

Smoking: The Subtle Element Affecting the Success and Failure of Implants

Aishwarya Krishnan^{1*} Rootu Shah² Nikita Agrawal³ Teh Chai Liu⁴

¹BDS, MDS, Consulting Periodontist and Implantologist, Ahmedabad, Gujarat, India.

²BDS, MPH Student, Massachusetts College of Pharmacy and Health Sciences, Boston, USA.

³PG Student, Department of Periodontology and Implantology, Rungta College of Dental Sciences and Research, Bhilai, Chattisgarh, India.

⁴PG Student, Department of Periodontology and Implantology, Rungta College of Dental Sciences and Research, Bhilai, Chattisgarh, India.

ABSTRACT

Background: The success of the treatment of missing teeth with dental implants is the complete integration of an implant with the bone and the correct functioning of implant based prosthetic restoration for many years. Facts that may affect therapeutic failure are the patient's age, general diseases including osteoporosis, diabetes and hypertension, as well as dental and medical factors. Tobacco smoking is one of the essential factors that may affect the success of implant treatment of missing teeth.

Smoking is a prevalent behaviour in the population. The aim of this review is to bring to light the effects of smoking in dental implants. Smoking has its influence on general as well as oral health of an individual. Tobacco negatively affects the outcome of almost all therapeutic procedures performed in the oral cavity. The failure rate of implant osseointegration is considerably higher among smokers and risk of peri-implantitis are adversely affected by smoking. In this age, it is extremely important that the practitioner clearly understands and is able to convey the spectrum of possible complications and their frequency to the patients.

Keywords: Smoking, Implant, Implant Failure.

INTRODUCTION

The risk factors for surgical implant failures can be divided into two categories:-The first is related to the surgical technique, implant type and place, waiting time between tooth extraction and implant insertion, and between implant insertion and loading. The second consists in patient characteristics such as uncontrolled diabetes, alcohol consumption and smoking.

In the oral cavity, the smoking habit is associated with delayed bone healing, reduced bone height, increased rate of bone loss, formation of poor quality bone as well as increased incidence of peri-implantitis. Smokers present 1.69 times higher chances of implant failures than non smokers during the first implant surgical stage.¹ The

smoking habit has also been associated with delayed failures of dental implants such as those occurring during the second implant surgical stage.² Failures generally occur due to the deposition of fibrous tissue at the bone implant interface. The implant insertion may be compared to the healing process after bone fracture. Initially, the coagula is formed between the implant and the bone tissue. Depending on the local conditions and relative immobility of the implant, pluripotent mesenchymal cells differentiate into osteoblasts and fibroblasts, and bone tissues are formed. The presence of cigarette components affects this process.

SMOKING AND HEALTH

Tobacco appears to be as old as human civilization and was introduced into India by Portuguese

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*Correspondence Dr. Aishwarya Krishnan.

Private Consultant, Department of Periodontology, Ahmedabad, Gujarat, India.

Email: Not Disclosed

traders during 1600 AD. It spread like fire to such a great extent that today, India is the second largest producer and consumer of tobacco in the world.³

A primary relationship between smoking and coronary heart disease, stroke, chronic obstructive pulmonary disease, pneumonia, and various cancers has been established. Tobacco negatively affects the outcome of almost all routine procedures like non surgical periodontal therapies to orthognathic surgeries. Smokers respond less favourably than non smokers to surgical periodontal therapy.⁴ Fibrinolytic activity caused by smoking reduces alveolar blood supply after dental extractions.

Several mechanisms have been proposed by which smoking may affect wound healing:⁵

- a) Carbon monoxide released by cigarette smoke has a higher affinity for haemoglobin which reduces oxygenation of the healing tissues.
- b) Nicotine is vasoconstrictive which increases platelet adhesiveness and aggregation and thus reduces blood flow .
- c) The cytotoxic effects on fibroblasts and polymorphonuclear cells additionally disrupt cell repair and defence.
- d) Wound healing is fundamental to the process of osseointegration and smoking is recognised as a risk factor.

A GLANCE IN THE PAST

Moy et al reported a success ratio of 91% for non smokers compared with 80% for smokers. Most failures occurred in the first year following implant placement.⁶ There were twice as many implant failures in the maxilla compared with the mandible for smokers.

De Luca et al reported on a long term retrospective study of 1852 consecutive Branemark implants. The failure for non smokers was 13.3% and smokers 23.1%. Smokers at the time of implant surgery had a 1.69 times higher incidence of early implant failure compared with patients who had never smoked or who had stopped smoking at least one week before implant surgery. Thus, data indicated that some of the effects of smoking can be

minimised and this is in keeping with an earlier study by Bain.

Queiroz et al⁷ collected salivary samples of 41 subjects and determined the levels of salivary arginase activity by the measurement of L-ornithine and expressed as mIU/mg of protein. They found increased salivary arginase activity in smokers with dental implants as compared to non smokers with dental implants. They suggested that an increased arginase activity may lead to less NO production which consequently increases the susceptibility to bacterial infection and implant failures in smokers.

EFFECT OF NICOTINE

The cigarette has more than 4000 bioactive chemical components with potential deleterious effects to human tissues. The nitrosamines, aldehydes, CO, CO₂, ammonia and benzene are components of cigarette that may affect the bone healing process.^{8,22} CO is a competitor / inhibitor of the oxygen and decreases the oxygen carrying capacity of the RBCs. The HCN promotes hypoxia by inhibiting the enzyme systems necessary for metabolism oxidation.^{9,10,21} Nicotine on the other hand is the main component of the cigarette and increases the heart rate, blood pressure and respiratory rate, and makes the user feel more alert. It is found in the plasma and saliva of the smokers in a concentration of 4-73 ng / ml and 96 – 1.6 mg/ml, respectively.^{11,12,22} Nicotine has high diffusion potential and has been associated with deleterious effect on bone healing. The osseointegration process requires the recruitment of osteoblasts, their anchorage, adhesion, spreading, proliferation and differentiation into osteoblasts that secrete extra cellular matrix calcification on the implant surface. All these cellular events are sensitive to the local and systemic effects of nicotine and other associated components.^{13,20}

In addition, nicotine reduces osteoblastic activity effecting the amount of collagen available to form the extra cellular matrix. Nicotine also may induce microvascular obstruction which results in ischemia, with direct reduction of blood flow and nutrients in the healing area after implant insertion.^{14,23} Some authors suggest that changes in level of intracellular calcium ions followed by nicotine binding to its receptors and subsequent activation of voltage dependent calcium channels can

modulate in some way the effect of nicotine on bone metabolism.¹⁵

Nicotine also decreases the proliferation of macrophages that participate in acute phase of cell injury and act against antigens, cytokines and initiates the immune process. When macrophages function is decreased, the immune process is directly affected and causes increased susceptibility to infections in the surgical area of implant insertion.¹⁶

Nicotine also increases platelet adhesiveness which can lead to poor perfusion due to the micro-clots. It also act as sympathomimetics by increasing the release of epinephrine and nor epinephrine and causes increased vasoconstriction which limits overall tissue perfusion. Thus, smoking compromises wound healing.

SMOKING AND IMPLANTS

Predictors for implant success and failures are generally divided into patient related factors eg. general patient health status, smoking habits, quality and quantity of bone, oral hygiene maintenance, implant characteristics (dimensions, coating and loading), implant location and clinician experience. In general, factors related to the patient appear to be more critical than those related to the implant in determining the likelihood of implant failure.¹⁷

Clinical trials of endosseous implants consistently rate smoking as a primary patient centered risk factor for implant loss.^{2,18,19} Effects of smoking on implant survival and success are more pronounced in areas of poor quality trabecular bone. In smokers, maxillary implants have more failure rates as compared to mandibular implants. ^{1,20,31} Vasoconstriction caused by the local absorption of nicotine into the blood stream is shown to be a significant factor for implant failure by some studies. This can explain lower failure rate in the posterior mandible among smokers, since this area is covered by the tongue and protected against local influence of tobacco smoke.

The effects of smoking on the process of osseointegration are not as pronounced as its effects after second stage surgery.^{2,22} Gorman et al in a study on patients who had received 2000

implants, found significantly more failures in smokers after second stage surgery. In a surgery, Lambert et al¹⁹ noticed a trend of greater failures in smokers between the time after uncovering and before insertion of the prosthesis. The author theorized that the effect of tobacco on healing after implant placement was different from that after tooth extraction, because implant wounds were closed and the intimate adaptation of the implant to the bone tissue did not allow the same magnitude of interference in healing by the vasoconstrictive action of nicotine. But once the implants were uncovered, the soft tissues around them were adversely affected by tobacco in a manner similar to that by which periodontal tissues were harmfully affected. These results suggested that increased implant failures in smokers is not the result of poor healing or osseointegration, but because of exposure of peri-implant tissues to tobacco smoke.

Studies suggest smoking as the factor associated with complications like marginal bone loss, peri-implantitis, bone quality and quantity, which in turn affect the implant success rate and the success of bone graft. Smoking has prominent effect when implant is placed with the existing bone height less than 4 mm and marginal bone loss found in smokers is greater compared to non smokers.

Marginal bone loss around implant in the smokers is more prominent in the maxilla. In a study by Levin et al, present smokers demonstrated higher marginal bone loss during all time intervals than ex-smokers and both demonstrated higher marginal bone loss than non smokers. Oates et al demonstrated elevated pyridinoline levels in the crevicular fluid associated with endosseous dental implants of smokers and suggested that smoking may affect implant success to a certain extent through alterations in the level of bone resorption.²³

Smoking has been specifically associated with a variety of implant complications eg. increased incidence of peri-implantitis ^{24,28} (deep mucosal pockets around dental implants, inflammation of the peri-implant mucosa and increased resorption of peri-implant bone). It has also been found to adversely affect wound healing and thus jeopardize the success of bone grafting and dental implantation.

The failure rates of implants placed in the grafted maxillary sinuses of smokers are again more than twice that seen in non smokers.²⁹

Patients who quit smoking tend to have a reduction of the adverse effects of smoking on implant survival, but the length of the time after cessation that is necessary for significant improvement has not been sufficiently investigated.

On the basis of above study, for every patient willing for implant, following recommendations are made:-

- (i) The smoking history should first be obtained, this should include the duration of smoking, the intensity (past and present) and the present status. It is especially important to identify former heavy smokers who have recently stopped.
- (ii) Location of implant in presence of long history of smoking as implants in maxilla is in greater risk than in mandible.
- (iii) Appropriate oral hygiene instructions should be given and the deleterious effects of smoking on oral hygiene should be highlighted, with special mention made of the effect of smoking as a risk for periodontal disease. The periodontal status of the patient is also a valuable indicator of the prognosis.
- (iv) Surgeon should keep on counselling for smokers to cease or reduce smoking, atleast temporarily (Bain & Moy recommended a minimum smoking cessation protocol of one week prior to implant surgery and two months thereafter).²⁵
- (v) Patients with smoking habits should be informed prior to procedure about the ill-effects on dental implant and chances of failure if they don't agree to stop smoking.

Thus, the most important target to avoid such negative effect would be eliminating the smoking habit. Some studies have reported that both temporary and complete cessation of cigarette consumption and cigarette smoke inhalation can reverse the negative effect of smoking to the bone

healing around dental implants.^{26,27} However, maintenance of a cessation protocol is always an issue. Consequently, the use of implant with surface treatment could decrease the negative impact of smoking on the survival of dental implants, as the implant roughness has a direct effect on the migration, adhesion, proliferation and differentiation of osteoblasts. D'Avila et al evaluated the effect of surface topography on the survival of implants inserted in the posterior regions of maxilla of smokers after two months of healing without loading. The surface treatment with 100 µm aluminium oxide particles enhanced the histometric results in smokers.^{30,31,32} Therefore; simple modification of the implant topography may improve the survival of implants in smokers.

CONCLUSION

There is a significant difference in the failure rates of dental implants between smokers and non smokers and smokers are at twice the risk for implant failure compared to that in non smokers. Smoking effects maxillary implants more compared to mandibular implants. The failure rates of implants placed in grafted maxillary sinuses of smokers are more than twice that seen in non smokers. Smoking has a significant effect on dental implant placed in patients having bone height less than 4 mm. Effect of smoking gets worse with increased amount and duration of smoking per day. Effect of smoking on the dental implant can be reversed if patient follows smoking cessation protocol.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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