Effects of smoking on the success of dental implants: A literature review

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Abstract
Statement of Problem: The use of dental implants has revolutionized the treatment procedure for over last 25 years. Dental implants now have been widely accepted by the patients as their treatment plan and have become a routine procedure done by dental surgeon. Owing to the remarkable success of implant, there have been various researches going on to find out factors responsible for the failure of dental implants. With the growing use of tobacco among patients and its ill effects on bone quality and quantity has been well documented through several studies and it arises a keen interest to associate its effect on the success of implants.

Purpose: To establish the relationship between smoking and implant success and its long term survival and compare the result with non-smokers based on the literature.

Materials and Methods: Relevant clinical studies and reviews published in English literature published between 1990 and 2012 were reviewed. The articles were located through EBSCO host and manually through the references of peer reviewed literature.

Results: Most of the literatures supported the fact that smoking is a prominent risk factor affecting the success of dental implants. Studies reported that implant failure and its complications associated are twice in smokers as compared to non-smokers. Literatures also revealed that maxillary implant are more affected than mandibular in smokers. Several studies suggested that effects of smoking were reversible in smokers who followed the smoking cessation protocol prior to the procedure.

Conclusions: smokers have a greater chances of implant failure and more prone to the complications following implants and related procedures. Surgeons should stress on counseling of patient willing for implant for smoking cessations protocols.

Key words
Dental implants, failures, nicotine, Smoking, cessations, success, survival

Introduction
Now in days Dental Implants are the best permanent and secure solution in the replacement of one or more missing teeth giving you a natural appearance. They are made of biocompatible materials, just the same as hip implants or similar orthopedic devices, and function as anchors or support for traditional forms of dentistry, such as crowns, bridges or dentures. Implants are artificial tooth that is anchored in the gums or jaw bone to
Compared to Moy et al. suggested that 12 were reviewed. Article were [11,1986; Smith & he studies related to the ch can lead to poor ul [12] -

International Dental Journal of Student's Research

As 65% in smokers. Currently and content found in the smokers than compared bone osteoporosis also found to be associated with
detriment to the skeletal impairs bone wound healing and cause clear There are many studies compromises wound healing. All studies posterior, stability, radiographic bone loss and absence of infection in pre-implant soft tissues [12](Alberktsson et al., 1986; Smith & Zerb, 1989; Buser et al., 1990; Alberktsson & Zerb, 1988; Misch et al., 2008; Annibali et al., 2009). On the basis of past literature, smoking may be associated with compromised wound healing, effect on bone architecture, width, length, density, effect on peri-implant tissues. So it becomes a matter of interest to establish the effect of smoking on implant and its success. It is also necessary to study the different outcome of implant success among smokers and non-smokers. This review of the literature will give a brief outline to all dental heath professional regarding the management of patient with habit of smoking and would guide to formulate treatment plan accordingly.

Review of literature

The aim of current review of literature to throw light on the studies related to the smoking effects on dental implant success. This review co-relate the studies done on effect of smoking on peri-implant tissues and its effect on success of implant. Relevant clinical studies written in English between 1990 and 2012 were reviewed. Article were searched through EBSCO and manually through the references of peer reviewed literature.

Bain and Moy, 1993 [11] were the first to evaluate the influence of smoking on the failure rate of dental implant. They compared the results between smokers and non-smokers in which implants were placed. He found that overall failure rate of 5.92% and specifically implant failure in smokers was 11.28% as compared to 4.76% in non-smokers.

replace a missing tooth. Dental implant success is related to operator skill, quality and quantity of bone available at the site and patient’s oral hygiene. In general practice, the number of patients coming with this article gives a review of the studies done on the effect of smoking on dental implants. According to WHO Global burden disease report, 2004, The World Health Organization estimate that tobacco caused 5.4 million deaths in 2004 and 100 million deaths over the course of the 20th century. Similarly, the United States Centers for Disease Control and Prevention describes tobacco use as "the single most important preventable risk to human health in developed countries and an important cause of premature death worldwide.” Studies[1] suggest that smokers have an increased prevalence of periodontal diseases, tooth loss and oral cancer. There are several studies associating implant failures with smoking [11-10]. Moy et al. suggested that smoking caused both systemic and local injury to the tissues and is a common contributor to decrease tissue oxygenation, which negatively affects wound healing.[11] Nicotine present as a main element of cigarette reduces proliferation of RBC, macrophages and fibroblast which are the main element of healing(Sherwin & Gastwirth, 1990)[11,12]. It also increases platelet adhesiveness which can lead to poor perfusion due to micro-clots(Mosley & Finseth, 1977)[12]. It also act as sympathomimetics by increasing the release of epinephrine and nor epinephrine and causes increased vasoconstriction which limits over all tissue perfusion(Jhones & Triplette, 1992)[11,12]. These all studies [11,13-20] hypothesized that smoking compromises wound healing.

There are many studies [12] showing smoking impairs bone wound healing and cause clear detriment to the skeletal tissues. Smoking is also found to be associated with osteoporosis [12] as well as with reduced bone dentistry in femur, vertebra and jaw bone [12] and decreases in the bone mineral content found in the smokers than compared to non-smokers (Raiken et al., 1998). Smoking effect on bone regeneration is established by studies [21] that found success of bone regeneration in non-smokers may reach 95% where as 65% in smokers. Currently and lifetime tobacco smoking has been associated with deterioration in bone quality.[1] A higher incidence of marginal bone loss has been found in smoking group and this was more pronounced in maxilla. [22] The commonly accepted criteria for assessment of implant success were proposed by(Alberktsson & colleague, 1986) to identify clinical evidence of successful osseointegration and survival of implant. [23] Over past three decades, implant success has been assessed by survival rate, continuous prosthesis, stability, radiographic bone loss and absence of infection in pre-implant soft tissues [23](Alberktsson et al., 1986; Smith & Zerb, 1989; Buser et al., 1990; Alberktsson & Zerb, 1988; Misch et al., 2008; Annibali et al., 2009).

On the basis of past literature, smoking may be associated with compromised wound healing, effect on bone architecture, width, length, density, effect on peri-implant tissues. So it becomes a matter of interest to establish the effect of smoking on implant and its success. It is also necessary to study the different outcome of implant success among smokers and non-smokers. This review of the literature will give a brief outline to all dental heath professional regarding the management of patient with habit of smoking and would guide to formulate treatment plan accordingly.

References


[12] Raiken et al., 1998


[16] Smith & Zerb, 1989

[17] Buser et al., 1990


[19] Misch et al., 2008

[20] Annibali et al., 2009

[21] Raiken et al., 1998

[22] Alberktsson et al., 1986

[23] Smith & Zerb, 1989

[24] Buser et al., 1990


[26] Misch et al., 2008

[27] Annibali et al., 2009

[28] Bain and Moy, 1993

[29] Jones & Triplette, 1992


[31] Sherwin & Gastwirth, 1990


[33] Buser et al., 1990

[34] Alberktsson & Zerb, 1988

[35] Misch et al., 2008

[36] Annibali et al., 2009
Bain, 1996[^24] done a prospective study which constituted 223 consecutive Branemark implant placed in 78 patient. Patient were divided in three groups: non-smokers (NS), smokers cessation protocol (SQ), and smokers who continued smoking (SNQ). He found that there was statistically significant difference between failure rate in NS and SNQ group (p<0.005) and between SQ and SNQ group (p<0.5), but none between NS and SQ groups.

Devorah et al, 2002[^25] in his study compared incidence of complication and survival rate related to dental implants among smokers and non smokers by analyzing data of 959 implants placed in 261 patients between 1995 and 1998. He subdivided patient in non-smokers, mild smokers (up to 10/day) and heavy smokers (>10/day). Smokers were further subdivide according to duration in two groups <10years and >10 years. In his study he found, smokers

<table>
<thead>
<tr>
<th></th>
<th>smokers</th>
<th>Non smokers</th>
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<tbody>
<tr>
<td>Implant failure</td>
<td>4%</td>
<td>2%</td>
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<tr>
<td>Minor and major</td>
<td>46%</td>
<td>31%</td>
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<tr>
<td>complication</td>
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Joao et al., 2005[^26] tested a hypothesis that interrupted cigarette smoke inhalation would reverse the bone quality around implant and found that smoking may affect bone quality in cancellous bone & smoke cessation could result in a return towards the level of control group.

Daniel et al., 2005[^22] compared marginal bone loss (MBL), survival and Radiographic evidence of success of dental implants among smokers and non-smokers. The study demonstrated a relationship between MBL and smoking habits. A higher incidence of MBL was found in the smoking group, and this was more pronounced in the maxilla.

Cesar et al., 2006[^30] evaluated effect of smoking on the supporting alveolar bone and its cessation effect. Total 60 male rats were taken and divided in groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Implant status</th>
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<tbody>
<tr>
<td>1</td>
<td>Control group n=15</td>
</tr>
<tr>
<td>2</td>
<td>2 months of cigarette smoke inhalation n=13</td>
</tr>
<tr>
<td>3</td>
<td>3 months of cigarette smoke inhalation and 2 months</td>
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</table>

Stephelynn et al., 2006[^27] done a long term retrospective study to evaluate the Survival of Branemark endosseous dental implants in relation to cigarette smoking. The sample consisted of 464 consecutively treated completely and partially edentulous patients who had a total of 1852 implants placed between 1979 and 1999, and who were part of a surgical/prosthodontic prospective treatment outcomes study. The effect of cigarette smoking on implant survival in relation to the time of implant failure, gender, age, surgeon, date and site of implant placement, implant length and diameter, prosthesis design, and occlusal loading. Considerations were assessed in bivariate and multivariate survival analyses. Result were:

<table>
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<th>Overall failure rate</th>
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<tr>
<td></td>
<td>Failure rate in smokers</td>
</tr>
<tr>
<td></td>
<td>7.72%</td>
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Leviv et al., 2010[^28] conducted a case controlled study with 5 year follow up study consisted 226 patients, 113 consecutive patients with immediately provisionalised dental implant (cases) and 113 randomly selected controls with conventional late implant loading. In his study, he reported
20.8% patient having habit of smoking. Average time of smoking was 23.8+/− 10.9 years and average amount of cigarette per day was 16.5+/− 8.9. He found that there is no significance difference found between case and control regarding habit of smoking. He concluded that smoking cessation protocol described shows considerable promise in improving success rate or osseointegration in smokers who follow it.

Wahlstrom et al., 2010, done a study to evaluate (1) the success rate of unilateral maxillary fixed dental prosthesis (FDPs) on implants in patients at a periodontal clinic referred for periodontal treatment, (2) the prevalence of varying mechanical and biological complications and (3) effects of potential risk factors on the success rate. He analyzed that Smokers had significantly fewer teeth, more periodontal pockets > 4mm and a tendency towards greater marginal bone loss at the follow-up, compared with non-smokers.

Srinivas et al., 2011 A study to assess and compare the peripheral blood neutrophil chemotaxis in smokers and non-smokers with healthy periodontium, gingivitis, and chronic periodontitis. A total of 60 smokers and 60 non-smokers were examined for this study. Both the groups included 20 subjects with gingivitis, periodontitis, and healthy periodontium. The periodontal status of the study subjects were assessed by gingival index, Russels periodontal index, sulcus bleeding index, and clinical attachment level. The blood sample was taken from each individual for the chemotactic analysis using agarose method. In this study, there was a significant decrease in the neutrophil chemotaxis in smokers with gingivitis, periodontitis, and healthy periodontium, compared to non-smokers with similar findings.

Thomas et al., 2012, done a retrospective study to determine the effect of cigarette smoking and residual native bone height on the survival of dental implant, placed in immediately in grafted sinus. 334 subjects were screened in which 75 subjects were selected and 155 implants were placed. He subdivided subjects in to smokers and non-smokers, in which he found:

<table>
<thead>
<tr>
<th></th>
<th>Smoker</th>
<th>Non-smoker</th>
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<tr>
<td>Survival rate at stage 2 surgery</td>
<td>84%</td>
<td>93%</td>
</tr>
<tr>
<td>Survival after 12 months of functional loading</td>
<td>79% (p&lt;0.0001)</td>
<td>87%</td>
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In his studies, he also related implant success rate with bone height among smokers and non-smokers and analyzed that effect of smoking was significant when pre-operative length of bone height is less than 4mm.

<table>
<thead>
<tr>
<th></th>
<th>Smokers</th>
<th>Non smokers</th>
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<tbody>
<tr>
<td>Survival rate in patient with bone height &lt;4mm</td>
<td>60% (p&lt;0.005)</td>
<td>82.4%</td>
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</table>

Discussion
Most of the literatures suggest that smoking is one of the prominent risk factors affecting the success rate of dental implants. With only few studies failing to establish a significant result on the smoking effects on implants. 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. In fact, success rate of dental implant is found to be twice [11] in non-smokers as compared to smokers and that too maxillary implant is more affected.

In a meta-analysis to investigate the influence of smoking on implant failures and complications, reported a significantly enhanced risk of peri-implant complications and bone loss in smokers. Also, Roos-Jansaker et al, reported in a cohort study an association between smoking and mucositis, bone level and peri-implantitis, following the same pattern identified earlier by Esposito et al, in a literature review.

Smoking has prominent effect when implant placed with the existing bone height less
than 4 mm\textsuperscript{11} and Marginal bone loss found in smokers is greater compared to non-smokers. Major and minor complication related to implant procedure also follow the same pattern and is found greater in smokers than non-smokers.

Bain et al.\textsuperscript{1996}, has shown the benefit of smoking cessation on success rate as well as osseointegration.\textsuperscript{24} So patients who are in habit of smoking should be advised to follow a smoking cessation protocol. Patient who quit smoking before the implant procedure get the same result as non-smoking group.

Studies\textsuperscript{26} also suggest that effect of smoking on implant may be reversible and therefore suggest that smokers should realize satisfactory outcomes if they cease smoking even temporarily.

However, smoking dependence is a chronic disorder, characterized by a multiple periods of relapse and remission and therefore not so easy to be abandoned. To be most effective in assisting patient with smoking cessation, it is important for dentist to tailor their approach based on the patient’s readiness or willingness.

On the basis of above studies, for every patient willing for implant, surgeon should keep following points in mind:

2. Location of implant, in presence of long history of smoking, as implants in maxilla is in greater risk than mandible.
3. Surgeon should keep on counseling for smokers to cease or reduce smoking; at least temporarily.
4. Heavy smokers or patient with long term smoking should be strictly advised to stop or reduce number of cigarettes.
5. Patient with smoking habit, should be informed prior to procedure about the ill effect on dental implant and chances of failure if he doesn’t agree to stop smoking.

**Conclusion**

- There is significant difference in the failure rates of dental implants between smokers and non-smokers and smokers are at twice risk of implant failure compared to that in non-smokers and effect maxillary implant more compared to mandibular implants.
- Smoking have a significant effect on dental implants placed in patient having bone height less than 4 mm.
- Effect of smoking get worse with increased amount and duration of smoking per day.
- Effect of smoking on the dental implant can be reversed if patient follow smoking cessation protocols.

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Acknowledgments
I would like to express my gratitude to all those who gave me the possibility to complete this article. I want to thank Dr. Shashikiran N.D. Dean, Prof & Head of Department of Pedodontics,(PCDS&RC). I am deeply indebted of Dr. Surendra Agrawal, Head of the department, Department of Prosthodontics(PCDS &RC,Bhopal) for allowing me to conduct the study. I have furthermore to thank Dr. Gaurav Beohar and Dr. Utkarsh Katare who encouraged me to go ahead with my article and their stimulating suggestions and encouragement helped me in all the time of writing of this article.

My colleagues Kush Sahu, Kapil Jain, Shashi Bhushan who supported me in my review work. I want to thank them for all their help, support, interest and valuable hints. My colleague Adamya Shakti Nigam looked closely at the final version of the article for English style and grammar, correcting both and offering suggestions for improvement.

Especially, I would like to give my special thanks to my father Mr. Sant Kumar Roy whose patient love enabled me to complete this work.