Evaluation of Crestal Bone Loss Around Dental Implants in Cigarette Smokers

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ABSTRACT

Introduction: The success of dental implants depends on numerous factors. The harmful effects of smoking on wound healing after tooth extraction are well documented. Cigarette smoke mainly contains nicotine that delays bone healing and affects the survival of the implant.

Objectives: This study was done to assess the marginal bone loss around dental implants in smokers and nonsmokers.

Methods: The study included 100 individuals who received dental implants in maxillary or mandibular edentulous regions from 2015 to 2019. The sample was divided into two groups: Group A (smokers, n = 50) and Group B (nonsmokers, n = 50). Marginal bone loss was measured on the distal, mesial, buccal, and lingual side of each implant after 3, 6 and 12 months using periapical radiographs.

Results: The crystal bone loss around dental implants was significantly higher in smokers (Group A) as compared to nonsmokers (Group B) regardless of the period of loading (P < 0.001).

Conclusion: Smoking overall lowers the success rate of dental implants. With increased duration and frequency of smoking, a higher degree of marginal bone loss around dental implants can occur.

Key Words: Dental implants, Marginal bone loss, Smoking

INTRODUCTION

The long term dental implants depend on the conservation of the bony support around the implant. Osteointegration or osseointegration denotes a direct bone-to-metal interface without the interposition of nonbone tissue. This perception has been defined by Branemark, as containing a highly differentiated tissue making a direct structural and functional connection between ordered, living bone and the surface of a load-carrying implant.1 Over his early comments on osseointegration, Branemark revealed that titanium implants could become undyingly incorporated within the bone.2 Bone healing around implants contains a cascade of extracellular and cellular biological proceedings that take place at the bone-implant boundary till the implant surface appears finally enclosed with a recently formed bone.3 These biological proceedings comprise of activation of osteogenetic processes comparable to those of the bone healing process, at least in terms of initial host response.4,5 Early connections of blood cells with the implant affect clot formation. Platelets undergo morphological and biochemical changes. The formed fibrin matrix acts as a scaffold (osseoconduction) for the migration of osteogenic cells and ultimate differentiation (osseoinduction) of these cells in the healing section. Osteogenic cells form osteoid tissue and new trabecular bone that ultimately remodels into the lamellar bone in direct contact with most of the implant surface (osseointegration).6,7 Matrix is an early-formed calcified fibrillar layer on the implant surface, relating poorly mineralized osteoid similar to the bone cement lines and laminae limitans that forms a continuous, 0.5 mm thick layer that is rich in calcium, phosphorus, osteopontin, and bone sialoprotein.8

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In the oral cavity, the smoking habit is related to delayed bone healing, decreased bone height, increased bone loss rate, poor quality bone formation and increased incidence of peri-implants. Smokers present 1.69 times higher chances of implant failures than nonsmokers during the first implant surgical stage (before prosthesis insertion). Furthermore, a multivariate survival examination displayed that implant placement in the maxilla and short implants were risk factors for failure of the implant.

Generally, implant failure is defined as the mobility of the implant during osseointegration or postoperative loading.

The success rate of implant based on several factors consisting of; operator skill, oral hygiene, implant material used, bone quality and quantity, occlusal load, absence of medical conditions, and personal oral habit such as smoking. This prospective study was done to evaluate the smoking effect on the dental implant survival rate.

**MATERIALS AND METHODS**

The present study was conducted on 100 patients (68 men, 32 women) within an age group of 30–55 years who received 160 dental implants between 2015 and 2019. All these patients were divided into two study groups, Group A (smokers, n = 50) and Group B (nonsmokers, n = 50) and the detailed smoking history (type, number of cigarettes smoked per day and duration) was noted on a self-assessment questionnaire.

The inclusion criteria were; patients with or without a history of smoking, with periodontal healthy teeth adjacent to the implant site and without any periapical lesion. The exclusion criteria were; inadequate bone volume, history of local or systemic disease, pregnancy or breastfeeding, long-term oral medications, and nontreated periodontal disease.

Detailed information of each participant about implant characteristics such as implant location, type, implanted jaw, and bone quality was attained. The location of implant placement was either classified into the anterior or posterior region and maxillary or mandibular area. Ethical approval was attained from the institutional review board. Informed consent was taken from all participants. Patients were recalled at 3, 6 and 9 months for evaluation of implant success.

The smoking effect on the success of the implant was recognized by measuring the bone loss around the distal, mesial, lingual and buccal side of each implant using periapical radiographs. On the radiographic images, the distance from the widest part of the implant to the crestal bone level was calculated. Marginal bone attachment at the buccal, lingual, mesial and distal, portions of all implants was visually evaluated, the mean of their measurements was deliberated, and the difference in marginal bone over time was noted as the MBL (mesial buccal lingual) of each implant.

The obtained data were evaluated statistically using the Statistical Package for Scientific Studies for Windows (SPSS) version 21, IBM, Armonk, NY, USA, using “Paired t-test” at a significance level of $P \leq 0.05$.

**RESULTS**

Table 1 shows marginal bone loss around dental implants in Group A (smoker) patients. The mean marginal bone loss around Group A dental implants 3 months after loading was 2.2±0.13 mm in the maxillary anterior region, 2.4±0.18 mm in the maxillary posterior region, 2.6±0.14 mm in the mandibular anterior region, and 2.9±0.19 mm in the mandibular posterior region, 6 months after loading was 2.6±0.18 mm in the maxillary anterior region, 2.7±0.23 mm in the maxillary posterior region, 2.7±0.21 mm in the mandibular anterior region, and 2.8±0.24 mm in the mandibular posterior region, and 9 months after loading was 3.2±.34 mm in the maxillary anterior region, 3.5±0.46 mm in the maxillary posterior region, 3.6±0.25 mm in the mandibular anterior region, and 3.8±0.53 mm in the mandibular posterior region. Figure 1 indicates, a diagrammatic representation of marginal bone loss around the implant in smokers at 6, 9 months.

Table 2 shows marginal bone loss around dental implants in Group B (nonsmoker) patients. The mean marginal bone loss around Group B dental implants 3 months after loading was 1±0.28 mm in the maxillary anterior region, 1.2±0.28 mm in the maxillary posterior region, 1.4±0.37 mm in the mandibular anterior region, and 1.6±0.40 mm in the mandibular posterior region, 6 months after loading was 1.4±0.56 mm in the maxillary anterior region, 1.4±0.39 mm in the maxillary posterior region, 1.8±0.37 mm in the mandibular anterior region, and 1.9±0.42 mm in the mandibular posterior region, 9 months after loading was 1.5±0.65 mm in the maxillary anterior region, 1.9±0.52 mm in the maxillary posterior region, 2.0±0.56 mm in the mandibular anterior region, and 2.2±0.48 mm in the mandibular posterior region.

Marginal bone loss around dental implants was significantly higher in smokers (Group A) as compared to nonsmokers (Group B) regardless of the period of loading ($P < 0.001$). With increased frequency and duration of cigarette smoking habit, there was a higher implant failure rate and mobility among smokers as compared to nonsmokers and it was statistically significant (Table 3).

**DISCUSSION**

Cigarette smoking may harmfully affect wound healing and thus, threaten the success of bone grafting and dental implantation. Heat and the toxic by-products of cigarette smoking...
can impair healing, and, therefore, may affect the success and survival of the dental implant.

Yang et al. have done a study to assess the alterations in the characteristics of titanium surface and the osteoblast-titanium interactions under cigarette smoke extract (CSE) exposure. Titanium samples were submerged in CSE to explore the changes in the characteristics of the titanium surface. They found that the adsorbed carbon-containing compounds were the chief reason for smoking-mediated inhibition of the osseointegration.16

Baig and Rajan 17 in their study suggested significantly more marginal bone loss following implant placement and an increase in the incidence of peri-implantitis. Bain and Moy 18 suggest that long periods of abstinence are required. Yet, the mechanism in which the tobacco affects the osseointegration and the survival of implants remains unidentified. Implant failure commonly found due to the deposition of fibrous tissue at the bone-implant interface.9,12

The cigarette has more than four thousand bioactive chemical components with potential deleterious effect on human tissues including bone.19 The aldehydes, nitrosamines, carbon monoxide, ammonia, carbon dioxide, and benzene are constituents of the cigarette that may disturb the bone healing process. Carbon monoxide is a competitor/inhibitor of the oxygen and reduces the oxygen-carrying capability of red blood cells; the hydrogen cyanide encourages hypoxia by hindering the enzyme systems essential for metabolism oxidation. Besides, smoking is related to an increased concentration of reactive oxygen and decreased levels of vitamins. The earlier studies have associated high levels of reactive oxygen with the bone resorption process which may clarify the negative outcome of smoking on the osseointegration process.19

Furthermore, nicotine decreases osteoblastic activity disturbing the amount of collagen available to form the extracellular matrix. Nicotine may encourage microvascular obstruction which results in ischemia and reduces the blood cells.20 Nicotine also decreases the proliferation of macrophages.11,12 Fe-loutzis et al.21 described that heavy smokers (>20 cigarettes per day) confirmed a suggestively increased marginal bone loss (mean = 1.98 mm) (P < 0.01) around the implants when associated with nonsmokers (0.18 mm) and patients who stopped smoking (mean = 0.24 mm).

Kan et al.22 used a cumulative success rate (CSR) analysis and reported that nonsmokers had a significantly higher implant success rate (82.7%) when compared to smokers (65.3%) (P = 0.027). The risk of failure in smokers was described to be twice higher than in nonsmokers; however, these researchers failed to prove the smoking effect as being dose-dependent.

Lindquist et al.23 described significantly higher marginal bone loss around implants in heavy smokers of more than >14 cigarettes per day compared to those with low cigarette consumption of lesser than <14 cigarettes per day.

In our study, the success of the implant was noticeably higher in nonsmokers compared to smokers. Implant mobility and the failure rate was found to be expressively greater in individuals who smoked > 20 cigarettes/day over 10 years.

Comparable results were assessed by Fartash et al.24 in a study on mandibular implant overdentures. Hamad assessed the smoking effect on the bone around the dental implant and concluded that Smoking could be a factor results in future implant failure.25 Chrcanovic et al, evaluated the smoking effect on failure rates, postoperative infection and marginal bone loss of dental implants and concluded that smoking can influence implant failure similar to our findings.26 Takamiya et al. and observed higher implant failures with a smoking habit similar to our findings.27

The success of implant was noticeably higher in nonsmokers compared to smokers. Additionally, the failure rate of implant increased with the frequency and duration of cigarette smoking habit but was statistically not significant. Further, longer-term studies are needed on larger samples size.

**CONCLUSION**

The present study indicated that increased frequency and long duration of smoking habit were associated with decreased implant survival rate compared to nonsmokers.

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**Authors contribution**

1. SA- Investigation, Data analysis
2. PB- Editing
3. SJ- Analysis
4. RAR- Data analysis
5. GBST - Manuscript writing
6. IK- Editing

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Table 1: Marginal bone loss around dental implants in Group A (smoker) patients

| Site                  | 3 months after loading in mm | 6 months after loading in mm | 9 months after loading in mm |
|-----------------------|------------------------------|-----------------------------|-----------------------------|
| Maxillary anterior region | 2.2±0.13                    | 2.6±0.18                    | 3.2±0.34                    |
| Maxillary posterior region | 2.4±0.18                    | 2.7±0.23                    | 3.5±0.46                    |
| Mandibular anterior region | 2.6±0.14                    | 2.7±0.21                    | 3.6±0.25                    |
| Mandibular posterior region | 2.9±0.19                    | 2.8±0.24                    | 3.8±0.53                    |

Table 2: Marginal bone loss around dental implants in Group B (nonsmoker) patients

| Site                  | 3 months after loading | 6 months after loading | 9 months after loading |
|-----------------------|------------------------|------------------------|------------------------|
| Maxillary anterior region | 1.2±0.28               | 1.4±0.56               | 1.5±0.65               |
| Maxillary posterior region | 1.2±0.28               | 1.4±0.39               | 1.9±0.52               |
| Mandibular anterior region | 1.4±0.37               | 1.8±0.37               | 2.0±0.56               |
| Mandibular posterior region | 1.6±0.40               | 1.9±0.42               | 2.2±0.48               |
Table 3: Implant mobility in relation to smoking habit

| Habit                     | Variable      | Mobility | P    |
|---------------------------|---------------|----------|------|
| Smoking history           | Smokers       | 18       | 0.001|
|                           | nonsmokers    | 2        |      |
| Number of cigarette/day   | <20           | 5        | 0.001|
|                           | >20           | 13       |      |
| Smoking years             | <10           | 4        | 0.001|
|                           | >10           | 14       |      |

Figure 1: Diagrammatic representation of marginal bone loss around implant in smokers. A. Marginal bone around implant in non smokers, B. Marginal bone around implant at 6 months in smokers, C. Marginal bone around implant at 9 months in smokers.