



Impact of Smoking Cessation on Periodontal Disease and Treatment: A Literature Review

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Abstract

The deleterious impact of tobacco on the periodontium is widely acknowledged, as smoking has been implicated as a significant risk factor for the development and progression of periodontal disease. The objective of this review is to assess the impact of smoking cessation on periodontal disease and to evaluate the effects of quitting smoking on the response to periodontal treatment. Smoking cessation plays an important role in reducing the risk of onset and progression of periodontitis. Encouraging smoking cessation not only fosters overall systemic well-being but also plays a pivotal role in preserving the health and integrity of the periodontium, ultimately enhancing the prospects of long-term periodontal stability and oral health.

Keywords: Smoking Cessation; Smoking; Periodontitis; Periodontal Diseases

Introduction

Periodontal disease is an inflammatory condition that affects the periodontal tissues, and could lead to tooth loss or have an impact on the inflammatory systemic response [1].

On the other hand, smoking is a significant risk factor for several diseases, including various types of cancer, respiratory infections and cardiovascular diseases [2]. It's also associated with oral and dental conditions such as periodontitis and oral cancer [2,3]. Concerning periodontitis, it has been proven that tobacco has an impact on decreasing the immune response, on increasing the release of pro-inflammatory mediators. It can also induce a long-term microvascular dysfunction, which may not be entirely reversible upon tobacco cessation [1].

Taking into consideration the studies conducted on smoking cessation, it is conceivable that smoking cessation programs could positively influence the periodontal status [4]. Indeed, authors have conducted several studies on the impact of smoking cessation on the periodontium, suggesting a reduction in the risk of onset and progression of periodontal disease.

The objective of this study is to assess the impact of smoking cessation on periodontal disease and to evaluate the effects of quitting smoking on the response to periodontal treatment, aim-

ing to address the primary research question: "What is the impact of smoking cessation on periodontal disease and its treatment?"

Material and Methods

In order to answer the following question: "What is the impact of smoking cessation on periodontal disease and its treatment?" We conducted a literature search in the following online databases: Pubmed, Scopus, Science Direct and cochrane Library. We used the following specific keywords: "Smoking cessation," "Smoking," "Periodontitis," and "Periodontal diseases."

The review included studies that meet the following inclusion criteria:

- Studies published between 2005 and 2022.
- Systematic reviews, meta-analyses, clinical trials, cross-sectional studies, longitudinal studies and case studies conducted on humans.

And excluded

- Articles written in languages other than English.
- Articles that did not match with the objective of our study.
- Articles published before 2005.
- *In vitro* studies and also studies conducted on animals.

Results

On the total yield of 1462 publications identified with electronic search, 17 articles were selected for this literature review. The selected papers reflected the effect of smoking cessation on periodontal disease, the impact of smoking cessation on the response to periodontal treatment and the relationship between the number of years of smoking cessation and periodontal disease.

Discussion

Our literature review aims to evaluate the impact of smoking cessation on periodontal disease and periodontal treatment. For a

better exploitation of the results, we have opted to separate data into three categories of articles, depending on the main topic. Articles treated:

- The impact of smoking cessation on periodontal disease.
- The impact of smoking cessation on the response to periodontal treatment.
- The relationship between the duration of smoking cessation and periodontal disease.

The impact of smoking cessation on periodontal disease (Table 1).

Article	Title	Author	Type of the study	Review	Year of publication	Follow up period	Type of intervention
1	Associations of duration of smoking cessation and cumulative smoking exposure with periodontitis	Costa and coll	Cross sectional study	Journal of Oral Science	2013	From June 2008 to December 2010	Full mouth periodontal examination PD, CAL, BOP, PI, tooth loss
2	Is There a Positive Effect of Smoking Cessation on Periodontal Health? A Systematic Review	Fiorini and coll	Systematic Review	Journal of Periodontology	2014	At least one year	Measurement of CAL, PPD, radiographic bone level and bleeding on probing
3	Smoking, Smoking Cessation, and Risk of Tooth Loss: The EPIC-Post dam study	Dietrich and coll	Cohort study	Journal of Dental Research	2015	-	-
4	Effect of Smoking on Periodontitis: A Systematic Review and Meta-regression	Leite and coll	Systematic Review and meta analysis	American Journal of Preventive Medicine	2019	Studies with ≥12 months of follow-up	Studies with at least two measures of periodontitis (clinical attachment level/probing depth/alveolar bone loss)
5	Association Between Time Since Quitting Smoking and Periodontitis in Former Smokers in the National Health and Nutrition Examination Surveys (NHANES) 2009-2012	AlHarthi and coll	Cross-sectional analytical study	Journal of periodontology	2019	from the 2009-2010 and 2011-2012	Oral and periodontal examination
6	Effect of smoking cessation on tooth loss: a systematic review with meta-analysis	Souto and coll	Systematic review with meta analysis	BMC Oral Health	2019		
7	Impact of Smoking Cessation on Periodontal Tissues	Duarte and coll	Literature review	International dental journal	2021		
8	Smoking cessation and response to periodontal treatment	Alexandridi and coll	Literature review	Australian Dental Journal	2018		
9	Smoking and periodontal tissues: a review	Neto and coll	Literature review	Brazilian Oral Research	2012		
10	Oral health risks of tobacco use and effects of cessation	Warnakulasuriya and coll	Literature review	International dental journal	2010		
11	The effect of smoking on periodontal treatment response: a review of clinical evidence	Heasman et coll	Literature review	Journal of Clinical Periodontology	2006		

Table 1: Association between smoking cessation and periodontal disease.

In this section, we have selected eleven (5-15) papers that evaluated the impact of smoking cessation on the onset and progression of periodontal disease. The Authors assessed many parameters: plaque index, probing depth, clinical attachment loss, bleeding on probing, radiographic bone loss and tooth loss.

Plaque index

Costa and al. reported in a cross-sectional study conducted in 2013 that plaque index was higher among smokers than non-smokers [5]. This was the only study that has assessed the prevalence of periodontitis based on plaque index. Torrungruang and al. in 2005, have found similar results in their study, they have revealed a plaque score of 66,3% in current smokers compared to 62.2% in former smokers [16].

Similarly, Nair, *et al.* reported, in a longitudinal study in 2003, a reduction in the number of sites with dental plaque in subjects who had quit smoking over a follow-up period of 4-6 weeks [17].

Probing depth

Four studies [5,7,8,12]. evaluated the impact of smoking cessation on probing depth. According to Costa and al. 2013, the percentage of sites with a probing depth (PD) \geq 5mm was 7.1% in smokers compared to 6.3% in former smokers. These studies confirmed that smoking cessation reduces the probing depth in patients with periodontal disease.

Bergstöm and al. in 2000, revealed that the mean frequency of sites with a PD \geq 4mm is 6.6 % in former smokers compared to 16.8% in current smokers [18]. The same results were found in study of Torrungruang and al, where the mean probing depth is 2.8 ± 0.8 mm in current smokers and 2.5 ± 0.7 mm in former smokers [16].

Clinical attachment loss

In evaluating the effect of smoking cessation on periodontitis, four studies included the measurement of clinical attachment loss [5-8]. These studies confirmed that smoking cessation reduces the progression of attachment loss.

These results align with those found in the NHANES III National Health and Nutrition Examination Survey conducted in the USA between 1988-1994. Where the odds ratios (OR) for clinical attachment loss (CAL) were higher in current smokers than former smokers [19].

Bleeding on probing

Only one study assessed this parameter: Costa and, *et al.* in 2013 [5]. The authors revealed that the mean number of sites with bleeding on probing was lower among tobacco users than ex smokers and non-smokers. These findings are comparable with those of Haffajee and al. in their study conducted in 2001, where current smokers had a lower percentage of sites with bleeding on probing than former smokers [20].

Nair and al. also reported a significant increase in sites with bleeding on probing in patients with moderate periodontitis or gingivitis and who had quit smoking [17].

These findings may be explained by the fact that smoking is responsible of changes in blood vessels diameter in periodontal tissues, which may decrease gingival bleeding [6]. This vasoconstriction hides signs of gingival inflammation and reduces bleeding.

Radiographic bone loss RBL

Three articles [6,7,14] evaluated radiographic bone loss in their analysis of the relationship between smoking cessation and periodontal disease. These studies demonstrated that smoking cessation can reduce radiographic bone loss.

The same results were found in the Cohort study conducted by Bergström and al. in 2000. Authors have shown that smokers had a radiographic bone loss rate estimated at 3.8% versus 1.1% in ex-smokers over a 10-year follow-up period [18].

Jansson and al. also demonstrated through a Cohort study conducted in 1970 with a 20-year follow-up period that individuals who quit smoking during the study period had significantly less bone loss than those who continued to smoke [21].

Tooth loss

Three studies examined tooth loss as a means of evaluating the influence of quitting smoking on periodontal disease [5,9,10].

Costa and, *et al.* in 2013 [5], revealed that the average number of teeth lost in smokers is higher than ex-smokers and non-smokers. The same results were identified in a study of Dietrich and, *et al.* in 2015 [9], showing that ex-smokers have lost more teeth than non-smokers but have more remaining teeth than current smokers. Haffajee and al. also demonstrated in 2001 that current smokers have more missing teeth than ex smokers and non smokers [20].

In the three studies cited above, we found that smoking cessation seems to play a significant role in reducing the risk of tooth loss in periodontitis patients.

Different findings were proved in a systematic review of Souto and al in 2019. These authors affirmed that the risk of losing teeth in patients who have quit smoking is not significantly different from that of individuals who have never smoked [10].

The impact of smoking cessation on the response to periodontal treatment: table 2.

Thirteen articles analyzed the effect of smoking cessation on periodontal treatment response [6,11,13-15,22-27]. The same parameters were evaluated.

Plaque index

Four studies [22,23,25,26]. have assessed the plaque index in the evaluation of the effect of smoking cessation on periodontal treatment response.

In 2005, Preshaw and colleagues demonstrated a decrease in plaque index between the baseline measurement and each subsequent post-baseline time point [22]. No significant difference was found in the pattern of change between the groups smokers and ex smokers at the beginning of the study and 12 months after non surgical periodontal therapy. The same findings were proved in a longitudinal study of Rosa and al. where a significant reduction ($p < 0.05$) in the number of sites with visible plaque in smokers and ex-smokers was reported 1 year after initial treatment. The authors haven't detected any difference between the two groups at any time during the study [23].

However, Rosa and., *et al.* in 2014 [25] found that ex smokers had a decreased mean ratio of sites with visible plaque, compared to regular or irregular smokers. This also aligns with findings of the cohort study of Costa and., *et al.* in 2019, [26] where current smokers had a higher plaque index compared to ex smokers and non smokers, 6 years after periodontal therapy.

Grossi and al. in 1997 found that former smokers showed a significantly greater reduction in plaque index than current smokers 3 months after non surgical periodontal treatment [28]. Nevertheless, we can assume that smoking cessation may be involved in the increased attention of individuals to their oral health.

Probing depth

All the studies, that we used in our review employed the probing depth as a parameter in the evaluation of the impact of smoking cessation on periodontal treatment [6,7,12,22-27].

These studies confirmed that tobacco cessation reduces probing depth in patients after non surgical treatment. Grossi and al. showed in a prospective study in 1997, that the mean reduction of probing depth was lower in current smokers than former smokers 3 months after periodontal treatment [28].

Clinical attachment loss

Seven studies [6,7,12,14,15,22-26] evaluated the clinical attachment loss in the assessment the impact of smoking cessation on the response to periodontal treatment. All these studies affirmed that smoking cessation contributes to clinical attachment gain after non surgical treatment.

Grossi and al. also confirmed these findings in a prospective study where current smokers showed less attachment gain in deep pockets than former smokers, 3 months after periodontal treatment [28].

Bleeding on probing

8 articles [13-15,22,23,25-27] evaluated bleeding on probing in their works: Through a Cohort study of 6-year follow-up, Costa and al. demonstrated that current smokers presented fewer sites with bleeding on probing than ex-smokers and non-smokers after periodontal therapy [26].

In 2005, Preshaw and al. didn't find any significant difference in sites with bleeding on probing between smokers and ex-smokers after periodontal therapy [22]. This is consistent with the findings of Rosa and al. where no significant difference was found in the percentage of sites with bleeding on probing between the two groups after a 12-month follow-up period [23], and also in a prospective study of Rosa and., *et al.* [25].

The effect of smoking cessation on bleeding on probing after periodontal therapy remains unclear and controversial.

Radiographic bone loss RBL

Four articles [6,13,14,22] analyzed radiographic bone loss in assessing the effect of smoking cessation on response to periodontal treatment.

Preshaw., *et al.* demonstrated in a clinical trial that there was no significant difference in bone levels between smokers and ex-smokers at any time during the 12 months of follow-up after periodontal treatment [22]. This agrees with the findings of the systematic review by Fiorini, *et al.* in 2013. Authors showed that there where no significant difference in bone level between the two groups of smokers and ex smokers after periodontal therapy [6].

Smoking cessation does not appear to have a clear, established effect on radiographic bone levels after periodontal treatment.

The relationship between the duration of smoking cessation and periodontal disease. (Table 3).

Five articles evaluated the relationship between the number of years of smoking cessation and:

- Incidence or recurrence of periodontitis
- Risk of tooth loss

Duration of smoking cessation and periodontitis

Three studies [5,8,26] evaluated the relationship between the number of years of smoking cessation and the incidence or recurrence of periodontal disease.

AlHarthi and al. conducted a survey in 2019 revealing that in ex-smokers, each additional year since smoking cessation was associated with a significant reduction in the odds ratio (OR) of periodontitis of 3.9% [8]. These results are similar to those found by

Article	Title	Author	Type of the study	Review	Year of publication	Follow up period	Type of intervention
12	The effect of quitting smoking on chronic periodontitis	Preshaw and al	Longitudinal, non-blinded, clinical trial	Journal of Clinical Periodontology	2005	12-month period.	Clinical measurement were performed before and after the non surgical therapy, in order to evaluate the effect of periodontal treatment.
13	A prospective 12-month study of the effect of smoking cessation on periodontal clinical parameters	Rosa and al	prospective, singleblinded study	Journal of Clinical Periodontology	2011	12 month period	Full mouth periodontal examination and expired air carbon monoxide concentration measurement and interview were performed in order to collect demographix and smoking data
14	Effects of smoking cessation on the outcomes of non-surgical periodontal therapy: a systematic review and individual patient data meta-analysis	Chambrone and al	Systematic re-view and meta analysis	Journal of Clinical Periodontology	2013	6 months duration	Primary outcome measures were clinical attachment level (CAL) and probing depth (PD). Secondary outcome measures were plaque score, bleeding on probing, radiographic changes of the alveolar bone level and number of teeth lost during the period of the study
2	Is There a Positive Effect of Smoking Cessation on Periodontal Health? A Systematic Review	Fiorini and coll	Systematic Review	Journal of Periodontology	2014	At least one year	Measurement of CAL,PPD, radiographic bone level and bleeding on probing
15	Effect of smoking cessation on non-surgical periodontal therapy: results after 24 months	Rosa and coll	Prospective follow up study	Journal of Clinical Periodontology	2014	From 12 to 24 months	Measurement of CO and full mouth clinical periodontal examination
16	Cumulative smoking exposure and cessation associated with the recurrence of periodontitis in periodontal maintenance therapy: A 6-year follow-up	Costa and coll	Follow-up cohort study	Journal of Periodontology	2019	From june 2008 to december 2010	Full mouth periodontal examinations and interviews
4	Effect of Smoking on Periodontitis: A Systematic Review and Meta-regression	Leite and coll	Systematic Review and meta analysis	American Journal of Preventive Medicine	2019	Studies with ≥12 months of follow-up	Studies with at least two measures of periodontitis (clinical attachment level/probing depth/alveolar bone loss
17	Treatment of Chronic Periodontitis with Smoking Cessation Care and Periodontal Surgery in an Elderly Patient: A Case Report Including a 4-year Follow-up	Yamashita and coll	Case report	Bull Tokyo Dent Coll	2022	4 years	Periodontal examination before and after non surgical treatment
7	Impact of Smoking Cessation on Periodontal Tissues	Duarte et al	Literature review	International Dental Journal	2021	From 2005 to 2020	-
8	Smoking cessation and response to periodontal treatment	Alexandridi et al	Literature review	Australian Dental Journal	2018	12 months	PD, CAL or alveolar bone levels
9	Smoking and periodontal tissues: a review	Neto and al	Litterature review	Brazilian Oral Research	2012	-	-
10	Oral health risks of tobacco use and effects of cessation	Warnakulasuriya and coll	Literature review	International Dental Journal	2010		
11	The effect of smoking on periodontal treatment response: a review of clinical evidence	Heasman et coll	Literature review	Journal of Clinical Periodontology	2006	-	-

Table 2: Association between smoking cessation and periodontal treatment.

Costa, *et al.* in their cross-sectional study. They revealed that the risk of periodontitis decreased with increasing years of smoking cessation : the odds ratio of those who had quit smoking less than 5 years previously was significantly higher than that of those who had quit smoking more than 15 years previously [5].

Costa and al. found in a cohort study that periodontitis recurrence in ex-smokers and smokers was 68.2% and 80.0%, respectively. They deduced that the risk of periodontitis recurrence decreased significantly as the number of years of smoking cessation increased [26].

Similarly, Thomson, *et al.* in 2007 found in a prospective population-based study at age 26 and again at age 32 that there were no significant differences in periodontal status between never smokers and those who quit smoking after age 26 [29].

However, few studies have attempted to determine a threshold for the duration of smoking cessation that is associated with these beneficial effects [5]. Torrungruang, *et al.* [16] and Thomson, *et al.* [29] proposed 10 years of smoking cessation as a threshold for reducing the negative effects of smoking on periodontal health.

As for the study of Costa., *et al.* [5], the risk of developing periodontitis was significantly lower when the duration of smoking cessation was >11 years, whereas smoking cessation ≤10 years was not associated with a lower risk of periodontitis. This suggests that a long-time interval is necessary to reduce the harmful effects of smoking.

We can therefore deduce that the incidence of periodontal disease or its recurrence decreases as the time since smoking cessation increases.

Duration of smoking cessation and tooth loss

Only one study has analyzed the relationship between the number of years since smoking cessation and tooth loss [9] In this large cohort study (from 1994 to 1998), Dietrich and al. found that the average number of teeth present increased as the number of years of smoking cessation increased [9]. They also found that the risk of tooth loss decreased with increasing duration of smoking cessation. However, up to 20 years of smoking cessation is required to decrease the risk to that of non-smokers.

This work is in line with the results of Dietrich., *et al.* 2007 prospective study, where the risk of tooth loss decreased with increasing time since smoking cessation [30].

Article	Title	Author	Type of the study	Review	Year of publication	Follow up period	Type of intervention
1	Associations of duration of smoking cessation and cumulative smoking exposure with periodontitis	Costa and coll	Cross sectional study	Journal of Oral Science	2013	From june 2008 to december 2010	Full mouth periodontal examination(PD, CAL, BOP, PI, teeth lost
3	Smoking, Smoking Cessation, and Risk of Tooth Loss: The EPIC-Post dam study	Dietrich and coll	Cohort study	Journal of Dental Research	2015	-	-
5	Association Between Time Since Quitting Smoking and Periodontitis in Former Smokers in the National Health and Nutrition Examination Surveys (NHANES) 2009-2012	ALHarthi and coll	Cross-sectional analytical study	Journal of periodontology	2019	from the 2009-2010 and 2011-2012	Oral and periodontal examination
9	Smoking and periodontal tissues: a review	Neto and al	Litterature review	Brazilian Oral Research	2012	-	-

Table 3: Association between the duration of smoking cessation and periodontal disease.

Conclusion

We can conclude that smoking cessation plays an important role in reducing the risk of onset and progression of periodontitis to a level comparable to that of never smokers. Smoking cessation also appears to improve response to surgical and non-surgical periodontal treatment. It also reduces the risk of periodontitis recurrence during the periodontal maintenance period.

The time elapsed since smoking cessation seems to be a factor that affects the incidence of periodontal disease: a longer duration is associated with the reduction of the risk of developing periodontitis.

However, it is not clear how long it takes for the body to return to normal inflammatory conditions after smoking cessation, which is an important factor in interpreting results.

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