

Periodontal treatment outcomes in smokers: A narrative review

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ABSTRACT

Smoking is considered as the major environmental risk factor for periodontal diseases. Smokers have a higher risk for severe periodontitis with more periodontal tissue destruction, more gingival recession, and more susceptibility for tooth loss. The aim of this narrative review is to provide up-to-date evidence on the clinical outcomes of periodontal treatment in smokers. Electronic databases were searched for studies that compare the clinical outcomes in smokers and non-smokers following non-surgical and surgical periodontal treatment modalities and also during the supportive periodontal treatment. Clinical studies published before May 2021 were included in the review. Smokers have a higher risk for recurrence of periodontal disease and the response to non-surgical as well as surgical periodontal treatment is not as good as that of non-smokers. Moreover, there is a dose-response effect in the adverse effects of smoking on periodontal health. Compared to non-smokers, smoker patients with periodontitis tend to respond less favorably to non-surgical and surgical periodontal treatment, and exhibit recurrence more frequently during supportive periodontal treatment. Along with the periodontal treatment, smokers may be encouraged to quit. Long follow-up and the communication between the dentist and the patient give a great opportunity for such counseling.

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INTRODUCTION

Periodontal diseases are a group of chronic inflammatory diseases that are caused by bacteria populated on the teeth surfaces. Periodontal treatment has three phases: non-surgical, surgical, and supportive periodontal treatment. Non-surgical and supportive periodontal treatment phases are mandatory in every patient with any type and severity of periodontal disease. Surgical periodontal treatment may contain regenerative or resective goals in cases where non-surgical periodontal treatment is not sufficient to provide optimal clinical outcomes.

Basic clinical periodontal parameters for periodontal diagnosis as well as evaluation of prognosis and treatment outcomes are probing depth and clinical attachment level, gingival inflammation, and level of oral hygiene. Endpoints of active periodontal treatment have been recently revisited during the World Workshop for Classification of Periodontal and Peri-implant Diseases¹. It was found that periodontitis patients with a low proportion of deep residual pockets after active periodontal therapy are more likely to be stable in long follow-up periods.

Treatment plan of a single periodontal disease case

depends on the diagnosis of the disease, evaluation of the prognosis, and patient's expectations from the treatment. Patient-clinician cooperation plays a critical role in the eventual success of periodontal treatment. Systemic health state and presence or absence of environmental factors and psychological stress are also important factors. Smoking is accepted as the major environmental risk factor for periodontal diseases. This fact is now reflected in the current classification of periodontal diseases and the grade of periodontitis is directly modified by the smoking status and the number of cigarettes smoked per day². Smokers have a higher risk for both the onset and progression of periodontal disease^{3,4}. Accordingly, passive smokers exhibit probing depth and clinical attachment level values smaller than those of active smokers and greater than those of non-smokers, with significant correlations between these clinical measurements and the salivary cotinine concentrations⁵. Wound healing following periodontal treatment is adversely affected by smoking and smokers tend to respond less favorably to non-surgical as well as surgical periodontal treatment compared to non-smokers^{6,7}. However, there are also studies documenting comparable clinical treatment outcomes in non-smokers and smokers⁸⁻¹⁰. Nicotine is one of the major detrimental components of tobacco and it is regarded as the major addictive chemical of tobacco products. *In vitro* studies have reported detrimental effects of nicotine on various cells, possibly explaining the negative clinical outcomes together with vascular harms of tobacco products¹¹.

The aim of this narrative review is to provide up-to-date evidence on the nature of the relationship between smoking and treatment outcomes in patients with periodontal disease. Studies evaluating clinical periodontal findings following non-surgical, surgical, and supportive phases of periodontal treatment were within the scope of this review.

DEVELOPMENTS

A manual and an electronic search were performed for studies published before May 2021. Clinical intervention and follow-up studies having at least the two study groups of smoker periodontitis patients and non-smoker periodontitis patients were included in the review. The focused intervention was non-surgical or surgical periodontal treatment. Studies evaluating

treatment outcomes in supportive periodontal treatment phase were also included. Electronic databases, MEDLINE (PubMed), EMBASE, Scopus were searched using specific key words. Manual search was performed in the Journal of Clinical Periodontology, Journal of Periodontology, Journal of Periodontal Research, and Journal of Dental Research.

Smoking and non-surgical periodontal treatment

Smokers usually respond less favorably to non-surgical periodontal treatment compared to non-smokers. Numerous clinical follow-up studies reported that smoker patients exhibited less reduction in probing depth and less gains in clinical attachment level values following scaling and root planing¹²⁻¹⁴. On the other hand, similar clinical outcomes in non-smokers and smokers were reported in some other studies following non-surgical periodontal treatment^{10,15}. Accordingly, D'Aiuto et al.⁸ concluded that local periodontal disease-related factors such as the number of affected posterior teeth, number of interproximal periodontitis lesions, severity of baseline mobility, and deep baseline probing depths were significantly related to the clinical outcomes, whereas there was no significant relation to the smoking status. The conflicting findings published in the literature may be explained by the methodological differences between studies. Some studies report only the mean values of full-mouth probing depth and clinical attachment level measurements; the duration of follow-up after completion of the non-surgical periodontal treatment varies between studies from 1 to 12 months, and power calculations are not provided in all relevant studies^{5,6,11-18}.

In a recent study, Stage III and IV periodontitis patients (generalized aggressive periodontitis) either in the current smoker or never smoker group received non-surgical periodontal treatment and were followed up for six months¹⁶. The study comprised microbiological and biochemical investigations together with clinical periodontal evaluations. It was reported the clinical responses of non-smoker and smoker patients to the non-surgical periodontal treatment were comparable. However, Gram-negative bacteria repopulated much faster in the smoker patients, possibly suggesting a higher risk for recurrence.

A recent randomized controlled clinical trial compared current smokers and never smokers with the diagnosis of chronic periodontitis in terms of their response to scaling and root planning, with and without adjunctive photodynamic therapy¹⁷. The researchers reported that clinical outcomes of non-surgical periodontal treatment were compromised in the current smokers regardless of the content of the treatment, while never smokers' response to mechanical periodontal treatment, with and without photodynamic therapy, was similar. Another study comparing cigarette smokers, never smokers, and those individuals vaping electronic-cigarettes reported that the worst gingival inflammation was detected in cigarette smokers¹⁸.

Moreover, patient-related factors such as compliance and quality of home care are known to affect the clinical outcomes after periodontal therapy¹⁹. There is usually a dose-response effect between the number of cigarettes smoked and negative effects of smoking on various health problems including periodontal diseases. Clinical findings from a comparative study that compares non-smokers, current smokers and passive smokers, reported further support for a negative, dose-related effect of tobacco on periodontal health⁵. The authors concluded that the tendency for a more prevalent detection of *T. denticola* and for a suppressed inflammatory response observed in the smokers may at least partly explain the increased susceptibility to periodontal destruction. However, not all studies report the pack-years or other similar data for the smoker group. Another very important issue in studies focusing on the possible effects of smoking on periodontal health is whether or not the smoking status is chemically validated. Usually, researchers rely on self-reports of the study participants while assigning the patients into smoker or non-smoker groups. Yet, self-reports may not always reflect the reality on the status of smoking and, therefore, chemical validation is of utmost importance. Chemical validation can easily be performed by determining cotinine levels in saliva samples. Cotinine is a major component of tobacco smoke that has a long half-life and its concentration in biofluids such as saliva, urine, and blood provide reliable information on the state of smoking of an individual^{3,5}. Smokers exhibit salivary cotinine levels above 100 ng/mL, whereas passive smoking may be reflected by 5–7 ng/mL salivary

cotinine concentrations^{20,21}.

Smoking and surgical periodontal treatment

Surgical periodontal treatment can be applied after non-surgical periodontal treatment. This treatment includes wide variety of surgical procedures for the patient's need²². In this context, open flap debridement for patients with deep pockets, periodontal plastic surgery for individuals with gingival recession, periodontal regeneration surgery for individuals with bone defects, and implant surgery for patients with tooth deficiency can be performed^{22,23}. Non-surgical periodontal treatment of the patient must be completed prior to the surgical intervention, and gingival tissues must be inflammation free. Experience of the dentist, conditions of the surgery and home care, as well as habits of the patient, may affect the postoperative recovery²². The harmful effects of smoking, especially in the wound healing period after periodontal surgical treatment, have been mentioned previously^{24,25}.

Periodontal access flap is generally applied to areas that cannot be reached during non-surgical periodontal treatment to remove subgingival deposits and do root planing with a clearer vision. Reductions in gingival inflammation and probing depth (PD) with gain in clinical attachment level (CAL) are expected to be achieved after this treatment²⁴. Possible detrimental effects of smoking on the outcomes of flap surgery have been investigated in several studies^{6,26-30}. Effects of cigarette smoking on the outcomes of surgical periodontal therapy (modified Widman flap) were analyzed in 54 patients (24 of them were smokers) with moderate to severe periodontitis and deep periodontal pockets²⁶. The authors reported that smoking may impair the outcomes of surgical periodontal therapy. Ah et al.⁶ performed a similar study in 74 patients and observed less improvement in clinical periodontal parameters in smokers. In another study, effects of cigarette consumption on active periodontal treatment (non-surgical and surgical periodontal treatment) were evaluated and it was stated that heavy smokers (20 cigarettes/day) and light smokers (<19 cigarettes/day) exhibited less PD reduction and CAL gain than ex-smokers and never smokers²⁷. Scabbia et al.²⁸ and Trombelli et al.²⁹ evaluated effects of smoking on the clinical outcomes of open flap debridement in deep pockets

and furcation defects. Both studies indicated that less improvement was observed in smoker patients than non-smoker patients after treatment^{28,29}. In another study, local immune response was found to be poorer in the smokers following different periodontal treatment modalities in chronic periodontitis patients³⁰. In a review paper, the authors concluded that smoking has negative effects on surgical periodontal treatment outcomes and this situation should be explained to smoker patients during the treatment planning phase²⁵. However, other factors such as poorly controlled diabetes mellitus, stress, immunodeficiency, older age and female gender should not be underestimated, when considering the effects of smoking on periodontal surgery outcomes²⁴.

Another step of periodontal surgery aims to correct mucogingival deformities. Gingival recessions, especially in the anterior region can cause esthetic problems and patients seek treatment also for the dental hypersensitivity that may occur on the root surfaces. Plastic periodontal surgical interventions for root coverage are very comprehensive and require delicate procedures with technical difficulties. Chambrone et al.³¹ stated that significant improvements can be achieved in gingival recessions and clinical attachment levels in both smokers and non-smokers, but the root coverage rate with subepithelial connective tissue graft was found to be lower in smokers. Silva et al.³² evaluated the effects of smoking on free gingival graft procedure in the treatment of gingival recessions and reported that blood supply was decreased, and epithelization was delayed in the donor sites of smoker patients. However, no detectable effects on postoperative dimensional changes of free gingival grafts were found³². Another study with similar scope and design reported that the free gingival graft exhibited more shrinkage in smokers than in non-smokers and failed to completely cover the recession area³³. On the other hand, comparable clinical outcomes were found in smoker and non-smoker patients following coronally advanced flap for root coverage⁹. Accordingly, no difference was detected in complete root coverage rates between smoker and non-smoker patients who underwent coronally advanced flap procedure for root coverage³⁴. However, there is a dominance of evidence in the existing literature indicating that the rate of complete root coverage in smokers is lower

than the rate in non-smokers³⁵.

Regenerative periodontal surgical approach with various barrier membranes and bone graft materials has been widely used for treatment of intrabony defects during the last two decades to regenerate the lost periodontal tissues³⁶. The findings of a retrospective study emphasized that smoking negatively affected the success of guided tissue regeneration procedures³⁷. Similarly, another study evaluating treatment of Class II furcation defects using bioresorbable barrier membrane with and without decalcified freeze-dried bone allograft, reported negative effects of smoking³⁸. On the contrary, the regenerative procedure involving supracrestal soft tissue preservation together with enamel matrix proteins (EMP), revealed no significant negative effect of smoking on CAL gain and probing depth reduction³⁹. Loos et al.⁴⁰ stated that smoking exhibited adverse effects on healing after regenerative periodontal surgery. In the meta-analysis of Patel et al.⁴¹, it was reported that smoking negatively affected regenerative periodontal treatment outcomes. In a review on regenerative periodontal treatment procedures in intrabony defects, smoking was stated as an important detrimental factor for the success of this treatment and should be considered while making the treatment plan⁴².

Placing intrabony dental implants has become a common treatment modality in rehabilitation of dentition after single or multiple tooth loss²³. Complications of dental implants are increasing with the increase in dental implant applications⁴³. Smoking has been stated as an important risk factor deteriorating the prognosis of dental implants and, therefore, should be taken into account in treatment planning, and patients should be informed about the risks⁴⁴. Reduced success rates of dental implants and increases in the extent and severity of marginal bone loss have been reported^{45,46}. In a recent systematic review and meta-analysis published in 2020, the number of cigarettes smoked per day was reported to be inversely correlated with the implant success rate⁴⁷. Based on the available evidence, it may be suggested that patients who currently smoke as well as those who are passive smokers should be warned about the possible complications of implant applications, and patients with 5–10 pack-years or more should not be regarded as candidates for implant placement, but rather treated by conventional prosthetic

approaches⁴⁸. In a recent review evaluating the possible effects of other tobacco products on dental implants, the harmful effects of nicotine-containing products on the peri-implant tissues were emphasized although there is limited scientific evidence⁴⁹.

Smoking and supportive periodontal treatment

Supportive periodontal therapy aims to maintain periodontal health achieved by active periodontal therapy either with non-surgical or surgical modalities⁵⁰. Following resolution of clinical signs and symptoms of periodontal disease by active periodontal treatment, patients' motivation tends to decrease over time, and many patients may not continue performing oral care adequately. For this reason, supportive periodontal treatment needs to be planned considering the present risk factors that may cause recurrence of the disease, and periodontal condition of the patient should be monitored with regular recalls; motivation and instructions for adequate oral care should be provided repeatedly. Smoking is among the risk factors that negatively affect periodontal supportive treatment outcomes⁵¹. The clinical and biochemical parameters of patients, who received supportive periodontal treatment with regular recall visits after surgical periodontal treatment were evaluated for five years and significantly greater alveolar bone loss together with higher tumor necrosis factor- α levels were found in smoker patients⁷. Evaluation of the effects of smoking over 20 years revealed greater marginal bone resorption and tooth loss in smokers⁵². Another study indicated that smoking was directly related to tooth loss⁵³. Similarly, Matuliene et al.⁵⁴ stated that the number of residual pockets and tooth loss increased with the increase in the number of cigarettes smoked per day. Quitting smoking may reduce the risk of tooth loss over time⁵⁵. However, this risk of tooth loss becomes equal to that in never-smoker patients only after smoking abstinence for 9–12 years, and this information may be used to encourage smoker patients to quit smoking along with periodontal treatment⁵⁵.

Pretzl et al.⁵⁶ followed periodontally compromised patients for 20 years after completion of active periodontal therapy and emphasized smoking as a major reason for the increase in tooth loss rates, and for non-compliance to supportive periodontal therapy together with older age and confounding systemic

diseases such as diabetes. These risk factors were further verified to increase the risk of tooth loss⁵⁷.

Supportive periodontal treatment plays a critical role in maintaining the periodontal health status of the patient after active periodontal therapy⁵¹. Patient's age, habits, lifestyle, and systemic condition should be followed carefully during the supportive periodontal treatment. Frequency of recall visits should be planned on each patient's individual characteristics and needs⁵⁸.

Future considerations

Future large-scale follow-up studies that comparatively evaluate current smokers, ex-smokers, never smokers, and also passive smokers, whose smoking status is chemically validated, may help to better clarify the possible relationship between smoking and periodontal treatment outcomes. Moreover, studies that stick to some basic standards with regard to clinical periodontal measurement and periodontal treatment methods are warranted. Another expectation from future studies is focusing not only on conventional cigarettes but also waterpipes and e-cigarettes, as their usage rates are increasing particularly among young people.

CONCLUSION

The existing literature clearly suggests that smoking has adverse effects on the periodontal treatment outcomes. Therefore, smoker patients should be informed about these detrimental effects, and advice and counselling on quitting smoking should be considered by the dental-care provider along with the active and supportive periodontal treatment phases.

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CONFLICTS OF INTEREST

The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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ETHICAL APPROVAL AND INFORMED CONSENT

Ethical approval and informed consent were not required as this is a review of existing literature.

DATA AVAILABILITY

The data supporting this study are available from the authors on reasonable request.

AUTHORS' CONTRIBUTIONS

NB provided primary oversight to the organization of the review, as well as specific sections on periodontal treatment. MK and BK provided the content for the review.

PROVENANCE AND PEER REVIEW

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