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Research Article

Crestal Bone and Soft Tissue Stability Surrounding Laser Microtextured Collar of Dental Implant; A 3- Year Clinical and Radiographic Evaluation

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Abstract

Objective: To evaluate marginal bone level (MBL) and clinical performance of dental implants with laser microtextured collar after three years of loading.

Material and Methods: Randomly selected were 24 patients (mean age ± standard deviation [SD] 44.0 ± 11.1 years) who had dental implants in the dental center at the Arab American University in Ramallah, Palestine. 64 implants are necessary to achieve 99% confidence level with a margin of error 0.1mm. Periapical radiographs were taken for these dental implants immeadiatly after loading and 3-years after loading. Crestal bone resorption was evaluated taking into consideration the attached gingivae width. Probing pocket depth and bleeding scores were also evaluated.

Results: After 3 years of loading, the crestal bone loss was 0.74 ± 1.06 SD. Probing pocket depth 3.73 ± 0.85 SD. Gingivitis index (Bleeding on probing 0.77 ± 0.86 SD). Plaque index 0.40 ± 0.76 SD. In addition, no significant differences (P = 0.708) related to the attached gingiva width and radiograpgic bone loss were observed.

Conclusion: Laser microtexturing of the collar of the dental implants provide stability of hard and soft tissue around dental implants. Nevertheless, it did not eliminate crestal bone resorption. Within the limits of this study, the laser microtexuring can stabilize the soft tissue regardless of the width of attached ginigiva.

Keywords: Crestal Bone Loss; Laser- Microtextured Collar Dental Implants; Biologic Width; Peri-Implantitis; Micro Gap

Abbreviations

MBL: Marginal Bone Level; SD: Standard Deviation; PPD: Probing Pocket Depth

Introduction

Dental implants are the most suitable procedures to replace missing teeth [1]. Multiple clinical trials and scientific research have been done on dental implant materials and designs to enhance osseointegration and to produce ideal stability of crestal bone and soft tissue around dental implants [2,3]. These studies concentrated on the change and physical, topographical, mechanical, and chemical characteristics of the surface of the dental implants [4,5]. One of these surface treatments is laser Microtexturing, which can enhance soft and hard tissue integrity around dental implants [6-9].

In laser microtexturing technology, the surface of the coronal collar of the dental implant are designed by microgrooves which were made using computer-controlled laser ablation techniques [6,10,11]. This technique can produce a connective tissue attachment that works as a barrier which prevents epithelial down growth and protect the crestal bone [6,12,13].

Many factors contribute to the crestal bone loss including implant surgery, micro gap, biological width, implant crest module, occlusal overload, and peri-implantitis [14-17]. Implant crest module received the highest magnitude of shear and rotational forces during function. This will produce crestal bone resorption with time [16,17]. In a three Dimensional finite element analysis in 2010, Wan-Ling Shen., *et al.* examined the influence of implant collar design on stress and strain distribution in the crestal compact bone. In his study, he evaluated different dental implants' collars (straight, divergent, and convergent collar designs). He found that the divergent collar design had the lowest stress and strain in the adjacent compact crestal bone followed by straight and convergent collars [18]. Additionally, the surface of the implant collar affected the marginal bone stability. Recently, dental implant clinical trials are focusing on reducing or eliminating crestal bone loss. In the past, they used the machined collar dental implants. They thought it would be effective in preventing plaque and calculus accumulation. Studies have demonstrated that roughened collars were more retentive to crestal bone and provide more stability for the peri-implant tissue than the machined smoothed collars. The roughness value of the implant collar were adjusted to stabilize the blood clot; so bone integration followed [14,15]. Nevertheless, after the normal bone remodeling occured, the exposed rough surface accumulated as oral biofilm which yields to mucositis and peri-implantitis. The moderate roughness value and the nano-topography of laser microchanells had no biofilm formation in comparison with other surfaces [19]. Consequently, the micro surface enhanced the soft tissue attachment and fibril orientation to protect the implant biologic width when this surface was exposed to soft tissue [20-22].

In this study, the clinical observation of laser microtexured surface was done in terms of marginal bone stability and soft tissue stability.

Material and Methods

Patient population

This retrospective clinical study was approved by the Helsinki Committee for ethical approval (Palestinian Health Research Council, Gaza, Palestine. Approval no: PHRC/HC/1085/22). The study was conducted on patients treated with dental implants at the dental center at the Arab American University, Palestininian Territories, and the implant prosthesis were delivered between March 2019 and August 2019. 24 patients (mean age ± standard deviation [SD] 44.0 ± 11.1 years) with 64 implants were selected randomly from patient files where the patients signed an informed consent form. Among the 24 patients, 14 were male and 10 were female. Most of the patients were non-smokers (18) table 1.

The patients included in this study have adhere to the following criteria: good oral hygiene, healthy patients without any systemic diseases, implant placed without bone augmentation, implant placed in complete healing sites, and at least 3 months passed after tooth extraction. Moreover, they have healthy adjacent teeth without periapical lesions and implants placed at the level of bone from the mesial and distal margins. In addittion, the exclusion criteria include patients with any local or systemic disease, alcoholism, patients complaining from bruxism, patients complaining from untreated periodontal disease, and all implants placed sup or supra bone level were also excluded.

Gender	
Male, n (%)	14 (58.3)
Female, n (%)	10 (41.7)
Smoking status	
Smoker, n (%)	6 (25.0)
Non-smoker, n (%)	18 (75.0)
Age	
Mean ± SD	44.0 ± 11.1
Median	42.0
Range	47.0 (70.0-23.0)

Table 1: Patient population.

Marginal bone level (MBL)

MBL of dental implant was evaluated on Periapical radiograph taken at baseline (Implant Placement), at the time of prosthetic crown placement (3-4 months). A follow-up was done after 3 years. In addition, standard parallel periapical radiographs with film holder (KerrHawe SA) were taken by a phosphor plate (Xios scan, Sirona heliodent pluse). Sidexis software was used to measure the distance from the implant shoulder to the first visible bone contact of mesial and distal of the dental implants. All measurements were done by one investigator (O.R).

The MBL was measured as a linear distance from the margin of dental implant at the mesial and distal sides to the level of crestal bone margin, and the average of mesial and distal values were calculated.

Clinical parameters

All clinical parameters were investigated by one clinician (O.R). At patients recall (3 years after loading), the probing pocket depth (PPD) at the mesial, distal, buccal, and lingual surfaces of these dental implants was done by 1mm graduated perio-probe (Hu-Friedy). Plaque index scores were recorded according to the silness and loe index 1963 on all surfaces of the dental implants. Also, the Gingivitis index (bleeding index) scores were recorded according to the gingival index of Löe and Silness, 1963 [23]. Implant survival and success rates were also measured according to Albrektsson., *et* *al*. 1986 [1,24,25]. The attached gingiva width were measured by Perio-probe (HuFriedy) from the gingival margin to the mucogingival line.

Statistical Analysis

Sample size calculation determined that 46 implants are necessary to achieve a 99% confidence level with a margin of error 0.1mm (Minitab®). The study's clinical and radiographic variables were described by mean and standard deviation (SPSS V.23). Mann-Whitney U test was used for the comparison of MBL of attached gingiva ≥2mm surounding implant and attached gingiva < 2mm.

Results

At the 3-year follow up, all 24 patients were available for radiographic (Figure 1) and clinical evaluation. All 64 implants were functional with a cumulative survival rate of 100% at the 3- year follow up. Based on the criteria of Albrektsson, the implants had a success rate of 93.84%. Additionally, the prosthesis were functional without chipping or complications.

Figure 1: Peri-apical radiographs at implant placement day and 3 years after loading.

MBL

Table 2 summarizes the MBL change from the time of implant placement to the 36th month after loading. After 3 years of loading, the crestal bone loss was 0.74 ±1.06 SD. In 30 implants the average of marginal bone lose is 0-0.5m, while in 32 implants the average of marginal bone loss is 0.5-1mm. To add, at 7 implants the average of marginal bone loss is 1-1.5mm, and in 6 implants the marginal bone loss >1.5. No correlation was observed between implant site, smoking and sex with MBL. (Table 5)

	Mean	Standard Deviation	Rang (Max-Min)	Median
Radiographic Crystal bone	0.74	1.06	-0.00)7.53 (7.53	0.00
Mesial	0.71	1.07	-0.00)7.18 (7.18	0.00
Distal	0.77	1.09	-0.00)7.36 (7.36	0.00

Table 2: Radiographic marginal bone loss after 3 years of loading.

Soft tissue parameters

The PPD, BI and PI were 3.73 ± 0.85, 0.77 ± 0.86, 0.40 ± 0.76 respectively (Table 3).

	Mean	Standard Deviation	Rang (Max-Min)	Median
Plaque index	0.40	0.76	3.0 (3.00-0.00)	0.00
Probing pocket depth	3.73	0.85	6.5 (7.50-1.00)	3.75
Gingivitis index (Bleeding on probing)	0.77	0.86	2.0 (2.00-0.00)	0.50

Table 3: Peri-implant soft tissue parameters after 3 years of loading.

No significant differences (P = 0.708) related to the attached gingiva width and radiographic bone loss were observed. (Table 4,5).

Discussion

According to previous studies, the mean of crestal bone loss around dental implants was 1.5mm after the first year of loading and 0.2 mm in every following year with a standard deviation of 0.3mm [24,26-28].

The results of this clinical and radiographic study showed 0.7 mm average marginal bone loss after 3 years of functional loading. Confimatory results were also observed by Koodaryan., *et al*, where laser microtextured collar dental implants have significant crestal bone resorption reduction than machined collar dental implants. Moreover, he found a significant reduction in propping pocket depth around laser microtextured collar implants [29]. In another histologic study, the Laser Microchannels can produce connective tissue attachment with perpendicular collagen fibers resembling the tooth attachment which prevent epithelial down growth and crestal bone loss [10].

Attached Gingiva Width	<2	>2	Test-statistic	p-value
Radiographic crestal bone level	0.80 ± 1.35	0.69 ± 0.80	463.00	0.708

Table 4: Radiographic marginal bone loss according to the attached gingiva width.

	Mean (Std. deviation)	Test statistic	p-value
Gender		-1.238	0.216
Male	0.77 (0.79)		
Female	0.70 (1.33)		
Smoking status		-0.320	0.749
Smoker	0.87 (1.46)		
Non-smoker	0.67 (0.74)		
Arch		-0.376	0.707
Mandible	0.86 (0.07)		
Maxillae	0.97 (1.87)		
Number of implants		-0.088	0.930
Single implant	1.00 (1.87)		
Two adjacent implants	0.67 (0.70)		

Table 5: Univariant analysis of marginal bone loss.

- Mann-Whitney U test was used to calculate significant levels (P value); cell value represents the percentage within the column (count).

Renzo Guarnieri., *et al.* evaluated 160 laser microtextured collar dental implants and 140 machined collars. The results of their research after 2 years support our study that a radiograghical crestal bone resorption for test group is 0.58mm and for control group 1.09. Moreover, the clinical attachment loss was 0.55mm for the test group and 1.12mm for the control group [30].

Yojana B. Patil., *et al*. compared the crestal bone loss around implants with smooth collar and implants with micro threaded rough collar design. He found that Crestal bone loss adjacent to rough micro threaded-collar implants was significantly lower than smooth-collar implants [31]. Additionally, other studies that observe the laser micro structured collar in term of MBL and soft tissue stability were in line with our results [14,32,33].

Furthermore, Spyros Botos., *et al*. found that laser microtextured-collar dental implants have significantly shallower peri-implant pockets compared to machined collar. At a 6 and 12 month follow up the crestal bone loss adjacent to loaded laser microtextured dental implants were (0.19mm and 0.42mm, respectively) and unloaded laser microtextured implants were (0.15mm and 0.29mm, respectively). For the control group (machined implants) at 6 and 12 months the crestal bone loss of loaded machined dental implants were (0.72 mm and 1.13 mm, respectively) and for the unloaded conrol group was (0.29mm and 0.55mm, respectively) [34].

Found in a study done by Gabriele E. Pecora., *et al*. in 2009, Laser-Lok surface treatment of dental implants reduced crestal bone resorption around the dental implant to 0.59 compared to 1.94 around machined dental surface implants, and probing pocket depth was of 2.30 mm versus 3.60 respectively [6].

Another study done by Linkevicius T., *et al.* compared laser-microtextured implants with platform switching implants according to crestal bone loss around them in thin peri-implant mucosa patients. They found that the laser microtexturing surface treated implant may produce less proximal bone loss than platform switching type in the pre-loading period. In the same study they found that those modalities in surface treatment of implants will not eliminate crestal bone resorption completely. Crestal bone loss of 0.71 and 1.02 was found in laser microtexturing and platform switching after 2 months respectively. At prosthesis delivery, it was 1.10 and 1.37 in laser microtexturing and platform switching, respectively. After a 1-year follow-up, the crestal bone loss was 1.41 and 1.43 in laser microtexturing and platform switching, respectively [35].

All the previous studies demonstrated good clinical and radiograghical performance of laser microtextured collar dental implants. These results are comparable with our results.

The gingival biotype is the critical parameter that will influence the degree of crestal bone resorption and the stability of soft and hard tissue around dental implants [35]. In our study, when the attached gingiva is more than 2mm, there were no significant differences in MBL with those implants surrounded by less than 2mm of attached gingiva. This may be due to the limited numbers of implants incorporated in this study.

We cannot solely depend on bleeding upon probing to establish a diagnosis of peri implant condition, rather it needs multiclinical parameters like visual signs of inflammation (color changes, swelling, and suppuration), probing pocket depth and radiograghical bone level around dental implants.

Conclusion

Within the limitations of this study, we can conclude that laser-microtextured collar dental implants provide stability of soft and hard tissue around it but do not prevent crestal bone loss completely.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of this study.

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