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Connective tissue graft plus resin-modified glass ionomer restoration for the treatment of gingival recession associated with non-carious cervical lesion: a randomized-controlled clinical trial

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Abstract

Background: The aim of this clinical study was to evaluate the treatment of gingival recession, associated with non-carious cervical lesions by a connective tissue graft (CTG) alone, or in combination with a resin-modified glass ionomer restoration (CTG+R).

Materials and Methods: Forty patients presenting Miller Class I buccal gingival recessions, associated with non-carious cervical lesions, were selected. The defects were randomly assigned to receive either CTG or CTG+R. Bleeding on probing (BOP), probing depth (PD), relative gingival recession (RGR), clinical attachment level (CAL) and cervical lesion height (CLH) coverage were measured at baseline and 45 days, and 2, 3 and 6 months after treatment.

Results: Both groups showed statistically significant gains in CAL and soft tissue coverage. The differences between groups were not statistically significant in BOP, PD, RGR and CAL, after 6 months. The percentages of CLH covered were 74.88 ± 8.66% for CTG and 70.76 ± 9.81% for CTG+R ($p > 0.05$). The estimated root coverage was 91.91 ± 17.76% for CTG and 88.64 ± 11.9% for CTG+R ($p > 0.05$).

Conclusion: Within the limits of the present study, it can be concluded that both procedures provide comparable soft tissue coverage. The presence of the glass ionomer restoration may not prevent the root coverage achieved by CTG.

Key words: cemento-enamel junction; gingival recession/surgery; glass ionomer cement; surgical flap; tooth abrasion.

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Conflict of interest and source of funding statement

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During the past few decades, the periodontal literature has presented a huge number of clinical trials aimed to evaluate different surgical approaches for root coverage. It has been recognized that buccal gingival recession, presenting no loss of inter-proximal periodontal attachment and bone (Miller Class I and II), can be predictably covered by a variety of surgical procedures (Roccuzzo et al. 2002, Cairo et al. 2008). The main outcomes of these studies were to evaluate the complete root coverage and percentage of root coverage achieved by the procedures. For this, the cemento-enamel junction (CEJ) was used as the reference point.

It has also been recognized that gingival recession is frequently associated with cervical wear. Sangnes & Gjermo

(1976) reported that gingival recession and a wedge-shaped defect in the cervical area were often seen affecting the same tooth. In another report (Zucchelli et al. 2006), no signs of the CEJ were observed in about 50% of the examined teeth showing gingival recession, due to cervical abrasion. The presence of a non-carious cervical lesion, associated with gingival recession, can cause some confusion regarding the identification of the CEJ location, which is often mistaken with the coronal border of the cervical lesion.

With the loss of the CEJ, caused by the progression of the non-carious cervical lesion, it could be inferred that the cervical lesion simultaneously affects parts of the root and crown of the tooth. Therefore, it may be speculated that the most coronal zone of the non-carious cervical lesion is mainly formed by the exposed dentin of the dental anatomic crown. This condition makes the complete coverage of the associated lesion (gingival recession plus non-carious cervical) an unpredictable goal. There is a trend towards leaving the coronal border of the lesion still exposed after the surgical procedures; however, even in the presence of complete root coverage (gingival margin at the level or pre-existing CEJ) the patient can still present dentin sensitivity (DS), associated with the portion of the non-carious cervical lesion that is exposed above the gingival margin (located in the anatomic crown).

Recently, it has been shown that gingival recessions, associated with non-carious cervical lesions, can be successfully treated by glass ionomer restoration (Santamaria et al. 2007, 2008, 2009) or a composite resin (Lucchesi et al. 2007) combined with a coronally advanced flap. After the healing period, part of the restoration was covered by the soft tissue. Good aesthetic outcome and gingival health with no signs of inflammation, such as redness and bleeding on probing (BOP), were observed. Even though soft tissue coverage was obtained in these cases, the coronal zone of the restorations in the group treated by a coronally advanced flap plus restoration, or the coronal zone of the non-restored cervical lesion in the group treated only by a coronally advanced flap, remained uncovered, probably due to the fact that the crown portion of the lesion could not be completely covered. However, there is a lack of information derived from randomized-controlled clinical trials on the ability of other surgical procedures to treat gingival recession, associated with a non-carious cervical lesion. Therefore, the aim of the present study was to compare the outcome of connective tissue graft (CTG) alone or in combination with a resin-modified glass ionomer restoration in the treatment of gingival recessions associated with non-carious cervical lesions.

Materials and Methods

Before the beginning of the study, the consent form and the protocol of the study were approved by the Institutional Review Board of the University of Campinas (CEP-UNICAMP 104/2005). Informed consent was signed by each subject after a thorough explanation of the nature, risks and benefits of the clinical investigation and associated procedures.

Study population

Forty patients, 21 males and 19 females, aged 19–71 years (mean age 36.25 $\pm$ 22.8 years), were included. The subjects were selected from the group of patients referred for periodontal treatment to the Graduate Clinic of the Piracicaba Dental School, University of Campinas, to participate in this study. The patients were selected from March of 2006 to February of 2007, according to the following eligibility criteria:

1. Presence of one Class I Miller gingival recession, associated with a non-carious cervical lesion 1–2 mm deep in maxillary canines or premolars.
2. Non-smokers.
3. Systemically and periodontally healthy.
4. No contraindication for periodontal surgery.
5. No use of medications known to interfere with periodontal tissue health and healing.
6. Probing depth (PD) $<$ 3 mm without BOP.
7. Tooth vitality, absence of restoration on cervical area and absence of severe occlusal interferences in the area to be treated.
8. No previous periodontal surgery in the area.

The patients were referred for periodontal treatment based on their complaints (DS and/or aesthetic concerns). Because a non-carious cervical lesion may be the consequence of a multifactorial process, including tooth structure loss caused by non-bacterial acids (erosion), traumatic toothbrushing (abrasion) and occlusal loading (abfraction) (Litonjua et al. 2003, Bartlett & Shah 2006), all patients were included in a pre-treatment programme in order to eliminate the possible aetiologic factors related to a non-carious cervical lesion and gingival recession. Oral hygiene instructions with a non-traumatic brushing technique and a soft toothbrush were given. Patients were also encouraged to avoid excessive consumption of acidic beverages or acidic foods. When necessary, selective grinding was performed to remove occlusal interferences on the teeth included in the study. Scaling, root planing and crown polishing were performed as necessary.

Clinical assessments

After this initial therapy, the following parameters were recorded: (1) full-mouth visible plaque index (FMPI) (Ainamo & Bay 1975) and presence or absence of visible plaque accumulation at the site included in the study [plaque index (PI)]; (2) full-mouth sulcus bleeding index (FMBI) (Mühlemann & Son, 1971) and presence or absence of BOP at the site included in the study (BOP); (3) PD, assessed as the distance from the gingival margin to the apical end of the gingival sulcus; (4) relative gingival recession (RGR), measured as the distance from the gingival margin to the incisal border of the tooth; (5) relative clinical attachment level (CAL) as PD+RGR; (6) non-carious cervical lesion height (CLH), measured as the distance between the coronal and the apical margins of the non-carious cervical lesion; (7) height of the non-carious cervical lesion located on the root surface (CLH-R): the CEJ was estimated by the method described by Zucchelli et al. (2006) using digital photographs obtained with a camera positioned perpendicular to the buccal surface of the experimental teeth at a magnification ratio of 1:1. The distance from the estimated CEJ to the incisal border of the tooth and RGR were measured using an image analysis software. CLH-R was calculated by subtracting the distance from the estimated CEJ to the incisal border from RGR. This parameter allowed the calculation of the percentage of root coverage. The subtraction of the non-carious CLH on the root from

the total CLH provided the amount of cervical lesion located on the crown (CLH-C); (8) keratinized tissue width (KTW), measured as the distance from the gingival margin to the mucogingival junction; (9) keratinized tissue thickness (KTT); (10) DS, which was determined by asking patients about the presence or absence of cervical sensitivity in the sites included in the study before and after treatment. No thermal stimulus was applied to assess this parameter and the patients simply answered whether they felt any discomfort in the area.

The PD was measured using a manual periodontal probe. The RGR, non-CLH, and KTW were measured using a pair of dividers and a digital caliper with a 0.01 mm precision. The KTT was measured using a pierced endodontic spreader, perpendicular to a mid-point location between the gingival margin and the mucogingival junction and through the soft tissue with light pressure until a hard surface was felt. The silicone stop was then placed in tight contact with the external soft tissue surface. After carefully removing the spreader, penetration depth was measured with a digital caliper. The PD, RGR, CAL, visible plaque at the site (VPS) included in the study and BOP were measured at baseline and 45 days, and 2, 3 and 6 months after surgery. The KTW and KTT were obtained at baseline and at 6 months post-operatively.

Before the beginning of the study, the examiner (M. P. S.) measured the PD and RGR of all patients, two times, within 24 h, with at least 1 h between the examinations. The examiner was judged to be reproducible after fulfilling the pre-determined success criteria. The κ index was calculated to PD, resulting in 91% reproducibility, and the intraclass correlation was calculated relative to gingival recession, resulting in 89% agreement. The masking of the examiner was not practical, because it was possible to observe whether the glass ionomer restoration was applied at the site. Thus, it was impossible to hide, which treatment each site received.

Surgical procedures

All the surgical procedures were carried out by one operator (E. A. S.). The sites were randomly assigned by flipping a coin (F. F. S.) to the control group or the test group immediately before surgery. The control group received CTG group and the test group was subjected to CTG plus a resin-modified glass ionomer restoration (CTG+R group).

Briefly, after local anaesthesia (lidocaine with 1:100,000 epinephrine DFL, Rio de Janeiro, RJ, Brazil), an intrasulcular incision was made at the buccal aspect of the involved tooth. Two horizontal incisions were made at right angles to the adjacent inter-dental papillae, 1 mm apical to the level of the coronal border of the non-carious cervical lesion, without interfering with the gingival margin of neighbouring teeth. Two oblique vertical incisions were extended beyond the mucogingival junction and a trapezoidal mucoperiosteal flap was raised up to the mucogingival junction. After this point, a split-thickness flap was extended apically, releasing the tension and favouring coronal positioning of the flap. In the CTG group, the root and non-carious cervical lesion were planed with a finishing bur (KG Sorensen, 9803FF, SP, Brazil) and curettes until the tooth surface became smooth. In the CTG+R sites, a sterile rubber dam was placed to isolate the operative field and the non-carious cervical lesion restoration was performed with resin-modified glass ionomer cement (Vitremer, 3M ESPE, Saint Paul, MN, USA), following the manufacturer's instructions. The restoration was performed in order to reestablish the entire defect caused by the cervical wear. The entire length of the non-carious cervical lesion was restored and the original contour of the tooth was restored. Afterwards, the epithelium on the adjacent papillae was stripped away and the CTG harvested from the palate using a scalpel with parallel blades (1.5 mm distant from each other) was placed in such a way as to cover the entire non-carious lesion (CTG control group) or the restoration (CTG+R test group). Then the flap was coronally positioned and sutured (6.0 Polygalactin 910, Ethicon Inc., São José dos Campos, Brazil) to completely cover the graft.

Post-operative care

Patients were instructed to take analgesics (500 mg sodium dipyrone every 6 h for 2 days) and were instructed to discontinue toothbrushing around the surgical sites during the initial 30 days after surgery. During this period, plaque control was achieved with a 0.12% chlorhexidine solution rinse used twice a day. After this period, gentle toothbrushing with soft-bristle toothbrush was allowed.

Sutures were removed after 7 days and the patients were enrolled in a periodontal maintenance programme (professional plaque control and oral hygiene instruction) weekly during the first month and monthly during the 6 months.

Statistical analysis

Descriptive statistics were expressed as mean $\pm$ standard deviation (SD). The PD, RGR and relative CAL were examined by the Friedman's test to evaluate differences within groups, followed by a post hoc non-parametric test for multiple comparisons and by the Mann–Whitney test to evaluate differences between groups. The CLH (CLH), height of the non-carious cervical lesion located on the root (CLH-R) and on the crown (CLH-C) surfaces were examined by the Mann–Whitney test to evaluate differences between groups. The DS, the visible plaque at the site included in the study (VPS) and the BOP at the site included in the study (BOP) were examined by the χ^2-square test. The KTW and the KTT were examined by the Mann–Whitney test to evaluate differences within and between groups. A significance level of 0.05 was adopted for all statistical comparisons.

Power calculation

The study power was calculated using the SAS 9.01 software (Release 9.1, 2003, SAS Institute Inc., Cary, NC, USA). This analysis indicated that with 16 subjects in each group, the study would have $>80\%$ power to detect a 1 mm difference (1.0 mm between CTG and CTG+R groups was considered as clinically significant) in RGR and CAL between the two groups. After the completion of the study, considering the SD of each group of the present study, the power values were confirmed to be $>80\%$ to detect a 1 mm difference in RGR and CAL between the two groups. A difference of 1.0 mm between CTG and CTG+R groups was considered as clinically significant.

Results

Healing was uneventful for all patients and none were excluded from the study (40 patients one defect in each patient –

total of 40 defects treated). Full-mouth PI and FMBOP were maintained below 20%, indicating a good standard of supragingival plaque control during the study period. The sites included in the study did not show BOP or visible plaque during the entire study period. A flow diagram of the participants in the study is depicted (Fig. 1). Table 1 shows the patients' characteristics at baseline. No adverse event was observed in any patient during the study.

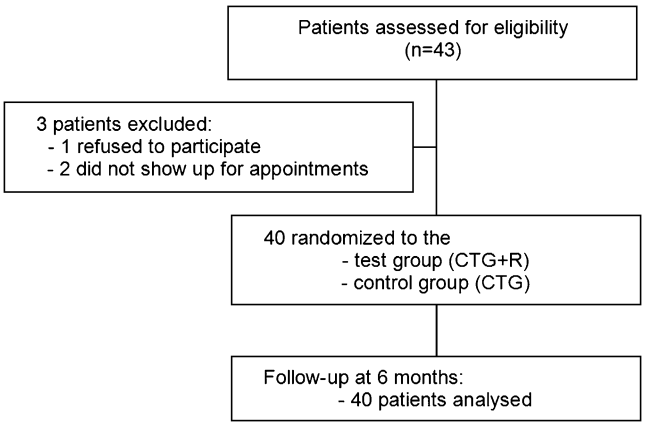

Fig. 1. Flowchart for the study patients. CTG, connective tissue graft group; CTG+R, connective tissue graft plus restoration group.

Table 1. Patient characteristics at the baseline ($N = 40$)

	CTG	CTG+R
Age	23–55 (mean age 31.8 ± 12.2 years)	19–71 (mean age 39.4 ± 20.4 years)
Gender	10 males and 10 females	11 males and nine females
	Canines: 8 (40%)	Canines: 10 (50%)
Teeth	1PM: 9 (45%)	1PM: 6 (30%)
	2PM: 3 (15%)	2PM: 4 (20%)
FMPI	19.4%	18.5
FMBI	18%	14%

FMPI, full-mouth visible plaque index; FMBI, full-mouth sulcus bleeding index; CTG, connective tissue graft; CTG+R, connective tissue graft plus restoration.

Table 2. Mean values and standard deviation for CTG and CTG+R

	CTG	CTG+R	*p*-value
CLH	3.22 ± 0.52 mm	3.27 ± 0.68 mm	0.81
CLH-R	2.45 ± 0.53 mm	2.36 ± 0.71 mm	0.43
	(74.88 ± 8.66%)	(70.76 ± 9.81%)	
CLH-C	0.77 ± 0.26 mm	0.91 ± 0.23 mm	0.67
CLH coverage	77.59 ± 20.15%	70.0 ± 13.85%	0.2
Root coverage	91.91 ± 17.76%	88.64 ± 11.9%	0.74

CLH, non-carious cervical lesion height; CLH-R, non-carious cervical lesion height located on the root; CLH-C, non-carious cervical lesion height located on the crown; CTG, connective tissue graft; CTG+R, connective tissue graft plus restoration.
p-values were calculated by the Mann–Whitney test to evaluate differences between groups.

Cervical lesion

The mean CLH was 3.22 ± 0.52 mm for the CTG group and 3.27 ± 0.68 mm for the CTG+R group ($p > 0.05$). Using the method described by Zucchelli et al. (2006), it was possible to estimate the place where the lost CEJ was located. Consequently, it was possible to identify the total amount of root (CLH-R) and crown (CLH-C) affected by the non-carious cervical lesion. CLH-R was 2.45 ± 0.53 for the CTG group and 2.36 ± 0.71 for the CTG+R group, representing 74.88 ± 8.66% and 70.76 ± 9.81% of the total CLH, respectively. CLH-C was 0.77 ± 0.26 mm for the CTG group and 0.91 ± 0.23 mm for the CTG+R group. The differences observed between groups were not statistically significant for these parameters ($p > 0.05$).

Gingival recession

The two groups presented statistically significant reductions in the RGR; 2.53 ± 0.78 mm for the CTG group and 2.31 ± 0.74 mm for the CTG+R group ($p < 0.05$). These reductions in the RGR represent 77.59 ± 20.15% of the CLH covered by CTG and 70.0 ± 13.85% by CTG+R. This difference between groups was not statistically significant ($p > 0.05$) for this parameter. Three sites in the CTG group and four sites in the CTG+R group had achieved complete CLH coverage after 6 months of observation.

The percentage of root coverage at the end of the study period was calculated. The CTG group showed a mean root coverage of 91.91 ± 17.76% and the CTG+R group showed a mean root coverage of 88.64 ± 11.9%. The difference between groups was not statistically significant ($p > 0.05$). Table 2 shows the characteristics of the cervical lesion in each group and the total amount of coverage achieved and Figs. 2–10 show the pre-operative view and the 6-month post-operative outcome.

PD and CAL

The two groups presented statistically significant increases in the PD from the baseline until the 6-month follow-up. In the CTG group, this parameter changed from 1.15 ± 0.48 to 2.1 ± 0.55 mm ($p < 0.05$), and from 1.1 ± 0.44 to 2.15 ± 0.67 mm ($p < 0.05$) in the CTG+R group. The difference between groups was not statistically significant ($p > 0.05$).

After 6 months, both groups showed statistically significant changes from baseline for CAL: 1.58 ± 0.74 mm for the CTG group ($p < 0.05$) and 1.26 ± 0.9 mm for the CTG+R group ($p < 0.05$). The difference between groups was not statistically significant ($p > 0.05$) (Table 3).

Keratinized tissue

The two groups produced statistically significant changes in the (KTT and the KTW. The keratinized thickness gain was 1.03 ± 0.43 mm for the CTG group and 1.1 ± 0.32 mm for the CTG+R group, while the keratinized width gain was 0.67 ± 33 and 0.8 ± 0.4 mm, respectively. There was no statistically significant difference between groups either in KTT or in KTW. Table 4 shows

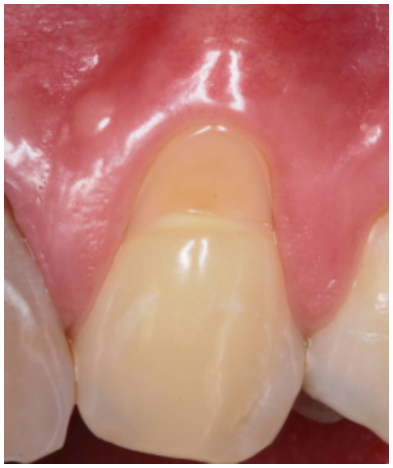

Fig. 2. Pre-operative view of the connective tissue graft plus restoration group site.

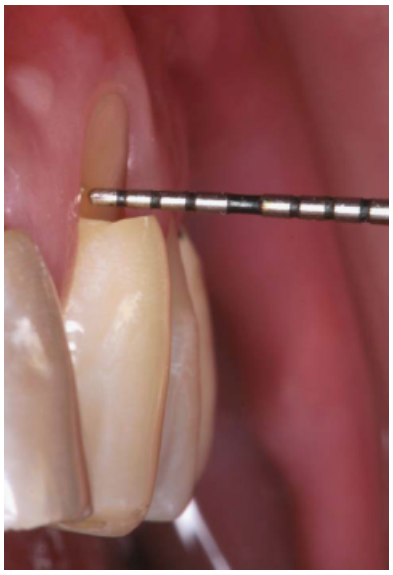

Fig. 3. Probing showing the depth of the non-carious cervical lesion.

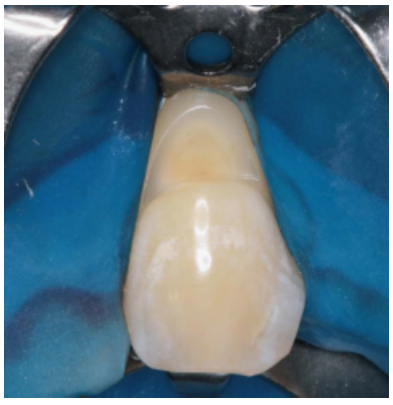

Fig. 4. Isolation of the operative field after the flap was raised. Note that the entire length of the non-carious cervical lesion was included.

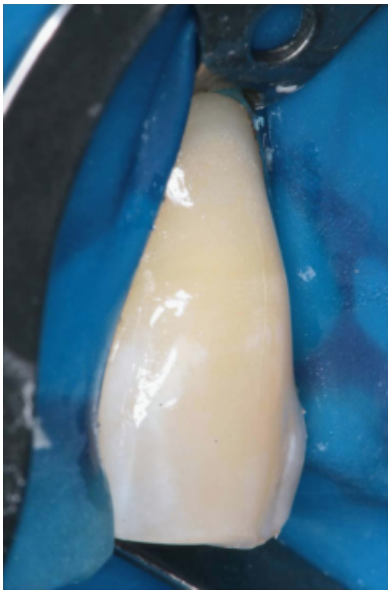

Fig. 5. Lateral view of the same tooth of Fig. 4, now restored. Note that the entire non-carious cervical lesion was restored.

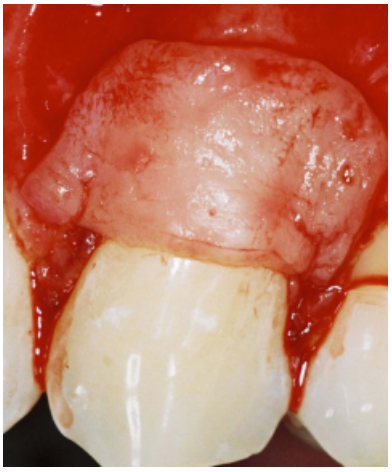

Fig. 6. Connective tissue graft positioned. The connective tissue graft was positioned in order to cover the entire restoration in the connective tissue graft plus restoration group and the entire non-restored cervical lesion in the connective tissue graft group.

the mean and SD of PD, CAL, RGR, KTT and KTW of the test and control groups.

Bleeding on probing

FMBI remained low during the entire study period. FMBI was 18% for CTG and 14% for CTG+R at baseline and 16.7% and 16% at the 6-month evaluation, respectively ($p > 0.05$). Additionally, low levels of FMPI were observed during the entire study period: mean of 19.4% for CTG and 18.5% for CTG+R. No BOP was observed at any site included in the study in any evaluated period.

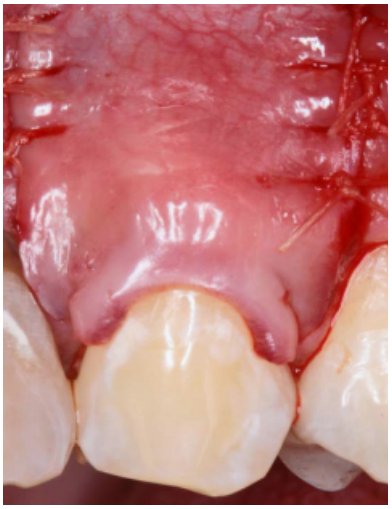

Fig. 7. Final suture showing that the connective tissue graft was completely covered.

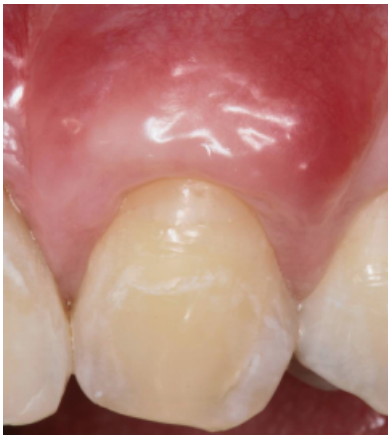

Fig. 8. Clinical outcome after 6 months of the connective tissue graft plus restoration group site.

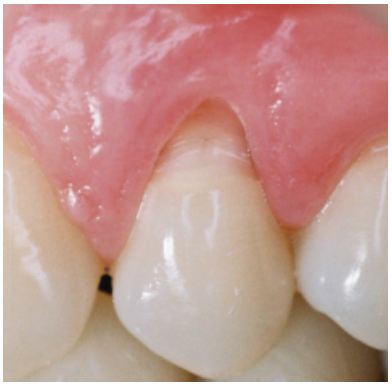

Fig. 9. Pre-operative view of the connective tissue graft site (CTG group).

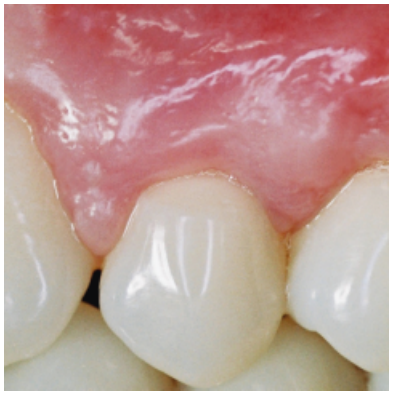

Fig. 10. Clinical outcome after 6 months of the connective tissue graft site.

DS

In the study sample, 60% of the subjects (12 patients) from the CTG group and 70% of the subjects (14 patients) from the CTG+R group reported DS at baseline. After 6 months, the CTG group presented 35% (seven patients) of sites exhibiting this symptom and the CTG+R group showed 5% (one patient). The reduction in the percentage of sites with DS was statistically significant for both groups ($p < 0.05$), and a statistically significant difference for this parameter was observed between groups ($p < 0.05$). Figure 11 shows the reduction in DS.

Discussion

Because gingival recession is frequently associated with cervical wear, some previous clinical trials have evaluated the ability of the coronally advanced flap to cover this combined lesion (Santamaria et al. 2008). The comparison between restored and non-restored sites has been performed previously (Santamaria et al. 2008, Lucchesi et al. 2007). However, there is a need for clinical trials evaluating different approaches to deal with this common condition. In the present study, the CTG was used to treat gingival recession, associated with a non-carious cervical lesion alone or combined with a glass ionomer restoration of the cervical wear. Therefore, the present study evaluated the ability of the CTG to cover the combined defect (CTG group) and determined whether the glass ionomer restoration interferes with the amount of coverage achieved by the CTG (CTG+R group).

The observed changes in the RGR after 6 months were 2.53 ± 0.78 and 2.31 ± 0.74 mm for CTG and CTG+R, respectively ($p > 0.05$). These changes in the position of the gingival margin to a more coronal level provided a comparable percentage of CLH coverage ($77.59 \pm 20.15\%$ in the CTG group and $70.0 \pm 13.85\%$ in the CTG+R group, $p > 0.05$) and gain of CAL ($1.57 \pm 0.74\%$ in the CTG group and $1.26 \pm 0.9\%$ in the CTG+R group, $p > 0.05$) after the two treatment approaches. Therefore, it can be assumed that the presence of the restoration on the cervical area may not prevent the amount of soft tissue coverage that can be achieved by a CTG flap in this situation, considering the period of observation of 6 months.

The values of CLH coverage reported in the present study are related to the total height of the cervical lesion (crown and root zones). Therefore, the CLH coverage reported in the present study should not be directly compared with other studies that included gingival recession on intact roots. This comparison is not possible because the non-carious cervical lesion simultaneously affects parts of the root and crown of the tooth and with its progression, the CEJ generally disappears. A new line is established, coronal to the original CEJ, representing the incisal border of the non-carious cervical lesion, and is often mistaken for the CEJ (Zucchelli et al. 2006). Only the part of the non-carious cervical lesion, located on the root could be predictably covered by soft tissue after the surgical procedure. This is

Table 3. Mean gain in CAL and RGR at 6 months (mm)

	CTG	CTG+R	*p*-value
CAL gain	1.58 ± 0.74	1.26 ± 0.9	0.16
RGR reduction	2.53 ± 0.78	2.31 ± 0.74	0.41

CTG, connective tissue graft group; CTG+R, connective tissue graft plus resin-modified glass ionomer restoration group; CAL, clinical attachment level; RGR, relative gingival recession. *p*-value were calculated by the Mann–Whitney test to evaluate differences within groups.

Table 4. Clinical results in mm (mean ± SD; $n = 40$ patients)

		Baseline	45 days	2 months	3 months	6 months
PD	CTG+R	1.1 ± 0.44	$1.9 \pm 0.64^*$	$2 \pm 0.56^*$	$2 \pm 0.56^*$	$2.15 \pm 0.67^*$
	CTG	1.15 ± 0.48	$1.98 \pm 0.6^*$	$2 \pm 0.45^*$	$2.15 \pm 0.48^*$	$2.1 \pm 0.55^*$
NIC	CTG+R	12.89 ± 1.09	$11.4 \pm 1.28^*$	$11.51 \pm 1.15^*$	$11.57 \pm 1.12^*$	$11.63 \pm 1.08^*$
	CTG	12.85 ± 2.06	$11.1 \pm 1.84^*$	$11.15 \pm 1.72^*$	$11.27 \pm 1.7^*$	$11.27 \pm 1.17^*$
RGR	CTG+R	11.79 ± 1.09	$9.5 \pm 0.87^*$	$9.51 \pm 0.88^*$	$9.57 \pm 0.81^*$	$9.48 \pm 0.82^*$
	CTG	11.7 ± 2.01	$9.12 \pm 1.55^*$	$9.15 \pm 1.46^*$	$9.12 \pm 1.52^*$	$9.17 \pm 1.53^*$
KTT	CTG+R	0.85 ± 0.19	–	–	–	$1.95 \pm 0.42^*$
	CTG	0.9 ± 0.23	–	–	–	$1.93 \pm 0.53^*$
KTW	CTG+R	2.54 ± 1.17	–	–	–	$3.34 \pm 0.91^*$
	CTG	2.38 ± 1.22	–	–	–	$3.05 \pm 1.11^*$

*Statistically significant difference within groups ($p < 0.05$) by the Friedman's test.
†Statistically significant difference between groups ($p < 0.05$) by the Mann–Whitney test.
CTG+R, connective tissue graft plus resin-modified glass ionomer restoration group; CTG, connective tissue graft group; PD, probing depth; RGR, relative gingival recession; KTT, keratinized tissue thickness; KTW, keratinized tissue width.

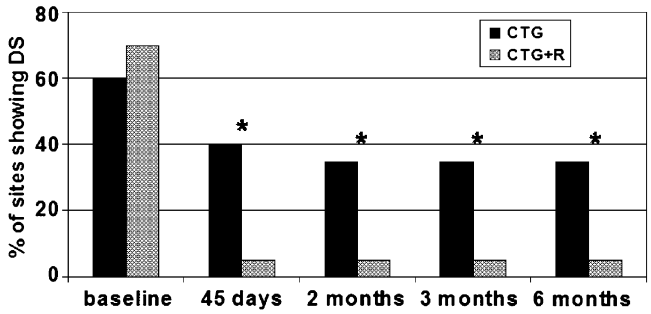

Fig. 11. Percentage of dentin sensitivity (DS) occurrence. The two groups presented a statistically significant reduction in DS after the treatment.

probably the reason why no total CLH coverage could be observed previously with the coronally advanced flap (Santamaria et al. 2008). However, in the present study, a total of seven sites (three in CTG group and four in the CTG+R group) presented complete CLH coverage. One possible explanation for this result could be that the presence of the CTG beneath the flap might have prevented the collapse of the flap inside the dead space created by the cervical lesion. The presence of the connective tissue under the flap might have provided an adequate support to the flap and, as a consequence, provided better stability (Mele et al. 2008). Successful cases in which the gingival margin was moved coronally, beyond the CEJ, using the CTG were shown by McNeelly (2005). This is probably the reason why both groups of the present study showed slightly better averages of CLH coverage, when compared with the groups of the previous study (Santamaria et al. 2008). However, additional studies are necessary to test this hypothesis.

In order to explore the hypothesis that the most coronal zone of the non-carious cervical lesion was mainly composed by the crown portion of the lesion, an estimation of the position of the CEJ by the method described by Zucchelli et al. (2006) was performed. According to this method, a scalloped line that represents the CEJ lost is constructed following the patient biotype and connecting the ideal dimension of the adjacent papilla. Therefore, it was possible to estimate the part of the CLH located on the root (CLH-R). The CLH-R was 2.45 ± 0.53 mm ($74.88 \pm 8.66\%$ of the CLH) for the CTG group and 2.36 ± 0.71 mm ($70.76 \pm 9.81\%$ of the CLH) for the CTG+R group. Based on these values, mean root coverage (CLH-R coverage) was calculated, reaching $91.91 \pm 17.76\%$ for the CTG group and $88.64 \pm 11.9\%$ for the CTG+R group ($p > 0.05$). The mean values of root coverage observed in the present study are comparable to the ones reported in other studies for this procedure (Allen & Miller 1989, Harris & Harris 1994, Wennström & Zucchelli 1996, Pini-Prato et al. 2000, Cortellini et al. 2009). However, caution should be exercised due to the subjective component of the method used to estimate the CEJ in the present study, which differs from the direct measurement obtained in studies with intact roots.

An interesting finding of the present study is related to BOP. In spite of the subgingival location of the apical margin of the restoration, as a consequence of the coverage achieved after the surgical procedures, no site in either the CTG+R group or in the CTG group showed BOP. This result is in accordance with other studies (Lucchesi et al. 2007, Santamaria et al. 2007, 2008, 2009). Conversely, these data do not agree with studies that demonstrated that the presence of restoration margins close to the gingival margin or within the crevicular space may cause gingival inflammation (Larato 1972). Dragoo (1996), Dragoo (1997) and Alkan et al. (2006) studies showed that periodontal health was maintained when a resin-modified glass ionomer was used for subgingival or transgingival restorations. Therefore, the selection of the resin-modified glass ionomer to be used in the present study was based on the results of these previous studies. The suggested biocompatibility of the material, added to the fact that the patients were followed up monthly for prophylaxis, plaque control and oral hygiene instructions, may help to explain the gingival health observed during the study. In addition, flap elevation allowed proper isolation of the operative field and a well-finished filling could be achieved, which might have facilitated plaque control.

In the present study, the patients were asked about the presence of dentin hypersensitivity (DS) before and after treatment, without application of any thermal or tactile stimuli to detect the sensitivity. The success of the therapy should be based on patients' evaluation of this symptom (Roccuzzo et al. 2002, Cairo et al. 2008). The results revealed a statistically significant reduction in DS between baseline and the subsequent observation periods for the CTG+R group, whereas these within-group differences were not observed for the CTG group. The comparison between the groups revealed a statistically significant difference, with better outcomes for the CTG+R group in all post-operative periods. This may be related to the fact that most of the cervical lesions did not achieve complete coverage with gingival tissue. Thus, part of the cervical lesion was still exposed to the oral environment in the CTG group. Conversely, cervical lesions in the CTG+R group were restored, sealing the exposed dentinal tubules and reducing the chances of symptoms. Again, the subjective nature of DS evaluation in the present study should be pointed out. A decision was made during the planning of the study to limit this evaluation to a simple question, without the use of a scale. If the patient reported any sensitivity, regardless of the intensity, it was considered positive for the analysis.

The PD showed a statistically significant change between baseline and post-operative periods in the two groups. They showed an increase of about 1 mm in the PD after the treatments. Although the increase was statistically significant, the clinical importance of this alteration could be questioned because both groups presented shallow PD after 6 months: 2.1 ± 0.55 mm for the CTG group and 2.15 ± 0.67 mm for the CTG+R group. The differences between groups were not statistically significant at any period of revaluation.

Within the limits of this short-term study, it can be concluded that the presence of resin-modified glass ionomer restoration may not interfere with the percentage of soft tissue coverage, when a CTG is performed for the treatment of Miller Class I gingival recessions, associated with non-carious cervical lesions. The combined treatment showed better results in the reduction of DS. However, these conclusions should be interpreted with caution, based on the following considerations: the periodontal surgery associated with the restorative procedure required a longer clinical time, compared with the isolated surgical procedure. Additionally, no assessment of patient satisfaction using a standardized approach was performed in the present study. The statistical analysis of the present study included a power value $> 80\%$ to detect a clinically significant difference of 1.0 mm between CTG and CTG+R in the RGR and CAL. Although this is an acceptable value, further studies with larger samples are strongly recommended to confirm these results. Longitudinal observation is also necessary to evaluate the stability of the results and to establish the long-term success of this combined approach. Other restorative materials and surgical techniques should be tested to achieve the best combination to treat this particular combined lesion.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Supporting information in accordance with the CONSORT Statement 2001 checklist used in reporting randomized trials.

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Clinical Relevance

Scientific rationale for the study: Gingival recession is frequently associated with a non-carious cervical lesion. The literature lacks controlled studies evaluating the use of CTGs and restorations to treat this condition.

Principal findings: The present study shows that CTG alone, or in combination with glass ionomer restoration, may provide comparable soft tissue coverage in the treatment of a gingival recession-associated cervical lesion.

Practical implications: The present results suggest that the combined approach may be considered as a treatment option for the type of lesion included in the study. Long-term observations are necessary to confirm the stability of the achieved results.