Effect of Cigarette Smoking on the Clinical Outcomes of Periodontal Surgical Procedures

Fawad Javed, PhD, Abdulaziz Al-Rasheed, MSc, Khalid Almas, MSc, George E. Romanos, PhD and Khalid Al-Hezaimi, MSc

Abstract: Introduction: Experimental studies have revealed that nicotine upregulates the expression of receptors of advanced glycation end products and retards fibroblastic cell migration in the gingiva of smokers compared with nonsmokers, thereby inducing a proinflammatory effect. The aim of this study was to review the effect of cigarette smoking on the clinical outcomes of periodontal surgical procedures. Methods: To address the focused question, “What is the effect of cigarette smoking on clinical outcomes after periodontal surgical interventions?”, databases were searched from 1968 to May 2010 using various combinations of the following key words: inflammation, mucoperiosteal flap, periodontal surgery, smoking and tobacco. The inclusion criteria included all levels of available evidence. Articles published only in the English language were evaluated, and unpublished data were not sought. Results: Twenty-four clinical studies were included. The duration of smoking habit ranged from at least 5 years to 27.8 years. Sixteen studies showed that reductions in probing depth and gains in clinical attachment levels were compromised in smokers in comparison with nonsmokers. Three studies showed residual recession after periodontal surgical interventions to be significantly higher in smokers compared with nonsmokers. Three case reports showed periodontal healing to be uneventful in smokers. Conclusion: Cigarette smoking has a negative effect on periodontal wound healing after surgical interventions.

Key Indexing Terms: Inflammation; Mucoperiosteal flap; Periodontal surgery; Smoking; Tobacco. [Am J Med Sci 2012;343(1):78-84.]

The primary goals of periodontal therapy are to eliminate or reduce bacterial plaque and contributing factors to arrest disease progression. Subgingival scaling and root planning may result in resolution of inflammation to some extent; however, with deep probing depths (PD), a mucoperiosteal flap surgery may be necessary to achieve a greater reduction in PD and gain in clinical attachment level (CAL).2,3 Risk factors for periodontal inflammatory conditions include smoking, stress and immunodeficiency.4–7

It has been hypothesized that smoking is associated with an increased expression of receptor of advanced glycation end products (RAGE) in gingival tissues.8,9 In their experimental study, Katz et al8 showed an increased expression of RAGE in gingival epithelial cells of smokers compared with nonsmokers. Furthermore, it has been reported that nornicotine (a metabolite of nicotine) upregulates RAGE expression in the gingiva of smokers and elicits a proinflammatory effect by stimulating the secretion of cytokines and reactive oxygen species that directly cause destruction of the periodontal apparatus.9 The vasoconstrictive effects of nicotine increase platelet adhesiveness, increase the risk of microvascular occlusion and cause tissue ischemia.10 Smoking is also associated with catecholamines release resulting in vasoconstriction and decreased tissue perfusion.11 These phenomena can negatively influence periodontal wound healing and the repair and regenerative capacities of periodontal tissues in smoking patients. Other proposed mechanisms regarding the negative effect of smoking on periodontal tissues include (1) decreased vascular flow; (2) decreased immunoglobulin G production and lymphocyte proliferation; (3) altered neutrophilic function; (4) amplified prevalence of periodontal pathogens; (5) impaired fibroblast attachment and function; and (6) negative local effects on growth factor and cytokine production.11,12

Because various mechanisms may contribute in impairing the periodontal healing process in smokers, the aim of this study was to review the literature with regard to the effect of cigarette smoking on clinical outcomes after open flap curettage (OFC) procedures.

MATERIALS AND METHODS

Focused Question

The addressed focused question was “What is the effect of cigarette smoking on clinical outcomes after periodontal surgical interventions?”

Eligibility Criteria

The eligibility criteria encompassed the following: (1) original articles; (2) clinical and experimental studies; (3) case reports; (4) studies designed specifically to investigate the effect of smoking on clinical outcomes of periodontal surgical procedures; (5) reference list of pertinent original and review studies; and (6) articles published only in English language. Letters to the editor, historic reviews and unpublished articles were excluded.

Search Strategy

The authors searched the MEDLINE/PubMed (National Library of Medicine, Bethesda, Maryland) and the Google scholar databases for appropriate articles addressing the focused question. Databases were explored from 1968 up to and including May 2010 using the following keywords in various combinations: inflammation, mucoperiosteal flap, periodontal surgery, smoking and tobacco. Titles and abstracts of articles that satisfied the eligibility criteria were screened by the authors and checked for agreement. The full text of the articles judged by title and abstract to be relevant were read and independently assessed against the eligibility criteria. Any disagreements between the authors were resolved via discussion.

Hand searching of the reference lists of original and review studies that were found to be relevant in the previous
RESULTS

Characteristics of Included Studies

All studies that fulfilled the eligibility criteria were clinical and were either performed at universities or oral healthcare centers. The numbers of participants ranged between 1 subject and 172 individuals, and all were regular cigarette smokers. All individuals were adults and their ages ranged between 22 and 77 years. The number of cigarettes smoked daily ranged between 1 and 20. Most of the studies that fulfilled our eligibility criteria were controlled clinical trials. Three studies were case reports, and 4 case-control studies were also included. Eight studies reported the duration of smoking, which ranged from at least 5 to 27.8 years.

In 17 studies, OFC procedures were performed; whereas in 7 studies the patients had undergone guided tissue regeneration (GTR) for the correction of periodontal defects. In studies on patients who underwent periodontal flap surgeries, 3 studies and 4 case-control studies were also included. Eight studies reported the duration of smoking, which ranged from at least 5 to 27.8 years.

DISCUSSION

Even though smoking is an inevitable risk factor for a less favorable periodontal healing response after surgical interventions; the role of confounding parameters (such as poorly controlled diabetes mellitus, stress, immunodeficiency, increasing age and female gender) that may also impair periodontal healing after surgical interventions cannot be disregarded. Hence, it may be argued that such confounding parameters may also play a role in impairing healing after periodontal surgery; however, further studies are needed in this regard.

From the literature reviewed, it was observed that only a limited number of studies expressed the exposure to cigarettes in pack-years. In this regard, we expressed the habit in terms of the numbers of cigarettes smoked daily, which, however, may be regarded as a limitation of the current study. We found no consistent patterns between the numbers of cigarettes smoked daily and their effect on periodontal surgical interventions. For example, the results from Kaldahl et al and Preber and Bergström showed that individuals who smoked at least 20 cigarettes daily exhibited significantly less reduction in plaque index and PD compared with nonsmokers. In the study by Kim et al, the periodontal status of patients was re-evaluated 6 months after periodontal surgery. The results showed that PD reductions and gains in vertical attachment level were compromised in patients who smoked at least 1 cigarette per day compared with nonsmokers. It may therefore be postulated that individuals who smoke once a day may not be pardoned from the detrimental effects of smoking on wound healing compared with subjects smoking more than 20 times daily. Because of lack of relevant information, the authors found it arduous to assess the effect of duration of smoking on periodontal healing in smokers compared with nonsmokers. From the studies included, we observed that smokers with a less favorable periodontal healing response after surgical interventions had been smoking since at least 5 years; however, the authors emphasize that a history of smoking of less than 5 years should not be considered safe in terms of periodontal healing. Further studies are warranted in this regard.

Interestingly, the 3 case reports that were included in the current review reported that regular smokers were not susceptible to impairments in periodontal healing after surgical interventions. Nevertheless, several essential parameters that could have influenced the long-term success of the surgical treatment in these patients were not addressed. For example, in the study by Blanchard et al, the postoperative healing was uneventful; however, the periodontally involved tooth was extracted. In the study by Walter et al, smoking cessation was advised to the patient before periodontal surgery. It was
<table>
<thead>
<tr>
<th>Authors</th>
<th>Aim</th>
<th>Subject/s (n) Mean age and range (yr)</th>
<th>Duration of smoking habit (yr)</th>
<th>Numbers of cigarettes smoked daily</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>To assess the effect of smoking on the treatment of a furcation defect in a male patient</td>
<td>Blanchard et al\textsuperscript{13}</td>
<td>One male 43</td>
<td>20</td>
<td>At least 20/day</td>
<td>Healing after the periodontal open flap debridement surgery was uneventful</td>
</tr>
<tr>
<td>To assess the effect of smoking on healing response of intrabony defects after surgical periodontal therapy</td>
<td>Yilmaz et al\textsuperscript{14}</td>
<td>24 NA (32–50)</td>
<td>NA</td>
<td>At least 10/day</td>
<td>Reduction in PD and CAL gains was poorer in smokers compared with nonsmokers</td>
</tr>
<tr>
<td>To assess the effect of cigarette smoking on the healing of periodontal lesions in a smoker</td>
<td>Walter et al\textsuperscript{15}</td>
<td>One male 53</td>
<td>34</td>
<td>At least 20/d</td>
<td>Healing after the periodontal open flap debridement surgery was uneventful, and the periodontal status was uneventful after 32 months of follow-up</td>
</tr>
<tr>
<td>To assess the adjunctive effects of systemic antibiotics in combination with periodontal surgery in smokers with chronic periodontitis</td>
<td>Dastoor et al\textsuperscript{16}</td>
<td>30 49.4 (35–65)</td>
<td>NA</td>
<td>At least 20/d</td>
<td>At 6 months of follow-up, adjunctive antibiotic therapy in combination with periodontal surgery failed to enhance PD reduction and clinical attachment gain</td>
</tr>
<tr>
<td>To investigate the effect of cigarette smoking on surgical periodontal therapy</td>
<td>Kim et al\textsuperscript{17}</td>
<td>41 46.3 (35–56.8)</td>
<td>NA</td>
<td>At least 1/d</td>
<td>At 6 months of maintenance, PD reduction and RAL-V gain were significantly less in smokers compared with nonsmokers</td>
</tr>
<tr>
<td>To assess the effect of cigarette smoking on the outcome CPF in the treatment of gingival recession defects</td>
<td>Silva et al\textsuperscript{18}</td>
<td>20 NA (22–53)</td>
<td>At least 5 years</td>
<td>At least 10/d</td>
<td>At 24 months of maintenance, residual recession was significantly greater in smokers compared with nonsmokers. The stability of the CPF was less stable in smokers compared with nonsmokers</td>
</tr>
<tr>
<td>To assess the changes in periodontal parameters in a patient having undergone apical surgery</td>
<td>von Arx et al\textsuperscript{19}</td>
<td>One male NA NA NA</td>
<td>At 2 months of follow-up, smoking habit did not have any significant effects on PD, CAL and plaque and bleeding on probing indices after apical surgery</td>
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</tr>
<tr>
<td>To assess the effect of smoking on the outcome CPF in the treatment of gingival recession defects</td>
<td>Silva et al\textsuperscript{20}</td>
<td>10 34.5 (22–53)</td>
<td>At least 5 years</td>
<td>At least 10/d</td>
<td>At 6 months of follow-up, smokers presented greater residual recession depth and lower percentage of root coverage compared with nonsmokers</td>
</tr>
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<thead>
<tr>
<th>Authors</th>
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<th>Subject/s (n)</th>
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<th>Numbers of cigarettes smoked daily</th>
<th>Main results</th>
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<tr>
<td>Erley et al&lt;sup&gt;21&lt;/sup&gt;</td>
<td>To assess the effect of cigarette smoking on the healing of subepithelial connective tissue grafts</td>
<td>17</td>
<td>NA (27–45)</td>
<td>NA</td>
<td>At least 10/d</td>
<td>At 3- and 6-month maintenance, root coverage was significantly less in smokers compared with nonsmokers</td>
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<tr>
<td>Trombelli et al&lt;sup&gt;22&lt;/sup&gt;</td>
<td>To evaluate the treatment outcome of flap debridement surgery in cigarette smokers and nonsmokers</td>
<td>31</td>
<td>40.3 (30–50)</td>
<td>NA</td>
<td>At least 10/d</td>
<td>At 6 months of maintenance, smokers presented a lesser horizontal CAL gain compared with nonsmokers</td>
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<tr>
<td>Tonetti et al&lt;sup&gt;23&lt;/sup&gt;</td>
<td>To evaluate the clinical effect of flap surgery with or without the application of enamel matrix proteins</td>
<td>172</td>
<td>48 (39–57)</td>
<td>NA</td>
<td>Less than 20/d</td>
<td>PD reduction and CAL gains were significantly less in smokers compared with nonsmokers</td>
</tr>
<tr>
<td>Scabbia et al&lt;sup&gt;24&lt;/sup&gt;</td>
<td>To compare the treatment outcome after flap surgery among cigarette smokers and nonsmokers</td>
<td>57</td>
<td>39.6 (27–56)</td>
<td>NA</td>
<td>At least 10/d</td>
<td>At 6 months of maintenance, PD reductions and CAL gains were poorer in smokers compared with nonsmokers</td>
</tr>
<tr>
<td>Boström et al&lt;sup&gt;25&lt;/sup&gt;</td>
<td>To assess the influence of smoking on the outcome of periodontal surgery</td>
<td>57</td>
<td>57.2 (33–77)</td>
<td>27.8</td>
<td>19.9/d</td>
<td>In terms of alveolar bone height, the results were less favorable among smokers compared with nonsmokers</td>
</tr>
<tr>
<td>Trombelli and Scabbia&lt;sup&gt;26&lt;/sup&gt;</td>
<td>To assess the gingival healing response in smokers and nonsmokers</td>
<td>22</td>
<td>29 (23–40)</td>
<td>NA</td>
<td>At least 10/d</td>
<td>Smokers showed significantly less reduction in recession depth and root coverage compared with nonsmokers</td>
</tr>
<tr>
<td>Kaldahl et al&lt;sup&gt;27&lt;/sup&gt;</td>
<td>To assess the effect of cigarette consumption on periodontal therapy</td>
<td>74</td>
<td>45.4 (37.4–53.4)</td>
<td>NA</td>
<td>At least 20/d</td>
<td>Smokers demonstrated less PD reduction and less CAL gain compared with past smokers and nonsmokers</td>
</tr>
<tr>
<td>Ah et al&lt;sup&gt;28&lt;/sup&gt;</td>
<td>To investigate the effect of smoking on the clinical response to surgical and nonsurgical periodontal therapy</td>
<td>74</td>
<td>42.5 (NA)</td>
<td>NA</td>
<td>At least 10/d</td>
<td>During each of the 6 years of maintenance, smokers exhibited significantly less reduction of PD and less gain of CAL compared with nonsmokers</td>
</tr>
<tr>
<td>Preber and Bergström&lt;sup&gt;29&lt;/sup&gt;</td>
<td>To investigate the effect of cigarette smoking on the reduction of pocket probing depth after surgical therapy</td>
<td>54</td>
<td>40.1 (33–49)</td>
<td>5</td>
<td>At least 20/d</td>
<td>At the 1 year of maintenance, smokers exhibited significantly less reduction in plaque index and PD compared with nonsmokers</td>
</tr>
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unclear that whether the patient quit smoking or not; however, in case he did, then this could be an explanation for the success of OFC in this individual. Similarly, in the study by von Arx et al, factors such as duration and daily frequency of smoking that may influence periodontal healing after surgery were not documented. In addition, in this study, the follow-up was performed after 2 months. We hypothesize that the long-term success of the offered OFC could be challenged in case the patient continued with the smoking habit. Thus, results from these case reports remain debatable.

Smoking cessation has been suggested to be effective in reducing wound complications of various types of invasive surgeries. However, the optimal duration of smoking cessation that may reduce the risk of impaired periodontal healing remains unclear. Results from Boström et al and Kim et al showed an improved periodontal healing in former smokers in comparison with current smokers; however, in these studies, former smokers were defined as individuals who ceased the smoking habit since at least 5 years and 1 year. Further long-term longitudinal clinical trials are warranted to assess the benefits of smoking cessation on periodontal wound healing.

**CONCLUSION**

Although periodontal surgical interventions exhibit less favorable healing outcomes in smokers compared with nonsmokers, the role of other confounding parameters (such as poorly controlled diabetes mellitus, stress, immunodeficiency, poverty, and tobacco use) in the treatment success of periodontal defects remains unknown. Thus, future research should be focused on elucidating the role of these parameters in the periodontal surgery treatment success.
increasing age and female gender) that may also impair periodontal healing after surgical interventions cannot be disregarded. Hence, further studies are warranted in this regard. Smoking cessation should be an important component in the overall treatment of periodontal inflammatory conditions.

APPENDIX: LIST OF EXCLUDED STUDIES
(REASON/S FOR EXCLUSION IS/ARE SHOWN IN PARENTHESIS)

- Soileau KM. Oral postsurgical complications following the administration of bisphosphonates for osteopenia related to malignancy. J Periodontol 2006;77:738 – 43. (Focused question not answered)

REFERENCES


