

Review
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Treatment efficacy of gingival recession defects associated with non-carious cervical lesions: a systematic review

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ABSTRACT

Purpose: This systematic review aimed to compare the efficacy, defined in terms of the mean percentage of root coverage (mRC), of surgical treatment approaches combined with adhesive restorations of non-carious cervical lesions (NCCLs) to that of root coverage alone in patients with a single gingival recession (GR) and NCCL.

Methods: A literature search was conducted to identify longitudinal studies reporting the mRC following treatment for the correction of GR defects associated with NCCLs using a combination of surgical and restorative techniques in systemically and periodontally healthy patients.

Results: The search resulted in the retrieval of 12,409 records. Seven publications met the inclusion criteria for the qualitative synthesis of data. The mRCs ranged from 69% to 97%. In the medium term, the gingival margin position was more stable when a connective tissue graft (CTG) was used, independently of whether restoration of teeth with NCCLs was performed.

Conclusions: The strength of the evidence was limited by methodological heterogeneity in terms of study design as well as the unit and period of analysis, which precluded a meta-analysis. Although no definitive conclusion could be drawn due to the lack of sufficient evidence to estimate the effectiveness of the interventions, CTG-based procedures contributed to gingival margin stability regardless of the performance of restoration to treat NCCLs.

Keywords: Dental restoration; Gingival recession; Permanent; Surgical flap, autograft; Tooth wear

INTRODUCTION

Gingival recession (GR) refers to apical displacement of the gingival margin beyond the cemento-enamel junction (CEJ) [1,2]. This is a relatively common condition with a multifactorial etiology, and the occurrence of GR tends to increase with age [3,4]. Although GR is not considered a disease *per se*, its presence increases the risk of developing dentin sensitivity [5], and it is also an esthetic concern when located on the anterior teeth, negatively impacting quality of life [6].

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Author Contributions

Conceptualization: Renata Cimões, Bruna de Carvalho Farias Vajgel; Formal analysis: Renata Cimões, Bruna de Carvalho Farias Vajgel; Investigation: Lívia Maria Lopes de Oliveira, Camila Agra Souza; Methodology: Bruna de Carvalho Farias Vajgel, Lívia Maria Lopes de Oliveira; Project administration: Lívia Maria Lopes de Oliveira; Writing - original draft: Lívia Maria Lopes de Oliveira; Writing - review & editing: Bruna de Carvalho Farias Vajgel, Rafael Siqueira.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

The treatment of GR defects poses a challenge to periodontists, especially in cases associated with the loss of hard dental tissue caused by non-carious cervical lesions (NCCLs) [7]. The presence of NCCLs increases the complexity of treatment planning for root coverage, as these lesions affect the predictability of the results and are associated with a greater likelihood of recurrence of the recession [7-10].

Techniques have been developed and improved over the years to increase the predictability of the surgical outcome and the mean percentage of root coverage (mRC), while achieving satisfactory esthetic results [11,12]. In a systematic review including only randomized clinical trials (RCTs), Madeley and Duane (2017) [13] concluded that the combination of a coronally advanced flap and connective tissue graft (CAF+CTG) achieved the most predictable results and should therefore be considered the “gold standard.”

Despite the negative influence of NCCLs on the outcomes of root coverage procedures [8], some researchers [14-16] have achieved promising results by employing a combination of surgical and restorative treatments. Santamaria et al. [14] reported an mRC of 60% after 2 years of follow-up for GR defects combined with NCCLs by CAF+CTG and restoration of the lesion with composite resin (CR). Furthermore, Cairo et al. [16] reported an mRC of 71% when employing the same restorative technique and material. These discrepancies in the literature hinder the interpretation of the results and, consequently, evidence-based therapeutic decision-making. Thus, questions remain regarding the need for NCCL restoration and the restorative material associated with the best results in terms of root coverage. Therefore, this systematic review of clinical trials aimed to compare the mRC between treatment approaches combining root coverage techniques with adhesive restorations and those involving root coverage alone, in patients with a single GR and NCCL.

MATERIALS AND METHODS

The research question was “Does NCCL restoration negatively impact root coverage outcomes in patients with both GR defects and NCCLs treated using CAF with or without CTG?”

The population, intervention, comparison, outcomes, and study design (PICOS) framework was used to guide the inclusion and exclusion of studies for the above-mentioned focused question:

Population (P): patients with both GR defects and NCCLs.

Intervention (I): recessions treated with CAF with or without CTG + adhesive restoration of the NCCL.

Comparison (C): all recessions treated with CAF with or without CTG.

Outcome (O): mRC achieved.

Study design (S): randomized controlled trials.

Protocol and registration

The protocol of the present systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO, identification number: CRD42018093601). This article followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement [17].

Eligibility criteria

Population

To be included, the participants of clinical trials were required to be adults who were systematically and periodontally healthy [18], and had a single GR defect combined with an NCCL treated with root coverage surgery with or without adhesive restoration of the NCCL, with at least 6 months of postoperative follow-up.

Studies that included teeth with carious lesions or multiple GRs, smokers, and individuals with a history of periodontal surgery or treatment at the site in question were excluded from the review. No restrictions were imposed regarding the classification of the type of GRs or the minimum number of participants in the studies.

Interventions and comparisons

For the intervention groups, the following procedures were considered:

- CAF and glass ionomer cement restoration (CAF+GIC);
- CAF and resin-modified glass ionomer cement restoration (CAF+GIC-R);
- CAF and CR restoration (CAF+CR);
- CAF and CTG and glass ionomer cement restoration (CAF+CTG+GIC);
- CAF, CTG, and resin-modified glass ionomer cement restoration (CAF+CTG+GIC-R);
- CAF and CTG and CR restoration (CAF+CTG+CR).

For the control groups, only surgical periodontal procedures performed in the region with or without NCCL were considered (CAF and CAF+CTG).

Outcomes

1) Primary outcome

The primary outcome was the mRC, defined as the difference in the distance from the gingival margin to a reference point (e.g., CEJ, marking of a stent, incisal margin, etc.), measured before and after the intervention and multiplied by 100.

Secondary outcomes

1) Width and thickness of the keratinized tissue

The keratinized tissue width was defined as the distance between the mucogingival junction and the free gingival margin [19]. Keratinized tissue thickness was defined as the distance between the gingival surface and the bone.

2) Clinical periodontal variables

The gain in clinical attachment was the difference between the clinical attachment levels before and after the intervention. Probing depth and bleeding on probing were analyzed considering the methodological differences described in the studies.

3) Dentin sensitivity and esthetic assessment

Dentin sensitivity and esthetic assessments were performed using different assessment methods, as described in the studies.

Search strategy

Searches were performed by 2 reviewers (LM and CA) in the Ovid MEDLINE, Ovid Embase, and BIREME databases. Hand searches were also performed of the reference lists of the articles included and in specialized journals, including the *Journal of Periodontology*, *Journal*

of *Clinical Periodontology*, *Journal of Periodontal Research*, and *Journal of Dental Research*, for other potentially eligible studies. Considering the risk of publication bias, the OpenGrey database was also searched to survey the gray literature.

The search covered the period from January 1946 to May 2020. A search for ongoing studies was performed in the following clinical trial registry platforms: Current Controlled Trials, International Clinical Trials, and ClinicalTrials.gov. No restrictions were imposed on language or year of publication. Studies published in other languages had their titles and abstracts translated into English, which made the selection possible.

A highly sensitive search strategy was developed for this study. The strategy for MEDLINE and Embase involved a combination of MeSH terms and keywords. The search strategy formulated for MEDLINE was subsequently modified for Embase, when appropriate. The details of the electronic search are listed below.

Population: “(Cervical AND (tooth wear OR lesions))” OR “Tooth (wear\$ OR cervix\$ OR root\$)” OR “Gingival (recession\$ OR margin\$)” OR “(step AND defects)” OR “Abrasion\$” OR “Erosion\$” OR “Attrition\$” OR “Abfraction\$” OR “Cemento-enamel AND Junction” OR “Dentine” OR “Enamel”

Intervention: “Glass ionomer cement\$” OR “Resin\$” OR “(Resin\$ AND (modified glass-ionomer\$ OR composite\$))” OR “(Composite\$ AND (restoration\$ OR resin\$))” OR “Compomer\$” OR “flowable AND (composite OR material\$)” OR “(Connective AND tissue graft\$)” OR “(Subepithelial AND connective)” OR “((Reconstructive procedure\$ OR periodontal plastic OR mucogingival OR mouth mucosa OR gingival OR flaps OR grafts OR connective tissue) AND surg\$)” OR “(Transplantation AND autologous)” OR “Root coverage procedure” OR “Coronally advanced flap procedure” OR “Coronally positioned flap”

Comparison: “(Connective AND tissue graft\$)” OR “(Subepithelial AND connective)” OR “((Reconstructive procedure\$ OR periodontal plastic OR mucogingival OR mouth mucosa OR gingival OR flaps OR grafts OR connective tissue) AND surg\$)” OR “(Transplantation AND autologous)” OR “Root coverage procedure” OR “Coronally advanced flap procedure”

Outcomes: “Wound healing” OR “Root AND (coverage OR sensitivity)” OR “Dentin\$ AND (Sensitivity OR hypersensitivity)” OR “Periodontal AND (plastic OR surg\$)” OR “Periodontal attachment” OR “(Attachment AND clinical gain)” OR “Keratinized Tissue” OR “Probing Depth” OR “Gingival Bleeding” OR “Root AND Coverage”

Type of study: “(prospective OR cohort OR longitudinal OR observational)” OR “Cohort” OR “((clinical) AND trial\$)” OR “(follow AND up)”

These terms were combined in the following manner: *Population* AND *Intervention* AND *Comparison* AND *Outcome* AND *Type of study*. Ambiguous or incomplete information was clarified, whenever possible, by the original authors. The reference lists of all articles included and the relevant review articles were also searched for additional potentially eligible studies.

Assessment of the eligibility of studies and the data extraction method

A 3-stage selection process was performed independently and in duplicate. At each step, divergent opinions were resolved through discussion. If a consensus was not reached

regarding the inclusion of a title or abstract, the reference in question was included in the following stage.

The initial stage (selection based on titles [LM and CA]) was conducted to eliminate materials that were irrelevant to the review, title by title, from an Excel list exported from the reference manager (EndNote Desktop; Clarivate Analytics, London, UK). In the second stage (selection based on abstracts [LM and CA]), studies were included or excluded based on the type of recession (single or multiple), follow-up period, evaluated outcomes, participants' systemic and periodontal status, and smoking habit. The third stage (LM and CA) involved reading the full texts using data extraction forms to determine the eligibility of the studies based on the previously defined inclusion/exclusion criteria, to appraise the methodological quality, and to extract the relevant characteristics and outcomes of the studies.

The agreement level between the reviewers during the first, second, and third selection stages was calculated using the κ statistic. After extraction, the relevant data were reviewed by the first author. Divergent opinions were resolved through discussion. If a consensus was not reached, a third reviewer (BF) was consulted to make the final decision.

Appraisal of methodological quality

The methodological quality of the studies included in the systematic review was appraised independently and in duplicate by 2 reviewers (LM and CA) as part of the data extraction process. This was performed using the Risk of Bias assessment tool developed by the Cochrane Collaboration [20], which considers the following 7 domains: random sequence generation, allocation concealment, selective reporting, blinding of participants and researchers, blinding for evaluation of results, incomplete outcome data, and other sources of bias.

Data synthesis and analysis

The extracted data were gathered and grouped into tables. A descriptive analysis was performed to quantify and group the data and the characteristics of the study. For the data collected from the included studies, a thorough descriptive presentation was planned without anticipating statistical quantification or comparisons, due to the wide variability in the methods used to determine CEJ levels, which may influence the reported mRC. Moreover, there was high heterogeneity in the treatment approaches for GR defects associated with NCCLs among the studies.

Quantitative analysis

Due to the methodological heterogeneity and the differences in the assessment criteria and evaluation periods, it was not possible to perform meta-analyses of the outcomes of interest.

RESULTS

Study characteristics

The database searches led to the retrieval of 12,409 records and 3 from other sources, 2,628 of which were duplicates and were removed. Thus, 9,781 titles were analyzed for the selection of abstracts, and 25 articles were then selected for full-text analysis. Seven studies in 9 publications met the eligibility criteria and were included in the present systematic review (**Figure 1**). The 16 excluded publications and reasons for exclusion are listed in **Table 1**. The κ coefficient was 0.90, 0.96, and 0.89 for the selection of titles, abstracts, and full texts, respectively, demonstrating excellent agreement.

The 7 articles included in the review were RCTs [14,15,21-27]. One study in 2 publications [22,23] had a split-mouth design, and the rest were conducted with parallel groups simultaneously. The follow-up period was 6–24 months. Two articles [22,24] described changes in the variables analyzed in the same sample reported in previous studies [22,24] with a 24-month follow-up. In 2 studies [21,26], there were 3 evaluation groups: 2 for the comparison of different restorative materials and a control group without NCCLs (**Tables 2, 3, and 4**).

Patient characteristics

In 6 prospective RCTs, 293 GR defects were treated in 260 patients. In addition, 165 teeth with NCCLs were treated with a combination of adhesive restoration and periodontal coverage (with or without a CTG), whereas 90 teeth with NCCLs and 38 without NCCLs were treated with periodontal coverage surgery alone (**Table 2**) [14,15,21-27].

The characteristics of the study populations included in the present review are summarized in **Table 2**. In 5 studies [14,21-24,26,27], it was unclear whether a sample size calculation was performed. The age of the participants was 19–71 years. Five studies in 7 publications were conducted in Brazil [14,15,21-27], 1 in Turkey [26], and 1 in India [27]. In 3 studies [14,15,21,23,24,27], dropouts occurred after the interventions due to the refusal of participants to continue with the study, a change of address, or difficulty contacting the individuals. No studies reported healing problems or any adverse events resulting from the interventions.

Effects of interventions

Coverage rate

1) CAF+CTG

Five studies [14,15,24-27] evaluated the root coverage rate of GR defects and NCCLs using the CAF+CTG treatment (**Tables 3 and 4**). Santamaria et al. [14,15,24,25] reported mRC rates of 91%–92% in different evaluation periods. Santamaria et al. [15] also reported the coverage of both GRs and NCCLs, with an mRC of 82.16%. Other studies by the same authors reported root coverage rates estimated using the method proposed by Zucchelli et al. [28].

In the study group that received the CAF+CTG technique in the investigation conducted by Dursun et al. [26], GR was not associated with NCCLs, and the group was therefore not considered in this evaluation. Gharat et al. [27] reported maximum root coverage, which considered the coverage to the limit of the position of the CEJ, estimated using the method proposed by Zucchelli et al. [28]. The authors found an mRC of 69.24% (9 of 13 cases) in this group.

2) CAF+CTG+GIC

One study that evaluated this combination [26] found an mRC of 90.12%.

Table 1. Studies excluded

Reason for exclusion	Studies
1 Case report	Alkan et al. [32]; Santamaria et al. [33]; Yang et al. [34]
2 Did not evaluate the percentage of root coverage	Santos et al. [35]; Santamaria et al. [36]
3 Case series	Cairo et al. [37]; Zucchelli et al. [38]; Perez et al. [39]; Sharma et al. [40]
4 Study design not considered in review protocol	Santamaria et al. [41]; Santamaria et al. [42]; Yang et al. [34]
5 Comparison group with carious lesions	Pourabbas et al. [43]
6 Study included multiple gingival recessions	Zsuzsanna et al. [44]; Isler et al. [30]
7 Included smokers	Cairo et al. [16]

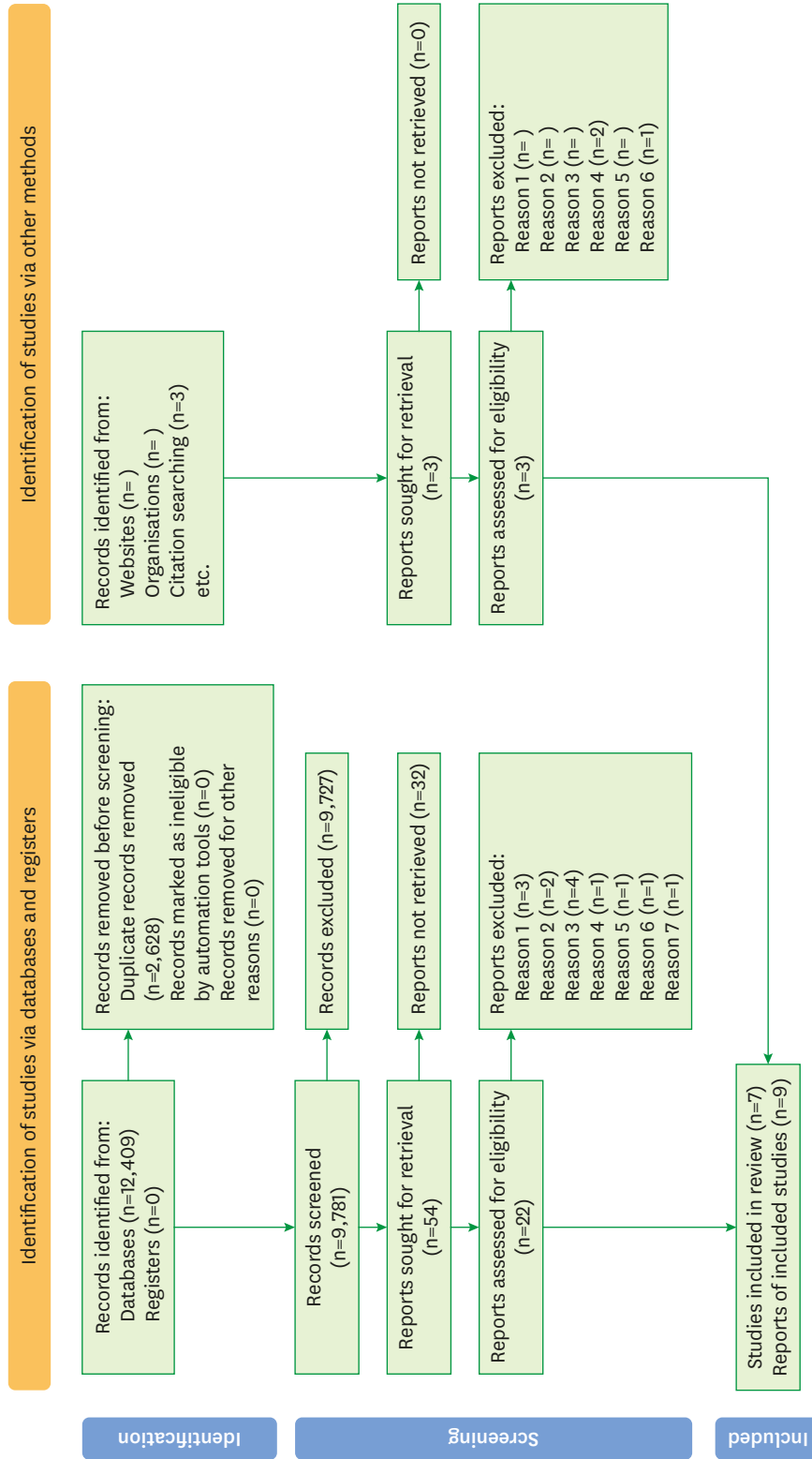


Figure 1. PRISMA diagram. Source: from the PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. adapted from preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;6: e1000097. doi: 10.1371/journal.pmed.1000097.

Table 2. Characteristics of the population and interventions of studies included in the review

Studies	Characteristics of the study and population				Intervention and comparison characteristics			
	Types of study	Participants	Follow-up (mon)	1. Characteristics of test centers	Test group	Control group	Orientation and care	Periodontal support
Lucchesi et al. [21]	Prospective, randomized clinical trial	1. Number (F, M) 2. Sample calculation 3. Age (year) 4. Dropouts	6	1. Number of restored teeth with gingival recession and NCCLs 2. Number of non-restored teeth with gingival recession and NCCLs 3. Number of non-restored teeth with gingival recession without NCCLs 4. Classification of gingival recession and NCCLs	1. Type of intervention (number of patients) 2. Period of placement of restoration material 3. NCCLs filled	1. Type of intervention (number of patients)	1. Preoperative 2. Postoperative	Follow-up was monthly until 6 months
Santamaria et al. [22, 23]	Prospective, randomized controlled clinical trial	1. 59 (44 women, 15 men) 2. Not reported 3. 44.66±13.01 (23-65) 4. Not reported	24	1. 39 2. Not reported 3. 20 4. Miller class I (maxillary canines or premolars)	1. GIC-R plus CAF (20); CR plus CAF [®] (19) 2. Two weeks before surgery 3. All filled	Root exposure without NCCL treated with CAF (20)	1. Single dose of dexamethasone (4 mg) 1 h before surgery; control group: root surfaces planned 2. No periodontal dressing. Chlorhexidine gluconate (0.12%) mouthwash for 2 weeks. Analgesics.	Weekly in the first month, then monthly during the first 6 months and every 4 months until the end of the study period
Santamaria et al. [14, 24]	Prospective, randomized clinical trial	1. 19 (10 women, 9 men) 2. Not reported 3. 36.26±9.2 (24-58) 4. 3	24	1. 19 2. 19 3. Not reported 4. Miller class I (maxillary canines or premolars)	1. GIC-R plus CAF (19) 2. After raising of the coronal flap, under absolute isolation 3. All filled	Root exposure with NCCL treated with CAF (19)	1. Not reported 2. Sodium dipyrone, 500 mg for 2 days; discontinued toothbrushing around surgical sites for 30 days after surgery, plaque control with 0.12% chlorhexidine solution rinse twice daily.	Weekly in the first month, then monthly during the first 6 months and every 4 months until the end of the study period
Santamaria et al. [15]	Prospective, single-blind Randomized clinical trial	1. 40 (19 women, 21 men) 2. >80% power to detect a 1-mm difference between groups in relative gingival recession and CAL (16 subjects) 3. 36.25±22.8 (19-71) 4. 4	24	1. 20 2. 20 3. Not reported 4. Miller class I (maxillary canines or premolars)	1. GIC-R plus CTG (20) 2. After raising of the coronal flap, under absolute isolation 3. All filled	Root exposure with NCCL treated with CTG (20)	1. Not reported 2. Sodium dipyrone, 500 mg for 2 days; discontinued toothbrushing around the surgical sites for 30 days after surgery, plaque control with 0.12% chlorhexidine solution rinse twice daily.	Weekly in the first month, then monthly during the first 6 months and recall every 3 or 4 months
Santamaria et al. [15]	Prospective, single-blind Randomized clinical trial	1. 36 (17 women, 19 men) 2. 80% power. $\alpha=0.05$ and 2.18 standard deviation of 0.5 mm to detect a 0.5-mm difference in root coverage after 1 year (18 subjects). 3. Test: 35.2±13.7; Control: 38.9±11.3 4. Not reported	12	1. 18 2. 18 3. Not reported 4. Miller class I and II; B+ (Pini-Prato 2010; maxillary canines or premolars)	1. CR plus CTG [®] (18) 2. After raising of the coronal flap, under absolute isolation 3. All filled	Root exposure with NCCL treated with CTG (18)	1. Not reported 2. Sodium dipyrone, 500 mg for 2 days; discontinued toothbrushing around the surgical sites for 30 days after surgery, plaque control with 0.12% chlorhexidine solution rinse twice daily.	Not reported

(continued to the next page)

Table 2. (Continued) Characteristics of the population and interventions of studies included in the review

Studies	Characteristics of the study and population		Intervention and comparison characteristics					
	Types of study	Participants	Follow-up (mon)	1. Characteristics of test	Test group	Control group	Orientation and care	Periodontal support
Santamaria et al. [25]	Prospective, single-blind Randomized clinical trial	1. Number (F, M) 2. Sample calculation 3. Age (Year) 4. Dropouts	12	1. Number of restored teeth with gingival recession and NCCLs 2. Number of non-restored teeth with gingival recession and NCCLs 3. Number of non-restored teeth with gingival recession without NCCLs 4. Classification of gingival recession and NCCLs	1. CR plus CTG ^a (20) 2. 48 h before surgery 3. Partly filled (1 mm apical to estimated CEJ position)	Root exposure with NCCL treated with CTG (20)	1. Not reported 2. Analgesic (as needed for pain); discontinued toothbrushing around the surgical sites for 2 weeks after surgery. 3. plaque control with 0.12% chlorhexidine solution rinse twice daily for 2 weeks.	Patients recalled every 3 months for prophylaxis
Dursun et al. [26]	Prospective, single-blind Randomized clinical trial	1. 36 (28 women, 8 men) 2. >80% power to detect a 1-mm difference between groups in CAL 3. 41.65±12.26 4. Not reported	12	1. Parallel 2. Single-center 3. FAPESP and CNPq 4. Miller class I or II, class B+ (Pini-Prato et al. 2010)	1. GIC-R plus CTG (18); NIC plus CTG (18) 2. 10 days before surgical procedures 3. All filled	Root exposure without NCCL treated with CAF (18)	1. Not reported 2. Not reported	Not reported
Gharat et al. [27]	Prospective, randomized controlled clinical trial	1. 30 (Not reported) 2. Not reported 3. Not reported 4. 4	6	1. Parallel 2. Single-center 3. Not reported 4. Miller class I (upper canines or premolars)	1. GIC-R plus CTG (13) 2. After raising of the coronal flap, under absolute isolation 3. All filled	Root exposure with NCCL treated with CTG (13)	1. Not reported 2. Amoxicillin (500 mg) and clavulanic acid (125 mg) (twice daily for 5 days). ketorolac (10 mg) (twice daily for 3 days), 0.2% chlorhexidine mouth rinse for 7 days.	Not reported

NCCL: non-carious cervical lesion, GIC-R: resin-modified glass ionomer cement, CR: composite resin, CTG: connective tissue graft, NIC: nano-ionomer cements, CAL: clinical attachment level, FAPESP: State of São Paulo Research Foundation, CAPES: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Advancement of Higher Education Personnel), CNPq: National Council of Technological and Scientific Development.

^aAll studies used CR from the same manufacturer (3M ESPE, St. Paul, MN, USA).

Table 3. Description of results

Studies	mRC (%)	KTT (mm)	KTW (mm)	CALG (mm)	PD (mm)	BOP	Sensitivity	AA
	1. Definition 2. Test group 3. Control group	1. Definition 2. Test group 3. Control group	1. Definition 2. Test group 3. Control group	1. Definition 2. Test group 3. Control group	1. Definition 2. Test group 3. Control group	1. Definition 2. Test group 3. Control group	1. Evaluation instrument 2. Test group 3. Control group	1. Evaluation instrument 2. Patient 3. Professional
Lucchesi et al. [21]	1. Root surface: standardized measurements per stent point. Test group: (100×RR)/LH; Control group: ((preoperative RH–postoperative RH)/preoperative RH)×100. 2. (6 mon): GIC-R plus CAF: 71.99±18.69; CR plus CAF: 74.18±15.02. 3. (6 mon): 80.83±21.08.	1. Midpoint between the GM and MGJ by inserting the probe into the tissue. 2. BL (GIC-R): 0.83±0.37; (6 mon): 0.93±0.37; BL (RC): 0.92±0.25; (6 mon): 0.92±0.25. 3. BL: 0.93±0.34; (6 mon): 0.88±0.28.	1. Distance between the most apical extension of the GM and MGJ. 2. BL (GIC-R): 3.58±0.94; (6 mon): 3.70±0.98; BL (RC): 3.37±1.01; (6 mon): 3.32±0.82. 3. BL: 3.18±0.91; (6 mon): 3.40±0.94.	1. rCAL: distance between the fixed landmark (stent) and bottom of the gingival sulcus. 2. BL (GIC-R): 1.5±0.5; (6 mon): 1.4±0.5; BL (RC): 1.3±0.5; (6 mon): 1.3±0.6. 3. BL: 7; (6 mon): 0.	1. Presence or absence of bleeding up to 15 s after gentle probing. 2. BL (GIC-R): 4; (6 mon): 1; BL (MRC): 3; (6 mon): 2. 3. BL: 7; (6 mon): 0.	1. Definition 2. Test group 3. Control group	1. Evaluation instrument 2. Test group 3. Control group	Not evaluated.
Santamaria et al. [38,39]	1. Root surface: subtracting distance from the estimated CEJ (Zucchelli et al. [28]) to the incisal border from RGR. 2. (6 mon): 88.02±19.45; (24 mon): 80.37±25.44. 3. (6 mon): 97.48±15.36; (24 mon): 83.46±20.79.	1. Midpoint between the GM and MGJ through the soft tissue with light pressure until hard surface with pierced endodontic spreader. 2. BL: 1.06±0.2; (6 mon): 0.98±0.16; (24 mon): 1.16±0.13; 1.07±0.2. 3. BL: 1.10±0.18; (6 mon): 1.05±0.15; BL: 1.12±0.16; (24 mon): 1.04±0.33.	1. Distance from the GM to the MGJ. 2. BL: 2.86±0.85; (6 mon): 2.97±0.77; BL: 3.16±0.85; (24 mon): 3.11±0.91. 3. BL: 3.05±0.86; (6 mon): 3.23±0.72; BL: 3.24±0.4; (24 mon): 3.25±0.56.	1. rCAL: PD+rRG. Gain: not reported. 2. (6 mon): 1.52±0.66; (24 mon): 1.31±0.6. 3. (6 mon): 1.50±0.73; (24 mon): 1.2±0.72. 3. BL: 1.25±0.44; (24 mon): 1.25±0.44). 3. BL: 1.25±0.44; (6 mon): 1.31±0.47; BL: 1.31±0.47; (24 mon): 1.5±0.51.	1. Distance from GM sites included in study. 2. No BOP 3. No BOP 1.25±0.44; (24 mon): 1.25±0.44). 3. BL: 1.25±0.44; (6 mon): 1.31±0.47; BL: 1.31±0.47; (24 mon): 1.5±0.51.	1. Presence or absence at 1. (6 mon): subjects' reports on the presence or absence before and after treatment. (24 mon): not evaluated. 2. BL: 68.42%; (6 mon): 5.26%. 3. BL: 68.42%; (6 mon): 47.36%. 3. Not evaluated.	1. Not evaluated. 2. 63.15% of subjects reported esthetic concerns (6 mon). 43.75% reported that the restoration color did not match the tooth color (darker, 24 mon). 3. Not evaluated.	
Santamaria et al. [14,24]	1. Root surface: subtracting distance from the estimated CEJ (Zucchelli et al. [28]) to the incisal border from RGR. 2. (6 mon): 88.64±11.9; (24 mon): 93.29±7.97. 3. (6 mon): 91.91±17.76; (24 mon): 91.56±11.74.	1. Midpoint between the GM and MGJ through the soft tissue with light pressure until hard surface with pierced endodontic spreader. 2. BL: 0.85±0.19; (6 mon): 0.95±0.42; (24 mon): 1.87±0.72. 3. BL: 0.9±0.23; (6 mon): 1.93±0.53; (24 mon): 1.82±0.44.	1. Distance from the GM to the MGJ. 2. BL: 2.54±1.17; (6 mon): 3.34±0.91; (24 mon): 3.56±1.46. 3. BL: 2.38±1.22; (6 mon): 3.05±1.11; (24 mon): 3.20±1.	1. rCAL: PD+rRG. Gain: not reported. 2. (6 mon): 1.26±0.9; (24 mon): 1.32±0.86. 3. (6 mon): 1.58±0.74; (24 mon): 1.84±0.8. 3. BL: 1.15±0.48; (6 mon): 2.1±0.55; BL: 1.15±0.48; (24 mon): 2.0±0.34.	1. Distance from GM sites included in study. 2. No BOP 3. No BOP 2.15±0.67; BL: 1.1±0.44; (24 mon): 2.11±0.78. 3. BL: 1.15±0.48; (6 mon): 2.1±0.55; BL: 1.15±0.48; (24 mon): 2.0±0.34.	1. Presence or absence at 1. (6 mon): subjects' reports on the presence or absence before and after treatment. (24 mon): Not evaluated. 2. BL: 70%; (6 mon): 5%. 3. BL: 60%; (6 mon): 35%.	1. Not reported. 2. Not reported. 3. 44.44% of restorations presented color change.	
Santamaria et al. [15]	1. Root surface: subtracting distance from the estimated CEJ (Zucchelli et al. [28]) to the incisal border from RGR. 2. 73.84±19.2 ^a 3. 82.16±16.1 ^a	1. Midpoint between GM and MGJ through soft tissues with light pressure until hard surface with pierced endodontic spreader. 2. BL: 0.9±0.24; (12 mon): 1.97±0.26. 3. BL: 0.9±0.23; (12 mon): 1.81±0.44.	1. Distance from the GM to the MGJ. 2. BL: 2.27±0.86; (12 mon): 2.73±0.75. 3. BL: 2.41±1.2; (12 mon): 3.0±0.9.	1. rCAL: PD+rRG. Gain: not reported. 2. 1.17±0.89 3. 1.98±0.81	1. Distance from GM to the apical end of the gingival sulcus. 2. BL: 1.11±0.47; (12 mon): 2.66±0.48. 3. BL: 1.16±0.38; (12 mon): 2.0±0.48.	1. Presence or absence at 1. Subjects' reports on the presence or absence, after air blast from triple syringe (5 sec). 2. BL: 88%; (6 mon): 5.5%. 3. BL: 94.4%; (6 mon): 44.4%.	1. Professional: modified Root Coverage 2. Patient: Esthetic Score (Cairo et al. 2009) (MRCES). 3. Professional: Patient: VAS before and after 1 year. 2. MRCES (1 year): 7.52±2.27; VAS (BL): 8.61±1.37; (1 year): 8.66±1.13. 3. MRCES (1 year): 7.44±2.3; VAS (BL): 2.41±2.19; (12 year): 8.29±2.3.	

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Table 3. (Continued) Description of results

Studies	mRC (%)			KTT (mm)			KTW (mm)			CALG (mm)			PD (mm)			BOP			Sensitivity			AA		
	1. Definition	2. Test group	3. Control group	1. Definition	2. Test group	3. Control group	1. Definition	2. Test group	3. Control group	1. Definition	2. Test group	3. Control group	1. Definition	2. Test group	3. Control group	1. Definition	2. Test group	3. Control group	1. Evaluation instrument	2. Test group	3. Professional	1. Evaluation instrument	2. Patient	3. Professional
Santamaria et al. [25]	1. Root surface: subtracting distance from the estimated CEJ (Zucchelli et al. [28]) to the incisal border from RGR.	2. 93.0±26.1%	3. 92.2±28.4%	1. Distance from endodontic spreader tip to silicone stop, measured with digital calipers.	2. BL: 1.0±0.5; (12 mon): 2.0±0.7	3. BL: 0.9±0.2; (12 mon): 1.9±0.6	1. Distance from the GMJ.	2. BL: 2.7±1.3; (12 mon): 4.2±1.7.	3. BL: 2.9±0.9; (12 mon): 4.1±1.1.	1. rCAL: PD+FRG. Gain: not reported.	2. 0.5±1.3	3. 1.7±1.4	1. Not reported.	2. BL: 1.2±0.5; (12 mon): 2.6±0.7.	3. BL: 1.3±0.5; (12 mon): 2.0±0.5.	1. Presence/absence of bleeding on probing.	2. No BOP	3. No BOP	1. Subjects' reports on the presence or absence, after air blast from triple syringe (3 sec) and VAS scale.	2. BL: 70%; VAS: 3.7±3.3; (6 mon); 10%; VAS: 0.6±1.8.	3. BL: 80%; VAS: 5.0±3.1. year); 9.1±1.0.	1. Professional: modified Root Coverage Esthetic Score (Cairo et al. 2009) (MRCEs).	2. Patient: VAS before and after 1 year.	3. MRCEs: not reported.
Dursun et al. [26]	1. Not reported.	2. GIC-R plus CTG: 89.49±18.15; NIC plus CTG: 90.12±16.58.	3. 96.22±10.75	1. Midpoint between GM and MGJ using an endodontic spreader.	2. BL (GIC-R): 1.22±0.54; (12 mon): 2.30±0.08	3. BL (NIC): 1.06±0.23; (12 mon): 2.16±0.16.	1. Distance from the GMJ.	2. BL (GIC-R): 2.83±1.85; (12 mon): 4.89±1.84.	3. BL (NIC): 3.28±1.56; (12 mon): 5.62±0.96.	1. CAL: PD+height of the gingival recession; CALG: not reported.	2. (GIC-R): 1.66±0.76; (12 mon): 1.61±0.47.	3. 1.35±0.76.	1. Distance from GM to the base of the gingival crevice.	2. BL (GIC-R): 1.73±0.64; (12 mon): 1.88±0.29.	3. BL (NIC): 1.21±0.03; (12 mon): 1.28±0.39.	1. Presence or absence of BOP at site.	2. BL (GIC-R): 0.38±0.80; absence of cervical hypersensitivity.	3. BL (NIC): 0.25±0.77; (12 mon): 0.00±0.00.	1. Subjects' reports on the presence or absence of cervical hypersensitivity.	2. BL: 1.45±0.61; (12 mon): 1.48±0.41.	3. BL: 0.88±1.14; (12 mon): 0.06±0.25.	1. Recorded according to Cairo et al.	2. Similar in GIC-R and NIC: 9.06±1.43.	3. Not reported.
Gharat et al. [27]	1. MRC using Zucchelli et al. [28] method for determining CEJ ^b .	2. 61.54	3. 69.24	1. Midpoint between gingival margin and MGJ using a piercing endodontic file.	2. BL: 11.97±1.62; (6 mon): 9.14±2.27.	3. BL: 12.34±1.72; (6 mon): 10.18±1.66.	1. Distance from the MGJ.	2. BL: 3.12±1.75; (6 mon): 4.56±1.42.	3. BL: 2.84±1.01. (6 mon): 4.26±0.75.	1. CAL: PD+height of the gingival recession; CALG: not reported.	2. BL: 2; (6 mon): 1.	3. BL: 2; (6 mon): 1.	1. GM to base of sulcus.	2. BL: 2; (6 mon): 1.	3. BL: 2; (6 mon): 1.	1. Not rated.	2. Not reported.	3. Not reported.	1. Visual analogue scale (VAS).	2. BL: 2; (6 mon): 0.	3. BL: 4; (6 mon): 1.	1. Not reported.	2. Not reported.	3. Not reported.

mRC: mean percentage of root coverage, RGR: relative gingival recession, RR: recession reduction, LH: lesion height, RH: recession height, KTT: keratinized tissue thickness, KTW: keratinized tissue width, BL: baseline, GM: gingival margin, MGJ: mucogingival junction, CALG: clinical attachment level gain, rCAL: relative clinical attachment level, PD: probing depth, BOP: bleeding on probing, AA: aesthetic analysis, CTG: connective tissue graft.

^aPercentage of combined defect coverage, ^bCoverage extending up to the estimated CEJ; ^cDropout considered.

Table 4. mRC, CALG, KTT, KTW, PD, DS, and AA at 6-month, 12-month, and 24-month follow-up

Parameters	6, 12, and 24 months of follow-up					
	Study	Participants	Baseline	After 6 months	After 12 months	After 24 months
GR						
CAF+CTG	Santamaria et al. [14,24]	20	11.7±2.01 ^a	9.17±1.53	9.15±1.46	9.12±1.52
	Santamaria et al. [15]	18	12.24±1.9 ^a	9.31±1.6	9.42±1.5	-
	Santamaria et al. [25]	20	9.2±2.5 ^a	6.7±1.3	6.8±1.9	-
	Gharat et al. [27]	13	12.34±1.72 ^a	10.18±1.66	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	3.13±0.68 ^b	0.24±0.56	0.41±0.71	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	11.79±1.09 ^a	9.48±0.82	9.51±0.88	9.57±0.81
	Dursun et al. [26]	18	3.5±1.04 ^b	0.44±0.7	0.44±0.7	-
	Gharat et al. [27]	13	11.97±1.62 ^a	9.14±2.27	-	-
CAF+CTG+CR	Santamaria et al. [15]	18	12.73±1.56 ^a	10.1±1.29	10.01±1.3	-
	Santamaria et al. [25]	20	8.7±1.4 ^a	6.3±1.7	6.2±1.8	-
CAF	Santamaria et al. [22,23]	19	10.57±0.94 ^a	9.01±0.83	-	-
			10.25±0.81 ^c	8.84±0.77	8.87±0.81	8.86±0.8
			-	-	-	-
CAF+GIC-R	Lucchesi et al. [21]	20	-	-	-	-
	Santamaria et al. [22,23]	19	10.94±1.32 ^a	9.54±1.25	-	-
CAF+CR	Lucchesi et al. [21]	19	10.48±1.09 ^c	9.14±1.0	9.17±0.99	9.17±1.0
			-	-	-	-
mRC%						
CAF+CTG	Santamaria et al. [14,24]	20	-	91.91±17.76	-	91.56±11.74
	Santamaria et al. [15]	18	-	-	82.16±16.1 ^a	-
	Santamaria et al. [25]	20	-	-	92.2±28.4	-
	Gharat et al. [27]	13	-	69.24	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	-	-	90.12±16.58	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	-	88.64±11.9	-	93.29±7.97
	Dursun et al. [26]	18	-	-	89.49±18.15	-
	Gharat et al. [27]	13	d	61.54	-	-
CAF+CTG+CR	Santamaria et al. [15]	18	-	-	73.84±19.2 ^e	-
	Santamaria et al. [25]	20	-	-	93.0±26.1	-
CAF	Santamaria et al. [22,23]	19	-	97.48±15.36	-	83.46±20.79
CAF+GIC-R	Lucchesi et al. [21]	20	-	71.99±18.69	-	-
	Santamaria et al. [22,23]	19	-	88.02±19.45	-	80.37±25.44
CAF+CR	Lucchesi et al. [21]	19	-	74.18±15.02	-	-
GCA (mm)						
CAF+CTG	Santamaria et al. [14,24]	20	-	1.58±0.74	-	1.84±0.8
	Santamaria et al. [15]	18	-	-	1.98±0.81	-
	Santamaria et al. [25]	20	-	-	1.7±1.4	-
	Gharat et al. [27]	13	-	-	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	-	-	1.61±0.47	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	-	1.26±0.9	-	1.32±0.86
	Dursun et al. [26]	18	-	-	1.66±0.76	-
	Gharat et al. [27]	13	-	-	-	-
CAF+CTG+CR	Santamaria et al. [15]	18	-	-	1.17±0.89	-
	Santamaria et al. [25]	20	-	-	0.5±1.3	-
CAF	Santamaria et al. [22,23]	19	-	1.50±0.73	-	1.2±0.72
CAF+GIC-R	Lucchesi et al. [21]	20	-	2.2±1.0	-	-
	Santamaria et al. [22,23]	19	-	1.52±0.66	-	1.31±0.6
CAF+CR	Lucchesi et al. [21]	19	-	2.2±0.7	-	-
KTT (mm)						
CAF+CTG	Santamaria et al. [14,24]	20	0.9±0.23	1.93±0.53	1.9±0.77	1.82±0.44
	Santamaria et al. [15]	18	0.9±0.23	1.87±0.47	1.81±0.44	-
	Santamaria et al. [25]	20	0.9±0.2	2.0±0.6	1.9±0.6	-
	Gharat et al. [27]	13	1.39±0.46	2.20±0.51	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	1.06±0.23	-	2.16±0.16	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	0.85±0.19	1.95±0.42	1.81±0.5	1.87±0.72
	Dursun et al. [26]	18	1.22±0.54	-	2.30±0.08	-
	Gharat et al. [27]	13	1.62±0.74	2.23±0.90	-	-
CAF+CTG+CR	Santamaria et al. [15]	18	0.9±0.24	2.0±0.3	1.97±0.26	-
	Santamaria et al. [25]	20	1.0±0.5	2.1±0.6	2.0±0.7	-

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Table 4. (Continued) mRC, CALG, KTT, KTW, PD, DS, and AA at 6-month, 12-month, and 24-month follow-up

Parameters	6, 12, and 24 months of follow-up					
	Study	Participants	Baseline	After 6 months	After 12 months	After 24 months
CAF	Santamaria et al. [22,23]	19	1.10±0.18	1.05±0.15	-	1.04±0.33
CAF+GIC-R	Lucchesi et al. [21]	20	0.83±0.37	0.93±0.37	-	-
	Santamaria et al. [22,23]	19	1.06±0.2	0.98±0.16	-	1.07±0.2
CAF+CR	Lucchesi et al. [21]	19	0.92±0.25	0.92±0.25	-	-
KTW (mm)						
CAF+CTG	Santamaria et al. [14,24]	20	2.38±1.22	3.05±1.11	3.17±1.5	3.20±1
	Santamaria et al. [15]	18	2.41±1.2	2.88±0.96	3.0±0.9	-
	Santamaria et al. [25]	20	2.9±0.9	4.1±0.8	4.1±1.1	-
	Gharat et al. [27]	13	2.84±1.01	4.26±0.75	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	3.28±1.56	5.62±0.96	5.62±0.96	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	2.54±1.17	3.34±0.91	3.38±1.46	3.56±1.46
	Dursun et al. [26]	18	2.83±1.85	4.89±1.84	4.89±1.84	-
CAF+CTG+CR	Gharat et al. [27]	13	3.12±1.75	4.56±1.42	-	-
	Santamaria et al. [15]	18	2.27±0.86	2.59±0.76	2.73±0.75	-
	Santamaria et al. [25]	20	2.7±1.3	4.1±0.9	4.2±1.7	-
CAF	Santamaria et al. [22,23]	19	3.05±0.86	3.23±0.72	-	3.25±0.56
CAF+GIC-R	Lucchesi et al. [21]	20	3.58±0.94	3.70±0.98	-	-
	Santamaria et al. [22,23]	19	2.86±0.85 ^f	2.97±0.77	-	3.11±0.91
CAF+CR	Lucchesi et al. [21]	20	3.37±1.01	3.32±0.82	-	-
PD (mm)						
CAF+CTG	Santamaria et al. [14,24]	20	1.15±0.48	2.1±0.55	2.0±0.45	2.0±0.34
	Santamaria et al. [15]	18	1.16±0.38	2.1±0.47	2.0±0.48	-
	Santamaria et al. [25]	20	1.3±0.5	2.1±0.6	2.0±0.5	-
	Gharat et al. [27]	13	2	1	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	1.21±0.03	1.37±0.43	1.28±0.39	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	1.1±0.44	2.15±0.67	2.12±0.56	2.11±0.78
	Dursun et al. [26]	18	1.73±0.64	1.61±0.35	1.88±0.29	-
	Gharat et al. [27]	13	2	1	-	-
CAF+CTG+CR	Santamaria et al. [15]	18	1.11±0.47	2.77±0.42	2.66±0.48	-
	Santamaria et al. [26]	20	1.2±0.5	2.5±0.5	2.6±0.7	-
CAF	Santamaria et al. [22,23]	19	1.25±0.44 ^g	1.31±0.47 ^g	1.5±0.51	1.5±0.51
CAF+GIC-R	Lucchesi et al. [21]	20	1.5±0.5	1.4±0.5	-	-
	Santamaria et al. [22,23]	19	1.18±0.40 ^h	1.00±0.36 ^h	1.12±0.5	1.25±0.44
CAF+CR	Lucchesi et al. [21]	20	1.3±0.5	1.3±0.6	-	-
DS (%)						
CAF+CTG	Santamaria et al. [14,24]	20	60	35	-	-
	Santamaria et al. [15]	18	94.4	44.4	-	-
	Santamaria et al. [26]	20	80	45	-	-
	Gharat et al. [27]	13	4	1	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	-	-	-	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	70	5	-	-
	Dursun et al. [26]	18	-	-	-	-
	Gharat et al. [27]	13	2	0	-	-
CAF+CTG+CR	Santamaria et al. [15]	18	88	5.5	-	-
	Santamaria et al. [25]	20	70	10	-	-
CAF	Santamaria et al. [22,23]	19	68.42	47.36	-	-
CAF+GIC-R	Lucchesi et al. [21]	20	-	-	-	-
	Santamaria et al. [22,23]	19	68.42	5.26	-	-
CAF+CR	Lucchesi et al. [21]	20	-	-	-	-
AA (VAS)						
CAF+CTG	Santamaria et al. [14,24]	20	-	-	-	-
	Santamaria et al. [15]	18	2.41±2.19	8.35±2.24	8.29±2.3	-
	Santamaria et al. [25]	20	4.1±2.9	9±2.3	9.2±1.1	-
	Gharat et al. [27]	13	-	-	-	-
CAF+CTG+GIC	Dursun et al. [26]	18	-	-	-	-
CAF+CTG+GIC-R	Santamaria et al. [14,24]	20	-	-	-	-
	Dursun et al. [26]	18	-	-	-	-
	Gharat et al. [27]	13	-	-	-	-

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Table 4. (Continued) mRC, CALG, KTT, KTW, PD, DS, and AA at 6-month, 12-month, and 24-month follow-up

Parameters	6, 12, and 24 months of follow-up					
	Study	Participants	Baseline	After 6 months	After 12 months	After 24 months
CAF+CTG+CR	Santamaria et al. [15]	18	3.44±2.9	8.61±1.37	8.66±1.13	-
	Santamaria et al. [25]	20	4.6±2.3	9.1±2.2	9.1±1.0	-
CAF	Santamaria et al. [22,23]	19	-	-	-	-
CAF+GIC-R	Lucchesi et al. [21]	20	-	-	-	-
	Santamaria et al. [22,23]	19	-	-	-	-
CAF+CR	Lucchesi et al. [21]	20	-	-	-	-

CALG: clinical attachment level gain, DS: dentin sensitivity, GR: gingival recession, mRC: mean percentage of root coverage, GCA: gain in clinical attachment, KTT: keratinized tissue thickness, KTW: keratinized tissue width, PD: probing depth, DS: dentin sensitivity, AA: aesthetic assessment, GM: gingival margin, CEJ: cementoenamel junction; CAF: coronally advanced flap, CTG: connective tissue graft, GIC: glass ionomer cement, GIC-R: glass ionomer cement restoration, CR: composite resin.

aRelative gingival recession: distance from the GM to the apical border of stent; bDistance from the CEJ (estimated by Zsuzsanna et al. [44]) to the GM; cConsidered losses; dCoverage extending up to the estimated CEJ [44]; ePercentage of coverage of the combined defect; fBaseline value recalculated with dropouts: KTW: 3.16±0.85; ePD: 1.31±0.47, 1.37±0.5; hPD: 1.25±0.44, 1±0.36.

3) CAF+CTG+GIC-R

This combination was investigated in 3 studies [14,24,26,29]. The mRCs ranged from 88.64% at the 6-month evaluation [30] to 93.29% at the 24-month evaluation. Dursun et al. [26] found an mRC of 89.49% in a 1-year evaluation. Meanwhile, Gharat et al. [27] reported a maximum coverage rate of 61% (8 of 13 cases).

4) CAF+CTG+CR

The mRC achieved using CAF+CTG+CR was evaluated in 2 studies [15,25]. Only the crown portion of the lesion was restored in a study by Santamaria et al. [25]. Filling with the restorative material was limited to 1 mm from the estimated position of the CEJ. In addition, the mRC of the combined defects in that study was 75.3%. Meanwhile, a study that evaluated the complete filling of the lesion with the restorative material found an mRC of 73.84%.

5) CAF

Among the studies included in the present review, only 1 [22,23] investigated the effect of periodontal surgery (CAF) on areas with NCCLs. The mRC was 97.48% and 83.46% at 6-month and 24-month evaluations, respectively. In the article by Lucchesi et al. [21], who used this technique, GR was not associated with NCCLs, and the control group was not considered for this or other evaluations, as the teeth did not have NCCLs.

6) CAF+GIC-R

In 2 studies [21-23], NCCLs were filled with restorative materials. The mRC was 71.99% at the 6-month evaluation in the study by Lucchesi et al. [21]. Meanwhile, the mRC was 88% at the 6-month evaluation in the study by Santamaria et al. [22,23], decreasing to 80.83% at the 24-month evaluation.

7) CAF+CR

Only 1 study [21], which had an mRC of 74.18%, compared the effect of CR restorations performed 2 weeks prior to the surgical procedure combined with coverage using a CAF.

Gain in clinical attachment and probing depth

1) CAF+CTG

The studies evaluating CAF+CTG found clinical attachment gains ranging from 1.5 mm at the 6-month evaluation [24] to 1.8 mm at the 24-month evaluation [14]. In subsequent studies of the same group, the mean attachment gain was 1.7 mm [25] and 1.9 mm [15]. Moreover, the

mean probing depth increased from 1 mm at baseline to 2 mm at the 6-, 12-, and 24-month follow-ups. Gharat et al. [27] did not report gains in clinical attachment, but the probing depth decreased to an average of 1 mm after the intervention.

2) CAF+CTG+GIC

In the study by Dursun et al. [26], the gain in clinical attachment was 1.6 mm at the 12-month evaluation. The mean probing depth remained practically unaltered throughout the entire follow-up period of the study (**Tables 3 and 4**).

3) CAF+CTG+GIC-R

The gain in clinical attachment in the study by Santamaria et al. [14,24] was 1.2 mm and 1.3 mm at the 6-month and 24-month evaluations, respectively. Meanwhile, Dursun et al. [26] reported a gain of 1.6 mm after 12 months. Santamaria et al. [14,24] found a mean increase of 1 mm in the probing depth throughout the follow-up period. In the study by Dursun et al. [26], the probing depth was 1.7 mm at baseline and 1.8 mm at the 1-year follow-up. In the study by Gharat et al. [27], the probing depth decreased by an average of 1 mm in the group that received CAF+CTG+GIC-R after the intervention.

4) CAF+CTG+CR

For the studies that investigated CAF+CTG+CR [15,25], the gain in clinical attachment ranged from 0.5 mm [25] to 1.1 mm [15]. Probing depth increased from 1.1 mm at baseline to 2.6 mm after 1 year of follow-up.

5) CAF

The study by Santamaria et al. [22,23] was the only one to report NCCL coverage using this technique. The mean gain in clinical attachment was 1.5 mm at the 6-month evaluation, changing to 1.2 mm after 24 months. The probing depth was 1.2 mm at baseline and 1.5 mm after 24 months.

6) CAF+GIC-R

The 2 studies that had this evaluation group [21-23] reported a gain in clinical attachment ranging from 1.5 mm [22] to 2.2 mm [21] at the 6-month follow-up, decreasing to 1.3 mm after 24 months. The probing depth changed from 1.5 to 1.4 mm in 1 study [21] and from 1.1 to 1.2 mm in another study [22,23] after 24 months.

7) CAF+CR

A mean gain in attachment of 2.2 mm was reported in a study that evaluated this combination [21]. The mean probing depth remained 1.3 mm from baseline until the 6-month follow-up.

Thickness and width of the keratinized tissue

1) CAF+CTG

In the studies by Santamaria et al. [14,15,24,25], the keratinized tissue thickness changed from 0.9 mm at baseline to 1.9 mm after 1 and 2 years of observation. Meanwhile, the keratinized tissue width increased from 2.3 to 3.2 mm [14,24] and from 2.9 to 4.1 mm [25]. In the study by Gharat et al. [27], the keratinized tissue thickness and width ranged from 1.39 to 2.20 mm and from 2.84 to 4.26 mm, respectively, at the 6-month evaluation.

2) CAF+CTG+GIC

In the study by Dursun et al. [26], the keratinized tissue thickness changed from 1.2 mm at baseline to 2.3 mm at the 12-month follow-up, while the width changed from 3.3 to 5.3 mm in the same period.

3) CAF+CTG+GIC-R

With CAF+CTG+GIC-R, the gingival tissue thickness changed from 0.8 mm at baseline [14] to 1.9 mm at the 6-month evaluation and 1.8 mm at the 24-month evaluation [24]. In the study by Dursun et al. [26], the thickness changed from 1.2 mm at baseline to 2.3 mm after 12 months of follow-up. Meanwhile, the keratinized tissue width changed from 2.5 to 3.5 mm after 24 months of follow-up in the study by Santamaria et al. [14,24]. Dursun et al. [26] also found an increase from 2.8 to 4.8 mm after 12 months of follow-up. In the study by Gharat et al. [27], the keratinized tissue thickness changed from 1.6 to 2.2 mm at the 6-month evaluation, while the keratinized tissue width changed from 3.1 to 4.56 mm in the same period.

4) CAF+CTG+CR

Studies that evaluated keratinized tissue thickness demonstrated a change from 0.9 mm at baseline to 2 mm after 24 months of follow-up [15,25]. The keratinized tissue width changed from 2.2 to 2.7 mm at the 1-year follow-up in the study with complete filling of the NCCL [15] and from 2.7 to 4.2 mm in the study with partial filling of the lesion [25].

5) CAF

Only 1 study [22,23] considered the coverage of NCCLs using CAF. The thickness of the gingival tissue slightly varied, changing from 1.10 mm at baseline to 1.05 mm 24 months after the intervention. The keratinized tissue width also changed from 3.05 mm to 3.25 mm in the same period.

6) CAF+GIC-R

Two studies considered CAF+GIC-R [21-23]. A minimal change in keratinized tissue thickness was found in both studies. The mean value changed from 0.8 to 0.9 mm after 6 months of follow-up in the study by Lucchesi et al. [21] and remained stable at 1 mm throughout the 2-year follow-up in the study by Santamaria et al. [22,23]. The keratinized tissue width also changed slightly throughout the evaluation period in both studies (**Tables 3 and 4**).

7) CAF+CR

In a study that evaluated CAF+CR [21], the keratinized tissue thickness was unaltered and remained 0.92 mm throughout the follow-up period. The average keratinized tissue width remained 3 mm in the same period evaluated in the study.

Dentin sensitivity and esthetic assessment

1) CAF+CTG

The method employed in most studies was to ask the patient regarding the presence or absence of dentin sensitivity before and after the intervention. This outcome was evaluated in studies conducted by Santamaria et al. [15,24,25], but with differences in the form of assessment.

In the study by Santamaria et al. [24], the assessment was based on the participants' answers regarding pain symptoms before and after CAF+CTG; 60% reported sensitivity prior to the intervention, and this figure dropped to 35% at the 6-month evaluation. A change in the assessment method was found in subsequent studies [15,25], in which the evaporative

stimulus was employed, with reductions of 35% [15] and 50% [25] in the number of positive answers for dentin sensitivity after the interventions. Meanwhile, Gharat et al. [27] used a visual analogue scale (VAS) as an assessment tool and reported a reduction in dentin sensitivity (**Tables 3 and 4**).

Two studies performed an esthetic assessment [15,25] considering the opinion of periodontists and patients using a modification of the esthetic score proposed by Cairo et al. [31] and a VAS, respectively. The esthetic score was 7.4 after the intervention with CAF+CTG [15]. Regarding the variables considered individually, more teeth presented a flatter marginal contour [15,25]. For the patient-reported assessment, a score of 9.2 was found. Gharat et al. [27] did not perform an esthetic assessment.

2) CAF+CTG+GIC

Dursun et al. [26] presented no data on this combination but reported a significant reduction in dentin sensitivity. Gharat et al. [27] also reported a significant reduction in dentin sensitivity. The study by Gharat et al. [27] conducted an esthetic assessment based on the method proposed by Cairo et al. [31], but it was limited to professional opinions, and the dentin sensitivity score was 9.06.

3) CAF+CTG+GIC-R

Three studies evaluated dentin sensitivity and esthetics in this group [24,26,27]. Santamaria et al. [24] reported a 65% reduction in positive answers regarding dentin sensitivity after the intervention, while Dursun et al. [26] only mentioned a significant reduction in positive answers. Gharat et al. [27] also reported a reduction in dentin sensitivity after the intervention (**Tables 3 and 4**), although the authors did not assess esthetics in their study.

4) CAF+CTG+CR

Two studies evaluated CAF+CTG+CR [15,25]. In the study by Santamaria et al. [15], complete restoration of NCCLs was performed, and a reduced number of reports on sensitivity was found in 83% of cases. In a subsequent study [25], the authors performed partial restoration of the lesion, with a 60% reduction in positive responses to stimuli. An esthetic assessment was performed by professionals using a modification of the esthetic score proposed by Cairo et al. [31] and by the patients using a VAS. No significant differences were found in the assessment by the professionals when the score was considered as a whole. Considering the variables individually, the teeth that received CR (complete or partial filling of the lesion) exhibited a better marginal contour of the gingiva. The esthetic assessment performed by the patients using a VAS yielded scores ranging from 8.6 [15] to 9.1 [25] at the 1-year follow-up.

5) CAF

The study of Santamaria et al. [22] was the only one that investigated the reduction in dentin sensitivity after CAF treatment. The method involved asking the patient regarding the presence or absence of sensitivity before and after the intervention. According to the authors, 47.36% of the participants reported symptoms of sensitivity after the intervention.

6) CAF+GIC-R

Santamaria et al. [22] evaluated CAF+GIC-R. The proportion of study participants with complaints of sensitivity decreased from 68.42% of the participants at baseline to 5.26% 6 months after the combined intervention.

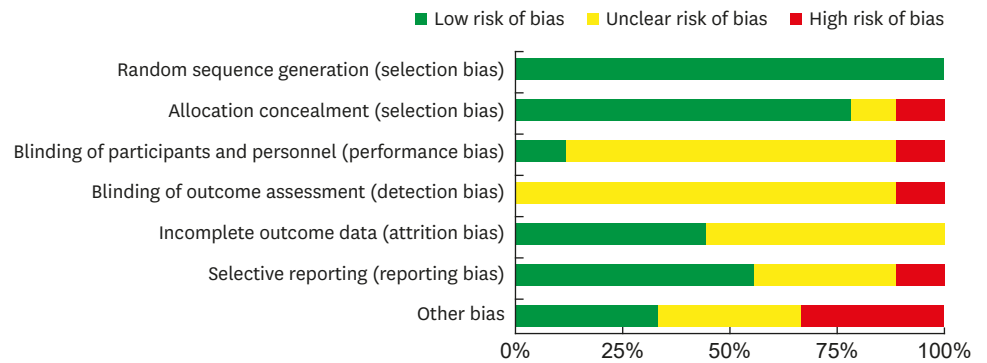


Figure 2. Graph of the risk of bias judgment: showing percentages of all included studies.

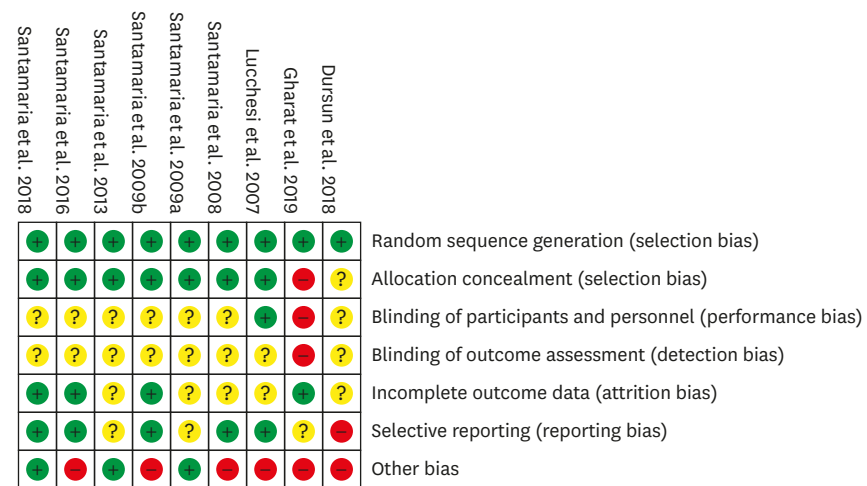


Figure 3. Summary of judgments for each risk of bias item in the included studies.

7) CAF+CR

None of the studies in the present review investigated the reduction in dentin sensitivity or performed esthetic assessments for the CAF+CR intervention.

Quality of studies included in the review

The assessment of the risk of bias is summarized in **Figures 2 and 3**. Regarding allocation concealment, the risk of bias was considered unclear in 1 study [26] and high in 1 study [27]. For blinding of participants, the risk was considered unclear in 5 studies [14,15,22-26] and high in 1 study [23]. The risk of detection bias was unclear in 6 studies [14-26,30,32-44] and high in 1 study [27]. Regarding incomplete outcome data, the risk of bias was unclear in 4 studies reported in 5 publications [14,21-23,26]. For selective reporting, 1 study [26] had a high risk of bias, and 3 had an unclear risk of bias [14,23,27]. For other sources of bias, 5 studies [15,21,22,24,26,27] were found to have a high risk of bias and 1 [27] had an unclear risk.

DISCUSSION

The present systematic review demonstrated that the combination of restorative treatment and periodontal plastic surgery yielded similar mRCs in the test and control groups [14,15,21,23-27]. However, considerable variation in mean values was found among the studies analyzed,

which may be explained by the variability in the methods employed to measure the dimensions of the root portion of the NCCLs that served as the basis for mRC determination.

Only 2 studies [15,25] evaluated mRC in Miller class II GRs. However, the results were not categorized for this type of recession. Complete coverage of the NCCLs occurred in 16 of the 255 defects that received surgical interventions and was commonly found in groups that received a CTG. This finding agrees with previous reports in the literature [45], demonstrating that the presence of an NCCL is a negative prognostic factor for complete coverage and recession reduction. It is considered that an NCCL reduces the contact and stability of the graft against the root surface, making it difficult to position the gingival margin of the flap [46]. Therefore, it would be expected that in studies where both comparison groups had NCCLs, those with restored lesions would present superior mRC results. This finding was not observed in this review, perhaps due to the small number of studies that made this comparison directly [14,15,22-25,27].

Furthermore, most of these studies were carried out by a single research group, which may have developed specialized skills and surgical methods to perform this type of procedure, making it difficult to compare their results with those of other periodontists. For the same reason, it was not possible to evaluate which restorative material was related to a higher or lower rate of root coverage.

All studies reported gains in clinical attachment at the end of the evaluation period. The lowest gain was reported for the test group in the study by Santamaria et al. [25], which investigated partial NCCL filling with CR combined with CAF+CTG treatment (**Tables 3 and 4**).

The analysis of the probing depth in the studies conducted by Santamaria et al. [14,15,24,25] revealed an increasing trend when CAF+CTG was used, especially when combined with restorations using CR [15,25]. However, this increase did not compromise periodontal health, as the gingival sulcus remained shallow and accessible to hygiene procedures.

Another study reported bleeding on probing and plaque buildup at the sites evaluated in this group, probably due to the periodontal maintenance protocol implemented for the study. However, other studies [26,27] have presented conflicting results. Dursun et al. found no significant changes in probing depth, whereas Gharat et al. [27] found a reduction in probing depth.

The thickness of keratinized tissues remained practically unaltered compared to the baseline in studies that employed CAF alone [21-23]. In contrast, a gain in keratinized tissue thickness occurred in those that used CAF+CTG [14,15,24-27], and this gain remained slightly more stable after 2 years when employing GIC-R as the restorative material [14] (**Table 4**). The same did not occur at the 2-year follow-up in the study that evaluated CAF alone combined with GIC-R.

The same trend was observed for the width of keratinized tissues. These findings agree with previous data reported in the literature [9,10]. The consideration of these aspects is important, as the risk of GR recurrence may be associated with keratinized tissue thickness of <2 mm [10]. Pini Prato et al. [9,10] found an increased risk of GR recurrence in patients with NCCLs following treatment with CAF or CAF+CTG after a 20-year follow-up. Rasperini et al. [45] compared the results of groups treated with CAF alone or CAF+CTG and found that the

presence of NCCL exerted a negative influence on the maintenance of complete root coverage ($P=0.022$; odds ratio, 0.12; 95% confidence interval, 0.02–0.74).

The detection of dentin sensitivity was evaluated at 6-month follow-up examinations in studies conducted by Santamaria et al. [15,22,24,25] and Gharat et al. [27], and at a 12-month follow-up in the study by Dursun et al. [26]. All studies that investigated this outcome reported a reduction in both the test and control groups.

In the studies by Santamaria et al. [15,25], which investigated the effect of restoration with CR and CAF+CTG, the reduction in dentin sensitivity differed significantly between groups, favoring the test group. However, caution should be exercised when interpreting this information because of the potential risks of bias related to the measurement instruments of the data found in several of these studies [15,22,24,25].

None of the researchers in the studies analyzed in the present review measured the degree of patient satisfaction with esthetic outcomes. However, Santamaria et al. [15,25] reported esthetic assessments by the patients using a VAS and found a significant improvement when comparing the final and baseline ratings within groups, although without significant differences.

Santamaria et al. [15,25] investigated the esthetic assessments of a periodontist after using CR as the restorative material. In their first study, the authors used a modified version of the esthetic score developed by Cairo et al. [31], in which an improvement was found in the color of the restoration or the uncovered cervical area. No significant differences were found between the test and control groups when all the components of the instrument were evaluated at the 12-month evaluation. However, when the evaluation was performed separately for each component, better results were found in the test group (having received a restoration) regarding the marginal contour of the gingiva, which tended to be flatter in the groups without a restoration. The authors explained this finding as reflecting a tendency for the gingival tissue to follow the contour of the surface on which it is supported during the healing process.

In a previous publication [46], the same research group used the same instrument in a retrospective analysis of the esthetic aspect of teeth that received a combination of restoration with GIC-R and periodontal coverage surgery involving CAF with or without CTG after 2 years of follow-up. The groups that underwent restorations with GIC-R had lower scores than those that did not receive restorations, despite maintaining a better gingival contour. This was explained by the tendency towards discoloration of the restorative material over time.

Dursun et al. [26] also used the esthetic score originally described by Cairo et al. [31] and found no difference between groups at the 2-year evaluation.

Several studies [14,15,22,24-26] were evaluated as having an unclear risk of performance and detection bias due to limitations regarding the blinding of the participants and evaluators. One study [27] was considered to have a high risk of selection, performance, and detection biases due to the failure to describe whether and how allocation concealment and blinding of the participants and evaluators were performed. Therefore, it was not possible to determine whether or how these factors may have interfered with the collection and evaluation of the results, which reduces the reliability of the effect estimates. One study [26] was determined to

have an unclear risk regarding allocation concealment, as the same researcher who performed the randomization of the participants also implemented the restoration procedures.

Five studies [15,21,22,24,26] were evaluated as having a high risk of bias from other sources, which mainly referred to the risk of measurement bias related to the data collection on dentin sensitivity [15,21,22,24,26,27]. In 1 study [21], a divergence was found between the number of patients reported in the publication and the number reported in the original dissertation. A high risk of selective reporting was found in another study [26], as there was no presentation of data referring to dentin sensitivity or esthetic assessments.

The possibility of classifying the groups in a more simplified way, considering only the type of surgical intervention (CAF or CAF+CTG) or restorative material was considered. However, the studies showed extensive methodological heterogeneity regarding the evaluation periods, comparison groups, type of restorative material, and restoration technique (total or partial filling of the NCCL). Moreover, most publications came from the same research group, and there was a possibility that data referring to the control groups could have been considered in more than 1 study. A meta-analysis performed using these data could result in misinterpretations.

This review process has limitations that should be considered. It was not possible to access the literature contained in databases with fewer technological resources that could be potential sources of publications of interest. Likewise, articles and abstracts presented at conferences not indexed with the terms used in the search filter could not be obtained. For articles with incomplete data, the authors were contacted, but some did not answer on time for the present review, which precluded meta-analyses.

During the analysis, the decision was made to report the rate of root coverage as described in previous publications. However, one must consider the different methods employed for the measurement of this outcome, which could lead to inconsistencies regarding the comparisons of the studies in terms of this and other variables. For instance, Lucchesi et al. [21] evaluated the width of the gingival tissue as a parameter to calculate the root coverage rate using a point marked on a stent as a reference, as an alternative to the lost CEJ, without clarifying the criterion for the location of this point.

Other authors [14,15,22-25,27] used the width of the cervical lesion on digital photographs as a parameter to estimate the position of the CEJ, citing the method developed by Zucchelli et al. [28]. A 2-dimensional image was used to determine the volume of coverage achieved in the cervical region affected by the NCCL without considering the morphological variations in the root surface resulting from NCCLs with different shapes [47].

Zucchelli et al. [28,29] stated that determining the CEJ in this manner can potentially induce small variations in the measurements. A previous study by the same authors demonstrated that the predetermination of the width of the gingival margin using this method was imprecise in 28% of the cases evaluated [29]. In the realm of research, variations of this magnitude are concerning.

The definition of a clear, easy, and reproducible method for accurately estimating the position of the CEJ is probably the most critical point in restorative procedures. The CEJ serves as a reference for the positioning of the gingival margin during root coverage surgery

and as a limit for the calculation of the percentage of root coverage, as it establishes the crown and root portions of the lesion.

In the comparison of the mean percentages of coverage achieved in the included studies, the periodontal surgical technique that achieved the best coverage and stability results in the medium term was CAF+CTG, which agrees with findings described in a previous systematic review [11,48]. Using adhesive restorative material to fill NCCLs did not contribute to any changes in the clinical parameters analyzed, which agrees with the data reported by Agossa et al. [49].

In addition, we generally observed that when the NCCLs were filled with CR, there were greater probing depths than when glass ionomer was used as a filling, which suggests a possible better tissue response to glass ionomer materials. However, in the medium term, glass ionomer restorations have compromised esthetics due to changes in the color of the material. Together, these findings justify the development of research on restorative materials that combine the biological effect of glass ionomers with the esthetics of CR.

In conclusions, no definitive conclusion could be drawn due to the insufficient evidence for estimating the effectiveness of the interventions. Despite this limitation, the findings suggest the following points:

- The treatment of NCCLs on teeth with GR through a combination of restoration and periodontal surgery involving CAF with or without CTG does not seem to promote better results in terms of periodontal parameters in comparison to periodontal surgery alone.
- The surgical technique that led to greatest keratinized tissue width and thickness and stable results in terms of the percentage of root coverage after 2 years was CAF+CTG, without a significant difference between groups (with or without restoration of the NCCL).
- The use of GIC-R was associated with better results in terms of tissue behavior compared to the use of CR. However, the tendency toward discoloration of the material over time negatively influenced the esthetic evaluation, whereas this was not a problem when CR was used.
- Owing to the currently employed measurement methods, it is not possible to demonstrate the degree of predictability of root coverage on teeth with NCCLs.

Future research should include 1) studies presenting more accurate methods for the estimation of CEJ position and, consequently, the definition of the volume of root coverage on surfaces with anatomic changes caused by NCCLs; 2) studies investigating the risk of the recurrence of GR on surfaces with non-restored NCCLs in the long term in different populations, focusing on patient-centered outcomes (dentin sensitivity, esthetics, etc.); 3) studies including larger populations and employing similar methods with a longer follow-up period; and 4) studies assessing a possible association between the width of the lesion and the coverage potential of the defect using different surgical techniques.

REFERENCES

1. Caffesse RG, Guinard EA. Treatment of localized gingival recessions. Part II. Coronally repositioned flap with a free gingival graft. *J Periodontol* 1978;49:357-61.
[PUBMED](#) | [CROSSREF](#)

2. Løe H, Ånerud A, Boysen H. The natural history of periodontal disease in man: prevalence, severity, and extent of gingival recession. *J Periodontol* 1992;63:489-95.
[PUBMED](#) | [CROSSREF](#)
3. Jati AS, Furquim LZ, Consolaro A. Gingival recession: its causes and types, and the importance of orthodontic treatment. *Dental Press J Orthod* 2016;21:18-29.
[PUBMED](#) | [CROSSREF](#)
4. Billings M, Holtfreter B, Papapanou PN, Mitnik GL, Kocher T, Dye BA. Age-dependent distribution of periodontitis in two countries: Findings from NHANES 2009 to 2014 and SHIP-TREND 2008 to 2012. *J Periodontol* 2018;89 Suppl 1:S140-58.
[PUBMED](#) | [CROSSREF](#)
5. Chrysanthakopoulos NA. Gingival recession: prevalence and risk indicators among young Greek adults. *J Clin Exp Dent* 2014;6:e243-9.
[PUBMED](#) | [CROSSREF](#)
6. Costa RSA, Rios FS, Moura MS, Jardim JJ, Maltz M, Haas AN. Prevalence and risk indicators of dentin hypersensitivity in adult and elderly populations from Porto Alegre, Brazil. *J Periodontol* 2014;85:1247-58.
[PUBMED](#) | [CROSSREF](#)
7. Wagner TP, Costa RSA, Rios FS, Moura MS, Maltz M, Jardim JJ, et al. Gingival recession and oral health-related quality of life: a population-based cross-sectional study in Brazil. *Community Dent Oral Epidemiol* 2016;44:390-9.
[PUBMED](#) | [CROSSREF](#)
8. Pini-Prato G, Magnani C, Zaheer F, Rotundo R, Buti J. Influence of inter-dental tissues and root surface condition on complete root coverage following treatment of gingival recessions: a 1-year retrospective study. *J Clin Periodontol* 2015;42:567-74.
[PUBMED](#) | [CROSSREF](#)
9. Pini Prato GP, Magnani C, Chambrone L. Long-term evaluation (20 years) of the outcomes of coronally advanced flap in the treatment of single recession-type defects. *J Periodontol* 2018;89:265-74.
[PUBMED](#) | [CROSSREF](#)
10. Pini Prato GP, Franceschi D, Cortellini P, Chambrone L. Long-term evaluation (20 years) of the outcomes of subepithelial connective tissue graft plus coronally advanced flap in the treatment of maxillary single recession-type defects. *J Periodontol* 2018;89:1290-9.
[PUBMED](#) | [CROSSREF](#)
11. Cairo F, Pagliaro U, Buti J, Baccini M, Graziani F, Tonelli P, et al. Root coverage procedures improve patient aesthetics. A systematic review and Bayesian network meta-analysis. *J Clin Periodontol* 2016;43:965-75.
[PUBMED](#) | [CROSSREF](#)
12. Cairo F. Periodontal plastic surgery of gingival recessions at single and multiple teeth. *Periodontol* 2000 2017;75:296-316.
[PUBMED](#) | [CROSSREF](#)
13. Madeley E, Duane B. Coronally advanced flap combined with connective tissue graft; treatment of choice for root coverage following recession? *Evid Based Dent* 2017;18:6-7.
[PUBMED](#) | [CROSSREF](#)
14. Santamaria MP, da Silva Feitosa D, Casati MZ, Nociti FH Jr, Sallum AW, Sallum EA. Randomized controlled clinical trial evaluating connective tissue graft plus resin-modified glass ionomer restoration for the treatment of gingival recession associated with non-carious cervical lesion: 2-year follow-up. *J Periodontol* 2013;84:e1-8.
[PUBMED](#) | [CROSSREF](#)
15. Santamaria MP, Queiroz LA, Mathias IF, Neves FL, Silveira CA, Bresciani E, et al. Resin composite plus connective tissue graft to treat single maxillary gingival recession associated with non-carious cervical lesion: randomized clinical trial. *J Clin Periodontol* 2016;43:461-8.
[PUBMED](#) | [CROSSREF](#)
16. Cairo F, Cortellini P, Nieri M, Pilloni A, Barbato L, Pagavino G, et al. Coronally advanced flap and composite restoration of the enamel with or without connective tissue graft for the treatment of single maxillary gingival recession with non-carious cervical lesion. A randomized controlled clinical trial. *J Clin Periodontol* 2020;47:362-71.
[PUBMED](#) | [CROSSREF](#)
17. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015;4:1.
[PUBMED](#) | [CROSSREF](#)
18. Lang NP, Bartold PM. Periodontal health. *J Clin Periodontol* 2018;45 Suppl 20:S9-16.
[PUBMED](#) | [CROSSREF](#)

19. Bimstein E, Eidelman E. Morphological changes in the attached and keratinized gingiva and gingival sulcus in the mixed dentition period. A 5-year longitudinal study. *J Clin Periodontol* 1988;15:175-9.
[PUBMED](#) | [CROSSREF](#)
20. Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al. *Cochrane handbook for systematic reviews of interventions*. Chichester: John Wiley & Sons; 2019.
21. Lucchesi JA, Santos VR, Amaral CM, Peruzzo DC, Duarte PM. Coronally positioned flap for treatment of restored root surfaces: a 6-month clinical evaluation. *J Periodontol* 2007;78:615-23.
[PUBMED](#) | [CROSSREF](#)
22. Santamaria MP, Suaid FF, Casati MZ, Nociti FH Jr, Sallum AW, Sallum EA. Coronally positioned flap plus resin-modified glass ionomer restoration for the treatment of gingival recession associated with non-carious cervical lesions: a randomized controlled clinical trial. *J Periodontol* 2008;79:621-8.
[PUBMED](#) | [CROSSREF](#)
23. Santamaria MP, da Silva Feitosa D, Nociti FH Jr, Casati MZ, Sallum AW, Sallum EA. 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* 2009;36:434-41.
[PUBMED](#) | [CROSSREF](#)
24. Santamaria MP, Ambrosano GM, Casati MZ, Nociti Júnior FH, Sallum AW, Sallum EA. 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. *J Clin Periodontol* 2009;36:791-8.
[PUBMED](#) | [CROSSREF](#)
25. Santamaria MP, Silveira CA, Mathias IF, Neves FLDS, Dos Santos LM, Jardini MAN, et al. 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* 2018;45:968-76.
[PUBMED](#) | [CROSSREF](#)
26. Dursun E, Güncü GN, Dursun CK, Kiremitçi A, Karabulut E, Akalın FA. Nanofilled and conventional resin-modified glass ionomer fillings combined with connective tissue grafts for treatment of gingival recessions with non-carious cervical lesions. *J Oral Sci* 2018;60:344-51.
[PUBMED](#) | [CROSSREF](#)
27. Gharat MR, Zingade AN, Metgud R, Ajbani JM, Kaderi MA. Treatment of gingival recession associated with non-carious cervical lesions using resin modified glass ionomer cement with connective tissue graft a randomized controlled clinical trial. *J Dent Mater Tech* 2019;8:85-94.
28. Zucchelli G, Testori T, De Sanctis M. Clinical and anatomical factors limiting treatment outcomes of gingival recession: a new method to predetermine the line of root coverage. *J Periodontol* 2006;77:714-21.
[PUBMED](#) | [CROSSREF](#)
29. Zucchelli G, Mele M, Stefanini M, Mazzotti C, Mounssif I, Marzadori M, et al. Predetermination of root coverage. *J Periodontol* 2010;81:1019-26.
[PUBMED](#) | [CROSSREF](#)
30. Isler SC, Ozcan G, Ozcan M, Omurlu H. Clinical evaluation of combined surgical/ restorative treatment of gingival recession-type defects using different restorative materials: a randomized clinical trial. *J Dent Sci* 2018;13:20-9.
[PUBMED](#) | [CROSSREF](#)
31. Cairo F, Rotundo R, Miller PD Jr, Pini Prato GP. Root coverage esthetic score: a system to evaluate the esthetic outcome of the treatment of gingival recession through evaluation of clinical cases. *J Periodontol* 2009;80:705-10.
[PUBMED](#) | [CROSSREF](#)
32. Alkan A, Keskiner I, Yuzbasioglu E. Connective tissue grafting on resin ionomer in localized gingival recession. *J Periodontol* 2006;77:1446-51.
[PUBMED](#) | [CROSSREF](#)
33. Santamaria MP, Saito MT, Casati MZ, Nociti Junior FH, Sallum AW, Sallum EA. Gingival recession associated with noncarious cervical lesions: combined periodontal-restorative approach and the treatment of long-term esthetic complications. *Gen Dent* 2012;60:306-11.
[PUBMED](#)
34. Yang S, Lee H, Jin SH. A combined approach to non-carious cervical lesions associated with gingival recession. *Restor Dent Endod* 2016;41:218-24.
[PUBMED](#) | [CROSSREF](#)
35. Santos VR, Lucchesi JA, Cortelli SC, Amaral CM, Feres M, Duarte PM. Effects of glass ionomer and microfilled composite subgingival restorations on periodontal tissue and subgingival biofilm: a 6-month evaluation. *J Periodontol* 2007;78:1522-8.
[PUBMED](#) | [CROSSREF](#)

36. Santamaria MP, Casati MZ, Nociti FH Jr, Sallum AW, Sallum EA, Aukhil I, et al. Connective tissue graft plus resin-modified glass ionomer restoration for the treatment of gingival recession associated with non-carious cervical lesions: microbiological and immunological results. *Clin Oral Investig* 2013;17:67-77.
[PUBMED](#) | [CROSSREF](#)
37. Cairo F, Pini-Prato GP. A technique to identify and reconstruct the cemento-enamel junction level using combined periodontal and restorative treatment of gingival recession. A prospective clinical study. *Int J Periodontics Restorative Dent* 2010;30:573-81.
[PUBMED](#)
38. Zucchelli G, Gori G, Mele M, Stefanini M, Mazzotti C, Marzadori M, et al. Non-carious cervical lesions associated with gingival recessions: a decision-making process. *J Periodontol* 2011;82:1713-24.
[PUBMED](#) | [CROSSREF](#)
39. Perez LA, Lee A, Medina G, Eber R, Wang HL, Oh TJ. Combination flap surgery with resin-modified glass ionomer for the treatment of radicular lesions: a long-term follow-up. *Int J Periodontics Restorative Dent* 2013;33:825-32.
[PUBMED](#) | [CROSSREF](#)
40. Sharma V, Sharma M, Singh P, Saxena H, Sharma V, Sharma S, et al. Cervical restoration and the amount of soft tissue coverage achieved by coronally advanced flap. *J Adv Med Dent Sci Res* 2019;7:65-9.
41. Santamaria MP, Ambrosano GMB, Casati MZ, Nociti FH Jr, Sallum AW, Sallum EA. The influence of local anatomy on the outcome of treatment of gingival recession associated with non-carious cervical lesions. *J Periodontol* 2010;81:1027-34.
[PUBMED](#) | [CROSSREF](#)
42. Santamaria MP, Mathias IF, Dias SBF, Jardini MAN, Junior MS, Sallum EA. Esthetic evaluation of different approaches to treat gingival recession associated with non-carious cervical lesion treatment: a 2-year follow-up. *Am J Dent* 2014;27:220-4.
[PUBMED](#)
43. Pourabbas R, Kimyain S, Chitsazi T, Nourbaksh F. Clinical comparison of localized gingival recession coverage in root surfaces restored with giomer and intact root surfaces. *Afr J Biotechnol* 2011;10:5893-9.
[CROSSREF](#)
44. Zsuzsanna P, István G, Zsuzsanna E, Attila H. Miller I–II ínnyecesszióval kombinált fognyaki léziók restauratív és sebészi ellátása – Randomizált, kontrollált klinikai vizsgálat 6 hónapos eredményei. *Fogorv Sz* 2017;110:122-34.
45. Rasperini G, Acunzo R, Pellegrini G, Pagni G, Tonetti M, Pini Prato GP, et al. Predictor factors for long-term outcomes stability of coronally advanced flap with or without connective tissue graft in the treatment of single maxillary gingival recessions: 9 years results of a randomized controlled clinical trial. *J Clin Periodontol* 2018;45:1107-17.
[PUBMED](#) | [CROSSREF](#)
46. Holbrook T, Ochsenbein C. Complete coverage of the denuded root surface with a one-stage gingival graft. *Int J Periodontics Restorative Dent* 1983;3:8-27.
[PUBMED](#)
47. Araveti SK, Hiraishi N, Kominami N, Otsuki M, Sumi Y, Yiu CK, et al. Swept-source optical coherence tomographic observation on prevalence and variations of cemento-enamel junction morphology. *Lasers Med Sci* 2020;35:213-9.
[PUBMED](#) | [CROSSREF](#)
48. Chambrone L, Ortega MAS, Sukekava F, Rotundo R, Kalemaj Z, Buti J, et al. Root coverage procedures for treating single and multiple recession-type defects: an updated Cochrane systematic review. *J Periodontol* 2019;90:1399-422.
[PUBMED](#) | [CROSSREF](#)
49. Agossa K, Godel G, Dubar M, S Y K, Behin P, Delcourt-Debruyne E. Does evidence support a combined restorative surgical approach for the treatment of gingival recessions associated with noncarious cervical lesions? *J Evid Based Dent Pract* 2017;17:226-38.
[PUBMED](#) | [CROSSREF](#)