Comparative study of two surgical techniques for root coverage of large recessions in heavy smokers

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Abstract

Reduced root coverage due to diminished periodontal vascularity can be expected in heavy smokers. The aim of this study was to evaluate the root coverage obtained for large gingival recessions in heavy smokers using two different surgical techniques. Twenty heavy smokers were selected. Each patient had large, bilateral Miller class I or II gingival recessions (Control Group (CG): 3.30 ± 1.29; Test Group (TG): 3.45 ± 0.80) on non-molar teeth. Clinical measurements of probing pocket depth (PPD), clinical attachment level (CAL), recession height (RH), keratinized mucosa height (KMH), and keratinized mucosa thickness (KMT) were determined at baseline and after 12 months. One side received a coronally positioned flap (CPF), while the contralateral side received the extended flap technique (EFT), both procedures carried out in conjunction with a subepithelial connective tissue graft (SCTG). Saliva samples to measure cotinine levels were taken at baseline and after 12 months as an indicator of the level of exposure to nicotine. Intergroup and intragroup analysis showed no statistical differences for the evaluated clinical parameters. Patients maintained the same exposure to smoke during the evaluation period. Both techniques resulted in low root coverage (CPF: 48.60%; EFT: 54.28%), but both techniques were effective in decreasing the gingival recessions (P ≤ 0.01). The variables smoke exposure, root coverage, and the thickness and height of keratinized tissue were subjected to linear regression. Regardless of the surgical technique used, heavy smoking strongly limits root coverage, especially for large recessions.

Introduction

Gingival recession is a very common esthetic problem, affecting more than 50% of the population. Root coverage procedures are indicated for esthetics, root hypersensitivity, and to avoid the occurrence of root dental caries. Various techniques have been described for achieving root coverage, and for how a subepithelial connective tissue graft (SCTG) enhances the predictability of esthetic root coverage.

However, very poor root coverage can be expected with the use of SCTG in smokers. The precise mechanisms by which tobacco smoke interferes with periodontal healing are not completely understood. Tobacco smoke is a significant factor associated with buccal gingival recession in epidemiological studies. Smokers exhibit higher prevalence, extension, and severity of gingival recessions when compared to non-smokers. Clinical studies have revealed reduced root coverage, both in terms of quantity and stability, when comparing smoking and non-smoking patient groups.

Some studies have suggested that the damaging effects of smoking may manifest by disturbing the vascular system. Another aspect to be considered is the possible change in the soft tissues caused by smoking. Nicotine has a vasoconstrictor effect on the blood vessels of the gingival tissues. In addition, smokers have 30% fewer blood vessels in the SCTG than non-smokers, which can retard the revascularization of the SCTG.

Adequate blood supply is very important for SCTG healing. To date, only four articles have been published about SCTG use for root coverage in smokers. All these studies used the conventional technique to compare smoking and non-smoking patients who have had root coverage procedures, reporting poor root coverage. This result can possibly be explained by the vertical incisions near the SCTG, which interfere with the blood vessel network. This hinders SCTG nourishment, which can cause exposure of the graft. To achieve higher SCTG vascularization in the extended flap technique (EFT), the vertical incisions can be placed at the gingiva of the tooth adjacent to the targeted one. This increases the flap area, avoiding blood vessel disruption nearby the graft, improving SCTG nourishment, and avoiding SCTG exposure.

This technique may increase the root coverage in smokers through flap area augmentation. Due to the many negative results shown by conventional root coverage techniques in smoker patients, the aim of this study was to evaluate the effect of flap length on the treatment of large gingival recession in heavy smokers by the EFT compared with the conventional SCTG technique, with a follow up of 12 months.

Material and methods

Patient selection

Twenty patients (10 females and 10 males), aged between 35 and 50 and with at least 20 teeth, were selected at the School of Dentistry of Ribeirão Preto, University of São Paulo, between March and October 2008. The study was
powered to detect a minimum clinically significant difference in root coverage of 1 mm, using a significance level of 5%. For a power level of 80%, 17 patients would be necessary.

Due to possible patient withdrawals during the study, 20 heavy smokers (20 or more cigarettes per day for more than 5 years) with esthetic complaints related to gingival recessions were selected. Exclusion criteria were HIV, diabetes, pregnancy, medical history of hepatitis, and periodontal pockets associated with the recession of adjacent teeth. Inclusion criteria were patients with bilateral gingival recession, large Miller23 recession (class I or II) of at least 3 mm in height, and less than 3 mm of keratinized tissue in non-molar teeth. All patients agreed with the study protocol and signed a consent form prior to treatment. The study was approved by the Human Research Committee of the School of Dentistry of Ribeirão Preto, University of São Paulo, Brazil (protocol 2008.1.170.58.4).

Outline and experimental stage

Clinical procedures
The patients received general oral hygiene instructions to eliminate habits related to the etiology of gingival recessions. They were also subjected to scaling, root planing, and prophylactic therapies. The surgical procedures were carried out when gingival bleeding and plaque indices were lower than 20%. Full-mouth plaque scores were recorded as the percentage of total surfaces (6 sites per tooth) that had plaque.24 Bleeding on probing (BOP) was assessed dichotomously and was recorded as the percentage of total surfaces (6 per tooth) that exhibited BOP.

At the same examinations (baseline and 12 months post-surgery), saliva was collected from the patients for later cotinine-level evaluation. All sample collection was carried out in the morning period, at approximately 9:00, with a maximum tolerance of 15 min before and after the designated period to avoid possible alterations in salivary composition. In order to avoid sample contamination, the patients were instructed to not eat 60 min prior to saliva collection, to avoid alcohol 24 h prior to saliva collection, to avoid performing oral hygiene 30 min prior to saliva collection, and to rinse their mouths with water 10 min prior to saliva collection. The patients donated up saliva for 5 min and, by inclining their heads, deposited saliva into sterile plastic tubes, thus avoiding the inclusion of air bubbles. Following saliva collection, the contents of the tubes were transferred to type 3810 microtubes (Eppendorf) and stored at -80°C until analysis was performed.

Two teeth in the same arch, bilaterally, were included in the study. Clinical measurements were taken before the surgical treatment (baseline) and 12 months after surgery, at the mid-buccal point of the involved tooth, of a) probing pocket depth (PPD), b) clinical attachment level (CAL), c) bleeding on probing (BOP), d) gingival recession height (RH) (Figs 1A and 2A), e) gingival recession width (RW), f) keratinized mucosa height (KMH), and g) keratinized mucosa thickness (KMT). Clinical examinations were always carried out by the same operator (SLSS), who was previously calibrated (intra-examiner
calibration). A computerized, force-controlled periodontal probe (Florida Probe Corporation) was used for PPD, CAL, and BOP, and a manual periodontal probe (UNC, Hu-Friedy) was used to measure the other clinical parameters.

Surgical procedures

All the surgical procedures were executed by the same surgeon (DMR). Two surgical procedures were performed in each patient: on one side, the conventional technique\(^\text{21}\) was used for the Control Group (CG), and on the opposite side, the Barros et al technique\(^\text{22}\) for the Test Group (TG). Both procedures used a SCTG. The side and the corresponding technique to be used were randomly chosen using computer software. The technique used for the CG consisted of an intracrevicular incision in the buccal face of the selected tooth, followed by mesial and distal releasing incisions in the same dental element, without including the adjacent papillae (Fig 1B). A partial thickness flap was raised beyond the mucogingival junction, and its base released so as to cover the gingival recession and the graft both coronally and passively.

In the TG, an intracrevicular incision was performed on the buccal face of the

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Fig 1  Control Group: (a) baseline, (b) incisions performed, (c) graft positioned and sutured, (d) sutures of the flap, (e) result after 12 months.
recession-compromised tooth, which included both adjacent teeth. A releasing incision was performed mesially and another one distally of the adjacent teeth closest to the element to be treated, without including the adjacent papillae (Fig 2B). A partial thickness flap was raised beyond the mucogingival junction and, after its base was released, the flap was displaced coronally to passively cover both the gingival recession and the graft (Fig 2D).

Following flap deflection, both groups received root planing and scaling in the exposed areas using Gracey curettes numbers 5 and 6, and the area was rinsed abundantly with sterile saline solution.

The graft was removed from the patient's palate according to the technique described by Lorenzana and Allen, and trimmed using Goldman-Fox scissors (Hu-Friedy) for improved adaptation to the gingival recession areas. The graft was then sutured to the receptor site using sling sutures with absorbable 5.0 (Vicryl) sutures (Figs 1C and 2C). The flap was then displaced coronally to completely cover the area, and was sutured in this position using the same technique as was previously described (Figs 1D and 2D). The donor

Fig 2  Test Group: (a) baseline, (b) incisions performed, (c) graft positioned and sutured, (d) sutures of the flap, (e) result after 12 months.
The patients received 4.0 silk sutures. Surgical dressing was placed in the receptor area and changed after 7 days; replaced and removed 14 days post-op.

All patients were instructed to discontinue with tooth brushing. A 0.12% chlorhexidine digluconate solution was prescribed as a mouthwash to be used twice daily for 15 days, following which the patients were instructed to clean the operated area with cotton swabs embedded in the cited solution. They also received a prescription for 3 days of analgesics. Sutures on the donor site were removed after 7 days, and after 15 days in the areas where root coverage was required. Thirty days later, the patients were allowed to carefully resume tooth brushing over the operated area. The patients were also called back to be reinstructed on oral hygiene procedures and prophylactic control at 2 and 4 weeks post-surgery, and then monthly until 12 months post-surgery.

**Saliva cotinine analysis**
Cotinine is a metabolite from nicotine. It allows for the monitoring of patients’ exposure to nicotine. Cotinine levels were detected through enzyme-linked immunosorbent assays (ELISA, Salimetrics), using a kit for quantitative cotinine analysis present in the saliva, and following the manufacturer’s instructions.

**Statistical analysis**
Statistical analysis was comparative and parametric (n = 20). Descriptive statistics are expressed as mean and standard deviation. The percentage of root coverage was calculated after 12 months using the formula: (baseline parameter - 12-month parameter)/baseline parameter x 100. The gingival tissue gain was calculated (baseline RH - 12-months RH).

Analysis of variance (ANOVA) with one criteria was used to evaluate differences between the CG and the TG in the pretreatment, and 12 months post-surgery periods for RH, RW, CAL, KMH, root coverage, as well as for cotinine. ANOVA with two criteria was used to compare the clinical parameters related to the surgical techniques and to the time intervals (intragroup difference: baseline x 12 months). In case of significance, the Bonferroni adjustment test was applied as a multiple comparison test. For all statistical analyses, $P < 0.05$ was chosen.

**Results**
Both surgical techniques were performed in all the patients. A total of 40 gingival recessions were treated. Both groups presented similar clinical values at baseline, with no statistically significant difference for PPD, CAL, KMH, and KMT. Data are summarized in Table 1.

All patients recovered without complications during the entire follow-up period. All patients presented less than 20% of bleeding and plaque indices. The results obtained after 12 months (Figs 1E and 2E, respectively) in the comparison between groups did not demonstrate any statistically significant differences for the clinical parameters analyzed (Table 1). Cotinine did not vary between the analyzed periods (Table 1).

Two-way variance analysis was used to compare the values from residual recession with the evaluation periods,
considering different surgical techniques. This way, the intragroup analysis showed that there was statistically significant reduction in recession sizes in 12 months when compared with pretreatment periods ($P < 0.01$) for both surgical techniques. However, when comparing CG and TG groups for 12 months, there was no statistically significant difference (comparison between groups) (Table 2). Even though the surgical procedures increased the height and thickness of

**Table 1**  Average and standard deviations of clinical parameters and cotinine levels assessed at baseline and at 12 months for Control Group (CG) and Test Group (TG)

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>12 months</th>
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<tbody>
<tr>
<td></td>
<td>CG</td>
<td>TG</td>
</tr>
<tr>
<td>PPD (mm)</td>
<td>1.36 ± 0.48</td>
<td>1.31 ± 0.43</td>
</tr>
<tr>
<td>CAL (mm)</td>
<td>4.57 ± 1.32</td>
<td>4.77 ± 0.91</td>
</tr>
<tr>
<td>KMH (mm)</td>
<td>2.15 ± 1.23</td>
<td>1.98 ± 0.79</td>
</tr>
<tr>
<td>KMT (mm)</td>
<td>1.25 ± 0.32</td>
<td>1.21 ± 0.33</td>
</tr>
<tr>
<td>Cotinine (ng/ml)</td>
<td>416 ± 283</td>
<td></td>
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</tbody>
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PPD = probing pocket depth, CAL = clinical attachment level, KMH = keratinized mucosa height, KMT = keratinized mucosa thickness. $P$ values obtained by ANOVA, comparison between groups at the same time of evaluation. Comparison between groups for several times by ANOVA, $P$ values > 0.05.

**Table 2**  Average and standard deviations of root coverage at 12 months for Test Group and Control Group

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>1 year</th>
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<tbody>
<tr>
<td>TG</td>
<td>3.30 ± 1.29</td>
<td>1.64 ± 0.95</td>
</tr>
<tr>
<td>CG</td>
<td>3.45 ± 0.80</td>
<td>1.65 ± 1.06</td>
</tr>
<tr>
<td>$P$</td>
<td>n/s</td>
<td>n/s</td>
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</tbody>
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n/s = not significant

**Table 3**  Average and standard deviations of difference between Test Group and Control Group at baseline and at 1 year for root coverage (tissue gain)

<table>
<thead>
<tr>
<th></th>
<th>Baseline 1 year (c)</th>
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<tbody>
<tr>
<td>TG</td>
<td>1.66 ± 0.76</td>
</tr>
<tr>
<td>CG</td>
<td>1.80 ± 0.8</td>
</tr>
<tr>
<td>$P$</td>
<td>n/s</td>
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</tbody>
</table>

**Table 4**  Average and standard deviations of difference between Test Group and Control Group at baseline and at 1 year for root coverage (tissue gain) in percentage

<table>
<thead>
<tr>
<th>% Baseline - 1 year</th>
<th></th>
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<tbody>
<tr>
<td>TG</td>
<td>48.60 ± 20.11</td>
</tr>
<tr>
<td>CG</td>
<td>54.28 ± 20.67</td>
</tr>
<tr>
<td>$P$</td>
<td>n/s</td>
</tr>
</tbody>
</table>

n/s = not significant
the keratinized mucosa (Table 1), the intragroup and between-group analyses did not show any statistical significance. There was no statistical difference for gingival tissue gain between CG and TG at 12 months (Tables 3 and 4).

Cotinine analysis demonstrated that the patients were similarly exposed to tobacco-composing chemicals during the evaluation period (pretreatment: 416 ± 283 ng/ml; 6 months: 310 ± 145 ng/ml; 12 months: 283 ± 180 ng/ml; P = 0.62).

Discussion

The medical literature has shown that smoking impairs the hard\textsuperscript{26} and soft\textsuperscript{27,28} tissue revascularization process, which may influence the repair of periodontal tissue. Some studies have shown that smoking can affect regenerative\textsuperscript{29} and periodontal plastic surgeries.\textsuperscript{3,5,7} SCTG survival depends on anastomoses between vessels of the periosteal bed and preexisting vessels in the graft.\textsuperscript{30,31} Souza\textsuperscript{6} showed that smokers had 30% less blood vessels than non-smokers, which can reduce the SCTG nourishment and jeopardize the root coverage in smokers.

Due to its higher number of blood vessels, a wider flap would be better able to nourish the SCTG in smokers than a shorter flap. In addition, the use of vertical incisions distant from the SCTG could prevent the decline in nutrition in the graft adjacent area, favoring root coverage. The aim of this study was to evaluate the influence of the flap length in the root coverage of large gingival recessions in heavy smokers by the extended technique\textsuperscript{22} (TG), compared with the conventional flap technique\textsuperscript{21} (CG) associated with SCTG through clinical analysis.

The proposed treatments were capable of reducing recession height (there were statistically significant intragroup differences: $P < 0.01$), but root coverage obtained with the CG after 12 months (48.60 ± 20.11%) and the TG after 12 months (54.28 ± 20.67%) was low when compared to non-smokers, and did not show any statistically significant difference between groups. The same was obtained for the gingival tissue gain (Tables 3 and 4). Scientific literature has shown that smokers exhibit worse results in gingival recession treatment than non-smokers, with or without SCTG use.\textsuperscript{5,6,14-16} Although the average of root coverage was low, Figure 3 shows that the TG presented two cases of complete root coverage and a larger number of root coverage over 50% compared with the CG.

Only a few studies have been published about the use of SCTG for root coverage in smokers. The low values for root coverage obtained in this study for both techniques corroborate the results obtained by Martins et al,\textsuperscript{7} which are that treating heavy smokers (more than 20 cigarettes per day) and non-smokers with the use of SCTG attained average root coverage of 58.84%. These results were then confirmed by Andia et al,\textsuperscript{3} who also used SCTG in heavy smokers and obtained only 50% of root coverage after 2 years of control. Similar results were also presented by Souza et al,\textsuperscript{6} with patients who smoked more than 10 cigarettes per day, and obtained 58.02% of root coverage after 6 months.

In previous studies,\textsuperscript{22,32,33} the TG technique has been shown to increase...
the predictability of root coverage for, among other factors, the allowance of better vascularization of the flap, thereby favoring a better SCTG healing process. In the present study, the TG technique did not demonstrate better efficacy or obtain superior results compared with the standard technique in smokers. Despite this, selected recessions larger than 3 mm must be taken into account. Furthermore, only heavy smokers were used in this study. This was confirmed by cotinine analysis, which showed that the patients continued to be exposed to tobacco throughout the period of evaluation. Without this control, it would not have been possible to determine whether patients had stopped smoking during the follow-up period, which could have interfered with the results. This control was not, however, done in other studies. Moreover, the larger recessions increase the complexity of treatment, thereby decreasing the rate of success. These factors may explain the lack of difference in root coverage between the TG and the CG.

Heavy smokers may experience structural body alterations caused by years of intense exposure to the many toxic substances present in tobacco. Their vascular blood flow is heavily hampered, thus jeopardizing graft nourishment and complicating periodontal healing and root coverage. The results of the present study suggest that smoking may preclude the benefits of the test technique. Moreover, due to excessive changes during healing, the benefits of longer flaps may not be seen in heavy smokers. Future studies should screen the different levels of smoking in patients so as to attempt to define smoking levels that may provide better results for root coverage, and should test techniques that do not use vertical incisions, in an attempt to improve the nutrition of the SCTG.

Fig 3 Frequency of root coverage obtained in Test Group (TG) and Control Group (CG).
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Conflict of interest statement

The authors declare that they have no financial relationships related to any products involved in this study.

References


19. Morozumi T, Kubota T, Sato T, Okuda K, Yoshibe H. Smoking cessation increases gingival blood flow and gingival