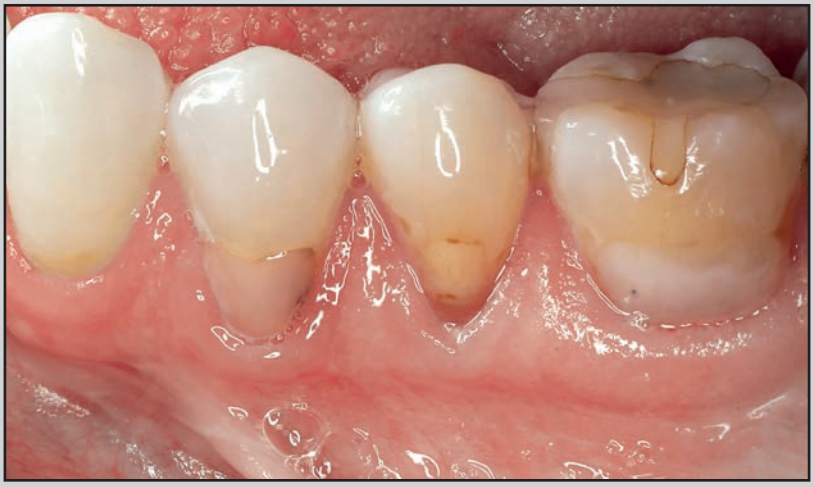
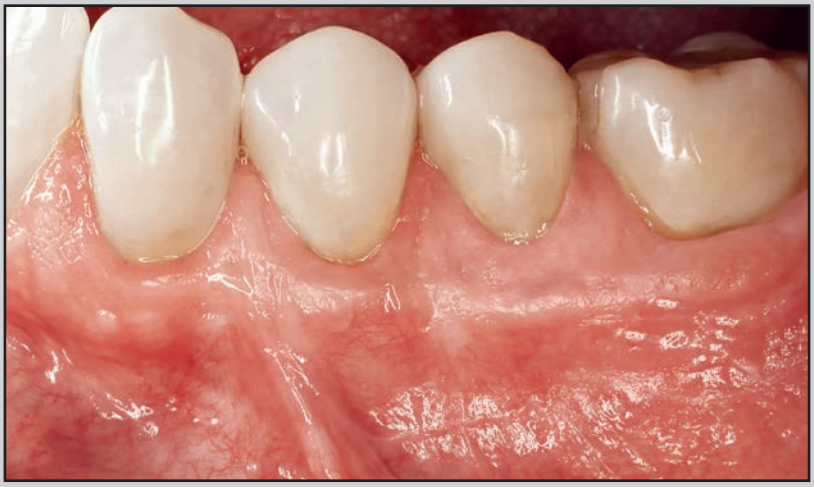
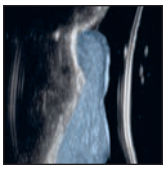




# Coronally Advanced Flap with Xenogeneic Collagen Matrix for the Treatment of Gingival Recessions at Sites Presenting with Cervical Restorations or Noncarious Cervical Lesions: A Clinical and Ultrasonographic Study



*Shayan Barootchi, DMD, MS*[1]
*Maria Vera Rodriguez, DDS*[2]
*Hsun-Liang Chan, DDS, MS*[3]
*Oliver D. Kripfgans, PhD*[4]
*Hom-Lay Wang, DDS, MS, PhD*[3]
*Lorenzo Tavelli, DDS, MS*[5]

*The aim of this prospective study was to evaluate the efficacy of a cross-linked xenogeneic volume-stable collagen matrix (CCM) in treating gingival recessions (GRs) at teeth presenting with cervical restorations or noncarious cervical lesions (NCCLs). Fifteen patients with esthetic concerns for multiple sites with GRs and cervical restorations were consecutively enrolled. The sites were treated with a coronally advanced flap (CAF) design in combination with a CCM. When present, the previous restoration was removed, and the cementoenamel junction was reconstructed with a composite material. The CCM was stabilized on the root surface(s) previously occupied by the restoration. The CAF was sutured to completely cover the graft. Clinical measurements and intraoral digital and ultrasonographic scans were collected at baseline and at 3 and 6 months postsurgery. Limited postoperative discomfort was reported by patients during the healing. The mean root coverage at 6 months was 74.81%. Average increases in gingival thickness of 0.43 mm and 0.52 mm were observed when measured with ultrasonography 1.5 mm and 3 mm apical to the gingival margin, respectively ($P < .05$). Relatively high patient-reported satisfaction and esthetics were associated with the treatment outcomes. The treatment resulted in a significant reduction in dental hypersensitivity (mean: 33 VAS points). The present study demonstrated that CAF + CCM is an effective approach for treating GRs at sites with cervical restorations or NCCLs.* Int J Periodontics Restorative Dent 2023;43:147–154. doi: 10.11607/prd.6448

[1]Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA; Center for Clinical Research and Evidence Synthesis in Oral Tissue Regeneration (CRITERION), Boston, Massachusetts, USA.
[2]Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA; Postgraduate Periodontics, Division of Periodontics, Columbia University College of Dental Medicine, New York, New York, USA.
[3]Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA.
[4]Biointerfaces Institute and Department of Biomedical Engineering, College of Engineering, Ann Arbor, Michigan, USA; Department of Radiology, University of Michigan Medical School, Ann Arbor, Michigan, USA.
[5]Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, Michigan, USA; Center for Clinical Research and Evidence Synthesis in Oral Tissue Regeneration (CRITERION), Boston, Massachusetts, USA; Department of Oral Medicine, Infection, and Immunity, Division of Periodontology, Harvard School of Dental Medicine, Boston, Massachusetts, USA.

Correspondence to: Dr Lorenzo Tavelli, Division of Periodontology, Department of Oral Medicine, Infection, and Immunity, Harvard School of Dental Medicine, 188 Longwood Ave, Boston, MA 02115, USA. Email: lorenzo_tavelli@hsdm.harvard.edu

Submitted June 29, 2022; accepted August 14, 2022.


Gingival recession (GR) is a common condition that can cause esthetic concerns and dental hypersensitivity.[1,2] Among the several predisposing and precipitating factors that have been identified for GRs, traumatic toothbrushing is considered one of the main determinants for its occurrence.[2] Traumatic toothbrushing can also cause loss of tooth structure at the level of the enamel, on the crown, and on the root surface (known as noncarious cervical lesions [NCCLs]). GRs associated with NCCLs are often "treated" with composite restorations, resulting in a long, nonesthetic, and unnatural appearance.

One of the main challenges for properly addressing these conditions is identifying the cementoenamel junction (CEJ).[2–4] Indeed, an unidentifiable CEJ does not allow a reference point for flap design and suturing, and it does not allow for an accurate evaluation of the obtained treatment outcomes.[4]

Pini-Prato et al introduced a classification of surface defects in GRs based on the presence/absence of an identifiable CEJ and on the presence/absence of a cervical discrepancy (step) of more than 0.5 mm between the root and the crown.[5] Zucchelli et al proposed a decision-making process for treating NCCLs, based on the relationship between the NCCL

and the maximum root coverage level.[3] Several studies have demonstrated the predictability of this combined restorative-periodontal approach, involving partial or complete defect restoration and a root coverage procedure with coronally advanced flap (CAF) or the addition of autogenous connective tissue graft (CTG).[3,6–9] It is reasonable to assume that GRs with preexisting restorations invading the root surface should be treated in a similar manner, with the removal of the restoration until the estimated CEJ is reached, and reconstruction of the CEJ, adding a soft tissue graft. Interestingly, despite graft substitutes frequently being used for root coverage in the last decade to achieve a less invasive and more patient-centered approach,[10–12] their application for the treatment of GRs associated with cervical restorations or NCCLs has been poorly investigated. Therefore, the aim of this manuscript was to evaluate the efficacy of CAF in combination with a xenogeneic collagen matrix for the treatment of GRs presenting with cervical restorations or NCCLs.

## Materials and Methods

### *Study Population*

Fifteen patients presenting with esthetic concerns associated with GRs with cervical restorations and/or NCCLs were consecutively enrolled between June 2021 and October 2021. The inclusion criteria were as follows: *(1)* age 18 years or older; *(2)* good general health with no systemic/periodontal disease; *(3)* good oral hygiene with full-mouth plaque scores ≤ 15%; *(4)* presence of single or multiple recession type [RT] 1 GRs[2] at least 2 mm in depth from the estimated CEJ[3,4]; and *(5)* presence of restorations at the cervical areas or presence of NCCLs.[5]

Smoking, pregnancy (or planning to become pregnant), previous history of mucogingival surgery at the experimental site, presence of prosthetic crowns, and severe step (> 2 mm)[6] were considered among the exclusion criteria. The study protocol was approved by the Institutional Review Board of the University of Michigan Medical School (HUM00146261), in accordance with the 1975 Declaration of Helsinki, revised in Fortaleza in 2013. Prior to the surgical procedure, all patients provided their informed consent to be included in the study.

### *Surgical Procedure*

At least 1 month before surgery, participants received a session of dental prophylaxis, including oral hygiene instructions that aimed at eliminating possible traumatic toothbrushing habits.

The surgical procedure consisted of a trapezoidal CAF[13] in combination with a cross-linked volume-stable xenogeneic collagen matrix (CCM) (Figs 1 and 2). The CEJ was identified using the adjacent/contralateral teeth, as previously described.[4,6] For sites with restorations at the cervical area, the restoration was removed either before or after flap elevation. After the split-full-split flap preparation and elevation,[13] preexisting restorations were completely removed from the surface area. The CEJ was reshaped or reconstructed with composite filling, with the apical margin located at the level of the ideal CEJ.[4,14] After mechanical scaling and root planing with ultrasonic instruments and mini curettes (Hu-Friedy), the new composite restoration was reshaped and smoothened with finishing burs. A conservative odontoplasty, aiming to bevel the step, was also performed with finishing burs to facilitate graft adaptation. The anatomical papillae were deepithelialized with mini blades (Hu-Friedy) and small round burs, if necessary. The flap was released to passively reach a position of approximately 2 mm coronal to the reconstructed/redefined CEJ without tension. The CCM (Fibro-Gide, Geistlich Pharma) was extraorally trimmed based on the characteristics of the recession defects, aiming for a graft 3 mm thick and 8 mm tall. The CCM was stabilized to the deepithelialized anatomical papillae with simple interrupted sutures (6/0 and 7/0 PGA; Unify Sutures, AD Surgical). If further stability of the CCM was needed, additional simple interrupted sutures, engaging the apical periosteum, or compressive sutures, from the apical periosteum and running around the teeth, were performed (6/0 and 7/0 PGA). The flap was coronally advanced and stabilized approximately 2 mm coronal to the CEJ with sling sutures at the level of the surgical and anatomical papillae

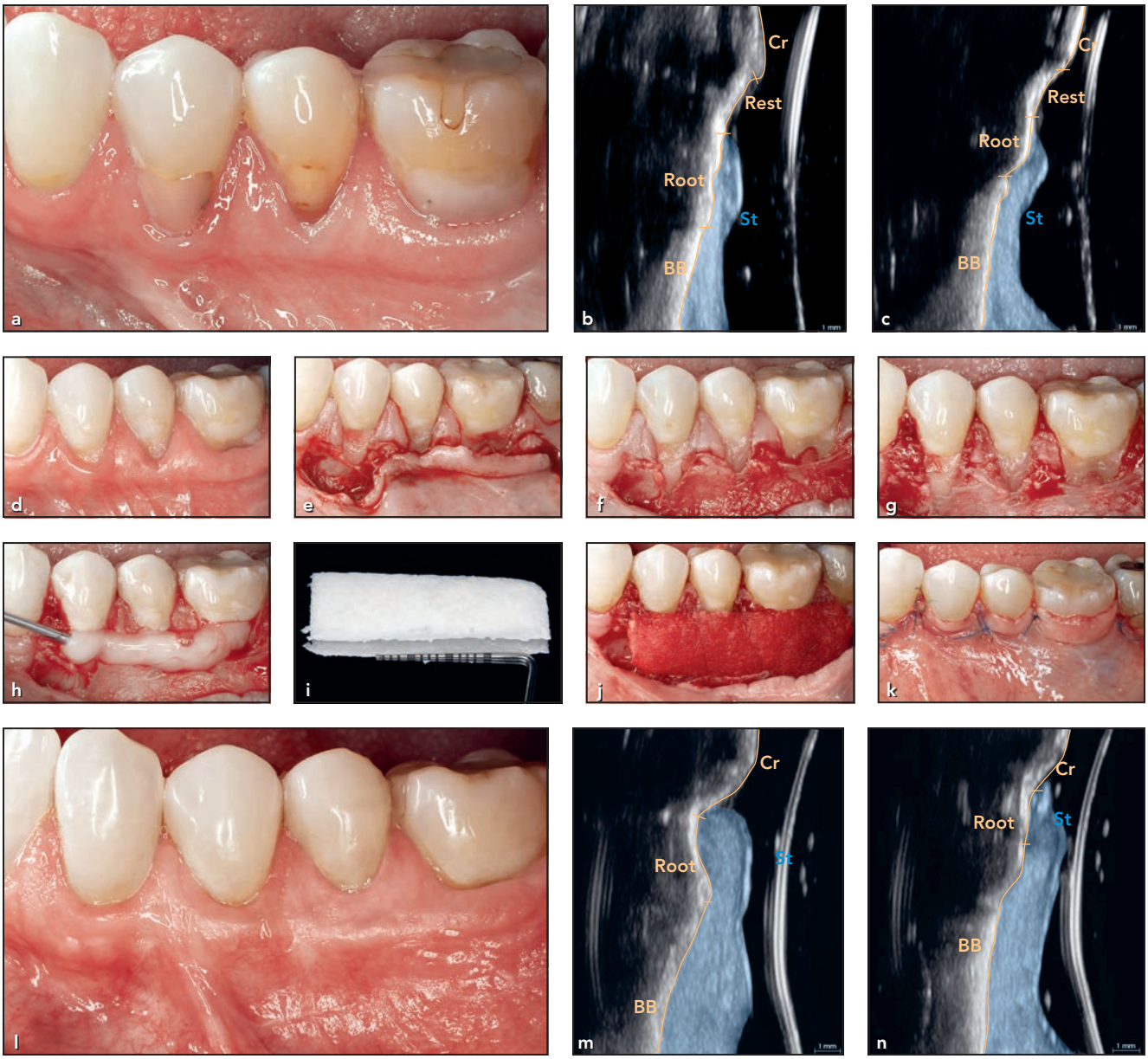



**Fig 1** *First example clinical case. Treatment of gingival recessions associated with preexisting restorations.* (a) *Baseline clinical view.* (b and c) *Baseline ultrasonographic scans at the midfacial aspect of teeth 34 and 35, respectively (FDI tooth-numbering system). The soft tissue is highlighted in blue.* (d) *Old restorations were removed, and the CEJ was reconstructed.* (e) *CAF preparation and* (f) *elevation.* (g) *Deepithelialization of the anatomical papillae.* (h) *Chemical root conditioning with 24% EDTA.* (i) *The CCM (Fibro-Gide) was selected for application.* (j) *The matrix was stabilized to the recipient site with sutures.* (k) *The flap was coronally advanced and sutured with sling and interrupted sutures.* (l) *Clinical outcomes at 6 months.* (m and n) *Ultrasonographic scans at the midfacial aspect of teeth 34 and 35, respectively, at 6 months. The soft tissue is highlighted in blue. BB = buccal bone; Cr = anatomical crown; Rest = restoration; ST = soft tissue.*

and with simple interrupted sutures at the level of the vertical incisions (6/0 and/or 7/0 polypropylene, Ethicon, Johnson & Johnson).

Oral and written postoperative instructions were provided to patients, as well as prescriptions for analgesics (600 mg ibuprofen every 8 hours as needed), antibiotics (500 mg amoxicillin every 8 hours for 7 days), and a mouth rinse (chlorhexidine gluconate 0.12%

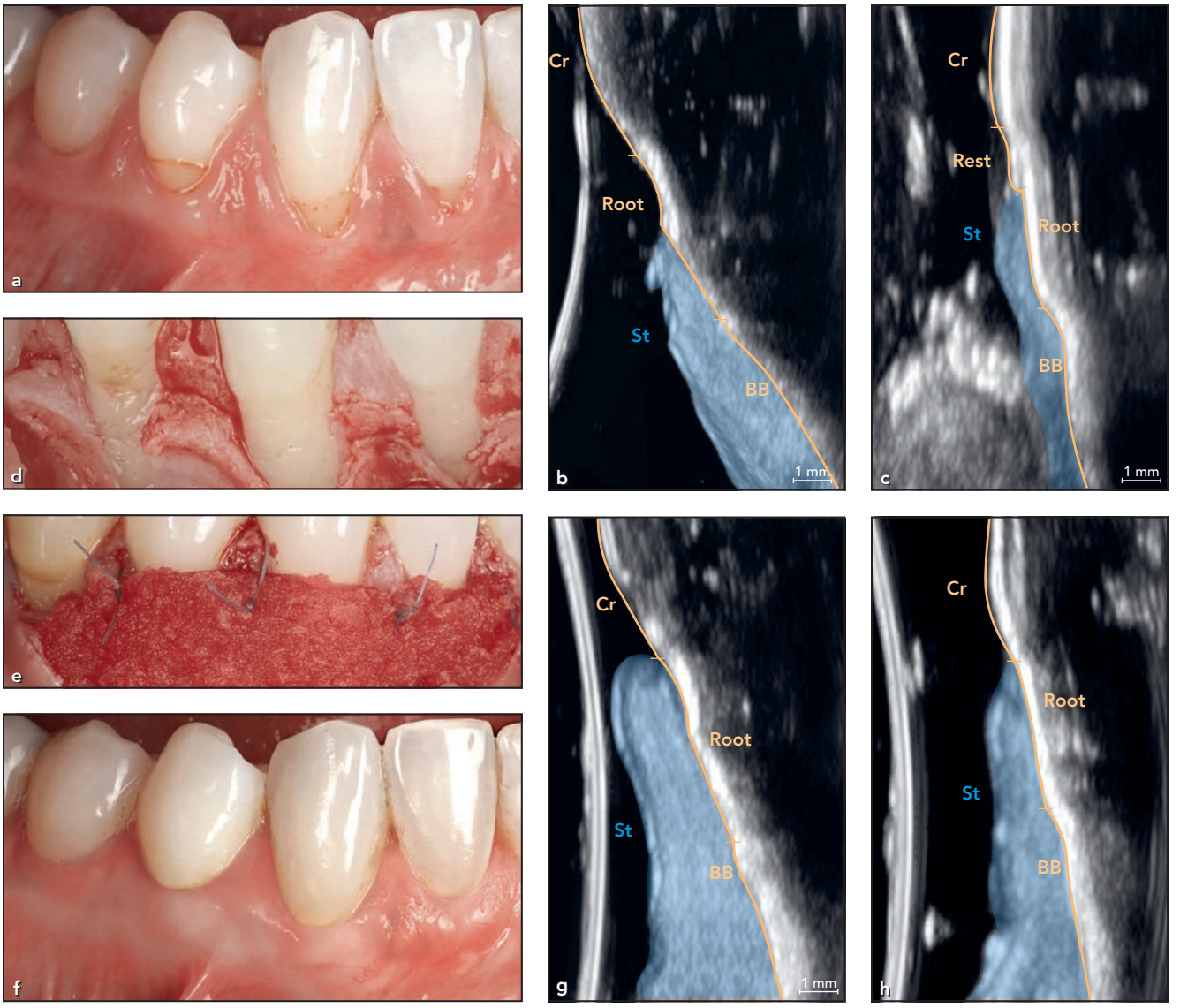



**Fig 2** *Second example clinical case.* (a) *Baseline clinical view of teeth with GRs to be treated.* (b and c) *Baseline ultrasonographic scans at the midfacial aspect of teeth 43 and 44, respectively. The soft tissue is highlighted in blue.* (d) *Flap elevation.* (e) *The CCM (Fibro-Gide) was stabilized with absorbable suture material.* (f) *Clinical outcomes at 6 months.* (g and h) *Ultrasonographic scans at the midfacial aspect of teeth 43 and 44, respectively, at 6 months. The soft tissue is highlighted in blue. BB = buccal bone; Cr = anatomical crown; Rest = restoration; ST = soft tissue.*

twice a day for the first 2 weeks). Sutures were removed at the 2-week postoperative visit, where subjects were instructed to resume oral hygiene procedures using a toothbrush with extra-soft bristles for the first month, prior to switching to a soft-bristle toothbrush. Patients were recalled at 1, 3, and 6 months.

### *Study Outcomes and Assessment*

The main outcome the study assessed was the mean root coverage (mRC) at 6 months, calculated as the percentage of recession depth (REC) reduction compared to baseline (preoperative).[12] Secondary outcomes were also evaluated at the 6-month visit and included changes in keratinized tissue width (KTW), changes in gingival thickness (GT) measured with ultrasonography, volumetric outcomes from superimposition of digital impressions at baseline and 6 months, professional esthetic evaluation using the Root

coverage Esthetic Score (RES),[15] and patient-reported outcome measures (PROMs).

A periodontal probe (PCP UNC-15, Hu-Friedy) was used to assess the REC (from the gingival margin to the ideal CEJ), probing depth (PD), clinical attachment level (CAL), and KTW. The mRC was determined as the percentage of the defect coverage at 6 months.[16,17]

Ultrasonography was performed at baseline, 3 months, and 6 months to evaluate changes in GT at the midfacial aspect of the experimental sites (Figs 1 and 2). The equipment setup and scanning procedures for ultrasonography have been previously described in detail.[18–21] The generated DICOM files were imported in a public-domain software package (Horos, version 3.3.6, Horos Project) for evaluating GT at reference points 1.5 mm and 3 mm apical to the gingival margin.[12] The depth of the horizontal step at baseline was also assessed using ultrasonography.

Digital impressions of the area of interest were taken with an intraoral optical scanner (Trios, 3Shape). The workflow to generate, superimpose, and analyze volumetric changes between STL (standard tessellation language) files at different time points has been previously described.[22] The volumetric outcomes of interest, assessed using an image analysis software (GOM Inspect, GOM MEtrology), were the changes in volume at surgical areas (Vol) and the mean thickness of the reconstructed volume/mean change in the surface profile from baseline to 6 months (ΔD).[22]

PROMs were recorded using questionnaires utilizing a 0- to 100-mm visual analogue scale (VAS) and dichotomous questions. Dental hypersensitivity (DH) was assessed at baseline and 6 months using the air spray approach and a VAS scale (0 = no sensitivity; 100 = worst sensitivity).[23] Postoperative discomfort was assessed during the first 2 weeks using a VAS (0 = no pain; 100 = the worst pain). Treatment satisfaction (VAS; 0 = worst outcome; 100 = best outcome), esthetic evaluation (VAS; 0 = worst outcome; 100 = best outcome), and willingness to undergo the treatment again (yes/no) were evaluated at 6 months.

### *Statistical Analysis*

Descriptive statistics were used to present the baseline and 6-month clinical, ultrasonographic, and volumetric data, as well as PROMs, as means ± standard deviations. To assess statistical significance in all outcomes (changes from baseline to 6 months), mixed linear regression models were used to account for the fact that patients contributed to more than one site (by inclusion of random effects). A *P* value threshold of .05 was set for statistical significance. The analyses were performed in RStudio (version 1.1.383).

## Results

Fifteen systemically healthy patients (4 men and 11 women; mean age: 37.6 ± 14.5 years) were included in the study. All subjects presented with at least two multiple adjacent cervical restorations or NCCLs, and a total of 36 sites were treated (23 in the maxilla and 13 in the mandible). Among them, 24 presented with cervical restorations (66.7%), and 12 exhibited NCCLs without previous restorations (33.3%). The NCCLs were classified as A+ in 3 cases (CEJ detectable with the presence of a step), and B+ (CEJ not detectable and presence of a step) for the remaining 9 sites.[2,5] The mean horizontal step was 0.62 ± 0.48 mm when measured with ultrasonography and was 0.78 ± 0.63 mm when measured intrasurgically with a periodontal probe ($P > .05$ for differences between clinical and ultrasound measurements).

No intraoperative complications occurred. Healing was uneventful at all sites, without postoperative complications at any sites during the healing period, and with minimal postoperative morbidity, as reported by the patients during the first 2 weeks (mean VAS score: 13.6).

The mRC at 6 months was 74.81% ± 24.86%. A statistically insignificant change in KTW was observed at 6 months (mean gain: 0.38 mm; $P > .05$), while the GT gain was statistically significant ($P < .05$) at both the 1.5-mm and 3-mm reference points (averaging 0.43 mm and 0.52 mm, respectively). Further clinical, volumetric, and PROMs data are reported in detail in Table 1. A statistically significant reduction in DH was also observed at 6 months, from a mean VAS of 54 ± 28 at baseline to a mean VAS of 21 ± 17 at the final visit ($P < .05$).

**Table 1 Clinical, Ultrasonographic, and Patient-Reported Outcomes**

| Outcome measurements | Baseline | 6 mo |
|---|---|---|
| Clinical | | |
| REC depth, mm | 2.57 ± 0.52 | 0.65 ± 0.65* |
| mRC, % | – | 74.81 ± 24.86 |
| PD, mm | 1.27 ± 0.45 | 1.41 ± 0.50 |
| CAL, mm | 3.85 ± 0.68 | 2.07 ± 0.83* |
| KTW, mm | 1.64 ± 0.94 | 2.01 ± 0.85 |
| Ultrasound GT, mm | | |
| At 1.5 mm | 0.91 ± 0.31 | 1.34 ± 0.38* |
| At 3 mm | 1.02 ± 0.27 | 1.53 ± 0.37* |
| Volumetric | | |
| Vol, $mm^3$ | – | 51.11 ± 24.38 |
| ΔD, mm | – | 0.51 ± 0.27 |
| Patient-reported outcome measures | | |
| RES score, n | – | 7.38 ± 1.96 |
| DH score, n | 54 ± 28 | 21 ± 17* |
| SAT score, n | – | 95 ± 11 |
| EST score, n | – | 88 ± 17 |
| Willingness to undergo treatment again (yes/no) (%) | – | 100 |

CAL = clinical attachment level; DH = dental hypersensitivity; EST = esthetic evaluation; GT = gingival thickness; KTW = keratinized tissue width; mRC = mean root coverage; PD = probing depth; REC = recession; RES = root coverage esthetic score; SAT = treatment satisfaction; Vol = volume change; ΔD = mean thickness of the reconstructed volume/mean change in the surface profile from baseline to 6 months.
All data except willingness to undergo treatment again are reported as mean ± SD. DH, SAT, and EST values are represented as VAS scores. For DH scores: 0 = no sensitivity; 100 = worst sensitivity. For SAT and EST scores: 0 = worst outcome; 100 = best outcome.
*Statistically significant change from baseline ($P < .05$).

## Discussion

Several approaches have been described for the treatment of GRs with NCCLs. These techniques aim to partially or completely reconstruct the defect on the root surface using resin-modified glass ionomer or composite resins.[6–9] Although partial vs complete restoration of the defect does not seem to affect the amount of root coverage,[9,24] concerns regarding complete restoration of the NCCL include color degradation of the material, worsening esthetic outcomes, complexity in managing possible restoration failures over time, and increased pocket depth.[9,25] Therefore, it has been recommended that the NCCL should be restored in a way that the apical margin of the composite resin filling is located at the ideal level of the CEJ or 1 mm apical to the CEJ.[3,4,6,9,14] A recent study highlighted the importance of soft tissue stability with an adequate NCCL restoration, as a lack of proper marginal adaptation of the composite restoration was significantly associated with a higher risk for occurrence or progression of GRs over time.[26]

The present study included GRs either with NCCLs or with unesthetic and "long" cervical restorations, as they represent the same condition once the preexisting restoration is removed. After CEJ reconstruction, the teeth with cervical lesions were treated with a CCM. The advantages of this graft material include avoiding a palatal donor site, reduced patient morbidity, unlimited availability, and increased soft tissue thickness.[10,27]

Most of the studies describing the treatment of GRs with NCCLs utilized CAF, either alone or in combination with CTG.[3,6–9] When CTG was performed at sites exhibiting NCCLs, the reported mRC ranged from 73% to 93%.[6,8,9,28] However, in line with contemporary periodontology (which aims to reduce invasiveness, focusing on patient-centered outcomes and avoiding autogenous grafts when possible), the present authors designed the present study to evaluate the performance of a novel graft substitute; an average mRC of 74.81% was observed at 6 months. The present results are in line with the ones obtained by McGuire et al when CAF + CCM was performed in isolated GRs without NCCLs,[29] suggesting that the described protocol is effective in treating GRs with NCCLs and preexisting cervical restorations.

A recent trial evaluating CAF alone or in combination with the first generation of xenogeneic collagen matrix for the treatment of GRs associated with NCCLs reported an mRC of 70.3% and 69%, respectively.[30] The authors found a superior gain in KTW (0.9 vs 0.3 mm) and GT (0.7 vs 0.1 mm) for sites that received the collagen matrix.[30] Bearing in mind that the accuracy of transgingival piercing for assessing tissue thickness is questionable, the present study used dental ultrasonography and observed a mean GT gain of 0.43 mm and 0.52 mm at the 1.5-mm and 3-mm reference points, respectively. The 3D volumetric analysis from superimposing the digital impressions revealed mean volume gains of 51.11 $mm^3$ (Vol) and 0.51 mm (DD). To the best of the present authors' knowledge, the present study is the first of its kind utilizing ultrasonography and optical scanning to evaluate GT and volumetric variations following root coverage procedures of sites presenting with NCCLs or cervical restorations. Therefore, a direct comparison of the present results to the literature is not feasible.

An important aspect of modern clinical studies is the assessment of PROMs. Patients reported minimal discomfort following the surgical procedure, which may have also contributed to the relatively high treatment satisfaction and willingness to undergo the treatment again. It should be considered that the positive PROM responses to treatment satisfaction, willingness to undergo treatment again, and esthetics are probably due to a variety of factors associated with the intervention, such as the removal of old restorations, the amount of root coverage, and the use of a CCM without palatal harvesting.

Lastly, it should be mentioned that CAF + CCM resulted in a DH reduction of 33 VAS points. This finding is encouraging, as DH is one of the main concerns associated with NCCLs. Previous studies reported a similar reduction in DH with partial restoration of the NCCLs using composite resin and CTG,[6,9] suggesting that CCM may have a similar efficacy as CTG in reducing DH in these case scenarios. Nevertheless, future studies should assess this speculation. The main limitations of the present pilot study include the lack of a control group and the relatively short-term follow-up. Further studies with longer follow-ups comparing CCM with CAF alone, CTG, or other biomaterials are needed.

## Conclusions

The present pilot study presented the outcomes of CCM in combination with CAF for the treatment of GRs with cervical restorations or NCCLs. This approach was found to be effective in covering/reducing the recession defect, increasing soft tissue thickness, and reducing DH, with minimal postoperative morbidity. Additional studies with multiple arms are needed to further explore these preliminary findings.

## Acknowledgments

This study was partially supported by Geistlich Pharma. Dr Lorenzo Tavelli has previously provided lectures sponsored by Geistlich Pharma. The other authors do not have any financial interests, either directly nor indirectly, in the products or information listed in the paper.

## References

1. Zucchelli G, Tavelli L, McGuire MK, et al. Autogenous soft tissue grafting for periodontal and peri-implant plastic surgical reconstruction. J Periodontol 2020;91:9–16.
2. Cortellini P, Bissada NF. Mucogingival conditions in the natural dentition: Narrative review, case definitions, and diagnostic considerations. J Periodontol 2018;89(suppl 1):s204–s213.
3. Zucchelli G, Gori G, Mele M, et al. Non-carious cervical lesions associated with gingival recessions: A decision-making process. J Periodontol 2011; 82:1713–1724.

4. 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;30:573–581.
5. Pini-Prato G, Franceschi D, Cairo F, Nieri M, Rotundo R. Classification of dental surface defects in areas of gingival recession. J Periodontol 2010; 81:885–890.
6. Cairo F, Cortellini P, Nieri M, 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;47:362–371.
7. Santamaria MP, Suaid FF, Casati MZ, Nociti FH, 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;79:621–628.
8. Santamaria MP, Ambrosano GM, Casati MZ, Nociti Junior 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; 36:791–798.
9. Santamaria MP, Silveira CA, Mathias IF, 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; 45:968–976.
10. Tavelli L, McGuire MK, Zucchelli G, et al. Extracellular matrix-based scaffolding technologies for periodontal and peri-implant soft tissue regeneration. J Periodontol 2020;91:17–25.
11. Barootchi S, Tavelli L, Zucchelli G, Giannobile WV, Wang HL. Gingival phenotype modification therapies on natural teeth: A network meta-analysis. J Periodontol 2020;91:1386–1399.
12. Tavelli L, Barootchi S, Rodriguez MV, et al. rhPDGF improves root coverage of a collagen matrix for multiple adjacent gingival recessions: A triple-blinded, randomized, placebo-controlled trial. J Clin Periodontol 2022;49:1169–1184.
13. de Sanctis M, Zucchelli G. Coronally advanced flap: A modified surgical approach for isolated recession-type defects: Three-year results. J Clin Periodontol 2007;34:262–268.
14. Allegri MA, Landi L, Zucchelli G. Non-carious cervical lesions associated with multiple gingival recessions in the maxillary arch. A restorative-periodontal effort for esthetic success. A 12-month case report. Eur J Esthet Dent 2010;5:10–27.
15. Cairo F, Nieri M, Cattabriga M, et al. Root coverage esthetic score after treatment of gingival recession: An interrater agreement multicenter study. J Periodontol 2010;81:1752–1758.
16. Wang HL, Bunyaratavej P, Labadie M, Shyr Y, MacNeil RL. Comparison of 2 clinical techniques for treatment of gingival recession. J Periodontol 2001;72:1301–1311.
17. Zucchelli G, Mele M, Mazzotti C, Marzadori M, Montebugnoli L, De Sanctis M. Coronally advanced flap with and without vertical releasing incisions for the treatment of multiple gingival recessions: A comparative controlled randomized clinical trial. J Periodontol 2009;80:1083–1094.
18. Barootchi S, Chan HL, Namazi SS, Wang HL, Kripfgans OD. Ultrasonographic characterization of lingual structures pertinent to oral, periodontal, and implant surgery. Clin Oral Implants Res 2020;31:352–359.
19. Chan HL, Kripfgans OD. Ultrasonography for diagnosis of peri-implant diseases and conditions: A detailed scanning protocol and case demonstration. Dentomaxillofac Radiol 2020:20190445.
20. Tavelli L, Barootchi S, Majzoub J, et al. Ultrasonographic tissue perfusion analysis at implant and palatal donor sites following soft tissue augmentation: A clinical pilot study. J Clin Periodontol 2021;48:602–614.
21. Barootchi S, Tavelli L, Majzoub J, Chan HL, Wang HL, Kripfgans OD. Ultrasonographic tissue perfusion in peri-implant health and disease. J Dent Res 2022;101:278–285.
22. Tavelli L, Barootchi S, Majzoub J, Siqueira R, Mendonça G, Wang HL. Volumetric changes at implant sites: A systematic appraisal of traditional methods and optical scanning-based digital technologies. J Clin Periodontol 2021;48:315–334.
23. Meza-Mauricio J, Cortez-Gianezzi J, Duarte PM, Tavelli L, Rasperini G, de Faveri M. Comparison between a xenogeneic dermal matrix and connective tissue graft for the treatment of multiple adjacent gingival recessions: A randomized controlled clinical trial. Clin Oral Investig 2021;25:6919–6929.
24. Santamaria MP, Casati MZ, Nociti FH Jr, 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.
25. 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–e8.
26. Favetti M, Montagner AF, Fontes ST, et al. Effects of cervical restorations on the periodontal tissues: 5-year follow-up results of a randomized clinical trial. J Dent 2021;106:103571.
27. Stefanini M, Mounssif I, Barootchi S, Tavelli L, Wang HL, Zucchelli G. An exploratory clinical study evaluating safety and performance of a volume-stable collagen matrix with coronally advanced flap for single gingival recession treatment. Clin Oral Investig 2020;24:3181–3191.
28. Pourabbas R, Kimyai S, Chitsazi MT, Nourbaksh F. Clinical comparison of localized gingival recession coverage in root surfaces restored with giomer and intact root surfaces. Afr J Biotechnol 2011;10:5893–5899.
29. McGuire MK, Janakievski J, Scheyer ET, et al. Efficacy of a harvest graft substitute for recession coverage and soft tissue volume augmentation: A randomized controlled trial. J Periodontol 2022;93:333–342.
30. Mathias-Santamaria IF, Silveira CA, Rossato A, Sampaio de Melo MA, Bresciani E, Santamaria MP. Single gingival recession associated with non-carious cervical lesion treated by partial restoration and coronally advanced flap with or without xenogenous collagen matrix: A randomized clinical trial evaluating the coverage procedures and restorative protocol. J Periodontol 2022;93:504–514.