a mucosal flap.

All patients received self-tapping implants with a conical shape (MIS SEVEN) with a microring at the implant neck with SLA (Sandblasted acid etched) surface. The implant had dual threads, spiral channels stemming from the apex, microrings on the implant neck, and a variable thread thickness along with the implant [26]. Local anaesthesia was administered, a full-thickness flap was elevated, and sequential osteotomy was performed according to the manufacturer's instructions. Implants with a 3.75 mm diameter and 10 mm height were placed supracrestally at 35 Nm torque.

5) Postoperative maintenance and care: The patients were prescribed analgesic (Ibuprofen 400 mg) and with 0.2% chlorhexidine BD for a week. Suture removal was done after a week. All patients were recalled one month after implant placement for evaluation, and loading was done after 3-4 months.

Then patients were recalled for a supportive periodontal maintenance program once in three months and oral hygiene measures reinforced [27].

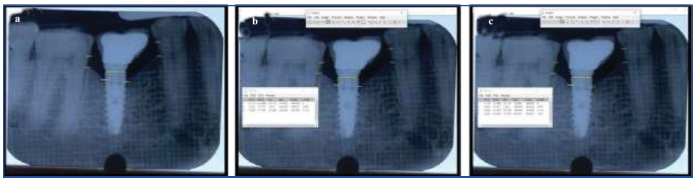
All the parameters were evaluated at the time of loading (IL), 3, 6, and 12 months postloading.

Clinical and Radiographic Evaluation of Implant at Various Follow-Up Sessions

The following parameters were evaluated at the time of loading and at 3, 6, and 12 months:

1. WKG, GT, PD, CAL, and BOP at loading and all subsequent appointments. The PD at six sites per implant utilising a plastic periodontal probe (Colorvue™ Probe, Hu-Friedy).
2. Presence of BOP on a dichotomous YES/NO scale by visual assessment.
3. Soft tissue complications such as inflammation (swelling of mucosa and BOP) and and pus around implants.
4. Radiographic evaluation/Crestal bone loss.

Crestal bone loss was analysed using an IOPA taken using an X-MIND DC intraoral x-ray machine with 70 kVp, eight mA, and 0.63 seconds exposure. Standardised radiographs were taken by the paralleling cone technique using an extension cone paralleling holder (RINN XCP FILM HOLDER, DENTSPLY) and a dental X-ray grid (Navadha, Mumbai). Crestal bone level, relative to the implant shoulder, was measured mesial and distal to the implants at following time points: at time of implant loading (IL), 3, 6 months, and 12 months after implant loading using measuring software "image J" ((Acteon, Satelec, X Mind DC) [Table/Fig-1].



[Table/Fig-1]: Setting scale and measurement analysis with the software "Image J".

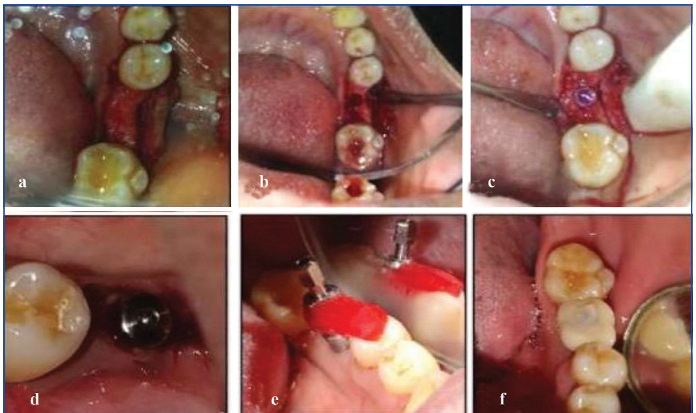
Each analysis of the measurement was downloaded in Excel format from the software. Implant success was determined based on the absence of mobility, radiolucency along the implant surface, recurrent peri-implant infection, continuous or recurrent pain probing depth ≤5 mm, no BOP, and ≥1.5 mm bone resorption between two consecutive visits [28].

STATISTICAL ANALYSIS

Descriptive statistics mean and standard deviation were calculated for continuous variables. Frequency and percentage were calculated for categorical variables. The unpaired t-test was used to calculate differences in GT, WKG, width from cementoenamel junction to crest bone (CAL), width from implant shoulder to bone crest, and PD around implant between the groups. Chi-square/Fisher test was used to assess the distribution of categorical variables. Paired t-test was used to compare the various variables after loading implant to 3, 6, and 12 months within groups A and B. A value of P<0.05 is considered statistically significant. Microsoft Excel and SPSS software version 22 was used for statistical analysis.

RESULTS

Eleven (45.8%) women and 13 (54.2%) men were recruited for the study. The mean age of the study population was 39±2.4 years. No implant loss occurred during the duration of the study (100% success rate). All implants received cement-retained restoration [Table/Fig- 2]. The mean GT (Group A-2.708±0.838, Group B-2.742±1.027) and WKG (Group A-2.75±1.055, Group B-2.667±0.778) at baseline did not differ significantly between the groups (P>0.05) [Table/Fig-3].



[Table/Fig-2]: Implant placement procedure (group A).
(a) Mucoperiosteal flap reflection (b) Osteotomy site (c) Implant placement (d). Second stage surgery and placement of healing abutment (e) Jig trail (f) Post restoration (Cementation)

Variables		Mean (in mm)	p-value
Gingival thickness	Group A	2.708±0.838	0.931
	Group B	2.742±1.027	
Width of keratinised mucosa	Group A	2.75±1.055	0.828
	Group B	2.667±0.778	

[Table/Fig-3]: Gingival thickness and width of keratinised mucosa between the groups at baseline.
Paired t-test. P<0.05 was considered as statistically significant; *Statistical significance; Values are taken only at baseline for standardization

The small 5 paragraphs should be combined mean CAL of adjacent teeth on mesial and distal sides of implant between the groups was not statistically significant [Table/Fig-4]. The PPD around implant did not differ significantly between groups A and B at IL, 3, 6, and 12 months (P>0.05) [Table/Fig-5]. The mean PPD differed significantly in groups A and B at various time intervals from baseline [Table/Fig-6]. Bleeding on probing around implants decreased as the time progressed. However, at the end of the study period, group B exhibited 33.3% of implants with bleeding on probing [Table/Fig-7]. In group A, the implant shoulder to bone crest (mesial and distal) after implant loading differed significantly at 3 months, 6 months, and 12 months (p<0.05*) [Table/Fig-8].

In group B, the implant shoulder to bone crest (mesial and distal) after implant loading differed significantly at 3, 6, and 12 months

Variables		CAL (mesial)		CAL (distal)	
		Mean	p-value	Mean	p-value
IL	Group A	2.282±0.525	0.791	1.854±1.028	0.265
	Group B	2.195±0.994		2.31±0.943	
3 months	Group A	2.569±0.444	0.971	1.944±1.052	0.136
	Group B	2.579±0.839		2.594±1.004	
6 months	Group A	2.742±0.474	0.895	2.245±1.181	0.268
	Group B	2.780±0.846		2.766±1.062	
12 months	Group A	2.899±0.515	0.807	2.197±1.409	0.169
	Group B	2.978±0.984		2.965±1.230	

[Table/Fig-4]: Mean CAL on the adjacent teeth (mesial and distal of the implant) between the groups at baseline, implant loading, and 3, 6, and 12 months post loading.
Paired t-test. P<0.05 was considered as statistically significant; *Statistical Significance; CAL: Clinical attachment level

Variables		Mean	p-value
IL	Group A	2.979±0.445	0.555
	Group B	2.875±0.406	
3 months	Group A	3.063±0.415	0.483
	Group B	3.167±0.289	
6 months	Group A	3.479±0.686	0.292
	Group B	3.792 ±0.73	
12 months	Group A	3.729±0.95	0.401
	Group B	4.017±0.672	

[Table/Fig-5]: Intergroup comparison for PPD around the implants at implant loading and 3, 6, and 12 months post loading.
Paired t-test. P<0.05 was considered as statistically significant. *Statistical significance; IL: Implant loading; PPD: Probing pocket depth

Variables	Group A		Group B	
	Mean	p-value	Mean	p-value
IL	2.9792±0.44541	0.305	2.8750±0.40592	0.002*
3 months	3.0625±0.41458		3.1667±0.28868	
IL	2.9792±0.44541	0.023*	2.8750±0.40592	0.001*
6 months	3.4792±0.68638		3.7917±0.72952	
IL	2.9792±0.44541	0.014*	2.8750±0.40592	<0.001*
12 months	3.7292±0.95023		4.0167±0.67161	

[Table/Fig-6]: PPD around implants within groups A and B from implant loading to 3, 6, and 12 months.
Paired t-test. P<0.05 was considered as statistically significant. *Statistical significance; IL: Implant loading; PPD: Probing pocket depth

Variables	IL	3 months	6 months	12 months
	Present	Present	Present	Present
GROUP-A	8 (66.7%)	8 (66.7%)	6 (50%)	0
GROUP-B	11 (91.7%)	11 (91.7%)	9 (75%)	4 (33.3%)

[Table/Fig-7]: Bleeding on probing (BOP) around implant between groups.
Chi-square test
Loading BOP-Fishers exact P=1 ns, 3 Months BOP-Fishers exact P=0.093 ns, 6 months BOP-Fishers exact P=0.40 ns, 12 Months BOP-Fishers exact P=0.317 ns

Variables	Shoulder-bone crest (mesial)		Shoulder-bone crest (distal)	
Group A	Mean	p-value	Mean	p-value
IL	0.5848±0.32608	0.002*	0.6258±0.38564	<0.001*
3 months	1.3508±0.67619		1.2252±0.45728	
IL	0.5848±0.32608	<0.001*	0.6258±0.38564	<0.001*
6 months	1.8798±0.69062		1.9664±1.01584	
IL	0.5848±0.32608	<0.001*	0.6258±0.38564	<0.001*
12 months	2.3167±0.91432		2.3696±1.2757	

[Table/Fig-8]: Implant shoulder-bone crest (mesial and distal) within group A from implant loading to 3, 6, and 12 months post loading.
Paired t-test. P<0.05 was considered as statistically significant. *Statistical significance

(p<0.05) [Table/Fig-9]. The mean distance from implant shoulder to bone crest (mesial and distal) did not differ significantly between group A and group B at Implant Loading (IL), 3 months, 6 months, and 12 months (p>0.05) [Table/Fig-10].

Variables	Shoulder-bone crest (mesial)		Shoulder-bone crest (distal)	
Group B	Mean	p-value	Mean	p-value
IL	0.4592±0.34574	0.002*	0.4273±0.33405	0.001*
3 months	1.3162±0.64549		1.4304±0.66705	
IL	0.4592±0.34574	<0.001*	0.4273±0.33405	<0.001*
6 months	1.9527±0.76352		2.1715±0.78726	
IL	0.4592±0.34574	<0.001*	0.4273±0.33405	<0.001*
12 months	2.6735±1.17788		2.8701±1.07498	

[Table/Fig-9]: Implant shoulder-bone crest (mesial and distal) within group B from implant loading to 3, 6, and 12 months post loading.
Paired t-test. P<0.05 was considered as statistically significant. *Statistical significance; IL: Implant loading

Variables		Implant shoulder-bone crest (mesial)		Implant shoulder-bone crest (distal)	
		Mean	p-value	Mean	p-value
IL shoulder-bone crest	Group A	0.585±0.326	0.37	0.626±0.386	0.19
	Group B	0.459±0.346		0.427±0.334	
3 months shoulder-bone crest	Group A	1.351±0.676	0.89	1.22±0.457	0.38
	Group B	1.316±0.645		1.43±0.667	
6 months shoulder-bone crest	Group A	1.880±0.691	0.80	1.966±1.016	0.58
	Group B	1.953±0.764		2.17±0.787	
12 months shoulder-bone crest	Group A	2.317±0.914	0.41	2.37±1.276	0.31
	Group B	2.673±1.178		2.87 ±1.075	

[Table/Fig-10]: Intergroup comparison for implant shoulder- bone crest (mesial and distal) at IL, and 3, 6, and 12 months post loading.
Paired t-test. P<0.05 was considered as statistically significant; *Statistical significance; IL: Implant loading

Soft tissue complications such as inflammation (swelling of mucosa and BOP), at six months were 16.7% and 42.7% in groups A and B, respectively. However, group A did not show any complications at 12-month follow-up but group B showed about 16.7% inflammation and exudate around implants [Table/Fig-11].

DISCUSSION

The present study evaluates the clinical and radiographic parameters around implants placed in periodontally healthy patients and those with history of treated periodontitis. The peri-implant soft tissue features such as PD, BOP, inflammation, exudate, pain, and implant mobility, and radiographic bone loss were considered to determine implant success. The present study indicates that PDs and crestal bone changes for implants placed in both groups statistically similar.

The mean PPD differed significantly in groups A and B at various time intervals from baseline. However, there was no significant inter-group difference in PD during 3, 6, and 12 months. Sbordone L et al., [29] reported no statistically significant alterations in PD around implants placed in patients with a history of chronic periodontitis throughout a 3-year observation period, similar to other studies, [30,31] including the present study. The crestal bone loss in the current study was slightly higher in both groups (2.275±1.262 mm and 2.839±0.847 mm in groups A and B, respectively), attributed to implant thread design and patient's non-compliance.

Crestal bone level in the tooth adjacent to the implant did not reveal significant bone loss on both mesial and distal aspects of the tooth adjacent to the implant in groups A and B. However, the crestal bone loss was considerably more than the adjacent tooth at the implant site after following supportive periodontal protocol. During the first-year postloading, bone resorption upto 1.5 to 2 mm, is generally considered physiological. After that, an annual bone loss of 0.2 mm can be anticipated under normal circumstances [28]. Evidence suggests that microthread design in the implant neck can minimise marginal bone loss by reducing shear stress in peri-implant bone, but that this effect fades as the marginal bone level declines [32] .The current study results are in line with the histological study in that despite producing significant bone-to-implant contact, implants with micro-rings result in higher bone loss [19]. With increasing crestal bone loss, there is an increasing PD, which causes plaque accumulation, eventually leading to increased bone loss [33]. Therefore, short-term clinical and radiological parameters play a significant role in the long-term success of implants.

The WKG and GT have an essential role in maintaining long-term crestal bone stability. The evidence regarding the need for keratinised mucosa to maintain peri-implant health is still divisive [34-36]. However, recent evidence suggests a need for keratinised gingiva of approximately 2 mm in non-compliant patients or those with poor oral hygiene [37]. In the present study, the keratinised mucosa and gingival thickness were >2 mm in most cases. Besides, thicker gingiva has a positive influence on maintaining crestal bone. More stable bone levels are observed in the thick gingival biotype compared with the thin biotype [36]. The WKG and GT would have had a negligible influence on the crestal bone loss as they were equally distributed among the present study population.

Generally, 2D radiography or intraoral periapical radiographs are recommended for radiographic evaluation of implants during maintenance therapy [38]. In the current study, radiographic evaluation of crestal bone loss was done using intraoral periapical

Variables	IL	3 months		6 months		12 months		
	NC	NC	Inflammation	NC	Inflammation	NC	Inflammation	Inflammatory exudate
Within group A (%)	100.00	66.67	33.33	83.33	16.67	100.00	0.00	0.00
Within group B (%)	100.00	50.00	50.00	58.00	42.00	83.33	8.33	8.33

[Table/Fig-11]: Soft tissue complications at implant loading and 3, 6 and 12 months post loading between groups.
#Inflammation included both swelling and BOP and was assessed visually. Dichotomous scale of Yes or No was used
NC: No complications; IL: Implant loading; BOP: Bleeding on probing

radiographs using grids. The grids have an added benefit of increased accuracy even in cases of angulation errors or image distortion [39].

On examining the soft tissue complication, there was a reduction in complication in group A from 3 to 12 months, whereas, in group B, 16.67% of patients exhibited complications at the end of 12 months. The response toward supportive periodontal therapy was moderate in group B, which also exhibited slightly more crestal bone loss than group A. The patients in group B exhibited BOP around the natural tooth and implant, strengthening the existing evidence. In a similar study, patients exhibited BOP at 61% of the implant sites, indicating inflamed peri-implant sites [40].

The other confounding factors for crestal bone loss are bone remodelling, biologic width, functional and mechanical loading, the distance between the tooth and the implant, and trauma during the surgical procedure [41], which were all standardised among the groups in the current study. In such scenario, the dentist might opt to restore the edentulous space either with removable or fixed prosthesis. In group B, the inherent host reaction in periodontitis patient towards the soft tissue support may be retained and resulted in a bone loss; hence a history of treated periodontitis should be considered a risk factor during case selection for implant placement [42].

Limitation(s)

One of the parameters used in the present study was radiographic evaluation of crestal bone loss using 2D IOPA. The accuracy of 3D imaging is more when compared to 2D imaging as periodontitis is slow progressing, long-standing disease, a long-term follow-up is required to evaluate the accurate association between the groups. Smaller sample size taken in present study was one of the shortcomings of the study.

CONCLUSION(S)

There was no significant difference between the peri-implant bone levels and clinical parameters around implants with and without a history of treated periodontitis. Nevertheless, soft tissue complications were more in the group with the history of treated periodontitis. However, more studies with larger sample size and appropriate study design in patients compliant with supportive therapy are required to strengthen the current evidence.

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