



Research article

Effectiveness of restorative materials on combined periodontal-restorative treatment of gingival recession with cervical lesion: A systematic review

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ABSTRACT

Introduction: Gingival recession associated with non-carious cervical lesions (NCCL) is a common finding in the majority of the population. Sometimes, periodontal surgery using connective tissue graft (CTG), which is the gold standard in the treatment of gingival recession, needs to be combined with adhesive restoration to restore sufficient convergence profile. Thus, this systematic review aims to evaluate periodontal-restorative therapy using CTG combined restorative material to treat gingival recession with NCCL.

Methods: This study, following PRISMA guidelines, involved a literature search across PubMed, Scopus, Embase, and Google Scholar for articles from 2014 to June 2023 using keywords related to connective tissue grafts, cervical lesions, and gingival recession combined using AND/OR as Boolean operator. It included randomized controlled trials (RCTs), prospective studies, case series, or reports involving adult subjects with gingival recession and non-carious cervical lesions treated with CTG and restorative care, with at least 6 months of follow-up. Data were independently extracted by two reviewers, with discrepancies resolved by consensus. Risk of bias was assessed using the Cochrane RoB 2.0 tool, ROBINS-I, and the JBI Critical Appraisal tool.

Results: 8 out of 1175 publications were selected for final analysis. Selected publications consist of randomized clinical trials, prospective studies, case series, and a case report. The restorative materials used include resin composite, resin-modified glass ionomer (RMGI), and giomers. It has been reported that the restoration showed no negative effect on the surrounding gingival tissue after surgical treatment. Resin composites and RMGI showed similar clinical results as restorative materials whereas giomers was reported to be less effective for the combined treatment of gingival recession associated with NCCL.

Conclusion: Therefore, the combination of surgical and restorative treatment provides stable clinical outcome and good emergence profile in gingival recession associated with NCCL. Root coverage with CTG is successful on teeth with cervical fillings.

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1. Introduction

Gingival recession (GR) is a common periodontal defect that is defined by the apical migration of the gingival margin beyond the cemento-enamel junction (CEJ) exposing root surface [1,2]. Etiology of this pathological finding can be divided into three groups: anatomical factors (bone dehiscence, root prominence, muscle traction, frenulum anatomy and abnormal position of teeth) [2–4], physiological factors (orthodontic movements), and pathological factors (traumatic brushing, periodontal disease, occlusal trauma, subgingival dental restorations, plaque biofilm, partial denture and iatrogenic factors) [2,5,6].

Approximately, 50 % of gingival recession is associated with non-carious cervical lesion (NCCL) creating a combined defect that complicates the determination of the original CEJ position [7,8]. Most of the NCCL occurred in upper premolars, due to their low capacity to absorb lateral forces [2]. Similar to GR, NCCLs also result from a variety of factors, including erosion, friction, attrition, abrasion, and occlusal stress contributing to their multifactorial origin [9,10]. Different etiologies of NCCL can be identified through different lesion morphologies, for example a wedge-shaped cervical lesion is usually associated with attrition or occlusal stress [11]. Prevalence of NCCLs are known to increase with age as a result of time-dependent progression process [12].

A classification based on the absence or presence of CEJ was proposed by Pini Prato et al. [13] consisting of four different classes: Class A, gingival recession presented a visible CEJ and intact root surface; Class A+, gingival recession presented a NCCL (step) and a visible CEJ; Class B, gingival recession associated with an unidentifiable CEJ without a surface discrepancy; Class B+, gingival recession associated with an unidentifiable CEJ with a surface discrepancy. This classification was presented as a decision tree intended for use by clinicians [7]. Class A, class A+ and class B can be managed solely by periodontal surgery. When dealing with class B+ cases, where a step is usually present between the root and crown, the optimal treatment approach would ideally combine periodontal and restorative interventions [13].

Among the various approaches available for treating gingival recession, the coronally advanced flap (CAF) is the most commonly used technique. The objective of gingival recession therapy is to achieve enduring, stable, functional and aesthetic long-term root coverage while minimizing morbidity and potential complication. The use of only CAF may result in recurrence of gingival recession, particularly among patients with thin tissue phenotype [14,15]. Combining CAF technique with the use of autogenous connective tissue graft (CTG), recognized as the gold standard grafting material [16,17], is regarded as the most predictable strategy for increasing the percentage of root coverage, tissue thickness, and keratinized tissue width. Up to now, this approach demonstrated greater effectiveness than other alternative treatment methods [16,18].

Restorative materials that have been reported to be successfully combined with CAF and CTG in the treatment of gingival recession accompanied by NCCL exhibit biocompatible properties [19,20]. Resin composites or resin modified glass ionomer cements is one of the frequently used restorative materials in NCCL treatment [21]. Surface texture, marginal integrity, anatomical form, and color match of resin composites are consistently found to be significantly superior in the majority of clinical assessments [22]. Resin-ionomer materials have many properties such as biocompatibility with soft and hard tissues and displaying high marginal adaptation and minimal surface roughness as well as allowing them to be used successfully in the subgingival region [23]. Another material that has been suggested is a Fluoride-releasing resin material with pre-reacted glass (PRG), called giomer. It is reported to have good color matching, biocompatibility, smooth surface finish, fluoride release and fluoride recharge potential [24,25]. Among the several recommended restorative materials, the aim of the present study is to evaluate various restorative materials in combination with connective tissue graft in the treatment of gingival recessions associated with non-carious cervical lesions.

2. Method

This systematic review is conducted in accordance with the principles outlined in the PRISMA statement (Preferred Reporting Items for Systematic Review and Meta-Analysis) and has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) with the code CRD42023445472.

2.1. Focused question

The aim of this systematic review is to compare various restorative materials used with connective tissue graft (CTG) for periodontal-restorative treatment in gingival recession with non-carious cervical lesions (NCCL). The systematic review's focused question, developed using the PICO framework (Population, Intervention, Comparison, Outcome), can be stated as follows:

- Population: Healthy adult patients with gingival recession and non-carious cervical lesions.
- Intervention: Periodontal-restorative treatment using CTG and restorative material for gingival recession treatment accompanied by NCCL.
- Comparison: Periodontal-restorative treatment using CTG and other restorative materials for gingival recession treatment accompanied by NCCL.
- Outcome: Conclusions from each study.

2.2. Search strategy

An extensive literature search was carried out across various databases, such as PubMed, Embase, Scopus, and Google Scholar, including articles from 2014 to June 2023, with the aim of retrieving relevant articles. This review incorporated the following key-words: “connective tissue graft”, restoration, resin, composite, “glass ionomer”, “gingival recession” and “cervical lesion” combined using AND/OR as Boolean operator.

2.3. Inclusion and exclusion criteria

This review includes articles that met the following criteria:

- Randomized controlled trials (RCTs), prospective studies, case series, or case reports evaluating the analyzed outcomes.
- Adult subjects with single or multiple gingival recessions accompanied by NCCL who underwent treatment with CTG and restorative care.
- Studies with a minimum follow-up period of 6 months.

Moreover, exclusion was determined based on the following criteria:

- In vitro studies.
- Animal studies.
- Studies comparing various types of tissue graft materials.
- Studies comparing different surgical techniques or restorative approaches.
- Studies where clinical outcomes were not relevant.

2.4. Screening method

Two reviewers (F.C.H. and Y.S.) carried out the initial search separately, and the screening of titles and abstracts was performed manually. Following this, both reviewers independently assessed the full texts of potentially eligible articles to ascertain their compliance with the inclusion criteria. In case of any discrepancies, a discussion involving the other authors (N.A.H., D.I.H., and B.S.) was held to reach a consensus.

2.5. Data extraction

The data from the included studies were extracted using a specially created Excel spreadsheet (Microsoft, Redmond, WA, USA) for this review. The extracted data included the following: title, authors, year of publication, study design, number of subjects, sample size, follow-up period, treatment groups, restorative material, restoration polishing procedure, quantitative outcome (recession depth (RD), probing depth (PD), keratinized tissue width (KTW), tissue thickness (TT), relative clinical attachment loss (rCAL), recession reduction

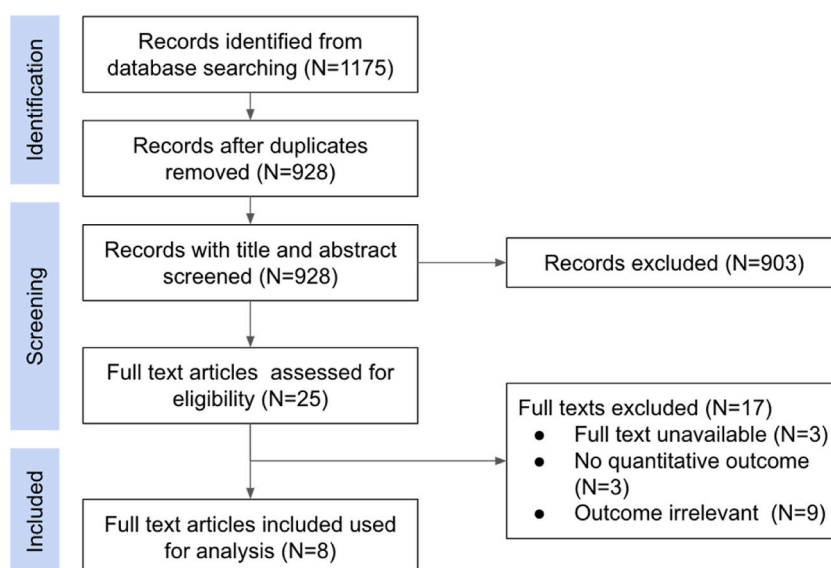


Fig. 1. PRISMA 2020 Flow diagram of study selection process [29].

and % root coverage at baseline, follow-up, and difference between baseline and follow up), and conclusions of each study.

2.6. Risk of bias and quality assessment

The assessment of risk of bias and quality utilized various tools, including the Cochrane Risk of Bias (RoB) 2.0 Tool according to the Cochrane Handbook for Systematic Review of Interventions for randomized controlled trials (RCTs) [26], the Risk Of Bias In Non-randomized Studies - of Interventions (ROBINS-I) tool [27] for prospective studies, and the Joanna Briggs Institute (JBI) Critical Appraisal tool [28] for case series and case reports. The evaluation was conducted by all reviewers, and discrepancies were resolved through open discussions.

3. Result

3.1. Selection of articles

The search results based on the PRISMA 2020 guidelines are depicted in Fig. 1. A total of 1175 articles were identified through electronic searches of databases. After removing duplicates, manual screening of 928 titles and abstracts resulted in 903 articles being excluded, leaving 25 full-text articles for further assessment. Ultimately, 8 articles were used for the final analysis.

All baseline data, including qualitative outcomes, from all included studies are summarized in Table 1. Eight studies consist of 5 RCTs (Cairo F et al., [30], Dursun E et al., [31], Santamaria MP et al., [32], Isler SC et al. [20], and Santamaria MP et al., [33]), 1 prospective study (de Sanctis M et al., [24]), 1 case series (Silveira CA et al., [34]), and 1 long-term case report (Al-Hamdan K.S. [35]) (Fig. 1). The selected studies had follow-up periods ranging from 6 months to 18 years.

3.2. Risk of bias and quality assessment

The results of the risk of bias assessment for RCTs using the Cochrane RoB 2.0 Tool [26] indicated that all analyzed RCTs had a low risk of bias (Fig. 2). The assessment results for the prospective study using the ROBINS-I tool [27] showed some concerns (Fig. 3). The assessment of the case series (Fig. 4) and the case report (Fig. 5) using the JBI Critical Appraisal tool [28] indicated that both studies were deemed suitable for inclusion in the analysis.

3.3. Quantitative clinical outcome of included studies

Table 2 presents a summary of the quantitative results obtained from all the studies that were included. Composite resin was the preferred choice of restorative material in the majority of studies [20,24,30,32–35]. Other restorative materials used besides composite resin included nanofilled ionomer cement [31], RMGIC [20,31], and giomer [20]. The techniques for finishing and polishing were not always described in the articles; however, studies that did include these details utilized various methods including silicon and soft silicon rubber bur points, oscillating tips [24], ultra-fine-grained burs, diamond paste, felt discs [34], and aluminum oxide abrasive discs [20,24,31]. Quantitative data extracted include RD, PD, KTW, TT, rCAL, recession reduction and % root coverage at baseline, follow-up, and difference between baseline and follow up.

4. Discussion

The CAF technique is the most documented approach in the literature, and when combined with CTG, it becomes the gold standard in treating gingival recession [36]. Sometimes, the outcomes of this gold standard treatment are less satisfying if gingival recession is accompanied by NCCL, as complete root coverage might not be achieved [31], and/or the emergence profile might not be adequately restored [32]. The included articles can demonstrate the stability of this multidisciplinary treatment as follow-up studies span up to 18 years. These long-term case reports show consistent results, as after 18 years, recession did not occur in teeth treated with periodontal-restorative procedures [20]. Al-Hamdan [35] reported that the results of their case report were similar to those of the case report by Cosair [37], which reported 100 % root coverage in a 7-year follow-up. These long-term case reports only reported the recession depth and keratinized tissue width.

The case series by Silveira et al. [34], represents a study with the shortest follow-up time, which was 6 months. In this case series, the restoration performed on NCCL was limited to only 1 mm from the estimated CEJ using composite resin material, resulting in a very restricted amount of filling covered by soft tissue after the healing period. This condition is advantageous because when the restoration becomes discolored or fails, a new restoration can be made without the need for surgery. This approach aligns with the recommendation of Zucchelli et al. [13], where the apical boundary of NCCL restoration is placed at the line of maximum root coverage. This implies that if 100 % root coverage is not achieved, the root surface between the restoration boundary and the gingival margin can remain exposed, while if the restoration boundary is positioned apically by 1 mm, the likelihood of root exposure decreases. Additionally, Silveira et al. reported that the CTG associated with restoration appeared stable after a 6-month follow-up, as evidenced by the absence of bleeding on probing (BOP) and shallow PD. Despite the satisfactory outcomes of this case series, further studies are needed to establish this approach as the standard treatment for gingival recession with NCCL [34].

The prospective study by de Sanctis et al. [30], is a study that compares CAF with and without CTG, and the study population consists of patients who have previously undergone cervical area restoration using composite resin before periodontal surgery. De

Table 1
Baseline information and qualitative result of selected studies.

	author	year	type of study	location	subjects	sample	Follow up	treatment groups	Study conclusion
1	de Sanctis M et al. [24]	2020	prospective study	Italy	23 patients (11 women and 12 men; mean age: 46.2 ± 10.6 years)	93 GRs type 1 (RT1) with NCCLs	1 year	RC + MCAF RC + MCAF + CTG	The use of composite resin restorations for NCCL defects positioned 1 mm apical to the CEJ does not have any influence on periodontal conditions and on the amount of CRC.
2	Cairo F et al. [30]	2019	parallel, randomized single-center clinical trial	Italy	30 patients (22 women and 8 men, age between 26 and 63)	30 single GR type 1	1 year	RC + CAF RC + CAF + CTG	Both procedures were effective for root coverage at single RT1 recession with previously restored CEJ. Adding a CTG under should be considered for recession with thin gingival phenotype
3	Al-Hamdan K.S [35].	2020	long term case report	Saudi Arabia	1 female patient, 36 year old	2 miller class II defect	18 years	RC + CAF + CTG	Placement of a graft on previously restored root surfaces provided highly predictable and stable results.
4	Dursun E et al. [31]	2018	prospective randomized clinical trial	Turkey	36 patients (28 females, 8 males, mean age 41.65 ± 12.26 years)	54 Miller class I GR defects (36 with NCCL, 18 without NCCL	1 year	CTG only (no NCCL) NIC + CTG + CAF with NCCL RMGIC + CTG + CAF with NCCL	Gingival recessions associated with NCCLs may be successfully treated with an integrated periodontal and restorative dentistry approach, and root coverage with CTG may be successfully obtained on cervical fillings.
5	Santamaria MP et al. [32].	2018	parallel arm, open-label randomized clinical trial	Brazil	40 patients (18 women and 22 men, mean age: 44.5 ± 10.6 years; range 22–60)	40 Miller class I or II GR defects associated with B+ tooth cervical defect	1 year	Odontoplasty + CTG + CAF RC (partial restoration) + CTG + CAF	CTG alone and CTG + PR result in similar clinical outcomes to treat B+ cervical defect.
6	Isler SC et al. [20]	2018	prospective randomized clinical trial	Turkey	23 patients (10 males and 13 females, aged between 28 and 59 years (mean 45 ± 9.5 years))	75 Miller class I GR defect associated with buccal NCCL Class B + step	1 year	NRC + CTG + MCAF RMGIC + CTG + MCAF giomer + CTG + MCAF	Combined surgical/ restorative treatments provided successful clinical results and a good emergence profile. NCR and RMGI showed similar clinical results as a restorative material for combined surgical/ restorative treatment. Giomer may be less effective compared to other groups for treatment of gingival recession associated with NCCL
7	Silveira CA et al. [34]	2017	case series	Brazil	10 patients (6 men and 4 women, age range 24–58 years, mean 36.26 ± 9.2 years)	10 Miller class I or II GR defects associated with B+ tooth cervical defect	6 months	RC + CAF + CTG	The presence of partial resin composite restoration does not interfere with the coverage achieved with CTG
8	Santamaria MP et al. [33]	2016	equivalence, parallel, single-blind, randomized clinical trial	Brazil	36 patients (19 males and 17 females, mean age test group 35.2 ± 13.7 and control group 38.9 ± 11.3 years)	36 Miller class I or II GR associated with NCCL B+ defect, in maxillary canines or premolars	1 year	CTG + CAF RC + CAF + CTG	CTG alone or in combination with the restoration of the tooth cervical lesion made with resin composite can successively treat gingival recession associated with B + NCCL

Abbreviations: GR (gingival recession), NCCL (non carious cervical lesion), RC (resin composite), MCAF (modified coronally advanced flap), CAF (coronally advanced flap), CTG (connective tissue graft), NIC (nanofilled ionomer cement), NRC (nanofilled resin composite), RMGIC (resin modified glass ionomer cement), PR (partial restoration).

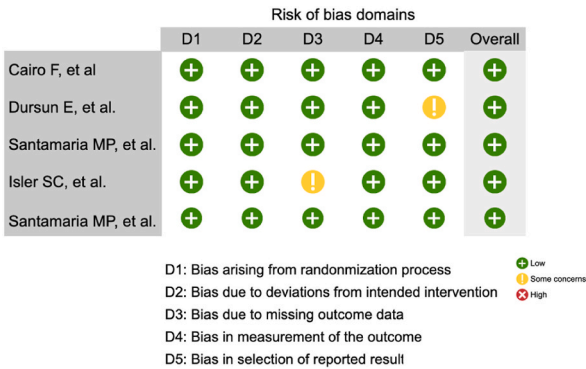


Fig. 2. Quality evaluation of the RCTs using the RoB 2 tool (Cochrane Collaboration) [25]. The risk of bias in all included studies was classified as either low (green).

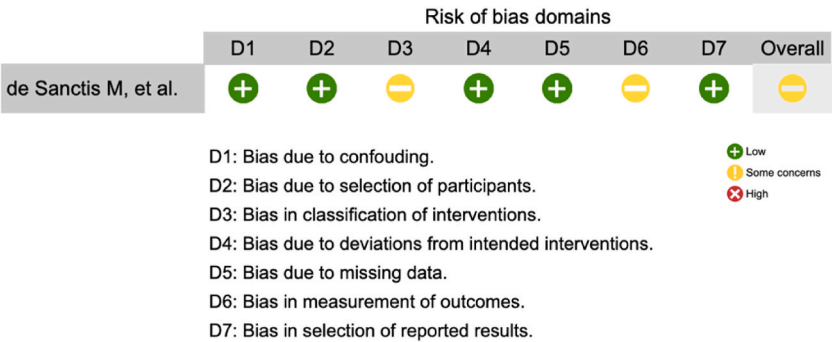


Fig. 3. Quality evaluation of the prospective study using the ROBINS-I tool [26].The risk of bias in the included study was classified as some concerns (yellow).

Sanctis reported that the presence of composite resin restoration does not affect the health of the soft tissues at the surgical sites. At both the baseline and the 1-year follow-up, measurements of PD, BOP, and plaque index were taken, revealing no statistically significant variances in values between these two time points. These results differ from the RCT by Santamaria et al. [32], which reported statistically significant differences in PD between restored and unrestored teeth. This difference may be related to the surface roughness of the filling after finishing and polishing [38].

Cairo et al. [30], conducted a randomized clinical trial not to compare different restoration materials, but to compare recession treatment on teeth with cervical restorations with or without CTG using the CAF technique. The conclusions drawn from this review are that after the surgery, soft tissue appears stable in covering the restoration material. The additional use of CTG is indicated when dealing with thin soft tissue phenotypes; however, if there is sufficient soft tissue thickness, CAF alone demonstrates more aesthetic outcomes because adding CTG in certain cases can result in overly thick gingival contours.

Studies that compare several restoration materials are the RCTs by Dursun et al. [31], and Isler et al., [20]. In both experimental groups, Dursun et al. [31] compared two different materials, resin-modified glass ionomer (RMGIC) and nano-ionomer cement (NIC).

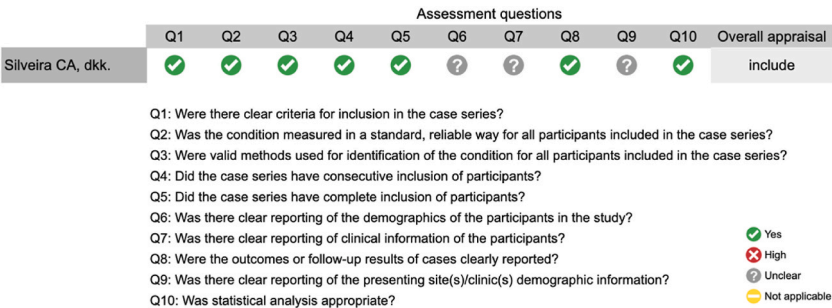


Fig. 4. Quality evaluation of the case series using the JBI critical appraisal tool [27] resulted in an overall appraisal that justified the inclusion of the study in the review.

	Assessment questions								Overall appraisal
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	
Al-Hamdan K.S	✓	✓	✓	✓	✓	?	✗	✓	include

Q1: Were patient's demographic characteristics clearly described?
 Q2: Was the patient's history clearly described and presented as a timeline?
 Q3: Was the current clinical condition of the patient on presentation clearly described?
 Q4: Were diagnostic tests or assessment methods and the results clearly described?
 Q5: Was the intervention(s) or treatment procedure(s) clearly described?
 Q6: Was the post-intervention clinical condition clearly described?
 Q7: Were adverse events (harms) or unanticipated events identified and described?
 Q8: Does the case report provide takeaway lessons?

✓ Yes
 ✗ High
 ? Unclear
 ○ Not applicable

Fig. 5. Quality evaluation of the case report using the JBI critical appraisal tool [27] resulted in an overall appraisal that justified the inclusion of the study in the review.

However, in the control group, no restorations were performed due to the absence of NCCL. The periodontal surgical therapy performed in all groups was the gold standard therapy using CTG with the CAF flap technique. Satisfactory results were reported in this study. The percentage of root coverage at the 12-month follow-up was 89.49 % for the RMGIC group, 90.12 % for the NIC group, and 96.22 % for the control group. Additionally, probing depth was minimal, and CAL significantly increased in all groups. These findings contradict some literature that has evaluated the impact of restorative approaches on the periodontium. Several studies have reported that the subgingival portion of dental restorations can cause gingival inflammation, as well as the development of gingivitis and periodontitis associated with increased local plaque accumulation [38–40].

Isler et al. [20], compared three different materials without a control group. The materials used in the study were nanofilled composite resin (NCR), RMGIC, and giomer. Among these three materials, the giomer group exhibited the lowest defect coverage (64.23 ± 20.33 %) compared to the NCR group (71.18 ± 23.16 %) and the RMGI group (71.33 ± 22.33 %). In all groups, soft tissue partially covered the restorations, and it was reported that the presence of restorations did not have a negative impact on the surrounding tissues, which is consistent with previous studies [41,42]. RMGIC was associated with better results in terms of tissue behavior compared to CR. However, the tendency for discoloration of the material over time negatively influenced the aesthetic evaluation, whereas this was not a concern when RC was used [43,44]. Furthermore, the results indicated that root coverage was comparable with or without RMGIC, while the presence of restorations contributed to a greater reduction in dentin hypersensitivity [45]. This result is in accordance with a systematic review by Gennai et al., which reported CTG alone yields better overall outcomes compared to its use with NCCL restoration, except in reducing dentin hypersensitivity, where the combined approach proves to be the most effective [46].

In an RCT conducted by Santamaria et al. [33], CTG and CAF treatment can successfully achieve defect closure in gingival recession cases accompanied by class B+ cervical defects, both with and without the use of resin composite (RC). The notable difference is seen in the parameter of PD. Probing depth appears to be higher for defects treated using composite resin. The presence of composite resin subgingivally leads to a longer formation of junctional epithelium on the restoration surface, potentially hindering periodontal regeneration [47]. Re-establishing the clinical CEJ and performing partial restoration benefit periodontal tissue by helping maintain long-term gingival height, reinforcing the efficacy of a combined approach for treating multiple gingival recessions with NCCLs while highlighting the need for careful restoration planning for optimal outcomes [48]. In terms of fracture resistance and microleakage, RC and RMGIC are acceptable for NCCL restorations [49].

The techniques for finishing and polishing restorations in the included studies utilized various tools and materials. To reattach the gingiva to the restoration surface, the restoration should be made as smooth as possible prior to the surgical procedure [39]. The studies by Dursun et al. [31] and Isler et al. [20] used different restoration materials, but the finishing and polishing protocol for all restoration materials was the same, using aluminum oxide disks of decreasing abrasiveness. The satisfactory results from these studies indicate that the use of aluminum oxide disks is effective in producing a smooth restoration surface. A favorable response from the periodontal tissues can be observed when restorations are well-finished and polished, and when plaque and bacteria are controlled during the surgical procedure prior to flap closure [47].

The surface roughness of restorative materials can influence the development of periodontal inflammation on the treatment site. The finishing and polishing procedures that report satisfactory results are not always the same across all studies. Machado et al., reported that the reduction of surface roughness is dependent on the compositions of the material, and the techniques applied [50]. In the included studies, the polishing tools used were aluminum oxide disks of decreasing abrasiveness [20,24,31], silicon rubber burs [24], diamond paste, and felt discs [34]. The importance of good finishing and polishing is also highlighted in the study by Teixeira et al. [51], where a clinical trial was conducted to compare two polishing techniques using rubber tips (Astropol) and aluminum oxide polishing discs (SofLex) on two different types of composite resin. Treating NCCL using a smooth composite surface showed favorable compatibility with periodontal tissues for up to 180 days after restoration, displaying no signs of irritation or inflammation. Although the evaluation of the two polishing burs employed in the clinical trial revealed no noteworthy variations in the 6-month follow-up outcomes, this study did not evaluate surface roughness [51].

Ozan et al. [52] reported that multi-step polishing results in a slightly smoother surface compared to the use of a one-step polishing system using rubber tips (Onegloss). Achieving a smooth restoration surface can be obtained through adequate finishing and polishing procedures. However, different restoration materials have distinct characteristics, causing variations in the assessment of surface

Table 2
Quantitative result of selected studies.

	Author	Year	Sample	Follow up	Treatment groups	Restorative material	Restoration polishing procedure	Outcome																
								Recession Depth (mm)			Probing depth (mm)			Keratinized tissue width (mm)			Tissue thickness (mm)			Relative clinical attachment loss (mm)			Recession reduction (mm)	% Root coverage
								Baseline	Follow up	Δ change	Baseline	Follow up	Δ change	Baseline	Follow up	Δ change	Baseline	Follow up	Δ change	Baseline	Follow up	Δ change		
1	de Sanctis M, et al. [24]	2020	93 GR type 1 (RT1) with NCCLs	1 year	RC + MCAF	resin composite (enamel plus HRI, Micerium)	silicon and soft silicon rubber bur points, aluminium oxide abrasive discs, and oscillating tips	1.97 ± 0.87	0.05 ± 0.22	NA	1.73 ± 0.42	1.76 ± 0.48	NA	2.39 ± 1.02	3.67 ± 1.52	NA	0.54 ± 0.23	2.1 ± 0.5	NA	NA	NA	NA	1.92 ± 0.87	97.86 ± 9.5
					RC + MCAF + CTG			2.91 ± 1.01	0.17 ± 0.46	NA	1.72 ± 0.53	1.88 ± 0.6	NA	1.74 ± 0.89	3.85 ± 1.51	NA	0.04 ± 0.22	2.3 ± 0.77	NA	NA	NA	NA	2.74 ± 1.05	94.7 ± 14.83
2	Cairo F, et al [28]	2019	30 single GR type 1	1 year	RC + CAF	resin composite (max 1 mm apical from ideal CEJ)	NA	3.2 ± 0.5	0.5 ± 0.5	NA	1.1 ± 0.3	1.2 ± 0.4	NA	3.1 ± 0.5	3.3 ± 0.7	0.2 ± 0.7	0.8 ± 0.09	0.86 ± 0.16	0.86 ± 0.16	NA	NA	NA	2.7 ± 0.6	NA
					RC + CAF + CTG			3.4 ± 0.6	0.3 ± 0.5	NA	1.1 ± 0.3	1.1 ± 0.3	NA	3.4 ± 0.6	4.6 ± 0.5	1.7 ± 0.7	0.78 ± 0.12	1.38 ± 0.09	1.38 ± 0.09	NA	NA	NA	3.1 ± 0.7	NA
3	Al-Hamdan K.S. [33]	2020	2 miller class II defect	18 years	RC + CAF + CTG	resin composite	NA	4	0	NA	NA	NA	NA	1	4.5 ± 0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Dursun E, et al. [28]	2018	54 Miller class I GR defects (36 with NCCL, 18 without NCCL)	1 year	CTG + CAF (no NCCL)	-	-	3.17 ± 0.85	0.06 ± 0.23	NA	1.45 ± 0.61	1.48 ± 0.41	NA	2.62 ± 1.19	5.12 ± 1.16	2.83 ± 1.02	1.28 ± 0.57	2.36 ± 0.18	2.43 ± 1.17	2.67 ± 0.63	1.25 ± 0.57	NA	NA	96.22 ± 10.75
					NIC + CTG + CAF with NCCL	nanofilled ionomer cement (Ketac N-100; 3M ESPE, Seefeld, Germany)	aluminum oxide disks of decreasing abrasiveness (SofLex; 3M ESPE)	3.13 ± 0.68	0.41 ± 0.71	NA	1.21 ± 0.03	1.28 ± 0.39	NA	3.28 ± 1.56	5.62 ± 0.96	3.06 ± 1.16	1.06 ± 0.23	2.10 ± 0.16	2.26 ± 0.69	3.03 ± 0.78	1.51 ± 0.86	NA	NA	90.12 ± 16.59
					RMGIC + CTG + CAF with NCCL	resin-modified GI (Vitremir, 3M ESPE, St. Paul, MN, USA)		3.5 ± 1.04	0.44 ± 0.7	NA	1.73 ± 0.64	1.88 ± 0.29	NA	2.83 ± 1.85	4.89 ± 1.84	2.81 ± 1.29	1.22 ± 0.54	2.30 ± 0.08	2.19 ± 0.73	3.16 ± 0.65	1.76 ± 0.76	NA	NA	89.49 ± 18.15
5	Santamaria MP, et al. [30]	2018	40 Miller class I or II GR defects associate d with B+ tooth cervical defect	1 year	Odontoplasty + CTG + CAF	-	-	NA	NA	NA	1.3 ± 0.5	2.0 ± 0.5	NA	2.9 ± 0.9	4.1 ± 1.1	1.2 ± 1.0	0.9 ± 0.2	1.9 ± 0.6	NA	10.5 ± 1.5	8.8 ± 2.0	1.7 ± 1.4	2.4 ± 1.1	92.2 ± 28.3
					RC (partial restoration) + CTG + CAF	resin composite (Filtek Z350 XT, 3M ESPE, St. Paul, MN, USA)	NA	NA	NA	NA	1.2 ± 0.5	2.6 ± 0.7	NA	2.7 ± 1.3	4.2 ± 1.7	1.4 ± 1.3	1.0 ± 0.5	2.1 ± 0.6	NA	9.3 ± 1.5	8.8 ± 1.8	0.5 ± 1.3	2.5 ± 1.0	93.0 ± 26.1
6	Isler SC, et al. [20]	2018	75 Miller class I GR defect associate d with buccal NCCL Class B + step	1 year	NRC + CTG + MCAF	nanofilled resin composite (NRC) (FiltekTM Supreme Plus- 3M ESPE, St. Paul, MN, USA)	aluminum oxide disks of decreasing abrasiveness (Sof-Lex XT, 3 M ESPE, St.Paul,MN, USA)	1.13 ± 0.34	1.43 ± 0.66	NA	NA	NA	NA	3.17 ± 1.15	3.78 ± 1.15	NA	0.89 ± 0.12	1.63 ± 0.36	NA	12.5 ± 0.88	10.83 ± 0.85	NA	NA	NA
					RMGIC + CTG + MCAF	resin modified glass ionomer cement (RMGI) (Fuji Ionomer Type II LC, GC Corporation, Tokyo, Japan)		1.13 ± 0.46	1.17 ± 0.39	NA	NA	NA	NA	3.3 ± 0.99	3.83 ± 1.1	NA	0.89 ± 0.12	1.68 ± 0.33	NA	12.48 ± 0.89	10.59 ± 0.62	NA	NA	NA
					giomer + CTG + MCAF	giomer (Beautifil, Shofu Inc., Kyoto Japan)		1.04 ± 0.21	1.3 ± 0.47	NA	NA	NA	NA	3.04 ± 0.99	3.61 ± 1.18	NA	0.88 ± 0.1	1.69 ± 0.32	NA	12.35 ± 0.71	10.76 ± 0.6	NA	NA	NA

6

	Author	Year	Sample	Follow up	Treatment groups	Restorative material	Restoration polishing procedure	Outcome																
								Recession Depth (mm)			Probing depth (mm)			Keratinized tissue width (mm)			Tissue thickness (mm)			Relative clinical attachment loss (mm)			Recession reduction (mm)	% Root coverage
								Baseline	Follow up	Δ change	Baseline	Follow up	Δ change	Baseline	Follow up	Δ change	Baseline	Follow up	Δ change	Baseline	Follow up	Δ change		
7	Silveira CA, et al [32]	2017	10 Miller class I or II GR defects associate d with B+ tooth cervical defect	6 months	RC + CAF + CTG	resin composite (Filtek Z350 XT, 3M ESPE, St Paul, MN, USA)	ultra-fine grained burs. and after 48 hours polishing was completed with diamond paste and felt discs	NA	NA	NA	1.3 ± 0.4	2.4 ± 0.4	1.1 ± 0.6	NA	NA	NA	NA	NA	NA	9.4 ± 0.8	8.4 ± 0.7	1.0 ± 0.6	NA	70 ± 20.2
8	Pantamaria MP, et al. [31]	2016	36 Miller class I or II GR associate d with NCCL B+ defect, in maxillary canines or premolars	1 year	CTG + CAF	-	-	NA	NA	NA	1.16 ± 0.38	2.0 ± 0.48	NA	NA	NA	NA	0.9 ± 0.23	1.81 ± 0.44	NA	13.41 ± 2.0	11.42 ± 1.6	1.98 ± 0.81	2.82 ± 0.74	82.16 ± 16.1
					RC + CAF + CTG	nanofilled resin composite (Filtek Supreme, 3M ESPE, St. Paul, MN, USA),	NA	NA	NA	NA	1.11 ± 0.47	2.66 ± 0.48	NA	NA	NA	NA	0.9 ± 0.24	1.97 ± 0.26	NA	12.73 ± 1.56	10.01 ± 1.3	1.17 ± 0.89	2.72 ± 0.69	73.84 ± 19.2

Abbreviations: GR (gingival recession), NCCL (non carious cervical lesion), RC (resin composite), MCAF (modified coronally advanced flap), CAF (coronally advanced flap), CTG (connective tissue graft), NIC (nanofilled ionomer cement), NRC (nanofilled resin composite), RMGIC (resin modified glass ionomer cement), NA (not available).

roughness despite using the same polishing method. Restoration materials containing GIC tend to exhibit roughness levels above 0.2 μm , which is the threshold value for bacterial retention, with all polishing techniques [53]. According to the study by Sismanoglu et al. [54], the sequence of restoration surfaces from smoothest to roughest is as follows: nanofilled composite, followed by giomer, compomer, RMGIC, and lastly, GIC.

Clinical failure of NCCL restorations is influenced by factors such as occlusal wear facets, adhesive strategy, operator experience, and caries risk, with occlusal wear and adhesive strategy being the most significant. Marginal integrity was the most common failure, but operator experience and additional enamel etching before applying a 2-step self-etching adhesive improved outcomes [55]. Ionomer restorations exhibited greater surface dullness than resin composites, while selective enamel etching improved retention with universal adhesives. [56] Adhesion strategies involving EDTA pre-treatment followed by resin-modified glass-ionomer cements showed delayed marginal defects, with gingival recession also affecting retention. These findings suggest that EDTA and resin-modified glass-ionomer cements may enhance the durability of NCCL restorations [57].

The studies included did not state techniques on teeth isolation during restoration. Proper isolation during the placement of restorations for NCCLs is crucial to minimizing the risk of gingival recession and maintaining long-term gingival health. While rubber dams with dental clamps are commonly used, they may contribute to the occurrence or progression of GR, particularly if the cervical restoration lacks proper marginal adaptation. Whenever possible, isolating the target tooth with cotton rolls should be considered as a less invasive alternative [58]. Additionally, dental floss ties offer a gentler method of isolation compared to clamps, especially active clamps, which can cause gingival trauma and potentially irreversible recession. Floss ligatures can be particularly useful for isolating teeth from second premolar to second premolar without the need for anchor clamps or local anesthesia, as premolars often have sufficient undercuts to retain them [59]. Though technique sensitivity and long-term gingival health are similar between isolation methods, subgingival clamps provide minimal chairside time, making them a practical option when carefully applied. However, caution is required to prevent gingival laceration [60]. Patients must be properly consented before clamp placement, with a clear explanation of potential risks, including the rare possibility of aspiration or ingestion, gingival recession from prolonged or aggressive use, iatrogenic damage to the tooth or restoration, and soft tissue trauma [61]. Further studies should evaluate periodontal parameters following restoration placement to better understand the impact of isolation techniques on gingival health.

The contact of restorations with soft tissue is also encountered in deep margin elevation (DME), which involves applying a composite resin base above the existing cervical margin to shift it more coronally [62]. In a literature review by Samartzi et al. [63], it was reported that DME is well-tolerated by the gingiva, although DME restorations are more challenging due to limited access compared to restorations in cases of GR and NCCL [41,64]. The key to subgingival restoration compatibility with periodontal tissue health, especially when using composites, lies in well-polished and refined fillings, maintaining the biological width integrity, strict supportive therapy, and good oral hygiene practices [65].

In cases with high aesthetic demands, an interdisciplinary approach that combines connective tissue grafts, CAD/CAM veneers, and periodontal and restorative treatments can lead to successful outcomes [66]. The clinical success and longevity of restorations depend on meeting the mechanical, biological, and aesthetic requirements [67]. Advances in dental materials and CAD/CAM technologies have made it possible to consistently design and manufacture highly aesthetic ceramic restorations with greater predictability [68]. Zirconium-based restorations produced through CAD/CAM technology have shown superior results in terms of marginal fit, inflammation reduction, maintenance, and the restoration of periodontal health compared to those made using conventional methods or other alloys [69]. The accuracy of marginal and internal adaptation is critical for the success and survival of fixed prosthetic treatments. Marginal discrepancies can lead to thick cement layers, which are more susceptible to oral environmental factors, resulting in cement dissolution, biofilm accumulation, microleakage, discoloration, and increased gingival crevicular fluid (GCF) flow. These issues can cause recurrent caries, pulp infections, and periodontal lesions, ultimately leading to treatment failure [70]. In this regard, supragingival margins provide better oral hygiene maintenance and help avoid secondary caries and periodontal disease, making them a preferable option over subgingival margins [69]. CAD/CAM fabricated restorations, particularly in single-unit crowns, demonstrate comparable and satisfactory marginal adaptation when compared to conventional methods, further confirming the reliability of this technology [71].

A recent case report with a 5-year follow-up involved the use of a ceramic CAD/CAM inlay for tooth 6, designed using specialized software and milled from feldspathic ceramic. After milling, the restoration was checked intraorally, and absolute isolation was achieved before adhesive cementation according to the manufacturer's instructions, followed by photopolymerization of resin cement for 2 min. Any excess was removed with a No.12 surgical blade, and final polishing was done with rubber silicone tips. For tooth 5, which had a shallower and narrower lesion, a direct composite restoration was chosen. A mucogingival tunnel from tooth 4 to 7 was created using a microblade, and a connective tissue graft (CTG) was harvested from the palate. The graft was inserted into the tunnel, with its coronal limit fixed at the CEJ level of teeth 5 and 6. The soft tissues were coronally advanced and secured with sutures. At the 60-month follow-up, both treated teeth (direct composite and indirect CAD/CAM restoration) showed stable clinical conditions and successful aesthetic outcomes, with complete root coverage maintained throughout the period [72].

In the included studies, creeping attachment is not mentioned. It is known that after periodontal surgical treatment, a phenomenon called creeping attachment often occurs, which involves the spontaneous coronal movement of the gingival margin [73]. This phenomenon occurs not only on the root surface of teeth but has also been reported to occur on restoration surfaces, such as composite resin and glass ionomer [41], as well as implant surfaces [74]. This phenomenon occurs between 1 and 12 months after the surgical procedure [75]. Creeping attachment has been reported not only in regenerative surgery using autogenous grafts but also in non-surgical therapies [76] and the use of substitute materials like acellular dermal matrix [77]. A literature review by Wan et al. [78] concludes that creeping attachment plays a crucial role in the prognosis of mucogingival surgery as it can enhance the long-term aesthetics and gingival health. However, it should be emphasized that this phenomenon is not always predictable and reliable. In

cases involving NCCL, however, the potential for achieving creeping attachment is significantly limited. The coexistence of NCCL and GR often requires a combined approach, both conservative and surgical, which some patients may be unwilling to undergo. Given these limitations, the possibility of inducing coronal migration of the gingival margin through a minimally invasive conservative restoration procedure presents an intriguing therapeutic alternative that warrants further investigation [79].

The limitations of this study include incomplete data in the reviewed studies and inconsistencies in parameter measurements, which made it impossible to conduct a meta-analysis. Additionally, clinical trials with long-term evaluations of treatment methods for GR associated with NCCL have been limited. Santamaria et al. conducted the first RCT for combined restorative-periodontal therapy in 2008 using RMGIC [34]. Following this study, numerous researchers have continued their search using different restorative materials to find the best approach. However, up to now, inquiries such as determining the most suitable restorative material and establishing the optimal finishing and polishing protocol for combined defects remain without definitive solutions. Therefore, further studies with larger sample sizes and extended time frames are required to establish a definitive combination treatment protocol.

5. Conclusion

It can be concluded that multidisciplinary periodontal-restorative treatment for gingival recession associated with NCCL, using a combination of CTG and restorative materials, results in favorable aesthetic outcomes and predictably successful results when effective finishing and polishing of restorations are conducted. Despite the prevalent use of composite resin in most studies, a definitive conclusion has not been entirely clarified and necessitates further research concerning the most satisfactory long-term restorative material for combined surgical/restorative treatment procedures.

CRedit authorship contribution statement

Felita Clarissa Halim: Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yuniarti Soeroso:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Dimas Ilham Hutomo:** Writing – review & editing, Investigation, Funding acquisition. **Nadhia Anindhita Harsas:** Writing – review & editing, Validation, Supervision, Project administration, Investigation, Funding acquisition. **Benso Sulijaya:** Writing – review & editing, Validation, Supervision, Investigation, Funding acquisition.

Data availability statement

Data will be made available on request. For requesting data, please write to the corresponding author.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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