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Review Article

EFFECT OF SMOKING ON PERIODONTAL TISSUE HEALTH – A REVIEW

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ABSTRACT

The role of smoking as a contributory factor in the progression of the periodontal disease process has long been suspected. Now days, a large number of studies have been published in the dental literature regarding this possible role. Much of the literature has also indicated that smokers affected with periodontitis respond less favourably to periodontal treatment be it non-surgical, surgical or regenerative. This paper will review the current literature regarding the effects of smoking on various aspects of the periodontal disease process and present an explanation for the possible association between smoking and the progression of periodontitis.

Keywords: Smoking, periodontal disease.

INTRODUCTION

Now a day smoking is one of the major forms of tobacco use in all over the world. According to the WHO, in 2001, there were 1.1 billon smokers, 800 million of whom inhibit developing countries[1]. This equates to approximately 1/3 of the world's entire population over 15 yrs of age and represents an enormous global health problem. Use of tobacco in any form is directly related to a variety of medical problems including cancer, low birth weight, pulmonary, cardiovascular diseases and various oral diseases. Smoking was one of the most significant risk factors in the development and progression of periodontal disease.

Smoking is present throughout the world and is increasing in the developing world when compared to developed world. In the European Union, an average of 29% of the adult population smoke[2]. The figure is higher for men (34%) than for women (24%). Most smokers start the habit as teenagers, with the highest prevalence in the 20-24 year old age group[3]. More than 4000 toxins are known to be present in cigarette smoke.1 Poisonous substances like carbon dioxide, oxidizing radicals, Nitrosamines, Nicotine, Cotinine, Thiocyanate etc. Nicotine is the most common pharmacologically active compound in tobacco smoke. Nicotine has a half-life of 1 to 2 hours. It can be found in body fluids like urine, plasma and saliva. The absorption of nicotine across the mucosa is dependent on ph. In commercial cigarettes the ph is acidic (5.5), there is minimal absorption of nicotine. In pipe and cigar tobacco the ph is alkaline and nicotine is unionized and is readily absorbed through the mucosa[4].

In smokers the oral tissue are continuous exposure to high nicotine concentrations that negatively affect local cell populations. Gingival crevicular fluid nicotine concentrations can be up to nearly 300 times that of nicotine plasma concentrations in smokers. Nicotine binds to root surface in smokers and in vitro studies show it can be stored and

released from periodontal fibroblasts. Nicotine may inhibit fibroblast attachment and integrin expression, fibronectin and collagen production and increase fibroblast collagenase activity. There is evidence of synergistic effect on inflammatory mediator production when bacterial lipopolysacharide is combined with nicotine. Together these factors could contribute to the increased tissue destruction observed in smokers.[5] Nicotine can also suppress the proliferation of cultured osteoblasts while stimulating osteoblast alkaline phosphatase activity.

Chronic low doses of nicotine act directly on blood vessels and capillaries to produce vasoconstriction causing decreased blood flow. Smokers have decreased blood flow to the tissues of periodontium, which may manifest clinically as reduced bleeding on probing.[6] Thus any scoring system which depends upon bleeding as an indices of gingival health would be an insensitive method of evaluating gingival inflammation in individuals who smoke, so some of the early warning signs of periodontal disease may go unnoticed until clinical attachment loss or radiographic bone loss are detected.

The reduced blood flow and bleeding could lead to a lower oxygen tension in pocket environment that would allow the anaerobic members of the sub gingival plaque microbiota to increase both absolutely and relatively. Some studies indicate that smoking may stimulate colonization of the subgingival area by periodontal pathogens like P.gingivalis, T.denticola or T.forsythia.

Smoking promotes growth of pathogenic bacteria at shallow pockets and may have a role in initial developments of periodontal lesions. It may be said that smoking disrupts the positive relationship between increasing probing depth and increasing growth of bacteria with pathogenic potential that is found in non-smokers[7], due to this disruption there is an increase in the ability of P.gingivalis to grow equally well in smokers who have either shallow probing depths at sampling sites (<5mm) or deep probing depths at sampling sites.

Research which has been done on smoking and its effects on periodontitis shows us that smoking is a major risk factor for increasing the prevalence and severity of periodontal destruction. In current smokers, the chances of having periodontitis are 2-6 times more when compared to non-smokers.[3] In former smokers, the odds of having periodontitis decrease with number of years of abstinence.

Smokers in general have an increased prevalence and severity of periodontal destruction. They have increased pocket depth, attachment loss and bone loss when compared to non–smokers. The current smokers have an increased rate of periodontal destruction and are more prone to have severe periodontitis.[8] Smokers do not respond well to non-surgical periodontal therapy as compared to former smokers and non-smokers. Pocket depth reduction is more effective in non-smokers with non-surgical periodontal treatment. The gains in clinical attachment as a result of scaling and root planning are less pronounced in smokers than in non smokers. 4 Smokers do not respond well to surgical periodontal therapy when compared to non-smokers. Smoking is significantly associated with implant failure, 0 to 17% of implants placed in smokers are reported as failures as compared to 2% to 7% in non smokers. The majority of implant failures in smokers occurred prior to prosthesis placement.[5]

Smoking cessation has beneficial effects on the general health and periodontal status. Former smokers are benefited by stopping smoking in terms of improved periodontal status and good response to different forms of periodontal therapy when compared to current smokers. The dentist and his team are important in motivating the patient to quit smoking.

Smoking is one of the social ills which affect the society. Smoking is present throughout the world and has devastating effects on all the major organ systems of the body. In 1964 the U.S. Surgeon General warned that smoking played a causative role in lung cancer and was associated with cardiovascular disease.5 Since then, the list of smoking-related health effects has grown and includes lung cancer, as well as other cancers, chronic obstructive lung disease, cardiovascular disease, pregnancy complications, osteoporosis, and several other adverse health consequences. Smoking has deleterious effects on the periodontal health and according to Gelskey S C[9] smoking fulfills the criteria for causation which were given by Hill to varying degrees.

Strength of association - the stronger an association between a given factor and a disease, the more likely this factor will be implicated as a risk factor. The strength of an association in both case control and prospective studies can

be measured by the relative risk, which is often expressed in terms of the odds ratio. Many meta-analyses, longitudinal and cross-sectional studies on the effect of smoking on periodontal health have been reported, with odds ratios generally in the order of 2 to 6 demonstrating a moderate to strong association between smoking and periodontitis.

Consistency - Multiple studies of various designs (cross-sectional, case-control, and longitudinal) and in various populations have demonstrated an association between smoking and periodontal attachment loss.

Specificity - studies have shown that disease progression slows in patients who quit smoking as compared to those who continue to smoke.

Temporality - Longitudinal studies show that smokers do not respond as well to periodontal therapy as non smokers.

Biologic gradient - There is a dose-response effect in that heavy smokers have increased disease severity compared to light smokers.

Biologic plausibility - the biologic plausibility of the explanation of the relationship between smoking and periodontitis is supported by tobacco's adverse impact on microbial and host response parameters.

Coherence - the effects of smoking on periodontitis are consistent with our knowledge of the natural history of periodontal disease.

Analogy - Periodontal effects of smoking are analogous to other adverse smoking-related general health effects.

Experiment - Evidence not currently available.

There is a vast amount of data on the prevalence of smoking worldwide and about the deleterious effects of smoking on general health. Tobacco contains many toxic products. The number of chemicals identified in tobacco totals more than 4000. Major components are alkaloids (0.5–5.0 %,) with nicotine as the predominant compound (85–95% of total alkaloids), terpenes (0.1–3.0%), polyphenols (0.5–4.5%), phytosterols (0.1–2.5%), carboxylic acids (0.1–0.7%) and alkanes (0.1–0.4%)). Other constituents are aromatic hydrocarbons, aldehydes, ketones, amines, nitriles, N- and O- heterocyclic hydrocarbons, pesticides, alkali nitrates (0.01–5%) and at least 30 metallic compounds.[10] Smoking has many deleterious effects on the periodontal and general health. Various factors contribute to the deleterious periodontal effects of smoking, including alterations in both microbial and host response factors. Systemic innate and immune responses are impacted by smoking, and tobacco components have toxic effects for local cell populations, and impact local host responses.[5]

Smoking and Microflora:

There are conflicting reports on the effects of smoking on the microflora which, in part, is explained by differences in methodology and statistical expression of the data. Some studies report show no difference in the prevalence of sub gingival bacteria associated with periodontitis. The studies done by Stoltenberg et al.[11], Hans Preber, Jan Bergström, Lars E. Linder,[12] and by Lennart Boström, Lars E. Linder and Jan Bergström[13] found that there was no statistically significant difference between smokers and non-smokers with respect to prevalence of the sub gingival bacteria examined. In contrast to this, the studies done by Zambon et al.[14], Van Wienkelhoff and colleagues[15], Hafajee and S S Socransky [16] show that differences do exist in sub gingival bacterial counts in smokers and non smokers, showing that the proportions of subjects positive for Actinobacillus actinomycetemcommitans, P.gingivalis, and T.forsythensis were higher among smokers. Bacteroides forsythus was harbored subgingivally more in smokers than in non-smokers.[14] Umeda et al.[17] found that current smokers displayed an increased risk for harboring Treponema denticola over non smokers with an odds ratio of 4.61.

Haffajee et al.[18] have reported significant clinical improvements, following scaling and root planing (SRP), in subjects who had never smoked or who were past smokers, but not in current smokers. P.gingivalis, B.forsythus and Treponema denticola were equally prevalent among current, former, and non smokers before therapy and decreased significantly post-SRP in all but the current smokers where it has slightly increased. Clinical improvement post-SRP in all patients was accompanied by a modest change in the subgingival microbiota, seen primarily as reductions in P. gingivalis, B. forsythus, and T. denticola.

EFFECT OF NICOTINE ON THE PERIODONTAL TISSUES

Studies done by Bergstrom et al.[19-21], Danielsen et al.[22], Thomas Dietrich, Jean-Pierrre Bernimoulin and Robert J. Glynn[23] have shown that gingival bleeding was less in smokers when compared to non smokers, despite the similarity in plaque index. This may be due to the

vasoconstrictive effect of nicotine on the peripheral blood vessels.[24] These results suggest that, in smokers, the clinical expression of gingivitis (i.e. chronic inflammation) in response to plaque is suppressed. A study by Holmes[25] compared crevicular fluid flow in smokers and non-smokers with clinically healthy gingiva and the crevicular fluid flow of smokers in the areas physically exposed to smoke (maxillary lingual) and in areas not physically exposed to smoke (maxillary buccal). Smokers had significantly less crevicular fluid flow than non-smokers. Interestingly, the exposed lingual areas of smokers showed no significant difference from the less exposed buccal areas, which suggests that the effect of nicotine may not be local or, if it is local, that it may be modified by saliva and its effects dispersed. It is suggested that the effect of tobacco smoke on clinically healthy gingiva may be through vasoconstriction rather than direct physical irritation. Kinane and Radvar[26], investigating the responses of smokers and non-smokers, with and without sub gingival antimicrobials, to instrumentation, also reported that gingival crevicular fluid (GCF) volumes were significantly lower among smokers than non-smokers. In this study, it was noted that, after therapy, the decrease in the GCF volume of smokers was less than that of non-smokers, regardless of treatment modality. However, the actual mean GCF volumes still remained lower in smokers than in non-smokers. These findings are consistent with a diminished peripheral blood flow leading to a diminished GCF flow.

SMOKING AND THE HOST RESPONSE

Smoking has been shown to affect various aspects of the host immune response. Smoking may have an adverse effect on fibroblast function, chemotaxis and phagocytosis by neutrophils[27] and immunoglobulin production.[28] To mount a successful response to the bacteria, immune cells must arrive at the inflammatory site in appropriate numbers. Nicotine increases intercellular adhesion molecule-I (ICAM-I) and endothelial leukocyte adhesion molecule-I (ELAM) on human umbilical vein cells (endothelial cells) and appears to increase soluble ICAM- I in the serum of smokers.[29] These adhesion molecule changes may affect leukocyte binding to endothelial cells lining the capillaries and post-capillary venules and thus, may impede the recruitment of important host defense cells to the area of inflammation and microbial challenge.

CYTOKINES AND SMOKING

Recent reports suggest that host cytokine levels are influenced by smoking. Tappia et a1.[30] have shown that the plasma responses of smokers following lipo-polysaccharide stimulation differed from those of non-smokers, in that smokers had significantly more tumor necrosis factor alpha (TNFα) and Interleukin-6 (IL-6) and also the acute phase protein α2-macroglobulin. Bostrom et al.[31] have reported that smokers had significantly higher TNF α levels in their GCF than did non-smokers in untreated and treated periodontitis patients. There is a dose-dependent effect of smoking on IL- 1, IL-6, IL-8, and monocyte chemotactic protein (MCP) - I levels.

SMOKING AND THE HUMORAL IMMUNE RESPONSE

Macrophages play important roles in both cell mediated and humoral immunity as antigen-presenting cells. However, antigens are presented in the context of class II major histocompatibility complex (MHC-II) surface molecules. It has been shown that alveolar macrophages from smokers exhibit reduced expression of class II MHC.[32] This may eventually lead to a reduction in the humoral immune response to invading organisms. Smoking has been shown to reduce the concentration of serum IgG generally.

Haber et al.[33] have shown that smokers have reduced titers of serum IgG to P.intermedia and F.nucleatum. Quinn et al.[34] have demonstrated that smoking tends to limit the production of IgG2 in generalized early-onset periodontitis patients. This is significant in that this isotype is associated with the humoral immune response against carbohydrate antigens commonly found on oral pathogens. Moreover, it has recently been shown that the level of IgG2 against A.actinomycetemcomitans is lower in smokers than in non-smokers among EOP patients.[35] Gunsolley et al. have shown that smoking modifies the concentrations of some IgG sub-classes in specific racial and diagnostic groups. In Afro-Americans who smoked, those with chronic adult periodontitis had lower IgG1, while those with generalized early-onset periodontitis had lower IgG2. In White subjects, complex relationships between smoking and allotypic markers were noted, but no influence of periodontal diagnosis was found. Thus, in addition to immunoglobulin allotype, smoking in Afro-Americans appears to influence their IgG subclass

concentrations. Thus, smoking may alter the type of humoral immune response seen.

RESPONSE TO PERIODONTAL TREATMENT

The present literature suggests that the clinical outcome in smokers is less favorable than in non-smokers. Ah MK et al.[37] have demonstrated a poorer response to periodontal treatment in smokers compared with non-smokers. Preber and Bergstrom[38] found that, 12 months following surgery, smokers had a statistically significantly reduced probing depth reduction compared with non-smokers, despite accounting for differences in levels of plaque accumulation.

Preber et al.[39] studied the clinical and microbiological effects of non-surgical therapy and found that smokers had a less favorable outcome in terms of pocket depth reduction than did smokers. The study revealed no difference; however, between smokers and non smokers in terms of the microbiological changes following therapy, i.e. the microflora was broadly similar in both categories of patients before and after treatment. Machtei et al.[40] considered the changes in attachment level and alveolar bone levels approximately one year after the hygiene phase of therapy. Non-smokers had relatively stable bone height, whereas smokers exhibited an annualized rate of bone loss of 1.17 mm. Bostrom et al.[41] found that smokers exhibit less improvement compared with non-smokers in terms of bone height.

Approximately 90% of patients with refractory periodontitis are cigarette smokers.[42, 43] Bostrom et al. suggested that former smokers often begin smoking again, and therefore one must interpret the status of the former smokers cautiously, since self-reporting of smoking status is not reliable as indicated by Gonzalez et al.[44] Smokers are reported to exhibit minimal responses to non-surgical procedures such as sub gingival debridement (Haber, Preber et al.)

Smokers don't respond well to surgical periodontal therapy when compared to non smokers. A study done by Tonetti et al.[45] to examine the effect of cigarette smoking on the healing response following guided tissue regeneration (GTR) in deep infrabony defects indicated that smoking was a significant factor in determining the clinical outcome. A risk-assessment analysis indicated that smokers had a significantly greater likelihood than non-smokers of having a reduced probing attachment level gain following GTR. More recent studies have concurred with these finding (Cortellini et al., Trombelli and Scabia, Trombelli et al.)[46-48] and other investigators, when using regenerative procedures with allografts, have also found smoking to be detrimental to healing.

Studies on the non surgical and surgical periodontal therapy in smokers suggest that probing depth reduction and clinical attachment level improvements in smokers are 50% to 75% those of non-smokers. Haber reported that despite surgical intervention, smoking patients in a suburban Boston population exhibited re-pocketing within one year of treatment. In a recent study, Ah et al. evaluated four periodontal treatment modalities in smoking and non-smoking patients. In these studies, the oral cavity was divided into four regions, and each region was subjected to a different treatment. The treatments ranged from coronal and sub gingival scaling and root planing to non-surgical procedures followed by modified Widman surgery or osseous resection surgery. In all cases, smoking patients exhibited reduced changes in probing depth and attachment loss compared with non-smoking patients.[36]

Smoking is detrimental to regenerative therapy in interproximal and furcation defects, whether treatment includes osseous grafts alone, membranes alone, or membranes in combination with osseous grafts. Smokers have only half the improvement in clinical attachment levels as compared to non smokers, which amounts to differences ranging from 0.35 mm120 to 2.9 mm. In terms of stability of treatment results, Cortellini et al.[46] found that stability was related to patient factors; patients, who smoked, were non-compliant with recall, and had deteriorating oral hygiene lost attachment (2.2 to 2.4 mm) following both guided tissue regeneration and scaling and root planing treatment modalities.

The differences in response between smokers and non smokers become more pronounced in probing depths ≥5 mm, where smokers demonstrated 0.4 mm[49] to 0.6 mm[50] less improvement in clinical attachment levels following scaling and root planing. Following flap debridement surgery, smokers experienced up to 1 mm less improvement in clinical attachment levels in probing depths initially ≥7 mm.[51] In terms of dose response, a trend, albeit not significant at most time points, has been noted for heavy smokers (≥20

cigarettes per day) to respond less favorably than light smokers (<20 cigarettes per day).[52]

Smoking seems to have a negative impact on the results of root coverage procedures using expanded polytetrafluoroethylene membranes in guided tissue regeneration procedures at recession sites, here smokers had significantly less root coverage (57%) compared to non-smokers (78%), in contrast studies by Harris[53] and Amarante et al.[54] showed no difference between smokers and non smokers when a connective tissue with partial-thickness pedicle graft, a Coronally repositioned flap alone or with a bio absorbable membrane were used respectively. In a prospective controlled clinical trial by Cléverson Oliveira Silva it was found that Coronally Positioned Flap provides benefits for both smokers and non-smokers in terms of root coverage of shallow Miller's Class I recession defects. However, smokers presented greater residual recession depth at 6 months and lower percentage of root coverage (69.3% versus 91.3%; P <0.05). No smokers obtained complete root coverage compared to 50% of non-smokers (P <0.05).[55]

Smoking has a detrimental effect on the success of implant osseointegration. A meta-analysis by Daisuke Hinode and colleagues[56] revealed a significant relationship between smoking and the risk of Osseointegrated implant failure, more particularly those implants located in the maxillary arch. The analysis concluded that smoking patients had more chances of osseointegrated implant failure compared to non smokers with an odds ratio of 2.17 for implant failure. Failure rate of implants in smokers was more in the maxillary arch compared to the mandibular arch.

Because of the diminished treatment response in smokers, clinicians may recommend adjunctive antimicrobial therapy for smokers, because evidence suggests that sub gingival pathogens are more difficult to eliminate in smokers following scaling and root planing. The present literature suggests that the clinical response in smokers is less favorable regardless of adjunctive systemic or local antimicrobial therapy. Soder et al.[57] concluded that there was little adjunctive effect of systemic metronidazole on non-surgical therapy in smokers. On the other hand, in studies where adjunctive systemic amoxicillin and metronidazole[58] or locally delivered minocycline micro spheres[59] were used, they enhanced the results of mechanical therapy. These enhanced results might be due to antimicrobial actions, and in the case of tetracycline derivatives, anticollagenase activity. A recent study reported a positive response to sub antimicrobial doxycycline (anticollagenase) therapy in combination with scaling and root planing in a group of severe periodontitis patients that included smokers; however, the comparative effectiveness of this host-modulatory therapy in smokers versus non-smokers has not been reported. Unique regimens that sequence systemic antimicrobial therapy or combine local antimicrobial delivery with host-modulatory therapy might offer clinicians and patients options that address microbial and host response alterations in smokers.

Smoking cessation has beneficial effects on general health and dental health of the patient. The rate of bone and attachment loss slows after patients quit smoking, and that their disease severity is intermediate to that of current and nonsmokers.[16,60-63] Former smokers respond to non-surgical and surgical therapy in a manner similar to never smokers.[49,52]. In fact, among patients who had quit smoking 1 year or more prior to scaling and root planing, there was no relationship between the number of years since cessation and changes in probing depth or clinical attachment levels.[49] Implant success rates for past smokers, and implant success rates improve on quitting smoking.[64]

The dentist should take an active role in helping patient in quitting smoking. Dentist and the office staff should take active role in determining patient tobacco use status; supporting abstinence; advising users to stop; and preparing users to stop and to remain tobacco free, in addition to offering cessation treatment. Nicotine dependence is a combination of physiological and psychological factors that must be addressed to help patients conquer the use of tobacco despite the extreme difficulty of the withdrawal process. Although tobacco use is a learned behavior with social implications and has characteristics of a habit, the main motivation behind continued use is relief of withdrawal symptoms. The symptoms can include irritability, anxiety, decreased heart rate, increased appetite, food cravings, restlessness, and difficulty concentrating.[5]

Tobacco cessation programmes can include brief intervention programme or a comprehensive intervention programme.

In the Brief intervention programme the dentist is basically offering information, encouragement, and support to patients, and providing information about resources that may help the patient become tobacco free. All smokers benefit from the advice of a trusted health professional; in up to 10% of patients the simple statement of encouragement to stop smoking will cause the patient to give up smoking. In brief intervention programme a five-step approach is recommended by the Agency for Health Care Research and Quality.

The program is known as the five A's for smoking cessation.[65] It includes:

1. Ask – systematically, identifying the tobacco use status of all patients.

2. Advise – strongly advising all who use tobacco products to stop.

3. Assess – evaluating the patient's willingness to quit.

4. Assist – offering assistance in quitting.

5. Arrange – following up on the patient's cessation efforts, especially early in the process.

The comprehensive program in the dental office includes using the five A, and expanding the scope of intervention. A responsible person, mostly the dental hygienist is identified as an office coordinator for tobacco cessation activities. The office should create a positive environment for smoking cessation and should lead by example i.e. no smoking by the dentist or other staff. The programme should have updated information about smoking status of the patients so that regular and timely actions can be taken in helping the patient stop smoking. A cessation program tailored to the patient's needs should be offered, it should one that ideally combines counseling, pharmacological therapy using both nicotine replacement and other medications, and supportive follow-up.[66]

The drugs which can be used in smoking cessation are nicotine chewing gum, nicotine lozen ges, nicotine nasal sprays, nicotine patches, and nicotine inhalers for use as nicotine replacement therapy. These act as a nicotine delivery system to help in managing nicotine withdrawal symptoms. Bupropion is a non nicotine based drug which can be used in tobacco cessation. Bupropion and nicotine replacement products can be used as first line agents and are generally free of side effects. Nicotine replacement therapy can be selected based on the patient's smoking habits and preferences. For patients who smoke less than 20 cigarettes in a day, nicotine patches can be a good option. Drugs such as Clonidine and Nortryptiline can be used as second line of drugs in tobacco cessation, but these are associated with side effects.[5]

CONCLUSION

Smoking is a strong risk factor for periodontal diseases. The mechanisms by which tobacco use favors periodontal destruction still need complementary investigation to be better understood. It seems that a down regulation of anti-inflammatory factors associated with an up-regulation of proinflammatory cytokines is involved. In addition, smoking cessation is the main option to revert the harmful effects of tobacco on periodontal risk and therapy.

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