Review Article

# CURRENT STATE ABOUT ROOT COVERAGE USING SOFT-TISSUE SUBSTITUTES IN THE PRESENCE OF NONCARIOUS CERVICAL LESIONS: A LITERATURE REVIEW

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**Received:** 27 October 2024; **Revised:** xx Janury 2025; **Accepted:** 03 February 2025 https://doi.org/10.51847/ObKD8WtEVh

**ABSTRACT**

About half of the cases of gingival recession are associated with the noncarious cervical lesion (NCCL), resulting in combined defects (CDs). NCCL negatively affects the root coverage outcomes. In addition, considering the morbidity associated with graft harvesting, soft-tissue substitutes (STSs) appeared as a suitable option for connective tissue grafts for surgical root coverage. Currently, the literature addressing the therapy of CDs employing STSs is scarce. Thus, the present review aimed to update the literature and outline the future perspectives about root coverage of CDs using STSs. A detailed literature search was conducted on MEDLINE, Web of Science, EMBASE, LILACS, Scopus, and Google Scholar databases using keywords and Boolean operators. Randomized clinical trials (2) and case reports (6) were included. None of the selected studies reported any adverse effect using STSs. Based on the limited evidence available, we cannot state that STSs may benefit the periodontal clinical and patient-centered outcomes. Randomized controlled trials are needed to assess the long-term outcomes, surgical approaches, and restorative protocols.

**Key words:** Biocompatible materials, Collagen, Dental esthetic, Dentin sensitivity, Acellular dermal matrix graft, Gingival recession.

## Introduction

Gingival recession (GR) is defined as the shift of the gingival margin apical to the cementoenamel junction (CEJ) of the tooth [1, 2]. There are many classifications of GR defects [3]. The most widely used classification was proposed by Miller *et al.* [4]. However, the workgroup 3 of the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases recommended the classification of Cairo *et al.* [5] for evaluating GR defects. The rationale for this recommendation is that Cairo's classification system overcomes some limitations of Miller's classification, such as the difficulty in differentiating class I and II recessions, and the employment of the term "bone or tissue loss" as a reference to diagnose interdental periodontal loss [6].

GR defects may be associated with noncarious cervical lesions (NCCLs) [7], which are described as the wear of the tooth substance at the level of the gingival one-third of the tooth due to other causes than dental caries [8]. Approximately half of the cases of GR are associated with NCCLs, resulting in combined defects (CDs) [9], and the majority of the latter are in the maxillary esthetic zone [10].

Zucchelli *et al*. classified CDs based on the topographic relationship involving the maximum root coverage level (MRC) and NCCLs [11]. MRC is the position in which the gingival tissues are stable after the healing process of the mucogingival root coverage procedure and the position in which the restoration using composite filling should be placed [11].

Pini-Prato *et al*. categorized the surface defects in GR area according to the dental surface discrepancy (<0.5 mm, without a step; and >0.5 mm, with a step) and the visibility of CEJ [12].

In addition, Santamaria *et al*. proposed two new subclasses considering the treatment's variation and management [13, 14] in extremely deep V-shaped defects: A + V, a defect with V-shaped topography, and B + V, a V-shaped defect with CEJ not visible [9].

CDs are associated with esthetic problems, compromised plaque control, and dental hypersensitivity (DH) [15]. A recent systematic review (SR) showed a percentage of root coverage ranging from 52.57% to 82.16% [16]. This study also demonstrated that restoration of NCCLs does not influence the periodontal clinical outcomes, such as overall root coverage, keratinized tissue width (KTW) change, and clinical attachment level (CAL) gain of surgical root coverage [16–20]. However, CDs reduce the probability of complete root coverage through treatment [21, 22] and are more likely to result in an apical shift in long-term follow-up [23]. Besides, the topography of CDs constitutes a complicating factor for root coverage in periodontal plastic surgery [24, 25]. When the NCCLs affect the CEJ, the root coverage procedure may not cover the total extent of the CDs [26]. The line of root coverage or MRC, which is based on the ideal height of the anatomic interdental papilla, should substitute the anatomic CEJ when this was undetectable on the tooth with GR [27]. A SR concluded that untreated buccal GR presents a higher risk of increase in GR depth during long-term follow-up [28]. Therefore, the

treatment of these defects is mandatory [29].

One common mistake is performing a restorative approach as the only treatment for NCCLs. Subgingival restorations in CDs may result in marginal bleeding and attachment loss due to the growth and dysbiosis of bacterial biofilm [26]. CDs require different treatment strategies according to their conditions [30]; hence, some studies focused on assessing the decision-making process for treating CDs in a multidisciplinary manner [9, 11, 31-33].

Connective tissue graft (CTG) is the gold standard considering soft-tissue grafts and can be harvested from the palate or the maxillary tuberosity [34]. However, CTG has some disadvantages: (1) requires another surgical area, (2) postoperative donor area pain, (3) limited amount of available graft, and (4) risk of surgical complications such as intraoperative damage of the greater palatine vessels and nerves or intense postoperative bleeding [26, 35]. Thus, soft-tissue substitutes (STSs) appeared as a reasonable alternative to decrease patient discomfort and morbidity [35-38]. Acellular dermal matrix of human origin (AlloDerm®, BioHorizons) or of porcine origin (mucoderm®, Straumann), the xenogeneic collagen matrix (CM) (Mucograft®, Geistlich), and the volume-stable collagen matrix (VCM) (Fibro-Gide®, Geistlich) are the most frequently used STSs for root and nonroot coverage procedures [35, 37, 39-41].

The present study focused on establishing an update on the clinical efficacy of STSs for the treatment of CDs. To the best of our knowledge, there is no review on that specific topic. Thus, this literature review aimed to analyze the current state and future perspectives about the treatment of GR associated with NCCLs using STSs [42–44].

## Materials and Methods

*Proposition*
To evaluate all clinical studies that used STSs for root coverage in patients with GR associated with NCCLs (CDs).

*Information source and search strategy*
The MEDLINE, Web of Science, EMBASE, LILACS, Scopus, and Google Scholar databases were searched up to August 2022. Manual search was conducted in the following periodontics journals that have the highest impact factor according to the 2016 ISI Thomson Reuters Impact Factor List: *JournalofClinicalPeriodontology*, *JournalofPeriodontology*, and *JournalofPeriodontalResearch*. Search strategies developed for each database were: ("NCCLs" OR "noncarious lesions") AND ("STSs" OR "CM" OR "xenogeneic collagen matrix" OR "VCM" OR "acellular dermal matrix" OR "acellular dermal matrix graft (ADMG)" OR "resorbable collagen matrix" OR "acellular matrices" OR "tissue engineered" OR "alloderm" OR "mucograft" OR "fibro-gide" OR "mucoderm" OR "mucomaix" OR "DynaMtrix" OR "Apligraf" OR "Dermagraft" OR "fibroblast-derived dermal substitute" OR "extracellular membrane" OR "soft tissue augmentation").

*Eligibility criteria*
Studies were included if they met all the following criteria: (1) peer-review journal articles, (2) human studies: randomized or nonrandomized clinical trials (RCTs), case reports, and case series, and (3) adult individuals ≥18 years of age.

*Invivo* or *in vitro* studies were excluded.

*Data collection*
Data were independently extracted by two reviewers (AAHM and INRR).

The following data were extracted and recorded using a standardized data collection form: (1) citation, (2) year of publication, (3) number of patients, (4) subject characteristics, (5) clinical defect models, (6) type and location of the defects, (7) STSs, (8) groups, (9) root conditioning, (10) restoration attributes, (11) type of study, (12) follow-up, (13) adverse effects, and (14) source of funding. An excellent inter-examiner agreement was observed ($k > 0.80$).

## Results and Discussion

*Search results*
A total of eight papers were retrieved from the electronic databases and hand searching. Among them, two RCTs [25, 26] and six case reports [45-50] were selected.

*Study characteristics*
The main characteristics of each study are depicted in **Table 1**, and the main results are shown in **Table 2**.

**Table 1.** Main characteristics of the studies

| Study | Type of study/follow-up | Number of patients/teeth with CDs | Patient characteristics | Clinical model/defect type/location (teeth) | Soft tissue substitutes (company) | Groups | | Root conditioning | Restoration attributes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Test Group | Control Group | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Reis *et al.*, 2020 (NCT03615092) [26] | Split-mouth RCT/6 months | 17/34 | three males and 15 females, aged 24–65 years; mean age 40.9±10.7 years | Bilateral GR RT1≥3 mm, in which one had NCCLs type 2 | ADMG (AlloDerm, BioHorizons, Birmingham, AL, USA) | Test Group (n=17, GR + NCCL): ECAF + ADMG | Control Group (*n*=17, GR without NCCL): ECAF+ADMG | EDTA 24%, in both groups | No restoration |
| Mathias- Santamaria *et al.*, 2022 (NCT03341598) [25] | Parallel arm, double-blind RCT/6 and 12 months | 62/62 | Systemically healthy adults>18 year old | GR RT1 and NCCLs B+/− in both groups | CM (Mucograft®, Geistlich-Pharma AG-Wolhusen, Switzerland) | Test Group (*n*=31): Partial restoration + CAF + CM | Control Group (*n*=31): Partial restoration+ CAF | Not used | Apical border of the resin composite restoration was placed 1 mm apically the CEJ estimation |
| Santamaria *et al.*, 2022 [45] | Case report/6 months | 1/2 | 27-year-old woman | Multiple GR and NCCLs B+ (1.5, 1.3) | VCM (Fibro-Gide®, Geistlich-Pharma AG-Wolhusen, Switzerland) | Partial restoration + Modified CAF + VCM | No | Not used | Apical border of the resin composite restoration was placed 1 mm apically the CEJ estimation |
| Martiniello *et al.*, 2016 [46] | Case report/2 years | 1/17 | 28-year-old woman | Multiple GR and NCCLs A−, B+ (1.3–1.6, 2.2–2.6, 3.3–3.6, 4.3–4.6) | CM (Mucograft®, Geistlich-Pharma AG-Wolhusen, Switzerland) | Partial restoration + CAF + CM | No | EDTA 24% | Composite restoration filled the deepest portion of the NCCLs and was finalized at the level of MRC |
| Efeoğlu *et al.*, 2012 [47] | Case report/1 year | 1/6 | 46-year-old healthy man. <5 cigarettes a day, but ensured that he would stop smoking during the treatment | Multiple GR and NCCLs (1.1–1.3, 2.1–2.3) | ADMG (not reported) | Partial restoration + CAF + ADMG | No | Not used | Compomer restoration filled the deepest portion of the NCCLs |
| Nunes *et al.*, 2021 [48] | Case series | Case 1/7 years | 1/1 | Man | Single GR and NCCLs A- (2.3) | CM (Mucograft®, Geistlich-Pharma AG-Wolhusen, Switzerland) | Trapezoidal CAF | No | Not used |
| | | Case 2/5 years | 1/2 | Woman | Multiple GR and NCCLs B−/B + (2.2, 2.3) | | Partial restoration + envelope CAF + CM | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Chang *et al.*, 2022 [49] | Case report/1 year | 1/3 | 38-year-old healthy male | GR RT1 and NCCLs type 1 (4.3, 4.5), GR RT1 and NCCLs type 3 (4.4) | CM (Mucograft®, Geistlich-Pharma North America, Princeton, NJ, USA) | Restoration + coronally advanced tunnel + CM | No | EDTA 24% | Combine restorative approach (for tooth 4.4): bioceramics-based cement, and resin-modified glass ionomer following surgical healing (6 months) |
| Mahn 2015 [50] | Case report/1 year | 1/6 | 57-year-old nonsmoking female | GR Miller class II to III and NCCLs (1.3–2.3) | ADMG (AlloDerm, BioHorizons, Birmingham, AL, USA) | Tunnel | No | Not used | No restoration before surgery. After 1 year, teeth were rehabilitated with ceramic veneers and full-coverage ceramic crowns |

ADMG – Acellular dermal matrix graft; CAF – Coronally advanced flap; CDs – Combined defects; CEJ – Cement-enamel junction; CM – Collagen matrix; ECAF – Extended CAF; GR – Gingival recession; MRC – Maximum root coverage level; NCCLs – Noncarious cervical lesions; RCT – Randomized clinical trial; RT – Recession type; VCM – Volume-stable collagen matrix; EDTA – Ethylenediaminetetraacetic acid

**Table 2.** Main results of the studies

| Study | Intervention | Outcomes* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **NCCL coverage (%) (or root coverage?)** | **PD difference (mm) GR reduction mm)** | **CAL gain (mm)** | **KTW gain (mm)** | **Esthetic assessment by periodontist** | **Esthetic evaluation by patients** | **Dental hypersensitivity after intervention (VAS/yes or no)** | **BoP (%)** |
| Reis *et al.*, 2020 [26] | Test Group | 72.2±16.5 | 0±0.9 | 2.4±0.5 | 2.1±1.2 | 0.8±0.8 | No | Complete satisfaction | No | ≤20 |
| | Control Group | 69.5±19 | 0±0.7 | 2.2±0.5 | 1.9±1.3 | 0.6±1 | No | Complete satisfaction | No | ≤20 |
| Mathias-Santamaria *et al.*, 2022 [25] | Test Group | 54.4±20.0 | 0.1±0.4 | 2.0±0.7 | 1.8±1.55 | 0.9±0.8* | MRES: 8.1±1.8 | VAS: 9.2±1.1 | 1.1±2.3/10 patients | ≤20 |
| | Control Group | 55.2±21.8 | 0±0.46 | 1.9±0.8 | 2±1.65 | 0.4±0.7* | MRES: 8.6±2.0 | VAS: 9.0±0.9 | 1.1±1.8/11 patients | ≤20 |
| Santamaria *et al.*, 2022 [45] | - | 69.05 | 0 | 2.25 | 2.25 | 0.75 | No | VAS: 8 | No | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Martiniello *et al.*, 2016 [46] | - | 100 | 0.23 | 1.59 | 1.71 | 1.29 | RES: 9.4 | VAS: 9.6 | No (any teeth) | 15-6 (9) |
| Efeoğlu *et al.*, 2012 [47] | - | 72 | 0.5 | 1.8 | 2.3 | - | Good | Good | Not reported | No |
| Nunes *et al.*, 2021 [48] | Case 1 | 85.71 | 0 | 3 | 3 | 3 | Not reported | Not reported | Not reported | 0 |
| | Case 2 | 92 | 0 | 2 | 1.5 | 2 | | | | 0 |
| Chang *et al.*, 2022 [49] | - | 100 | Not reported | | | | | | Not reported | 0 |
| Mahn 2015 [50] | Good root coverage, thicker gingiva, full interdental papillae, and a natural appearance | | | | | | Good | Good | Not reported | 0 |

*Intergroup statistically significant difference at $P< 0.05$. BoP – Bleeding on probing; CAL – Clinical attachment level; GR – Gingival recession; KTW – Keratinized tissue width; RES – Root coverage esthetic score; MRES – Modified RES; NCCL – Noncarious cervical lesion; PD – Probing depth; VAS – Visual analog scale; *P*-value – 0.004; *P*-level was 5%.

*Soft tissue substitutes*

All the studies employed STSs in test groups for evaluating root coverage. Among them, four studies used CM [25, 46, 48, 49]. One case report employed VCM [45], and three studies utilized ADMG [26, 47, 50].

*Adverse effects*

All studies reported no adverse effects using STSs [25, 26, 46-50].

*Effect of interventions*

All studies agreed that factors associated with the etiology of GR and NCCLs must be controlled and/or removed before restoration/surgical procedures. Thus, individuals were counseled to avoid an excessively acidic diet and received instruction for avoiding traumatic brushing techniques. In the same way, occlusal adjustment was performed when necessary. Finally, they received prophylaxis, scaling and root planing, and polishing [25, 26, 45-50].

*Effect of soft-tissue substitutes in clinical periodontal parameters*

One study showed that at 6 months of follow-up, all the clinical parameters of the control and test groups were significantly different from baseline, except for the probing depth. It demonstrated a reduction of GR, GR width, and CAL, and an enhancement in keratinized tissue (KT) height and KT thickness (KTT) [26]. Besides, there was no significant difference in using ADMG in the GR defects associated or not with NCCLs type 2 [26].

Mathias-Santamaria *et al*. showed subanalysis data according to the characteristics of the specific sites at baseline. Considering only sites with CDs height ≥3 mm, the coronally advanced flap (CAF) + CM group displayed a higher KTW gain (CAF + CM, 0.9 ± 0.8 mm; CAF, 0.3 ± 0.6 mm; $P = 0.002$) and KTT gain (CAF + CM, 0.6 ± 0.2 mm; CAF, 0.1 ± 0.3 mm; $P = 0.0001$) compared to the CAF group. Regarding only sites with thin phenotypes at baseline, the CAF + CM group showed a higher KTT gain (CAF, 0.5 ± 0.7 mm; CAF + CM, 1 ± 0.6 mm; $P = 0.001$). Besides that, in sites with KTW <2 mm, the CAF + CM showed a higher KTW gain and KTT gain [25].

Regarding the esthetic assessment of interventions, one study used the Root Coverage Esthetic Score (RES) [46], and another employed the Modified Root Coverage Esthetic Score (MRES) [25], achieving excellent results, but with no significant difference when compared to the control group [25]. Esthetic parameters were not evaluated by the professionals in the other studies [26, 45].

*Effect on patient-centered outcomes*

Regarding DH, only one of 17 participants of a RCT reported DH after the 1st month, and it continued until the 3rd month. On the other hand, the others declared a complete satisfaction [26]. Another RCT mentioned that both CAF and CAF + CM groups significantly reduced the DH scores and the frequency of DH reported by patients with no

intergroup difference [25]. In addition, patients in six case report studies included here did not disclose DH after interventions [45-50].

Mathias-Santamaria *et al*. evaluated postoperative pain and discomfort, which were estimated considering the number of analgesics taken and the postoperative pain score (Visual Analog Scale). They demonstrated that both control and test groups had low postoperative pain and discomfort levels in the initial-phase healing [25].

Considering the patient-centered esthetic assessment, overall, patients expressed a high level of esthetic satisfaction after interventions [25, 26, 45-50], but without significant difference compared to the control groups [25, 26].

*Employment of root conditioning agents*
Three studies used EDTA 24% previous to the surgical phase as a root conditioning agent [26, 46, 49] The other studies did not condition dental roots [25, 45, 47, 48, 50].

*Restorative phase*
Considering the restorations of CD defects, only two studies did not restore the teeth [26, 50]. On the other hand, the most studies restored the defects and employed direct composite resin restorations [26, 45, 46] Among them, Santamaria's group placed restorations 1 mm apically at the calculated CEJ level [25, 45, 48], and Martiniello *et al*. finalized them at the level of MRC [46].

*Main results*
The main goal of the root coverage procedures is complete root coverage, which depends on the type of GR, gingival phenotype, type of surgical procedure, anatomy, location of the teeth, interproximal tissues, root condition, and presence of CDs [26, 51]. Overall, we cannot state that STSs may benefit periodontal and patient-centered outcomes in root coverage procedures.

*Effects on periodontal outcomes*
The two RCTs considered in the present review evaluated changes in the mean CAL [25] and GR reduction [26] as the primary outcome. One RCT, which evaluated GR RT1 defects plus NCCL B ± in both groups, demonstrated the statistical improvement of KTT gain and KTW gain in the test group (CAF + CM) compared to the control group (only CAF) [25]. Thus, Mathias-Santamaria *et al*. affirmed that CM would be more useful in thinner phenotypes [25]. When ADMG was used in GR defects with an intact root or with the presence of NCCLs type 2, there were no statistical differences in any clinical parameter [26] Hence, Reis *et al*. supposed that the ADMG could support the flap, favoring the gingival margin stabilization and preventing the collapse even over the NCCLs [26].

One SR compared CTG versus STSs in nonroot coverage procedures. CTG groups consistently yielded significantly enhanced KTW compared to STS groups and achieved ≥ 2 mm KTW postoperatively, while STS groups did not. However, STS groups received a greater patient preference, achieved significantly a better esthetic outcomes, and were safe [35]. In the present review, none of the study compared CTG versus STSs for treating CDs.

Regarding assessing the esthetic parameters performed by a periodontist, a study used the RES [46] and other the MRES without significant differences between groups [25] RES system considers five variables: the marginal tissue contour, level of the gingival margin, soft tissue texture, mucogingival junction alignment, and gingival color [52]. Later, Santamaria *et al*. added another parameter: restoration/cervical lesion color in the MRES system [53].

*Effects on patient-centered outcomes*
Patients who underwent surgery using STSs in CDs reported excellent results in esthetic evaluation and DH, and no adverse effects were described. Nevertheless, it is probably because the CAF or extended CAF (ECAF) techniques were performed in conjunction with STSs during the surgical phase [25, 26, 45-50].

*Restorative phase*
In terms of the restoration of defects, six studies restored NCCLs before the root coverage [25, 45-49]. It leads to vast clinical advantages: The composite resin can be executed in an isolated field without the interference of soft tissues, and the restoration aids the surgery phase and provides a convex, stable, and smooth substrate for the surgical flap [11].

In addition, three studies placed the apical border of the resin composite restorations 1 mm apically to the predicted CEJ [25, 45, 48]. This way, they reduce the likelihood of residual root exposure and minimize the persistent DH [54].

Studies in the field of restorative dentistry reported that resin-modified glass ionomers and glass ionomer-based materials have presented the lowest annual failure rates [55]. Nevertheless, resin composites are often the first choice due to their esthetic and physical properties [56].

Besides that, after surgery, the flap margin touches the restoration. This way, the emergence profile could diminish the pressure over the graft, consequently increasing the gingival tissue gain [45]. The gingival thickness is an important factor for long-term results and for avoiding GR recurrence [45].

*Surgical phase*
Considering the surgical technique, one study used ECAF. Reis *et al*. mentioned that ECAF is a suitable technique for treating CDs and in association with STSs because ECAF provides a better nutrition for the avascular graft [26]. The other studies employed the conventional CAF technique plus STSs [25, 45-48] and tunnel technique plus STSs [49, 50].

*Study limitations*

There are a few clinical studies on that topic, and even a fewer RCTs. Among them, of the two RCTs included in our revision, one compares exposure variables (GR with and without NCCLs) [26] and other, intervention variables (CAF vs. CAF + STS) [25] demonstrating the methodological heterogeneity between studies. Another limitation could be the short-term evaluation of the restorative and coverage approaches.

*Recommendations and future research directions*

STSs are in continuous development in the arena of root coverage. Considerable efforts have been made to improve techniques and biomaterials for sorting out GR defects associated with NCCLs. Considering the available literature, it is necessary to conduct more RCTs comparing biomaterials versus negative (blank) or positive (CTGs) control groups for root coverage of CDs.

Finally, long-term evaluation of the different mucogingival surgery procedures employing STSs and the assessment of the restorations an adhesive techniques for the restorative protocols is needed [57]. Since a significant relapse of the gingival margin of multiple GRs treated with tunnel technique + STSs or CAF + STSs was reported after 12 years [40]. Future studies must use standardized protocols.

## Conclusion

In this review, we attempted to collect the available literature on treating GR associated with NCCLs using STSs. Considering the limited literature, so far, we cannot affirm that these substitutes may benefit periodontal and patient-centered outcomes. Further studies, especially well-conducted RCTs, are needed to analyze STSs further and to identify in which clinical situations could be more advantageous to use them.

**Acknowledgments:** None

**Conflict of interest:** None

**Financial support:** None

**Ethics statement:** None

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