# CORONALLY ADVANCED FLAP WITH OR WITHOUT CONNECTIVE TISSUE GRAFT FOR THE TREATMENT OF SINGLE MAXILLARY GINGIVAL RECESSION WITH NON-CARIOUS CERVICAL LESION. A RANDOMIZED CONTROLLED CLINICAL TRIAL

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**Running title:** Root coverage and NCCL

**Clinical Relevance**
*Scientific rationale for the study*
The treatment of single recession with previously restored NCCL is poorly investigated in RCT.

*Principal findings*
Both CAF+CTG and CAF alone were similarly effective to obtain complete root coverage after 12 months. An interaction between gingival thickness at baseline with amount of recession reduction and final RES was reported.

*Practical implications*
Caution is suggested in an excessive use of CTG when treating Rec with baseline KT >0.8 mm, since the CAF alone promotes optimal amount of root coverage and better RES score compared with bilaminar technique.

***Abstract***

***Introduzione:*** *In questo studio è stata valutata l'efficacia clinica del lembo spostato coronalmente (CAF) associato o meno a innesto di tessuto connettivo (CTG) per il trattamento di recessioni single mascellari con abrasioni cervicali non cariose.* ***Materiali e Metodi:*** *Trenta pazienti con recessione mascellare singola e giunzione amelo-cementizia ricostruita sono stati randomizzati in uno dei due gruppi. Un misuratore, in cieco rispetto al trattamento, ha rilevato: copertura radicolare completa (CRC), quantità di riduzione della recessione (RecRed), tessuto cheratinizzato (KT), spessore gengivale (GT), soddisfazione del paziente e il Root coverage Esthetic Score (RES).* ***Risultati:*** *A 12 mesi non ci sono state differenze statisticamente significative per il CRC mentre il gruppo CAF+CTG ha mostrato maggiore guadagno di KT ($p<0.0001$) ed aumento di GT ($p<0.0001$). Il tipo di trattamento e il GT hanno mostrato un'interazione statisticamente significativa. In particolare per GT iniziale ≤ 0.84mm il gruppo CAF+CTG ha mostrato maggiore RecRed mentre per GT >0.84 mm i risultati erano migliori nel gruppo CAF. Inoltre il gruppo CAF ha raggiunto migliore valore di RES quando il GT iniziale era >0.82mm.****Conclusioni:*** *Entrambe le procedure sono efficaci per la copertura di recessioni single con abrasioni dello smalto ricostruite. L'utilizzo dell'innesto di connettivo associato al lembo spostato coronalmente dovrebbe essere limitato al solo caso di fenotipo sottile.*

## Abstract

**Background**: The aim of this study was to assess the clinical efficacy of coronally advanced flap (CAF) with or without connective tissue graft (CTG) for the treatment of single maxillary gingival recession with restored non-carious cervical lesion

**Material and Methods**: Thirty patients with single gingival recessions and previously restored non-carious cervical lesions were randomly allocated to the two groups. A blind examiner evaluated complete root coverage (CRC), recession reduction (RecRed), keratinized tissue (KT) gain, increase in gingival thickness (GT), patient satisfaction and root coverage esthetic score (RES).

**Results**: No significant difference in term of CRC was reported after 12 months. CAF+CTG was associated with greater KT gain ($p<0.0001$) and GT increase ($p<0.0001$) than CAF alone. An interaction between treatment and baseline GT and type of treatment was reported suggesting that when baseline GT was ≤ 0.84 mm adding CTG led to higher RecRed, while for values >0.84 mm the use of CAF alone was associated with better outcomes. Similarly, CAF alone provided better final RES score for baseline GT >0.82mm.

**Conclusion**: Both procedures were similarly effective for root coverage at single recession with previously restored CEJ. Adding a CTG under CAF should be scheduled only when recession with thin periodontal phenotype is treated.

## Introduction

Successful outcome of a root-coverage procedure is a stable gingival margin (GM) coronal to the cemento–enamel junction (CEJ) and soft tissue integration with adjacent tissue (Cairo et al., 2009). Very often root coverage procedures may be complicated by the presence of non-carious cervical lesion (NCCL) involving the CEJ area (Pini-Prato et al., 2010), leading to difficult soft tissue management during surgery or poor clinical and esthetic outcomes after healing (Cairo et al., 2009)

Some clinical proposals to manage NCCL have been suggested, combining possible partial (Cairo and Pini Prato, 2010; Zucchelli et al., 2014) or complete restoration (Santamaria et al., 2009) of the defect area in association with coronally advanced flap (CAF) with or without connective tissue graft (CTG). Furthermore, some clinical features as interdental papilla height (Zucchelli et al., 2006) and CEJ levels at adjacent and/or homologues teeth (Cairo & Pini Prato 2010) have been considered proper references to reconstruct the CEJ area. A recent Randomized Clinical Trial (RCT) showed also that restoration of NCCL in conjunction with root coverage was associated with better esthetic outcomes and dentin

hypersensitivity reduction than surgery alone (Santamaria et al. 2018)
The aim of this RCT is to compare CAF with or without CTG for the treatment of single maxillary gingival recession with previously restored NCCL.

## Material and Methods

### Participants

The present study is a parallel, randomized single-center clinical trial on the treatment of single recession at maxillary arch associated with non-carious cervical lesion (NCCL), according to the CONSORT statement (http://www.consort-statement.org/). Two different treatment modalities were compared: the Coronally Advanced Flap (CAF) plus Connective Tissue Graft (CAF+CTG, test group) and the CAF alone (CAF, control group). The flowchart of the study is presented in figure 1.

The study protocol was approved by the University Ethical Board (Ref. 981/14b). Informed consent was obtained from all the subjects included in the study. The study was conducted according to the principles outlined in the Declaration of Helsinki on experimentation involving human subjects, as revised in 2000.

Participants satisfying the following entry criteria were recruited:

- Age ≥18 years
- No systemic diseases or pregnancy.
- Self-reported smoking ≤ 10 cigarettes/day.
- Full-mouth plaque score (FMPS) and full-mouth bleeding score (FMBS) ≤ 10% (measured at four sites per tooth).
- Presence of single RT1 (Cairo et al. 2011) buccal gingival recessions ≥ 2 mm of depth located in the anterior area of the upper jaw (central and lateral incisors, canine, first and second pre-molars, first molar) and associated with aesthetic complains and or dental sensitivity.
- Presence of NCCL associated with recession
- No history of mucogingival or periodontal surgery at experimental sites.

Exclusion criteria were:

- Prosthetic crown at experimental teeth
- Gingival recessions presenting minimal amount (< 1mm) of apico-coronal keratinized tissue (KT) extension apical to recession area.

All NCCL at experimental teeth were previously treated with a composite filling to reconstruct the CEJ area before surgery. Anatomic landmarks at adjacent or contra-lateral teeth were used to identify the correct CEJ position in cases with abrasion; care was taken to limit the extension of the restorative material within 1mm apical to the ideal CEJ level (Cairo and Pini Prato, 2010). Each patient (experimental unit) contributed with a single recession.

**Interventions/Operator/Investigators**

All surgical procedures were performed by a single expert clinician (F.C.) with more than 15 years of experience in periodontal plastic surgery. A blinded examiner assessed all the clinical and aesthetic outcomes of treatments and attended a preliminary calibration session reporting intra-class correlation coefficient of 0.87 (CI 95% 0.82; 0.91).

*Clinical measurements*

The following measurements were taken at baseline for each treated tooth before restorative procedure using a periodontal probe (PCP UNC 15, Hu-Friedy)

Before restoration of CEJ, the following parameter was collected

- GM-NCCLc: the distance between the gingival margin and the most coronal level of NCCL

After NCCL restoration, the following measurements were also collected

- Rec 0: Recession depth at the mid buccal site measured from restored CEJ level to the gingival margin
- PD 0: Probing depth at the mid buccal site
- CAL 0: Clinical Attachment Level was calculated as Rec 0+PD 0
- IM-CEJr 0: Distance from incisal margin (IM) to the restored CEJ level.
- IM-GM 0: Distance from gingival margin (GM) to incisal margin (IM).
- IM-GMJ 0: Distance from incisal margin to mucogingival junction (MGJ)
- KT 0: Keratinized Tissue measured from the gingival margin to the MGJ at the mid buccal point.
- GT 0: Gingival thickness at baseline was measured 1.5 mm apical to the gingival margin using an injection needle, perpendicular to the tissue surface, and a silicon stop over the gingival surface (Cairo et al., 2016a). The silicon disk stop was placed in tight contact with the soft tissue surface and fixed with a drop of cyanoacrylic adhesive. After needle removal, the distance between needle tip and the silicon stop was estimated using a digital caliper with 0.01mm of accuracy.
- Sens 0: experimental tooth for which the patient reported dental hypersensitivity
- Sens VAS: Dental hypersensitivity tested using the air spray and quantified by the patients on a visual analogic scale (VAS) 0-100.

All variations of the position of the gingival margin were monitored at 3-month, 6-month and 1-year follow-ups.

*Intra-operatory measurements*

The following measurements were taken during the surgical procedure at each experimental tooth.

- CEJr-BC: distance between restored cement enamel junction and bone crest after flap elevation
- IM-GM1: distance between incisal margin and gingival margin after suture

In addition, chair-time of the surgical procedure was measured from the end of local anesthesia until the completion of the sutures.

*Clinical measurements to monitor early healing (day 10 and day 14)*
At suture removal (10 days after surgery) and at the 2-week visit, the following measures were evaluated: Rec, IM-GM, IM-GMJ and KT. In addition, data on possible soft tissue complications (necrosis, edema, bleeding), general discomfort and pain (VAS) were also collected.

*Demographic data and patient questionnaires (Baseline, end of surgery, day 10, day 14, 1 year)*
At baseline, age, gender, smoking habits, number of cigarettes/day and presence root sensitivity (VAS from 0 to 100) were registered. After 10 and 14 days, data on post-operative pain and possible side effects or complications were registered. Patient discomfort was measured by VAS.
At the 1-year follow-up, patient reports on aesthetic satisfaction (VAS) and dental hypersensitivity (VAS) were collected. In case of drop out, the reason related was registered.

*Pre-treatment procedures*
Patients received oral hygiene instructions (roll technique) with a soft-bristled toothbrush to correct wrong habits related to the etiology of the recession at least 2 months before surgery.

*Treatment procedures*
The test group received CAF+CTG (Fig. 2) while the control group was treated with CAF alone (Fig. 3). After local anesthesia, two oblique, divergent releasing incisions extending beyond the mucogingival junction (MGJ) were performed. An intra-sulcular incision was performed at the buccal aspect of the involved tooth. Care was taken to raise split-thickness surgical papillae. A full-thickness flap until the exposure of 2-3 mm of buccal bone crest was then elevated using a small periosteal elevator. Subsequently, a partial-thickness flap was raised beyond the MGJ, eliminating any residual tension to achieve a passive coronal displacement of the flap. The papillae adjacent to the involved tooth were then de-epithelialized. A gentle root debridement was performed using a sharp curette up to 1 mm from the bone crest. The randomization sealed and opaque envelope was opened at this time and the operator was instructed whether or not to apply a CTG under the flap. In the test group only a 1mm-thick CTG was harvested and stabilized with periosteal sutures in the dehiscence area with the coronal border immediately apical to the restored CEJ level. The flap was then coronally displaced 1–2 mm above the CEJ in both test and control groups.

*Post-surgical instructions*
Patients were instructed to avoid mechanical trauma and tooth brushing for 2 weeks and to intermittently apply an ice bag for the first 4-5 hours. Patients received ibuprofen 600 mg at the end of the surgical procedure and were instructed to take another compulsory tablet 6 hours later. Additional doses were suggested in cases of need. Chlorhexidine mouth-risings (0.12%) were recommended twice daily for 1min. Smokers were reminded to quit smoking in the first 2 weeks after surgery. Ten days after surgery, sutures were removed and prophylaxis dental paste was applied using a rubber cup at teeth in the surgical area. Two weeks after surgery, patients were instructed to resume mechanical tooth-cleaning using a soft post-surgical toothbrush. Patients were recalled at 1, 2, 3, 6, 9 and 12 months after surgery for professional oral hygiene procedures and for collection clinical measurements when scheduled. The use of soft toothbrush was maintained until the 3-month follow-up, when a medium-bristle toothbrush was recommended.

*Sample size*
The sample dimension was calculated using $\alpha = 0.05$ and the power $(1-\beta)$ of 80%. For the variability, the value of standard deviation of 0.46 mm for recession reduction obtained in a previous article (Pini Prato et al., 2005) was used considering Rec T0 as covariate. The minimum clinically significant value

considered is 0.5 mm. On the basis of these data, the needed number of patients to be enrolled in this study was 12 for the test group (CAF+CTG) and 12 for the control group (CAF). However, the number of patients was increased of 20% for each arm considering the possibility of dropouts.

*Randomization/Allocation concealment/Masking of examiners*

Each experimental subject was randomly assigned to one of the two treatment regimens (CAF+CTG and CAF). The treatment assignment was noted in a specific form kept by the study registrar (M.N., statistician). Allocation concealment was performed by opaque sealed envelopes, sequentially numbered. The statistician generated the allocation sequence by means of a computer-generated random list and instructed a different subject to assign a sealed envelope containing the treatments. The opaque envelope was opened after flap elevation and treatment assignment communicated to the operator. Blinding of examiner was maintained throughout all experimental procedures.

*Statistical analysis*

Statistical analysis was performed using JMP 13.0 SAS Institute Inc. Descriptive statistics were performed using mean ± standard deviation for quantitative variables and frequency and percentage for qualitative variables. The primary outcomes variables were the presence of CRC and RecRed, Secondary variables included RES values, KT, surgical-time, intake of anti-inflammatory tablets, post-operative discomfort (VAS) and final aesthetic satisfaction (VAS).

Linear models in order to investigate factors influencing some outcomes variables (RecRed, KT gain, esthetic VAS and RES) were performed. The explicative variables were treatment (T), the value at baseline (for RecRed and KT gain), gingival thickness at baseline and the interaction between treatment and baseline thickness. The interaction was maintained in the model only when significant.

For CRC, the Fisher Exact test was performed. All the analyses were defined a priori.

## Results

### Experimental population, patients and defects characteristics at baseline

An original sample of 38 patients showing single gingival recession associated with NCCL at upper arch and satisfying the entry criteria were identified; 8 of 38 declined to follow the experimental procedures. A total of 30 patients were enrolled: 14 patients were treated in the test group (CAF+CTG) and 16 in the control group (CAF).

In the CAF+CTG group, 10 out of 14 were females (71%), and the mean age was 37.7 ±9.4 years [Minimum: 27; Maximum: 63]; 4 patients were smokers. Six treated teeth were canines (43%), 7 premolars (50%) and 1 first molar (7%). The baseline buccal recession (Rec 0) was 3.4±0.6 mm [2; 4].

In the CAF group, twelve out of 16 were females (75%), and the mean age was 40.5±10.3 years [Minimum: 26; Maximum: 53]. Two patients were smokers. One treated tooth was incisor (6%), 7 canines (44%) and 8 premolars (50%). The baseline buccal recession (Rec 0) was 3.2±0.5mm [2; 4].

Details of baseline data are presented in table 1. There was no clinical difference at baseline between the two groups.

### Evaluation of the surgical procedure and post-operative period

The mean duration of the surgical procedure was 55.4 ± 5.3 minutes for the test group and 38.4 ± 3.3 minutes for the control group ($p<0.0001$). After 10 days, patients from the CAF group reported an intake of 2.6±0.9 anti-inflammatory tablets and 4.0 ± 0.8 for the CAF+CTG group (difference 1.4; 95%CI from 0.7 to 2.0; $p=0.0001$). There was no significant difference in term of post-surgical discomfort VAS values between the two groups (29.4 ± 12.2 for CAF+CTG vs 24.5 ±11.1 for CAF, difference 4.9; 95%CI from -3.8 to 13.6; $p=0.2561$). Furthermore, patients allocated in the test group

reported greater number of days with post-surgical discomfort (2.6 ± 0.5 for CAF+CTG vs 1.4 ±0.6 for CAF, difference 1.2 days; 95%CI from 0.8 to 1.6; p<0.0001). At the 2-week evaluation no significant side effect was detected apart from 6 cases of swelling (3 cases for each group).

**Clinical outcomes**

All patients attended all follow-up visits and no significant complication was reported. All NCCL restorations were stable at the last follow-up. At the final visit all patients were satisfied, with 90.9 ±10.7 mean VAS value in the test group 95.4 ± 6.0 and in the control group. The difference was not significant (-4.6; 95% CI from -11.0 to 1.8; P=0.1531).

Details of the clinical outcomes at 3, 6 and 12 months are presented in table 1. At the final follow-up, 10 out of 14 sites (71%) in the test group and 8 out of 16 in the control group (50%) showed CRC with no significant difference between treatments (RR= 1.43 [ from 0.79 to 2.58]; p=0.2839). Furthermore, the additional use of CTG yielded to greater final GT (difference between treatments 0.52 mm [95%CI from 0.41 to 0.63] p<0.0001) than CAF alone.

Linear models to investigate factors influencing the outcomes variables (RecRed, KT gain RES nd esthetic VAS) were also performed. For the outcome variable RecRed (table 2), an interaction between the treatment and baseline gingival thickness was reported (p=0.0014), suggesting that for values of GT ≤ 0.84 mm add of CTG was associated with higher final RecRed, while for values >0.84 mm the use of CAF alone was associated with better outcomes. A similar model was also performed for KTgain For this outcome variable the interaction term was not significant. The treatment modality (CAF+CTG) was associated with higher benefit in term of KT gain (difference between treatments 1.4 mm [95%CI from 1.0 to 1.8] p<0.0001). Considering final RES score, linear model demonstrated an interaction between the treatment and GT0: for GT value ≤ 0.82 mm add of CTG was associated with higher RES scores, while for values >0.82 mm the use of CAF alone was associated with better aesthetic outcomes rated by the blind examiner (table 3). Considering the Esthetic VAS linear model demonstrated an interaction between the treatment and GT0: for GT value ≤ 0.76 mm add of CTG was associated with higher esthetic VAS scores, while for values >0.82 mm the use of CAF alone was associated with better aesthetic outcomes.

**Discussion**

Partial or total CEJ destruction and associated enamel/root discrepancy may lead to surgical difficulties in proper flap/graft management with possible unsuccessful clinical and aesthetic outcomes of root coverage procedures (Cairo, 2017). An epidemiological study on 1,010 gingival recessions retrieved from 353 patients showed that 39% of gingival recession were associated with dental surface defects at CEJ level (Pini-Prato et al., 2010). Combined restorative and muco-gingival procedures have been suggested as a proper treatment modality for Rec associated with NCCL, leading to high patient satisfaction and optimal esthetic outcomes (Cairo and Pini-Prato, 2010; Zucchelli et al., 2011; Tonetti et al., 2014).

The present RCT was aimed to compare the use of CAF with or without CTG for the treatment of single Rec at the upper jaw with previously restored CEJ level. After 12 months, both procedures were similarly effective to obtain complete root coverage with no significant difference between test and control groups. Linear models to investigate factors influencing final amount of RedRed demonstrated an interesting interaction between baseline GT and type of treatment, suggesting that for Rec with GT ≤ 0.84 mm the use of CTG under CAF yielded to higher RecRed, while for GT>0.84 the flap alone was

associated with better outcomes. Even if a large body of evidence suggests that the bilaminar procedure should be considered the gold standard for root coverage (Cairo et al., 2008; Cortellini et al., 2009; Cairo et al., 2014), the present finding seems to indicate the use CTG only at REC with thin periodontal phenotype (Jepsen et al., 2018; Cortellini and Bissada, 2018). In addition, outcomes of the present study support the conclusions of previous clinical trials about the importance of baseline GT when performing CAF at both single (Baldi et al., 1999; Hwang and Wang, 2006) and multiple recession defects (Cairo et al., 2016b).

In this study, a significant interaction between the type of treatment and final aesthetic outcomes in term of RES score was also detected, showing that for baseline GT value ≤ 0.82 mm CAF+CTG provided higher RES scores, while for values >0.82 mm the use of CAF alone was associated with better aesthetic outcomes. This finding seems to suggest caution in promotin an excessive thickening of well-represented baseline KT, since impairments of soft tissue texture, unpleasant changes in color and alteration in gingival margin/muco-gingival junction positions may occur, hindering the original soft tissue characteristics and the final aesthetic evaluation (Cairo et al., 2016b). On the other hand, when gingival recessions are associated with very thin KT the addition of a CTG improves both clinical and aesthetic outcomes compared with CAF alone.

The present investigation showed that the addition of a CTG under CAF was associated with a significant increase in both apico-coronal KT (mean difference 1.4 mm, $p<0.0001$) and 1-year GT (mean difference 0.52 mm, $p<0.0001$) also at gingival recessions with restored CEJ. This observation supports the hypothesis that adding soft tissue graft is a predictable method to change the gingival phenotype (Cortellini and Bissada, 2018) supporting a more predictable stability of the gingival margin in the long term (Pini-Prato et al., 2010; Cairo et al., 2015). The present study also confirmed that CAF alone does not seem to be able in promoting significant KT changes compared with baseline conditions.

A significant heterogeneity exists in literature regarding the possible restorative management of NCCL in conjunction with root coverage procedures, including the elimination of the enamel defect by planning the residual CEJ (Holbrook T and Ochsenbein, 1983) and the use of resin-modified glass-ionomer restoration to completely restore the root defect under the graft/flap (Santamaria et al., 2009). In the present trial, a well-defined procedure to restore the CEJ and the coronal portion of the clinical crown of the tooth with resin-composite material was applied, assessing reference points at adjacent and/or homologues teeth and limiting the apical extension of the restoration ~0.5-1mm below the level of ideal CEJ. Any root abrasion apical to this level was left unrestored. At the 1-year follow-up, all restorations were retained and well preserved; the associated gingival tissues presented with minimal probing depths and no BoP, thus showing that a composite reconstruction of NCCL limited to an area around the ideal allocation of the CEJ is compatible with periodontal health (Cairo & Pini-Prato, 2010).

This study confirmed that use of CTG was associated with longer surgical time (~ 17 minutes, $p<0.0001$) and higher morbidity with greater anti-inflammatory tablets consumption ($p=0.0001$) and greater number of days with post-surgical discomfort (~1.2 day, $p=0.0001$) than CAF alone (Cortellini et al., 2009; Cairo et al., 2012). Conversely, there was no significant difference in term of VAS values for post-surgical discomfort between groups at the time of suture removal (day 10). This finding seems to differ to that described in RCTs evaluating the treatment of multiple recessions defects (Cairo et al., 2016a; Tonetti et al., 2018): a possible reason could be related with graft dimension that may be significant higher when harvesting for multiple defects. Finally, this study confirmed that periodontal plastic surgery is well-accepted by patients as they reported to be very satisfied by procedures with no significant different between test and control groups.

Within the limit of this study, the following conclusions can be drawn:

- Both procedures were associated with similar probability to obtain CRC at single Rec with

restored NCCL

- Higher post-operative morbidity was reported for CAF+CTG group
- CAF + CTG overall is more effective than CAF alone in recessions with thin periodontal phenotype (<0.8 mm) and use of CTG might be selectively limited to these cases
- The use of CAF alone provided better aesthetic outcomes rated by RES score in recessions with well represented KT (>0.8 mm), thus suggesting caution in an excessive thickening of baseline KT.

## References


- BALDI, C., PINI-PRATO, G., PAGLIARO, U., NIERI, M., SALETTA, D., MUZZI, L. & CORTELLINI, P. 1999. Coronally advanced flap procedure for root coverage. Is flap thickness a relevant predictor to achieve root coverage? A 19-case series. *J Periodontol* **70**, 1077–1084.
- CAIRO, F., ROTUNDO, R., MILLER, P. D. & PINI PRATO, G. P. 2009. Root coverage esthetic score: a system to evaluate the esthetic outcome of the treatment of gingival recession through evaluation of clinical cases. *J Periodontol,* 80**,** 705-10.
- CAIRO, F., PINI-PRATO, G.P. 2010. A technique to identify and reconstruct the cement-enamel junction level using combined periodontal and restorative treatment of gingival recession. A prospective clinical study. *Int J Periodontics Restorative Dent*, **30**: 573–581.
- CAIRO, F., NIERI, M., CINCINELLI, S., MERVELT, J. & PAGLIARO, U. 2011. The interproximal clinical attachment level to classify gingival recessions and predict root coverage outcomes: an explorative and reliability study. *J Clin Periodontol,* 38**,** 661-6.
- CAIRO, F., CORTELLINI, P., TONETTI, M., NIERI, M., MERVELT, J., CINCINELLI, S. & PINI-PRATO, G. 2012. Coronally advanced flap with and with- out connective tissue graft for the treatment of single maxillary gingival recession with loss of inter-dental attachment. A randomized con- trolled clinical trial. *J Clin Periodontol* **39**, 760–768.
- CAIRO, F., NIERI, M. & PAGLIARO, U. 2014. Efficacy of periodontal plastic surgery procedures in the treatment of localized facial gingival recessions. A systematic review. *J Clin Periodontol,* 41 Suppl 15**,** S44-62.
- CAIRO, F., CORTELLINI, P., TONETTI, M., NIERI, M., MERVELT, J., PAGAVINO, G. & PINI-PRATO, G. (2015) Stability of root coverage outcomes at single maxillary gingival recession with loss of interdental attachment: 3-year extension results from a randomized, controlled, clinical trial. *J Clin Periodontol* **42**, 575–581.
- CAIRO, F., CORTELLINI, P., PILLONI, A., NIERI, M., CINCINELLI, S., AMUNNI, F., PAGAVINO, G. & TONETTI, M. S. 2016a Clinical efficacy of coronally advanced flap with or without connective tissue graft for the treatment of multiple adjacent gingival recessions in the aesthetic area: a randomized controlled clinical trial. *J Clin Periodontol,* 43**,** 849- 56.
- CAIRO, F., PAGLIARO, U., BUTI, J., BACCINI, M., GRAZIANI, F., TONELLI, P., PAGAVINO, G. & TONETTI, M. S. 2016b. Root coverage procedures improve patient aesthetics. A systematic review and Bayesian network meta-analysis. *J Clin Periodontol,* 43**,** 965- 975.
- CAIRO F. 2017. Periodontal plastic surgery of gingival recessions at single and multiple teeth.
- Periodontol 2000. 75(1):296-316.
- CORTELLINI, P., TONETTI, M., BALDI, C., FRANCETTI, L., RASPERINI, G., ROTUNDO, R., NIERI, M., FRANCESCHI, D., LABRIOLA, A. & PINI-PRATO, G. P. 2009. Does placement of a connective tissue graft improve the outcomes of coronally advanced flap for coverage of single gingival recessions in upper anterior teeth? A multi-centre, randomized, double-blind, clinical trial. *J Clin Periodontol* **36**, 68–79.
- CORTELLINI, P. & BISSADA, N. F. 2018. Muco-gingival conditions in the natural dentition: Narrative review, case definitions, and diagnostic considerations. *J Periodontol,* 89 Suppl 1**,** S204-S213.
- HOLBROOK, T., OCHSENBEIN, C. 1983. Complete coverage of the denuded root surface with a one-stage gingival graft. *Int J Periodontics Restorative Dent* **3**:8–27.
- HWANG, D. & WANG, H. L. (2006) Flap thickness as a predictor of root coverage: a systematic review. *J Periodontol* 77, 1625– 1634.
- JEPSEN, S., CATON, J.G., ALBANDAR, J.M., BISSADA, N.F., BOUCHARD, P., CORTELLINI, P., DEMIREL, K., DE SANCTIS, M., ERCOLI, C., FAN, J., GEURS, N.C., HUGHES, F.J., JIN, L., KANTARCI, A., LALLA, E., MADIANOS, P.N., MATTHEWS, D., MCGUIRE, M.K., MILLS, M.P., PRESHAW, P.M.,

REYNOLDS, M.A., SCULEAN, A., SUSIN, C., WEST, N.X., YAMAZAKI, K. 2018. Periodontal manifestations of systemic diseases and developmental and acquired conditions: Consensus report of workgroup 3 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Clin Periodontol*, **45** (Suppl 20),S219-S229.

- PINI PRATO, G. P., BALDI, C., NIERI, M., FRANCESCHI, D., CORTELLINI, P., CLAUSER, C., ROTUNDO, R. & MUZZI, L. 2005. Coronally advanced flap: the post-surgical position of the gingival margin is an important factor for achieving complete root coverage. *J Periodontol*, **76**, 713–722.
- PINI-PRATO, G., FRANCESCHI, D., CAIRO, F., NIERI, M. & ROTUNDO, R. 2010. Classification of dental surface defects in areas of gingival recession. *J Periodontol*, **81**(6):885-90.
- PINI-PRATO, G., CAIRO, F., NIERI, M., FRANCESCHI, D., ROTUNDO, R. & CORTELLINI, P. (2010) Coronally advanced flap versus connective tissue graft in the treatment of multiple gingival recessions: a split-mouth study with a 5-year follow-up. *J Clin Periodontol* **37**, 644–650.
- SANTAMARIA, M.P., DA SILVA FEITOSA, D., NOCITI, F.H. JR, CASATI, M.Z., SALLUM, A.W. & SALLUM, E.A. 2009. Cervical restoration and the amount of soft tissue coverage achieved by coronally advanced flap: a 2-year follow-up randomized-controlled clinical trial.
- *J Clin Periodontol*. **36**(5):434-41.
- SANTAMARIA, M.P., SILVEIRA, C.A., MATHIAS, I.F., NEVES, F.L.D.S., DOS SANTOS, L.M., JARDINI, MAN., TATAKIS, D.N., SALLUM, E.A. & BRESCIANI, E. 2018. Treatment of single maxillary gingival recession associated with non-carious cervical lesion: Randomized clinical trial comparing connective tissue graft alone to graft plus partial restoration. *J Clin Periodontol.* Apr 22.
- TONETTI, M. S., JEPSEN, S. & WORKING GROUP 2 OF THE EUROPEAN WORKSHOP ON PERIODONTOLOGY. 2014. Clinical efficacy of periodontal plastic surgery procedures: consensus report of Group 2 of the 10th European Workshop on Periodontology. *J Clin Periodontol* 41(Suppl. 15), S36–S43.
- TONETTI, M. S., CORTELLINI, P., PELLEGRINI, G., NIERI, M., BONACCINI, D., ALLEGRI, M., BOUCHARD, P., CAIRO, F., CONFORTI, G., FOURMOUSIS, I., GRAZIANI, F., GUERRERO, A., HALBEN, J., MALET, J., RASPERINI, G., TOPOLL, H., WACHTEL, H., WALLKAMM, B., ZABALEGUI, I. & ZUHR, O. 2018. Xenogenic collagen matrix or autologous connective tissue graft as adjunct to coronally advanced flaps for coverage of multiple adjacent gingival recession: Randomized trial assessing non-inferiority in root coverage and superiority in oral health-related quality of life. *J Clin Periodontol*, 45**,** 78-88.
- ZUCCHELLI, G., TESTORI, T., DE SANCTIS, M. 2006. Clinical and anatomical factors limiting treatment outcomes of gingival recession: a new method to predetermine the line of root coverage. *J Periodontol* **77**: 714–721.
- ZUCCHELLI, G., GORI, G., MELE, M., STEFANINI, M., MAZZOTTI, C., MARZADORI, M., MONTEBUGNOLI, L. & DE SANCTIS, M. 2011. Non-carious cervical lesions associated with gingival recessions: a decision-making process. *J Periodontol*, **82**: 1713– 1724.

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Table 1: Baseline data and mean clinical outcomes at 6 and 12 months.

| Variable | CAF (baseline) N=16 | CAF+CTG (baseline) N=14 | CAF (6 months) N=16 | CAF+CTG (6months) N=14 | CAF (12 months) N=16 | CAF+CTG (12 months) N=14 | p-value |
|---|---|---|---|---|---|---|---|
| Rec (mm) | 3.2 ± 0.5 | 3.4 ± 0.6 | 0.3 ±0.5 | 0.1 ± 0.3 | 0.5 ± 0.5 | 0.3 ± 0.5 | - |
| RecRed (mm) | - | - | - | - | 2.7 ± 0.6 | 3.1 ± 0.7 | - |
| IM-MGJ (mm) | 15.6 ±1.7 | 15.9 ±1.9 | 13.5 ±0.8 | 14.5 ± 1.0 | 10.3 ± 0.8 | 10.2 ± 1.1 | - |
| CRC (n/%) | - | - | - | - | 8 (50%) | 10 (71%) | 0.2839 |
| PD (mm) | 1.1 ± 0.3 | 1.1 ± 0.3 | 1.1 ± 0.3 | 1.2 ±0.4 | 1.2 ±0.4 | 1.1 ±0.3 | - |
| KT (mm) | 3.1 ± 0.5 | 2.9 ± 1.1 | 3.3 ± 0.5 | 4.6 ± 0.6 | 3.3 ± 0.7 | 4.6 ± 0.5 | - |
| KT Gain (mm) | - | - | | | 0.2 ± 0.7 | 1.7 ± 0.7 | <0.0001* |
| GT (mm) | 0.80 ± 0.09 | 0.78 ± 0.12 | - | - | 0.86 ± 0.16 | 1.38 ± 0.09 | <0.0001* |
| Sens (n /%) | 9 (56%) | 9 (64%) | 1 (6%) | 0 (0%) | 4 (25%) | 2 (14%) | 0.6567 |
| Sens VAS (0-100) | 24.9 ± 28.7 | 29.1 ± 29.6 | 1.4 ±5.5 | 0.0 ±0.0 | 3.6 ±7.3 | 1.9 ± 4.9 | 0.4505 |
| RES (0-10) | - | - | - | - | 7.7 ±1.8 | 8.3 ±1.8 | 0.3652 |

*Legend:*

CAF= Coronally Advanced Flap; CAF+CTG= Coronally Advanced Flap plus Connective Tissue Graft; Rec Red= Recession Reduction; CRC= Complete Root Coverage; IM-MGJ= Distance from muco-gingival junction (MGJ) to incisal margin; PD = probing depth; KT = width of keratinized tissue; KT Gain = Gain in width of keratinized tissue; GT = Gingival Thickness; Sens= Number of patient/tooth with hypersensitivity; Sens VAS= tooth hypersensitivity measured by Visual Analouge Scale; RES= Root coverage Esthetic Score.

Table 2: Linear model to investigate factors influencing RecRed at 12 months

| Term | Estimate | Std. Error | P-value |
|---|---|---|---|
| Intercept | -2.82 | 1.07 | |
| Treatment (CAF+CTG vs CAF) | 4.72 | 1.25 | 0.0009 |
| Rec 0 | 0.83 | 0.14 | <0.0001 |
| GT 0 | 3.61 | 1.25 | 0.0078 |
| Interaction (Treatment x GT 0) | -5.66 | 1.57 | 0.0014 |

*Legend:*
Rec 0= Buccal Recession at the baseline; GT 0= Gingival Thickness Baseline; CTG= Coronally Advanced Flap plus Connective Tissue Graft; CAF= Coronally Advanced Flap; Interaction (Treatment x GT 0)= interaction between treatment and gingival thickness at baseline.

Table 3: Linear model to investigate factors influencing RES score at 12 months.

| Term | Estimate | Std. Error | P-value |
|---|---|---|---|
| Intercept | -3.05 | 3.49 | |
| Treatment (CAF+CTG vs CAF) | 18.21 | 4.37 | 0.0003 |
| GT 0 | 13.50 | 4.37 | 0.0047 |
| Interaction (Treatment x GT 0) | -22.29 | 5.49 | 0.0004 |

*Legend:*
GT 0= Gingival Thickness Baseline; CAF+CTG= Coronally Advanced Flap plus Connective Tissue Graft; Interaction (Rand x GT 0)= interaction between treatment and gingival thickness at baseline.

Figure 1

CONSORT Flow Chart of the study

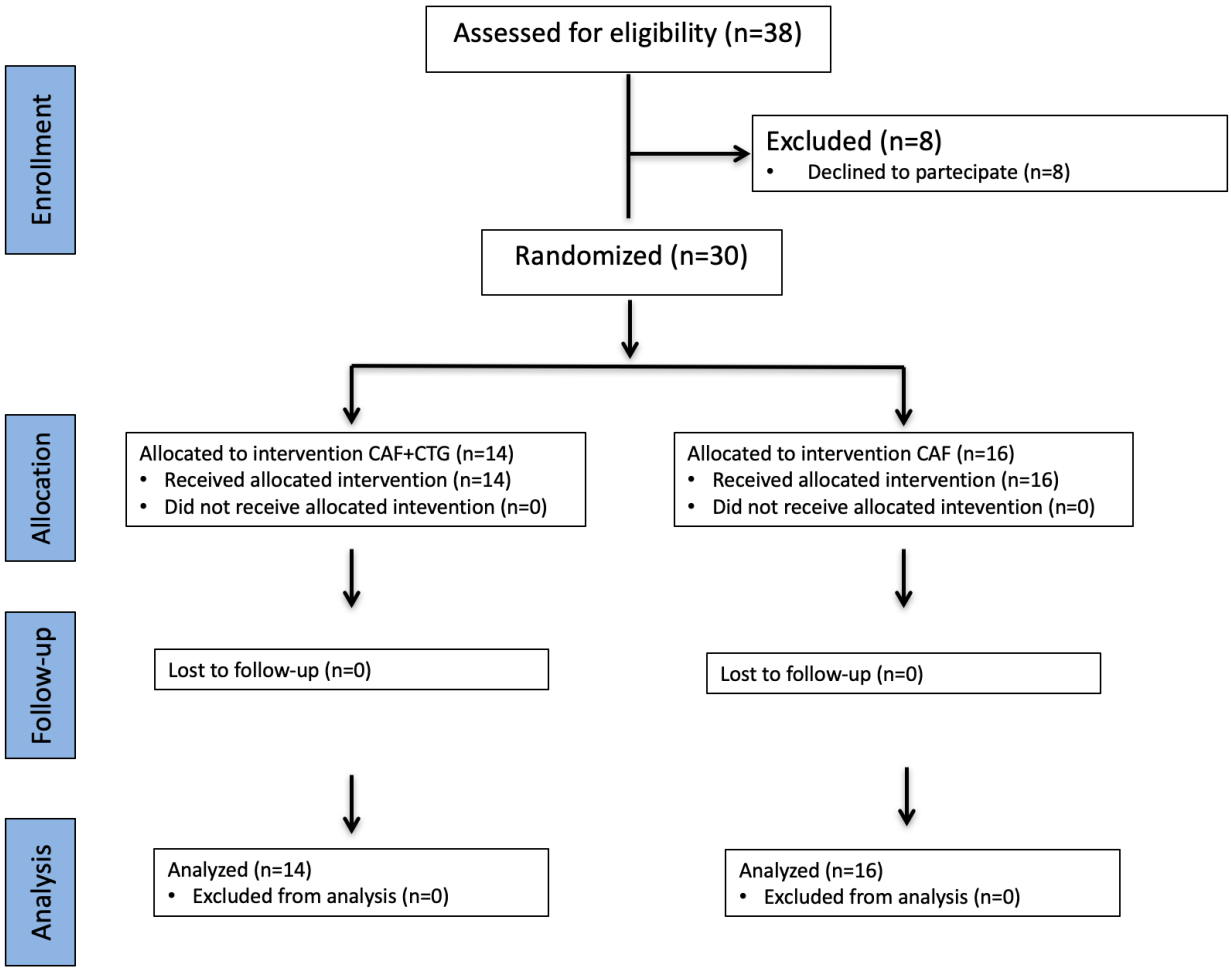

Figure 2

Patient allocated in the test group. (a) Baseline gingival recessions at upper first premolar associated with NCCL. (b) Restored CEJ level before surgery (c) Flap elevation (d) Connective tissue graft (CTG) was secured at the dehiscence area. (e) The flap is sutured. (d) Final healing at the 1-year follow-up with complete root coverage.


Figure 3

Patient allocated in the control group. (a) Baseline gingival recessions at upper first premolar associated with NCCL. (b) Restored CEJ level before surgery (c) The flap is sutured. (d) Final healing at the 1-year follow-up with complete root coverage.

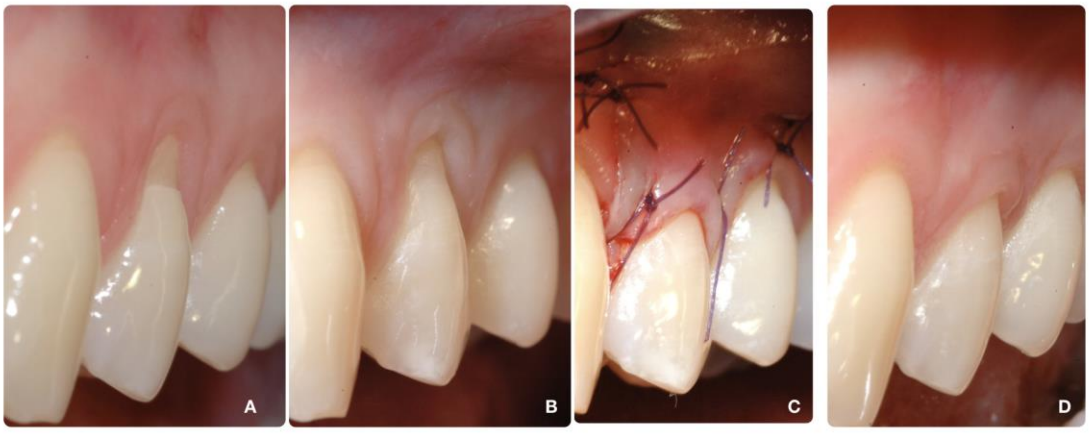

Figure 4

The explorative model considering the interaction between surgical procedures and baseline gingival thickness (GT 0) is shown. The axis of abscissas is the GT 0 value in mm while ordinate axis is the final amount of recession reduction (RecRed) in mm. Considering a baseline Rec 0 = 4 mm, for value of thickness ≤ 0.84 mm adding CTG was associated with higher RecRed, while CTG seems to be not useful for value >0.84 mm since CAF alone was associated with higher RecRed.