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Long-term assessment of root coverage stability using connective tissue graft with or without an epithelial collar for gingival recession treatment. A 12-year follow-up from a randomized clinical trial.

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Abstract:

Aim: To evaluate the long-term root coverage outcomes of coronally advanced flap plus a connective tissue graft with (CAF + CTG) or without an epithelial collar (CAF + ECTG), and evaluate the adjacent treated sites included in the flap.
Methods: Seventeen of the original 20 subjects included in the randomized clinical trial were available at 12 years (43 sites). mean root coverage (mRC), keratinized tissue width (KTW), gingival thickness (GT) on the grafted and adjacent sites were evaluated and compared with baseline and 6 months.
Result: There was a reduction in the mRC at all sites: 16.52% in the CAF + CTG ($P>0.05$), 19.42% in the CAF + ECTG ($P<0.05$), and 34.12% in the CAF-alone (adjacent treated sites) group ($P<0.05$). No significant differences were observed within the groups for changes in KTW, GT, and clinical attachment level (CAL) ($p>0.05$). KTW at baseline and at 6 months were found to be predictors for the stability of the gingival margin in the long-term.
Conclusions: CAF + CTG and CAF + ECTG were found equally efficacious in maintaining the levels of the gingival margin with a small amount of relapse over the period of 12 years while CAF-alone sites showed a greater gingival recession (GR) reoccurrence.

Clinical relevance

Scientific rationale for study. To evaluate the long-term outcomes of connective tissue graft with or without an epithelial collar for the treatment of multiple adjacent gingival recessions (MAGRs) and compare them with adjacent sites treated without a graft.

Principal findings. CAF + CTG vs CAF + ECTG showed similar long-term clinical, esthetic and patient-related outcomes, however CAF-alone treated sites showed a greater tendency for recession relapse. KTW at baseline and 6 months were predictors for the stability of the gingival margin over time.
Practical implications. Although a certain amount of recession relapse may be expected for all treated areas, sites that received a graft material (CTG or ECTG) exhibited a greater gingival margin stability than non-grafted sites overtime.

1. Introduction

The long-term stability of outcomes achieved with periodontal surgery has been of great interest in the scientific community (Cortellini et al., 2017, Pini Prato et al., 2018a, Pini Prato et al., 2018b, Rasperini et al., 2018, Tavelli et al., 2019a). In addition, whether the obtained surgical outcomes are maintained over time without requiring a secondary procedure is also a concern for many clinicians as well as for patients. Cortellini et al. demonstrated the superiority of regenerative techniques over access flap surgery in a 20-year follow-up study (Cortellini et al., 2017). However, it is interesting to note that most of the differences between regenerative techniques and open flap (in terms of percentage of lost dentition, and cost of retreatment) were found in the second decade of their observation, which would not have been detected had the study been only up to 10 years (Cortellini et al., 2017). This raised a concern regarding the definition of long-term. In a recent systematic review, Chambrone & Tatakis defined "long-term" for studies with a duration of ≥ 24 months, concluding that untreated GRs have a high probability of worsening over time (Chambrone and Tatakis, 2016). Other studies have reported the outcomes of root coverage at 3 or 5 years, referring to their period of observation as "long-term" as well. (Zucchelli et al., 2014, Jepsen et al., 2017, Kuis et al., 2013). Despite a recently published definition regarding short- (6-12 months), medium- (13-59 months), long-term (5> years) for periodontal plastic surgery (Chambrone et al., 2018), undoubtedly most of the studies on the outcomes of root coverage procedures conclude at 6 months or 1 year.

It has been suggested that several factors, including the addition of a connective tissue graft (CTG) and patient maintenance and motivation have an impact on the long-term stability of the gingival margin (Pini Prato et al., 2011, McGuire et al., 2014, Rasperini et al., 2018, Tavelli et al., 2019b). Nickles et al. compared the long-term outcomes of treated isolated GRs either with a CTG or guided tissue regeneration

(Nickles et al., 2010). While both groups showed a significant reoccurrence after 10 years, the authors reported that CTG provided greater stability of the outcomes. Similarly, an apical relapse of the gingival margin was also observed after 8 and 14 years following CAF alone (Pini Prato et al., 2011, Pini-Prato et al., 2012). McGuire et al. showed that biologic agents, such as platelet-derived growth factors (PDGF) and enamel matrix derivatives (EMD), seemed to maintain the stability of root coverage procedures up to 5 and 10 years (McGuire et al., 2012, McGuire et al., 2014), respectively, suggesting that the healing with regeneration rather than repair may be also a key factor for the stability of the gingival margin.

Pini-Prato and coworkers recently reported the 20-year outcomes of CAF alone (Pini Prato et al., 2018b) and CAF + CTG (Pini Prato et al., 2018a), highlighting the importance of baseline KTW, condition of the interdental tissue, and presence of non-carious cervical lesions on the probability of GRs recurrence. Rasperini et al., in a 9-year follow-up study confirmed the superiority of CAF + CTG over CAF alone in the long-term maintenance of complete root coverage (CRC). They estimated that sites treated with CAF + CTG had 70% chance either preserving or gaining CRC, while CAF alone was related to GRs reoccurrence in 38.5% of cases (Rasperini et al., 2018).

In this scenario, whether the use of an ECTG provides higher stability of root coverage outcomes than a CTG is unknown, as a recent meta-analysis showed different results between the two approaches in the short-term (Dodge et al., 2018). Therefore, the aim of this study was to investigate the long-term root coverage results when envelope CAF was performed with CTG or ECTG.

2. Materials and Methods

The CONSORT statement for improving the quality of reports of parallel RCT (http://www.consort-statement.org/) were followed in the preparation of the present manuscript.

2.1 Study design

The present study was designed as a 12-year follow-up investigation from a previous randomized clinical trial (RCT) conducted between September 2006 and June 2008 (Byun et al., 2009). Details of the study protocol, inclusion and exclusion criteria, data collection and surgical intervention have been described in the original article (Byun et al., 2009). Briefly, patients presenting with Miller class I or II GRs ≥ 2 mm (RT 1: GRs presenting without clinically detectable loss of interproximal attachment) (Cairo et al., 2011) were recruited and randomly assigned to receive either an envelope CAF (eCAF) with subepithelial connective tissue graft (CTG) (control group) or eCAF with subepithelial connective tissue graft with an epithelial collar (ECTG) (test group). Randomization was performed by drawing a card from a bag at the time of each surgical appointment. The CAF was designed as an envelope without vertical releasing incisions and was extended to the adjacent 1-2 teeth mesial and distal to the tooth with the GR defect. For the control group, the CTG was harvested using the single-incision technique, while for the test group, the ECTG was obtained with the double incision approach where the second incision was made 2 mm apical to the first allowing to obtaining a graft with a 2 mm of epithelial collar.

The protocol for the follow-up study was approved by the Western Institutional Review Board (HUM00146261) and was in full accordance with the Helsinki Declaration of 1975, as revised in 2000. Informed consents were obtained from all the subjects who participated in this study.

2.2 Intervention

All surgical procedures were performed at the University of Michigan School of Dentistry by the same operator (H.Y.B.). Each study participant received full mouth supragingival scaling, polishing and oral hygiene instruction 2 months before the scheduled surgery. In addition, patients were instructed to maintain an optimal toothbrushing technique to correct improper habits related to the etiology of the GRs.
Patients were randomly assigned to the control (eCAF+CTG) or the test group (eCAF+ECTG) by drawing a card from a bag prior to the surgery. In addition, the patients were not aware about which treatment they received. Post-operative instructions were provided for all subjects both verbally and in a written form. After suture removal at 2 weeks, patients were instructed to resume atraumatic brushing technique using a soft-bristle toothbrush, while discontinuing the use of Chlorhexidine. A session of professional oral hygiene procedures, with oral hygiene instructions, was performed at 1, 3 and 6 months. After the recall at 6 months, professional oral hygiene procedures were performed 2-3 times a year.

2.3 Study outcomes

The primary endpoint of the current investigation was to evaluate changes, in terms of mean root coverage (mRC) and complete root coverage (CRC) from 6 month to 12 years in both the eCAF + CTG, and eCAF + ECTG groups independently, and to compare both approaches at 12 years.
The secondary outcomes of the study were: 1) to investigate the presence of possible correlations between influential variables and stability of the gingival margin (from 6 months to 12 years); 2) to compare the stability of the outcomes in sites treated with a soft tissue graft (CTG or ECTG) to adjacent sites that presented with GRs and were included in the envelope CAF but had not received a graft; and lastly, 3) to assess the gathered patient-reported responses and test for any correlations with the changes in the gingival margin.

2.4 Clinical measurements

Recession depth (REC), probing depth (PD), clinical attachment level (CAL), KTW and gingival thickness (GT) were collected as described in the original protocol at each treated site using a periodontal probe (PCP UNC 15, Hu-Friedy, Chicago, USA) by a calibrated examiner (R.D.G.) which was blinded to the treatments performed. The gingival phenotype at each treated site was compared to the contralateral and opposing sites using a color-coded probe (Colorvue Biotpe probe, Hu-Friedy, Chicago, USA) (Rasperini et al., 2015). In addition, the esthetic outcomes were evaluated using the Root coverage Esthetic Score (RES)(Cairo et al., 2009). Lastly, patients were asked to fill out a questionnaire which included dichotomous questions and a self-evaluation form regarding the stability of their obtained results over time using a visual analogue scale (VAS) of 100 mm (Tonetti et al., 2004, Cortellini et al., 2009).

2.5 Data and Statistical analysis

The collected data from the RCT and the recall examination at 12 years, as well as the retrieved baseline and 6-month data of the adjacent treated sites were gathered and entered into pre-fabricated spread sheets and coded by an author (L.T.). All analyses were performed by a different investigator with expertise in statistical analyses who had not taken part in data collection or measurements at recall appointments and was blinded to the original data (S.B.). Means and standard deviations (SD) were calculated for continuous outcomes (REC, PD, CAL, KTW). CRC was calculated as the percentage of sites that achieved a complete coverage at 6 months and those that maintained their complete coverage at the 12-year recall and was expressed as a binary outcome. The Fisher exact test was used for comparison of CRC among different groups, and the McNemar test was used for comparing correlated samples of CRC different times. Paired-samples t-tests were used for evaluating the changes from 6 months to 12 years in each of the treatment groups. For comparing the differences among the groups at 12 years, linear mixed-effects and logistic regression models were produced, to explore possible correlations between the variables at baseline and 6 months, and the results at the final (12 years) recall that controlled for the type of graft material (CTG/ECTG), and the fact that each subject had contributed to more than one GR.

For comparison of the grafted versus adjacent non-grafted treated sites in the flap, linear mixed-effects regression models were conducted that similarly accounted for the same factors. Lastly, regression models were produced to correlate the gathered patient-reported responses to the changes in the level of the gingival margin from the 6-month recall to the current 12-year gathered data.

Confidence intervals (CI) were produced and a *p* value threshold of 0.05 was set for statistical significance. Statistical analyses were performed using Rstudio (Rstudio Version 1.1.383, Rstudio, Inc., Massachusettes, USA), the lme4 (Bates et al., 2015), and the dplyr packages (Wickham et al., 2017).

3. Results

3.1 Descriptive analysis

From the twenty patients that completed the study at 6 months (twelve females and eight males, with a mean age of 42.6 years), seventeen were available for the 12-year recall examination (response rate of 85%) (Figure 1). 14 of the patients received periodic professional cleaning or supportive periodontal therapy, according to their need at least twice a year at the University of Michigan School of Dentistry, while 3 were maintained at private practices.

3.2 Clinical outcomes

Table 1 depicts the examined clinical parameters with statistical comparisons at baseline, 6 months and 12 years for the CAF+CTG, CAF+ECTG, and CAF treated sites. No statistically significant differences were observed among the 3 groups for mRC at 6 months (p=0.34). At 12 years, despite an overall tendency for gingival relapse in all groups, the mRC was significantly different for the CAF treated sites which had not received a graft material (55.2% for CAF, versus 77.7% and 74.5% for the sites that received ECTG and

CTG, respectively) (Figures 2 and 3). The amount of KTW and GT was also significantly different at 6 months ($p<0.001$, $p<0.001$) and at 12 years ($p<0.001$, $p<0.001$). This was in favor of the grafted sites that showed greater KTW at 6 months for the ECTG-treated sites ($p=0.01$), while lacking significant differences for KTW at 12 years between the ECTG and CTG groups. Nevertheless, intergroup comparisons at 6 months and 12 years for GT between ECTG and CTG treated sites did not reach statistical significance ($p=0.11$ and $p=0.09$, respectively). When the gingival phenotypes of the treated sites were compared to their contralateral and opposing teeth, 92.3% of the ECTG-treated sites, and 87.5% of the CTG-treated sites demonstrated a thickening of the gingival phenotype at 12 years, significantly more than the CAF-alone treated areas that only presented with 28.5% thickening ($p<0.01$). Regarding the esthetic assessment, at the 6-month timepoint, the RES evaluation scores showed averages of 8.9 ± 1.32, 8.4 ± 1.51, and 8.25 ± 1.73 for the ECTG, CTG, and CAF-alone treated groups, respectively without demonstrating statistically significant intergroup differences. ($P>0.05$) However, at the 12-year recall, the sites that originally received ECTG exhibited an average 7.42 ± 1.22 RES score, while CTG treated sites revealed a score of 7.64 ± 1.42, and the CAF treated areas presented with an average RES score of 6.45 ± 1.36, a difference that was statistically significant between the grafted (CTG and ECTG) and the non-grafted CAF areas ($p=0.03$).

The changes in the clinical parameters in all groups from baseline to 6 months, and from 6 months to 12 years are presented in Table 2. From the 6 months evaluation to the 12-year recall, the differences in changes of mRC among the three groups was significant in the CAF treated sites which had not received a graft (34.12% reduction), while the ECTG (-4.62 (95% CI[-8.61, -0.64], $p=0.01$)) and CTG-treated sites (-2.85 (95% CI[-5.16, -0.53], $p=0.01$)) presented with less changes (19.4% and 16.5% reduction, respectively). The changes in KTW from baseline to 6 months were significantly different in the ECTG (1.37 (95% CI[0.65, 2.02], $p<0.001$)) and CTG (0.98 (95% CI[0.35, 1.52], $p=0.003$) treated sites compared to the sites in the flap that had not received a graft. From 6 months to the 12-year recall, KTW changes in both grafted groups were statistically different from the CAF-alone treated sites, but not from each other (-0.63 (95% CI[-1.12, -0.15], $p=0.01$), and 0.59 (95% CI[0.13, 1.06], $p=0.01$), for the ECTG, and CTG respectively), and presenting the most increase in gain for the ECTG-treated sites.

For changes in GT, while no significant differences could be observed from baseline to 6 months for sites which were not treated with a graft, both ECTG (0.9 (95% CI [0.51, 1.37], $p<0.001$)) and CTG (0.74 (95% CI [0.51, 1.37], $p<0.001$)) treated sites showed a great gain despite statistical intergroup differences. While, the changes in GT from 6 months to 12 years did not show statistical differences among any of the 3 groups.

3.3 Regression analyses

Table 3 shows the result of the regression analysis for the mean root coverage outcomes at 12 years. The regression models demonstrated that KTW at baseline and 6 months were significant predictors affecting the mean root coverage results at 12 years for all the treated sites regardless of the utilized graft material ($p<0.05$). Whereas, other investigated variables such as GT (at baseline or 6 months), and recession depth (at baseline or 6 months) did not seem to be significantly affecting the results ($p>0.05$).

3.4 Patient-reported outcomes at the 12 years recall

The patient-reported outcomes demonstrated a high satisfaction rate for both the ECTG and CTG treated group, with VAS scores of 8.96 ± 1.33 and 9.13 ± 1.46, respectively (p=0.89). Similar among both groups, 100% of patients showed a willingness for possible re-treatment if needed. Additionally, when patients were asked to indicate their own perception of "stability" of their root coverage outcomes using a VAS scale, the ones who has initially inquired about the surgical procedure for esthetic reasons were the most precise in detecting the relapse of the gingival recession at the 12-year recall, compared to patients which had had the procedure for non-esthetic purposes (hypersensitivity, non-carious cervical lesions, etc.) (p=0.01).

4. Discussion

4.1 Connective tissue graft with or without an epithelial collar

The possibility of leaving the coronal part of a CTG exposed has been explored by several authors (Cordioli et al., 2001, Han et al., 2008, Salhi et al., 2014, Tavelli et al., 2019b). The suggested advantages of this approach are the better initial graft tissue fluid seal during the healing process, and the faster healing and increased gain in KTW (Byun et al., 2009). However, since it is clinically challenging to have the flap positioned exactly at the interface between the epithelium and connective tissue area of the graft, cyst formation remains a concern (Romano et al., 2017, Byun et al., 2009). In addition, it has been reported that at some sites the healing occurs with a demarcation line between the flap and the graft which would require an additional gingivoplasty procedure (Byun et al., 2009).

In the previous report, our group found a greater mRC, while lacking significant significance, in favor of the CAF + ECTG treated sites at 6-months (compared to the CAF + CTG) and a significantly greater KTW, at 3 and 6 months, in the CAF + ECTG group (Byun et al., 2009). This 12-year examination confirmed that retaining the epithelial collar on a CTG does not add long-term clinical benefits and is not related to greater outcome stability, when compared to the CTG. A possible explanation might be that both ECTG and CTG result in a similar increase in KTW and GT, which are crucial factors for the long-term stability of the gingival margin. Furthermore, no significant differences were observed between ECTG and CTG in terms of the percentage of sites that showed change in their phenotype, while, none of the treated sites with flap alone (without a soft tissue graft (STG)) had an increased phenotype at the12-year recall. In addition, although it has been suggested that leaving the epithelial collar of a CTG exposed can result in reduced esthetic outcomes than the bilaminar technique when the CTG is completely covered by the flap (Byun et al., 2009, Dodge et al., 2018), the RES outcomes at 6 months and 12 years did not show significant differences between the ECTG and CTG groups.

Lastly, despite the secondary intention healing of the palatal donor site which has been referred to as a possible drawback of harvesting an ECTG, the patient-centered outcomes showed no differences between either groups at the early follow-up and at the 12-year recall. Our results are also in line with a recent report of a systematic review and meta-analysis that evaluated the impact of partially exposed connective tissue grafts on root coverage results (Dodge et al., 2018).

4.2 Long-term stability of the root coverage outcomes with or without a soft tissue graft

The detrimental effect of time on the recurrence of GRs has been documented (Leknes et al., 2005, Nickles et al., 2010, Pini Prato et al., 2011, Moslemi et al., 2011, Tavelli et al., 2019a). Despite the lack of a clear definition of success in the literature for the long-term results of root coverage procedures, several clinicians have reported the percentage of sites that maintained their complete root coverage and the amount of drop in the mRC that occurs over time (Rasperini et al., 2018, Pini Prato et al., 2018a, Pini Prato et al., 2018b). Within the present study, we also investigated the behavior of the gingival margin at the adjacent treated sites that were also included in the same flap design (eCAF) however did not receive a graft. In case of multiple adjacent GRs, the central and deeper defect(s) were randomly assigned to receive either an ECTG or a CTG, while the adjacent sites that were also included in the envelope flap did not receive a graft material. To the best of our knowledge, this is the first time that the outcomes of GRs with or without a CTG are investigated in the long-term and at adjacent sites within the same flap. In line with the literature, we observed a greater apical relapse of the gingival margin at sites where a graft was not used (mRC reduction of 34.12%), compared to sites that received a graft material (whether a CTG or an ECTG, with mRC reductions of 16.52% and 19.42%, respectively). A similar drop in the mRC was also described by Pini Prato et al. in the long-term for GRs that received CAF without a graft (Pini Prato et al., 2018b). Nevertheless, in line with the results of other investigations (Pini-Prato et al., 2010, Pini Prato et al., 2018a, Pini Prato et al., 2018b, Rasperini et al., 2018, Francetti et al., 2018), we also observed a lower tendency for GRs reoccurrence in the ECTG and CTG groups. Rasperini et al. reported an estimated coronal shift of 0.009 mm per year for their CAF + CTG group, while the trend for CAF alone was an apical shift of 0.017 mm per year (Rasperini et al., 2018). Similarly, Francetti et al. observed an improvement of the average REC over time following CAF + CTG, from 0.55 ± 0.69 mm at 1 year to 0.44 ± 0.62 at 5 years, while sites treated with CAF alone showed an average residual recession of 1.10 ± 0.99 mm at 1 year which became 1.15 ± 1.06 mm at 5 years (Francetti et al., 2018). The tendency for the stability or coronal migration of the gingival margin observed in some of the treated sites may be due to the maturation of the CTG that results in a modification of the biotype with greater KTW gain and soft tissue thickening (Rasperini et al., 2018, Chambrone and Pini Prato, 2018). These are key factor for the long-term stability of the gingival margin (Chambrone and Pini Prato, 2018). Additionally, it can be speculated that a thicker soft tissue and increased KTW can better tolerate traumatic toothbrushing in patients not able to correct their brushing technique over time. A significantly higher gain in KTW and GT were observed in our study for grafted sites versus the non-grafted areas, which may explain the greater gingival margin stability for the CTG and ECTG groups. In line with this speculation, it has been suggested that sites with thin gingival biotype are also more prone to develop GRs (Kim and Neiva, 2015, Scheyer et al., 2015, Cortellini and Bissada, 2018, Maroso et al., 2015).

4.3 Predictors for stability of the gingival margin

Several prognostic factors affecting the long-term stability of root coverage procedures have been identified in the literature. According to Pini-Prato et al., KTW < 2 mm at baseline is related to higher incidence of

GRs recurrence (Pini Prato et al., 2018a, Pini Prato et al., 2018b). In addition, the presence of non-carious cervical lesions has also been shown to be a negative prognostic factor in maintaining the stability of the achieved outcomes (Pini Prato et al., 2018a, Rasperini et al., 2018). Patient maintenance and motivation over time also play a decisive role on the stability of the results achieved with the surgery (Pini Prato et al., 2011, McGuire et al., 2014, Zucchelli et al., 2018a), as the resuming of the erratic brushing technique has been shown to highly correlate with GRs recurrence (Moslemi et al., 2011). In line with the literature, our multilevel model analysis exhibited that KTW at baseline and at 6 months were significant predictors affecting the stability of the gingival margin among all of the treated sites.

4.4 Limitations

The relatively low number of patients and sites among the three groups at the 12-year recall examination may pose challenges in detecting strong statistical differences among the treatment groups. In addition, although masked and calibrated, different examiners were used for the original study and the 12-year follow-up. Moreover, despite the established adverse role of non-carious cervical lesions on the stability of results over time, they were not taken into account in the original study protocol. Additionally, studies have highlighted on the impact of tooth location on the outcomes of root coverage procedures (Chambrone and Tatakis, 2015, Zucchelli et al., 2019, Zucchelli et al., 2018b). Most recently, Zucchelli et al. found that tooth location played a key role in determining the amount of achievable root coverage, in that treated maxillary recession defects exhibited a significantly greater mRC and CRC than sites in the mandibular arch (Zucchelli et al., 2019). While they highlighted upon the presence of certain unfavorable anatomical conditions frequently encountered in the mandibular area (i.e. marginal frenulum, shallow vestibule, a high muscle pull and flap tension) as restricting factors that may lessen the root coverage outcomes (particularly compared with their rare incidence in the maxillary region), in the original RCT, 1 maxillary site was assigned to the ECTG treatment group, whereas 7 were randomly allocated to receive the CTG (and 1 mandibular site for the ECTG group, versus 6 in the CTG group at this 12-year recall). Therefore, we note the unequal distribution of maxillary and mandibular sites as a restricting factor which may potentially have affected the results.

5. Conclusions

Within its limitations, the present investigation demonstrated that eCAF with CTG or ECTG showed similar outcomes after 12 years, maintaining the stability of the gingival margin. Adjacent sites that did not receive a graft exhibited a higher trend for an apical shift and a greater drop in the mRC than grafted sites. KTW at baseline and at 6 months seem to be predictors for the stability of the gingival margin.

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of the authors declare any potential conflict of interest with respect to the authorship and/or publication of this article.

Tables and Figures

Table 1. Clinical parameters at baseline, 6 months and 12 years

Table 2. Changes in the clinical parameters between baseline and 6 months, 6 months and 12 years and BL and 12 years

Table 3. Regression analysis investigating variables affecting the mean root coverage outcomes at 12 years

Figure 1. CONSORT flow chart of the study

Figure 2. Multiple gingival recessions treatment of the maxillary lateral incisor, canine and first premolar with eCAF. An ECTG was sutured over the canine. A) Baseline; B) Design of the eCAF; C) connective tissue graft with a 2mm band of epithelium (ECTG) before being trimmed and adapted to the recipient site; D) Flap coronally advanced and sutured. Note that the coronal part of the ECTG (with the epithelium) was left exposed; E) Healing at 2-weeks; F) Healing at 3-months; G) Healing at 6-months; H) 12 years results

Figure 3. Multiple gingival recession treatment of the maxillary canine and first premolar with eCAF. A CTG was sutured over the canine and the first premolar. A) Baseline; B) Design of the eCAF; C-D) CTG harvested from the palate (without a band of epithelium) and sutured over the canine and the first premolar; E) Flap coronally advanced and sutured; F) Healing at 3-months; G) Healing at 6-months; H) 12 years results

Table 1. Clinical parameters at baseline, 6 months and 12 years

Time point	Parameter	CAF + ECTG (mean ± SD) (n = 13)	CAF + CTG (mean ± SD) (n = 16)	CAF (mean ± SD) (n = 14)	*p*-value
Baseline	REC (mm)	2.54 ± 0.69	2.75 ± 0.85	1.93 ± 1.14	0.11
	PD (mm)	1.23 ± 0.56	1.12 ± 0.38	1.14 ± 0.36	0.79
	CAL (mm)	3.78 ± 0.88	3.87 ± 0.91	3.07 ± 1.07	0.09
	KTW (mm)	2.07 ± 0.67	1.18 ± 0.44	1.68 ± 0.72	0.18
	GT (mm)	1.05 ± 0.29	0.9 ± 0.27	1.07 ± 0.37	0.37
6 months	REC (mm)	0.11 ± 0.41	0.25 ± 0.36	0.28 ± 0.42	0.51
	mRC (%)	97.11 ± 10.4	91.02 ± 14.46	89.33 ± 16.95	0.34
	CRC (%)	84.61%	81.25%	71.42%	0.15
	PD (mm)	1.53 ± 0.47	1.4 ± 0.49	1.11 ± 0.4	0.08
	CAL (mm)	1.65 ± 0.62	1.65 ± 0.51	1.39 ± 0.71	0.43
	KTW (mm)	3.84 ± 0.55	2.62 ± 0.78	2.17 ± 0.84	**<0.001**
	GT (mm)	2.07 ± 0.61	1.72 ± 0.29	1.25 ± 0.32	**<0.001**
12 years	REC (mm)	0.57 ± 0.44	0.62 ± 0.46	0.82 ± 0.63	0.43
	mRC (%)	77.69 ± 18.27	74.51 ± 25.1	55.22 ± 32.64	0.02

CRC (%)	61.5%	56.25%	42.85%	0.54
PD (mm)	1.5 ± 0.57	1.43 ± 0.51	1.35 ± 0.49	0.78
CAL (mm)	2.07 ± 0.78	2.06 ± 0.79	2.17 ± 0.79	0.91
KTW (mm)	3.94 ± 0.54	3.87 ± 0.69	2.82 ± 0.66	**<0.001**
GT (mm)	2.11 ± 0.61	1.62 ± 0.67	0.93 ± 0.26	**<0.001**

bold *p* values signify statistical significance; n, number of treated sites

Table 2. Changes in the clinical parameters between baseline and 6 months and 6 months and 12 years following CAF + ECTG, CAF + CTG and CAF

Parameter	Baseline – 6 months			6 months – 12 years		
	CAF	CAF + CTG	CAF + ECTG	CAF	CAF + CTG	CAF + ECTG
mRC reduction (%)	-	-	-	34.12 ± 35.13 [ab]*	16.52 ± 31.8 [a]	19.42 ± 24.11 [b]*
CRC reduction (%)	-	-	-	28.57*	25.01*	23.11*
PD reduction (mm)	0.03 ± 0.57	-0.28 ± 0.51	-0.31 ± 0.72	-0.25 ± 0.64	-0.03 ± 0.64	0.03 ± 0.51
CAL reduction (mm)	1.67 ± 0.74	2.21 ± 1.06	2.11 ± 0.79	-0.78 ± 0.77*	-0.41 ± 0.91	-0.42 ± 0.78
KTW gain (mm)	0.5 ± 1.01 [ab]	1.43 ± 0.81 [a]	1.76 ± 0.69 [b]	0.64 ± 0.79 [ab]*	1.25 ± 0.57 [ac]*	0.1 ± 0.57 [bc]
GT gain (mm)	0.17 ± 0.56 [ab]	0.82 ± 0.41 [a]	1.02 ± 0.63 [b]	-0.32 ± 0.42*	-0.1 ± 0.72	0.03 ± 0.24

Different letters indicate significant intergroup differences

** denotes a significant change when compared to the previous timepoint in the same group*

Table 3. Regression analysis investigating variables affecting the mean root coverage outcomes at 12 years

Variable	Group	Estimate	St. Error	*p* value	95% CI
Recession depth at baseline					
	CAF + CTG	11.28	7.01	0.13	-2.95, 25.07
	CAF + ECTG	-2.41	7.94	0.76	-17.85, 13.02
	CAF	3.48	8.198	0.67	-12.46, 19.44
Recession depth at 6 months					
	CAF + CTG	19.92	18.01	0.28	-21.12, 57.49
	CAF + ECTG	16.11	12.32	0.21	-7.85, 40.07
	CAF	13.11	8.76	0.99	-4.41, 30.63
Gingival thickness at baseline					
	CAF + CTG	-26.72	18.34	0.11	-63.4, 9.96
	CAF + ECTG	-0.71	18.97	0.97	-37.6, 36.18
	CAF	7.42	20.52	0.77	-33.62, 48.46
Gingival thickness at 6 months					
	CAF + CTG	20.30	11.11	0.08	-1.92, 42.52
	CAF + ECTG	17.30	13.61	0.21	-9.92, 44.52
	CAF	5.53	10.32	0.59	-15.11, 26.17
Keratinized tissue width at baseline					
	CAF + CTG	24.39	10.13	**0.02**	4.13, 44.65
	CAF + ECTG	21.80	10.15	**0.03**	1.5, 42.1
	CAF	19.87	9.35	**0.03**	1.17, 38.57
Keratinized tissue width at 6 months					
	CAF + CTG	20.15	9.82	**0.03**	0.51, 39.79
	CAF + ECTG	14.71	7.22	**0.02**	0.27, 29.15
	CAF	18.57	8.92	**0.03**	0.73, 36.41

Bold signifies statistical significance

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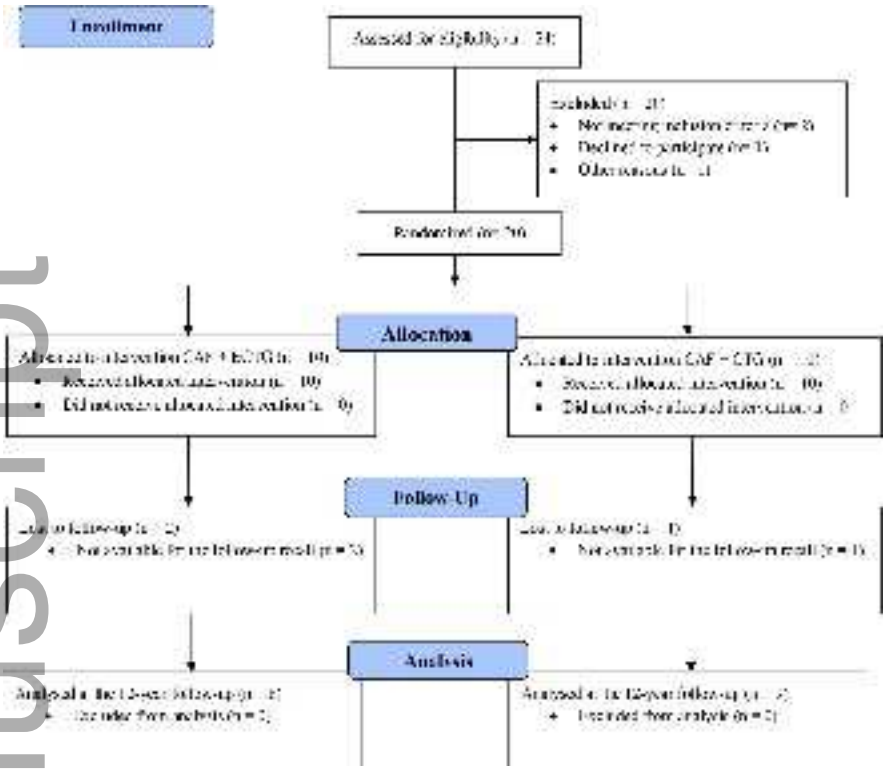

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