Long-Term Outcomes of Coronally Advanced Tunnel Flap (CATF) and the Envelope Flap (mCAF) Plus Subepithelial Connective Tissue Graft (SCTG) in the Treatment of Multiple Recession-Type Defects: A 6-Year Retrospective Analysis

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This study evaluated the 6-year results of the subepithelial connective tissue graft (SCTG) plus envelope-type flap (modified coronally advanced flap; mCAF) or coronally advanced tunnel flap (CATF) in the treatment of multiple recessions. Thirty-six patients with at least two adjacent recessions were included. Complete root coverage (CRC), mean root coverage (MRC), and keratinized tissue (KT) width were recorded over the course of the study. Both groups presented similar CRC, MRC, and KT outcomes between the 1-year and 6-year follow-ups. MRC decreased from 96.90% to 94.16% for mCAF, and from 89.56% to 83.10% for CATF. Both surgical techniques were similarly efficient in treating multiple recessions in the short term, and in maintaining the stability of therapy in the medium and long term. Int J Periodontics Restorative Dent 2019;39:623–630. doi: 10.11607/prd.4026

Root coverage procedures for gingival recession are an important aspect of periodontal surgery. Even individuals with good oral hygiene standards may experience gingival recession depth (RD) increases of their untreated buccal gingival recessions (GRs).

It has also been established that the use of subepithelial connective tissue graft (SCTG) associated with a coronally advanced flap (CAF) may promote the best outcomes for clinical practice—eg, a superior number of sites of complete root coverage (CRC), mean root coverage (MRC), and mean keratinized tissue (KT) width gain—when compared with most other procedures. Within SCTG-based procedures used for the treatment of MRTD, different flap designs have been used to cover the graft, such as conventional CAF with vertical incisions, modified split-full-split CAF “envelope type of flap” (mCAF), tunnel flap, and coronally advanced tunnel flap (CATF). A recent meta-analysis comparing mCAF with CATF...
showed higher CRC percentages in the mCAF group when similar graft materials were used with both techniques. On the other hand, the tunnel pouch technique has demonstrated a greater increase of KT at 6 months and has also demonstrated better gingival texture.14

Although there are several trials focusing on the effect of SCTGs in the treatment of GR, there is limited information regarding the long-term (> 5 years) outcomes of SCTGs used for treating MRTDs, especially in cases where these grafts were associated with a CATF. Therefore, the objective of this retrospective study was to compare the long-term clinical results (> 5 years) of SCTG in combination with mCAF or CATF in the treatment of MRTDs in the maxillary esthetic zone.

Materials and Methods

Study Population

Thirty-six systemically healthy, non-smoking patients (16 females and 20 males; age range: 22 to 54 years) with at least two gingival recession defects affecting adjacent maxillary teeth were consecutively treated in a private practice in Pune, India, between the years 2009 and 2010 and observed during a 6-year follow-up period. The patients’ chief complaints were esthetics and/or dental hypersensitivity. This group originated from a population of 44 patients referred for treatment presenting good oral hygiene and an absence of active periodontal disease. The patients were randomly treated with SCTG + mCAF or SCTG + CATF. Each patient received detailed information about the proposed therapy and gave written informed consent for treatment. This retrospective analysis was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000 and 2008.

Inclusion Criteria

All consecutive patients who met the following inclusion criteria were entered into the study: (1) age > 18 years; (2) nonsmoking status; (3) presence of one recession area including at least two adjacent teeth in the maxillary arch (esthetic zone, which was defined as the maxillary teeth visible during a broad smile and teeth of esthetic concern to the patient, including premolars and, in some instances, molars); (4) having defects classified as Miller Class I or II15 of at least 2 mm at one tooth, with no caries, or that had not undergone previous root coverage procedures; and (5) probing depth (PD) < 3 mm, absence of plaque and bleeding on probing in the sites scheduled for the procedure.

Exclusion Criteria

Medically compromised patients (eg, diabetes mellitus, AIDS, pregnant women), smokers, and those with a history of destructive periodontal disease, carious or restored teeth, and/or poor hygiene levels (full-mouth plaque score more than 20%) were not included in the study.

Measurements

Patient-related demographic data (age and gender) were recorded, and the following clinical measurements were performed by a single examiner (N.B.) at baseline and 1, 4, and 6 years after treatment: (1) RD, measured from the cementoenamel junction (CEJ) to the gingival margin at the deepest point; (2) PD, measured from the gingival margin to the bottom of the gingival sulcus, at the same point as the RD; and (3) width of KT, measured from the gingival margin to the mucogingival junction.

Presurgical Treatment

Following initial examination, all patients received explanations of the potential factors causing the development of their gingival recessions (ie, etiology of defects) and underwent oral hygiene instruction and full-mouth supragingival scaling and tooth polishing.

Surgical Procedures

Root coverage procedures using an mCAF were performed by one surgeon (N.B.). Exposed root surfaces and the intrasulcular area were planed with curettes, then polished at slow speed with a rubber cup and prophylaxis paste for 60 seconds under local anesthesia before flap elevation. The root surfaces were then treated with 24% EDTA (ethylenediaminetetraacetic acid) and washed with saline. Figures 1 and 2
demonstrate the surgical technique for both groups.

Envelope Type of Flap (mCAF)

An intrasulcular incision was made with a 15c surgical blade (Hu-Friedy) on the buccal aspect of the involved tooth. The incision was extended mesiodistally to dissect the buccal aspect of adjacent papillae, avoiding the gingival margin of adjacent teeth. A partial-thickness dissection was accomplished, leaving the underlying periosteum intact. An apical mesiodistal dissection was performed to release residual muscle tension to facilitate coronal advancement of the flap. The papillae adjacent to the tooth with recession were de-epithelialized with a #12 blade (Hu-Friedy) and the flap was coronally advanced. A second surgical site was then created on the palate to obtain an SCTG, as described by Bhatavadekar and Gharpure. The harvested graft was then positioned and trimmed to the required size. The SCTG was then stabilized onto the donor site with sling sutures using 5-0 chromic gut (Ethicon). The flap was positioned at the level of the CEJ, and the oblique incisions, if any, were secured using 5-0 polyglactin 910 (Ethicon) sutures with interrupted sutures. The coronal, mesial, and distal extremities of the flap were then secured with two single interrupted sutures using the same suture material. Additional interrupted sutures, if necessary, were placed to stabilize the flap (Fig 2).

Tunneling Group (CATF)

Intrasulcular incisions were made around the necks of the involved teeth using a 15c surgical blade. The gingival tissue was undermined and extended into the mucosal tissues around the buccal surface of each involved tooth, and individual pouch preparations were connected with each other. The tunneling preparation was achieved with blades or with the use of tunneling knives (Ossung). The entire buccal aspect was dissected as a partial-thickness flap, only leaving the papillary region attached. A full-thickness preparation of the papillary region was prepared using periosteal elevators to allow the flap to be advanced coronally. A second surgical site was then created on the palate to obtain an SCTG. The harvested graft was then positioned and trimmed to the required size with a sharp 15c surgical blade, and a support suture was performed to guide the SCTG into the recipient site. The graft was gently pushed into the tunnel pouch with a packing instrument and by pulling the support suture. In case of multiple recession defects in adjacent teeth, the securing needle was passed passively underneath the tunnel created between the adjacent recessions. The suture was passed from the mesial aspect of the tunnel and pushed gently to the distal direction with a periosteal elevator so that the graft could slide underneath the tunnel. The graft was positioned coronal to CEJ, and the entire gingivopapillary complex was moved coronally using 5-0 polyglactin 910 vertical mattress sutures in the interdental areas anchored in

Fig 1 Surgical technique used for the CATF group.
the palatal gingiva, such that the sutures captured the buccal flap and the subepithelial connective tissue to stabilize the SCTG.

Postoperative Care

After surgery, patients were instructed to discontinue toothbrushing for 1 week, and sutures of the flap were removed after 10 days. The patients were instructed to rinse with 0.2% chlorhexidine digluconate twice a day for at least 2 weeks and they were prescribed ibuprofen (600 mg) as needed for comfort. One week later, the patients resumed mechanical tooth cleaning of the treated areas using a soft toothbrush and careful roll technique. Following surgical treatment, the patients were recalled at 1, 2, and 4 weeks and at 2 and 3 months for control and oral hygiene instructions. During a follow-up period over 6 years, the patients were recalled every 6 months for reinforcement of oral hygiene instructions and supragingival plaque elimination. The clinical outcome variables measured were CRC, MRC, RD, PD, and KT width changes.

Statistical Analysis

Statistical analysis of clinical parameters (ie, RD, PD, and KT) was carried out to compare the baseline values with the 1-, 4-, and 6-year postoperative values using one-way repeated measures analysis of variance. If the assumption of sphericity was violated, Greenhouse-Geisser correction (for epsilon < 0.75) or Huynh-Feldt correction (for epsilon > 0.75) was used to correct the univariate results (ie, adjust the P values). Moreover, Tukey-Kramer test was performed where appropriate to identify differences between means. Chi-square test with Yates correction or Fisher exact test was used to compare mCAF and CATF groups concerning CRC at 1, 4, and 6 years at tooth and patient levels. The analyses were performed using a software package (NCSS 2007). Differences at P < .05 were considered statistically significant.
Results

Of the 36 patients included in the study, 21 were allocated to the mCAF group and 15 to the CATF group (Table 1). Each patient contributed with a single treatment site (ie, one MRTD area). A total of 99 teeth were treated, 54 in the mCAF group and 45 in the CATF group (Table 1). For 12 teeth (7 from the mCAF group and 5 from the CATF group), the GR was associated to an incipient (< 1 mm depth) noncarious cervical lesion. This data were presented to show equal distribution of shallow noncarious cervical lesions in both groups. No differences were found in shallow vs deep groups. Overall, 34 incisors, 22 canines, 35 premolars, and 8 molars were included. Representative incisions, suturing, and follow-up photographs of two treated cases are shown in Figs 1 to 4.

Clinical Outcomes

Changes in RD, PD, and KT over the course of the study are depicted in Table 2. For patients treated with SCTG + mCAF, mean RD decreased from 2.91 ± 0.87 mm to 0.09 ± 0.29 mm, 0.16 ± 0.17 mm, and 0.17 ± 0.40 mm at 1, 4, and 6 years postsurgery, respectively. Statistically significant reductions were found for RD from baseline to the different follow-up times (P < .05), whereas no significant RD recurrence was observed between the first, second, and last postoperative values (P > .05). PD showed comparable results at baseline (1.61 ± 0.76 mm) and at 1-year (1.50 ± 0.57 mm), 4-year (1.59 ± 0.63 mm) and 6-year (1.63 ± 0.68 mm) follow-ups (P > .05). Conversely, the mean KT width increased from 1.15 ± 0.59 mm at baseline to 2.05 ± 1.56 mm, 2.46 ± 0.60 mm, and 2.78 ± 0.69 mm at 1, 4, and 6 years, respectively. There were significant improvements in the width of KT between baseline and the different postoperative assessments (P < .05), but without differences between these follow-up values (P > .05).

Table 1 Demographic Data Demonstrating the Sample Distribution According to Gender, Site, and Tissue Quality

<table>
<thead>
<tr>
<th></th>
<th>mCAF</th>
<th>CATF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>21 (58.3% of total)</td>
<td>15 (41.67% of total)</td>
<td>36 (100%)</td>
</tr>
<tr>
<td>Male</td>
<td>11 (52.38%)</td>
<td>9 (60%)</td>
<td>20 (55.56%)</td>
</tr>
<tr>
<td>Female</td>
<td>10 (47.62%)</td>
<td>6 (40%)</td>
<td>16 (44.44%)</td>
</tr>
<tr>
<td>Sites (teeth)</td>
<td>54 (100%)</td>
<td>45 (100%)</td>
<td>99</td>
</tr>
<tr>
<td>NCCL (no)</td>
<td>7 (12.96%)</td>
<td>5 (11.11%)</td>
<td>12</td>
</tr>
<tr>
<td>NCCL (yes)</td>
<td>47 (87.04%)</td>
<td>40 (88.89%)</td>
<td>87</td>
</tr>
<tr>
<td>Sites (teeth)</td>
<td>54 (100%)</td>
<td>45 (100%)</td>
<td>99</td>
</tr>
<tr>
<td>Thin phenotype</td>
<td>10 (18.52%)</td>
<td>7 (15.56%)</td>
<td>17</td>
</tr>
<tr>
<td>Thick phenotype</td>
<td>44 (81.48%)</td>
<td>38 (84.45%)</td>
<td>82</td>
</tr>
<tr>
<td>Sites (teeth)</td>
<td>54 (100%)</td>
<td>45 (100%)</td>
<td>99</td>
</tr>
<tr>
<td>Central</td>
<td>10 (18.51%)</td>
<td>6 (13.34%)</td>
<td>16</td>
</tr>
<tr>
<td>Lateral</td>
<td>11 (20.37%)</td>
<td>7 (15.56%)</td>
<td>18</td>
</tr>
<tr>
<td>Canine</td>
<td>14 (25.93%)</td>
<td>8 (17.78%)</td>
<td>22</td>
</tr>
<tr>
<td>Premolar</td>
<td>17 (31.48%)</td>
<td>18 (40%)</td>
<td>35</td>
</tr>
<tr>
<td>Molar</td>
<td>2 (3.7%)</td>
<td>6 (13.34%)</td>
<td>8</td>
</tr>
</tbody>
</table>

mCAF = modified (envelope-type) coronally advanced flap; CATF = coronally advanced tunnel flap; NCCL = noncarious cervical lesions.
In the SCTG + CATF group, there was a decrease in mean RD from 2.78 ± 0.90 mm at baseline to 0.29 ± 0.59 mm, 0.35 ± 0.64 mm, and 0.47 ± 0.76 mm at 1, 4, and 6 years postsurgery, respectively. Statistically significant reductions were found for RD from baseline to the different follow-ups (P < .05), whereas no significant GR recurrence was observed between the first, second, and last postoperative values (P > .05). The mean PD remained nearly stable over the course of the study (baseline: 1.58 ± 0.62 mm; 1 year: 1.60 ± 0.61 mm; 4 years: 1.58 ± 0.72 mm; 6 years: 1.64 ± 0.68 mm; P > .05). Moreover, the mean KT width increased from 1.29 ± 0.73 mm at baseline to 2.11 ± 0.71 mm, 2.53 ± 0.50 mm, and 2.55 ± 0.54 mm at 1, 4, and 6 years, respectively. In addition, there were significant improvements in the width of KT between baseline and the different postoperative assessments (P < .05), but without differences between these follow-up values (P > .05).

Table 3 displays the percentages of sites and patients with CRC according to the treatment procedure. CRC at 1 year was achieved in 49 of 54 gingival recessions (90.74%) in the SCTG + mCAF group and in 35 of 45 defects (77.78%) in the SCTG + CATF group. At the patient level, CRC was observed in 16 (76.19%) SCTG + mCAF and 7 (46.67%) SCTG + CATF patients at 1 year postsurgery. Overall, CRC at tooth and patient levels decreased between the 1-year and 6-year follow-ups. With respect to MRC achieved by SCTG + mCAF, this decreased from 96.90% at 1 year to 94.50% and 94.16% at the 4- and 6-year assessments, respectively. Similarly, MRC accomplished by SCTG + CATF decreased from 89.56% at 1 year to 87.41% and 83.10% at the 4- and 6-year assessments, respectively. In addition, between groups,
no statistically significant differences were found in all preoperative (RD, PD, and KT) or postoperative (RD, PD, KT, and CRC) measurements (P > .05).

**Discussion**

To the best of the authors’ knowledge, this is the first long-term study (> 5 years) focusing on the results and stability of MRTD treated by SCTG + mCAF or SCTG + CATF in the esthetic zone, which included maxillary teeth that are visible during a broad smile and are of esthetic concern to the patient. This study demonstrates relevant clinical improvements in outcomes for both procedures, without significant differences between the two groups for any of the considered outcomes. Another RCT demonstrated comparable results at 1 year (98.3% vs 96.3%) for SCTG + mCAF and SCTG + CATF, respectively. However, the study samples included different recession sites (single, multiple, maxillary, mandibular, anterior, and posterior). Although 1-year results are useful in determining the short-term effects of procedures, they do not provide evidence on long-term stability. In this study, comparable results were noted in terms of MRC in both mCAF and CATF groups, and both techniques demonstrated similar clinical results over 6 years, providing useful insight into the long-term stability of both procedures.

Both procedures led to an increase in KT width, which was maintained at 1, 4, and 6 years. The long-term stable results obtained in this study for both groups can be attributed to the use of SCTG along with a coronally displaced flap and tunneling. Previous studies have shown that the use of SCTG with a CAF have the best outcomes for clinical practice in terms of superior number of sites of CRC, MRC, and mean KT width gain. A study by Zuhr et al. compared the tunneling technique plus SCTG with the CAF plus enamel matrix derivative. The authors reported better results with tunneling and SCTG as compared to CAF with enamel matrix protein (98% vs 72%). A couple of 20-year follow-up studies demonstrated that the gingival margin stability seems associated with the achievement of a minimum attached KT width of 2 mm at the short-term (ie, 6 to 12 months after treatment). Thus, it could be postulated that the use of SCTG in either technique could yield more stable results in the long-term. This is important because the additional use of SCTG is reportedly consistently associated with increases in root coverage and keratinized tissue gain.

In the present study, no major adverse events (eg, infection, graft exposure) were reported or observed during or after the surgical procedures. Additionally, the patients enrolled in this study continued to maintain high levels of oral hygiene (FMPS < 20%) and adhered to a stringent maintenance protocol with recalls every 4 to 6 months. The exclusion of periodontally diseased, medically compromised, and smoking patients, along with regular hygiene recall visits, could also play a role in the stable long-term results.

This analysis has its share of limitations. The data were collected retrospectively, and samples were not randomly assigned to the groups, thereby increasing selection bias and leading to unequal samples in both groups. Further, the operator was not blinded at the time of data collection. These limitations need to be factored in when results from this study are extrapolated. Also, patient-based outcomes, such as patient-perceived changes in RC, pain, discomfort, and swelling, were not compared in this study. These measures could be used in future studies to understand patient-centric factors in the choice of surgical technique.

### Table 3 CRC Measurements at Tooth Level and Patient Level for Groups at 1 Year, 4 Years, and 6 Years After Therapy

<table>
<thead>
<tr>
<th>Group</th>
<th>CRC, 1 y</th>
<th>CRC, 4 y</th>
<th>CRC, 6 y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tooth level</td>
<td>Patient level</td>
<td>Tooth level</td>
</tr>
<tr>
<td>mCAF</td>
<td>49/54 (90.74%)</td>
<td>16/21 (76.19%)</td>
<td>45/54 (83.33%)</td>
</tr>
<tr>
<td>CATF</td>
<td>35/45 (77.78%)</td>
<td>7/15 (46.67%)</td>
<td>33/45 (73.33%)</td>
</tr>
<tr>
<td>P</td>
<td>.207</td>
<td>.089</td>
<td>.334</td>
</tr>
</tbody>
</table>

CRC = complete root coverage; mCAF = modified (envelope-type) coronally advanced flap; CATF = coronally advanced tunnel flap.
So far, there have been no studies that have compared mCAF and CATF in terms of the time taken for completing the surgical procedure. Although surgical time is based on technique familiarity and expertise, in the authors’ clinical experience, CATF procedures took more time for completion. This would then prompt the clinical question of whether mCAF procedures might be the approach of choice, especially since both the techniques were equally effective at 1, 4, and 6 years. However, comparing procedure times was not an objective of this study, and this choice might largely remain a subjective decision of each clinician.

Conclusions

Within the limits of this study, it can be concluded that both treatment approaches (SCTG + mCAF and SCTG + CATF) were equally efficient concerning RD reduction and KT width gain. Overall, no significant difference in root coverage outcomes (CRC and MRC) between procedures were identified at short- (1 year), medium- (4 years), or long-term (6 years) follow-ups.

Acknowledgments

The authors report no conflicts of interest related to the study.

References