Several soft tissue graft materials have been utilized over the years as alternatives to the autogenous connective tissue graft for reducing patient morbidity. In particular, a novel volume-stable xenogeneic collagen matrix (VXCM) has recently been introduced for soft tissue augmentation at implant sites. The VXCM is porous in nature, and its mechanical properties suggest utilizing a specific flap approach when treating multiple adjacent gingival recessions (MAGRs). Herewith, a minimally invasive surgical technique is described in combination with VXCM for treatment of MAGRs. Five patients with 16 MAGRs were treated with this approach. All sites healed uneventfully, and patients reported minimal discomfort. At 6 months, the technique resulted in a mean root coverage of 94.73%, and complete root coverage was achieved in 13 sites (81.25%). The proposed minimally invasive approach may have potential to enhance flap blood supply and graft vascularization, promoting rapid healing with minimal postoperative discomfort. In addition, this approach can result in satisfactory clinical, esthetic, and patient-reported outcomes. Future adequately powered clinical trials are needed to validate the findings of this preliminary report. Int J Periodontics Restorative Dent 2022;42:155–162. doi: 10.11607/prd.5747

A substantial proportion of the population is affected by gingival recessions (GRs). This condition can cause esthetic concerns, dental hypersensitivity, root caries, and may even progress over time, if left untreated. Several surgical techniques have been suggested over the years for the treatment of GRs, starting from guided tissue regeneration approaches, pedicle flaps alone, and the introduction of other flap designs, such as the coronally advanced flap (CAF), the pouch, and later the modified tunnel approaches. These techniques have been used alone, in combination with autogenous connective tissue graft, or with graft substitutes. In the last decades, clinicians have shown an increased interest toward the use of allogeneic or xenogeneic matrices due to their unrestricted availability, avoidance of a secondary surgical site, and reduction of patient morbidity. A novel xenogeneic and porous collagen matrix has been introduced for soft tissue augmentation. Due to its property of maintaining good volume stability, this graft has been called volume-stable xenogeneic collagen matrix (VXCM). This material showed clinical outcomes similar to those achieved with the autogenous connective tissue graft, relative to volumetric soft tissue augmentation (mostly thickness) at implant sites.
Nonetheless, few studies have described the performance of VXCM in natural teeth for root coverage purposes. Stefanini et al utilized the conventional trapezoidal CAF in combination with VXCM for treatment of single GRs. Nonetheless, it may be reasonable to assume that graft substitutes, such as the VXCM, may be even more suitable for treating multiple adjacent GRs (MAGRs) due to the advantage of avoiding a second surgical site.

Therefore, this article describes a minimally invasive surgical approach (tunneled CAF [TCAF]) for optimizing the utilization and stabilization of the VXCM for the treatment of MAGRs, underling its rationale, advantages, and preliminary outcomes through a case series.

Materials and Methods

Five nonsmoking systemically and periodontally healthy patients presenting with at least two adjacent teeth with type 1 recession (RT1)\(^{11}\) with a thin or medium periodontal soft tissue phenotype\(^{12,13}\) who reported esthetic concerns associated with the GRs were recruited at the Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, USA. Patients received informed consent forms and were all treated with the same surgical approach described within this report and in combination with a VXCM (Fibro-Gide, Geistlich). The study protocol was in full accordance with the 1975 Declaration of Helsinki, as revised in 2000.

Recession depth, pocket depth, keratinized tissue width, and gingival thickness were assessed by the same examiner (S.B.) at baseline and at the 6-month follow-up, as previously described.\(^9\) The soft tissue phenotype was also evaluated with a color-coded probe (Colorvue, Hu-Friedy) before surgery and 6 months after.\(^{12}\) Patient morbidity during the first 10 postoperative days was recorded on a visual analogue scale (VAS) ranging from 0 to 10 (where 0 meant no pain and 10 meant maximum pain).\(^9\) The root coverage esthetic score (RES) system was used to assess the esthetic outcomes at 6 months.\(^9\)

Patients received personalized oral hygiene instruction in order to correct possible traumatic brushing habits at least 4 weeks prior to the surgical procedure, which was reinforced at subsequent follow-up visits.

Minimally Invasive Approach (TCAF) Without Vertical Incisions

When multiple recession defects with similar depths are present or when shallow GRs—as compared to the tooth/teeth with the deepest defect(s)—are located on the mesial and distal sides, the minimally invasive surgical approach can be performed without vertical incisions (Fig 1a). Only the two papillae at the center of the surgical area are incised with oblique incisions (Fig 1b), then elevated split-thickness using a mini blade (Salvin Bendable Miniature Surgical Blade no. 67, Salvin Dental Specialties). The split-thickness elevation continues in the interproximal area of the tooth in the middle of the surgical site, while at the midbuccal aspect, the flap is reflected full-thickness until 2 to 3 mm of buccal bone is exposed. The soft tissue of the adjacent teeth is elevated using tunnel knives (tunneling knife no. 1 and no. 2, American Dental Systems), so as to include one tooth without a GR on each side (mesial/distal) (Figs 1c to 1e). The flap is then released using a 15C blade (Hu-Friedy) and the tunnel knives. In particular, a tunneling knife with a small, curved angle is entered from the sulcus of the teeth with intact papillae and used to release the muscular insertions. Flap release at these regions is completed by introducing the 15C blade from the area in which the surgical papillae have been elevated. The papillae that are incised are then deepithelialized either with a mini blade (Salvin no. 67) or microsurgical scissors (Hu-Friedy), while the other papillae are gently mobilized with a papilla elevator instrument until they are able to be coronally advanced. Mechanical and chemical root conditioning is also performed with 24% EDTA (ethylenediaminetetraacetic acid) for 2 minutes followed by rinsing with sterile saline.\(^{14}\) After extraorally trimming the VXCM with a 15C blade according to the dimensions of the surgical site, the graft is inserted from the area in which the papillae have been incised and gently tunneled mesially and distally underneath the flap, utilizing tunneling instruments. The graft is then stabilized with simple interrupted absorbable sutures (7/0 PGA, AD Surgical) that engage the coronal portion of the matrix and the deepithelialized...
anatomical papillae (Figs 1f and 1g). Further stabilization of the graft can be achieved with anchoring sutures from the apical periosteum to the VXCM. The flap is then advanced and sutured 1 to 2 mm coronal to the cementoenamel junction with fine sling sutures (6/0 or 7/0 polypropylene [Ethicon, Johnson & Johnson] or 7/0 PGA) (Figs 1h and 1i).

Minimally Invasive Approach (TCAF) Without One Vertical Incision

In case of MAGRs with only one moderate/severe GR and the remaining teeth (located mesially or distally to the tooth with the deepest recessions) having shallow recession defects, only one vertical incision is performed mesially or distally to the tooth with the deepest recession (Figs 2 and 3) using a mini blade (Salvin no. 67). Both papillae of the tooth with the deepest recession are incised and elevated as described for the conventional CAF.15 The papilla adjacent to the vertical incision is incised horizontally, while the other papilla of the tooth with the deepest recession (which is adjacent to the area that has to be tunneled) is incised in an oblique direction, anticipating the flap's coronal advancement. The integrity of the other papillae of the adjacent teeth with shallow GRs is preserved with an approach similar to the conventional tunnel technique (TUN).16,17 The elevation of the flap around the tooth with the deepest recession is performed in a split-full-split manner, while tunneling knives are used on the adjacent teeth with GRs to elevate and mobilize the flap as described above. To achieve a tension-free flap, at least one more tooth after the recession defects has to be tunneled as well. Apical to the tooth with the deepest recession, the flap is released with a 15C blade.

Fig 1 The minimally invasive approach (TCAF) with an envelope design for the treatment of MAGRs in the left maxillary region. (a) Clinical view at baseline. (b) Flap design. Note that only the two papillae at the center of the flap were incised. (c to e) The papillae of the adjacent sites are preserved and mobilized with tunneling knives. The flap is further released using tunnel knives and a 15C blade until it can be advanced approximately 2 mm coronal to the cementoenamel junction of the treated teeth without tension. (f) Positioning a VXCM above the flap at the area of intended placement. (g) Insertion of the VXCM underneath the flap, followed by suturing it to the deepithelialized anatomical papillae. (h) The flap and the coronal advancement were sutured. (i) Clinical view at the 6-month follow-up.
that is first positioned parallel to the bone and then parallel to the external mucosal surface until an adequate passive coronal advancement of the flap is achieved.\textsuperscript{15} Flap release and papillae elevation are then completed as described for the envelope minimally invasive approach. After deepithelializing the previously incised papillae and root conditioning with 24\% EDTA for 2 minutes, followed by rinsing with sterile saline,\textsuperscript{14} the VXCM is entered from the side of the vertical releasing incision and gently tunneled underneath the flap. The graft is then stabilized with absorbable sutures (7/0 PGA) as described above. Multiple sling sutures (6/0 or 7/0 polypropylene or 7/0 PGA) are used to secure the flap in a

**Fig 2** Minimally invasive approach (TCAF) with a single vertical releasing incision for the treatment of two MAGRs in the right maxillary region. (a) Clinical view at baseline. (b) Flap design. Note that the integrity of the papilla distal to the first premolar is preserved. (c) Split-full-split flap elevation. The areas apical and distal to the premolar were tunneled. The papilla distal to the premolar was tunneled and mobilized as well. (d) Stabilization of a VXCM with simple interrupted sutures, engaging the deepithelialized surgical papillae. (e and f) Flap closure with sling and simple interrupted sutures from the front and side views, respectively. (g) Clinical view at 2 weeks postoperative and (h) at the 6-month follow-up.
coronally advanced position at the level of the papillae. The vertical incision is approximated to the adjacent soft tissue with simple interrupted sutures (7/0 polypropylene and 7/0 PGA).

Oral and written postoperative instructions were provided to patients. Ibuprofen (600 mg) every 4 to 6 hours as needed, amoxicillin (500 mg) 3 times a day for 7 days, and chlorhexidine mouth rinse (0.12%) twice daily for 2 weeks were prescribed, and gentle warm saltwater rinses were recommended. Suture removal occurred at 2 weeks, when patients received further instructions regarding the type of toothbrush and brushing technique to use.9

Data Analysis

Means and SDs were obtained for descriptive presentation of continuous data gathered at baseline and at 6 months. Complete root coverage (CRC) is reported as the percentage of sites that obtained full coverage of the GR at 6 months, reported as a percentage. The mean root coverage (mRC) was assessed as uniformly described in the literature.9,13 Paired t tests were used for statistical inferences regarding the changes in the continuous clinical measurements from baseline to 6 months.

Results

Five patients (mean age: 33.6 ± 14.3 years; 4 women, 1 man) with 16 MAGRs (12 localized in the maxilla) were treated with the described minimally invasive approach using the VXCM. Characteristics of the recessions at baseline and at the 6-month follow-up are depicted

Fig 3 Another example of the minimally invasive approach (TCAF) with a single vertical releasing incision for the treatment of MAGRs at two maxillary premolars. (a) Clinical view at baseline. (b) Flap design and split-full-split flap elevation. The papillae of the premolar with the deepest GR were incised and elevated. In particular, the papilla between the two premolars was incised with an oblique cut, anticipating the rotation of the flap after its coronal advancement. (c) The VXCM was positioned above the flap prior to its stabilization. (d) The VXCM was inserted below the flap and sutured to the two epithelialized anatomical papillae and to the periosteum apical to the graft. (e) Flap closure. (f) Clinical view at the 6-month follow-up.
in Table 1. Healing was uneventful, and patients consistently reported minimal discomfort (average VAS score: 1.75 ± 1.92). The minimally invasive approach resulted in an average mRC of 94.73% ± 13.32%, with 13 sites showing CRC (81.25%) at 6 months. Fifteen sites showed an increased soft tissue phenotype (93.75%), while the average gingival thickness gain was 0.72 ± 0.15 mm. No significant change in the amount of keratinized tissue width was observed at 6 months. The calculated esthetic outcome, according to RES, was 9.0 ± 1.3 (Table 1).

### Discussion

The present article describes a minimally invasive surgical approach that can potentially aid in enhancing the outcomes of MAGR treatment, particularly when utilizing a nonautogenous graft, such as the VXCM utilized in the present study. Due to the fibrous and porous structure of the VXCM, this graft material may pose some challenges if utilized in combination with TUN. Therefore, it is not surprising that VXCM has mainly been used with trapezoidal CAF.9 However, in the attempt to further reduce patient morbidity and to enhance the blood supply and vascularization of VXCM, the present authors believe that selective properties of the CAF and TUN may join (forming a TCAF) and enhance the outcomes. The described technique should be considered in the presence of MAGRs with an adequate band of keratinized tissue width (1.5 to 2 mm), which seems to be crucial for tunneling of the flap and for optimizing the VXCM outcomes.

According to the literature, CAF and TUN are both shown to be predictable approaches for treating single and multiple GRs.18–20 Zuhre et al achieved higher mRC and CRC with TUN compared to CAF,17 while other authors have found significantly better recession coverage with CAF.7,20,21 A systematic review and meta-analysis from the present authors’ group concluded that the two techniques mostly showed similar clinical outcomes except for the incidence of CRC, which was found to be superior for CAF.18 Interestingly, in a 2-year randomized trial comparing CAF and TUN, Santamaria et al showed that while CAF initially obtained superior mRC and CRC at 6 months,20 the two groups were not significantly different for the 2-year results, both presenting with similar clinical and esthetic outcomes.19

It has been suggested that the conventional CAF may impair the flap’s blood supply and the graft nutrition due to the vertical incisions and the elevation/opening of the papillae.22 In addition, scar tissue formation or keloid appearance at the incision level of CAF-treated sites are not rare findings,22,23 and this aspect can play a role in the esthetic outcomes of the treatment.24 The envelope CAF introduced by Zucchelli et al prevents the

### Table 1 Mean Clinical Parameters of the Treated Cases at Baseline, and 6 Months

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BL</th>
<th>6 mo</th>
<th>Changes* (6 mo – BL)</th>
</tr>
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<tbody>
<tr>
<td>REC, mm</td>
<td>2.16 ± 0.79</td>
<td>0.09 ± 0.20</td>
<td>−2.06 ± 0.79</td>
</tr>
<tr>
<td>PD, mm</td>
<td>1.25 ± 0.45</td>
<td>1.06 ± 0.25</td>
<td>−0.19 ± 0.40</td>
</tr>
<tr>
<td>CAL, mm</td>
<td>3.41 ± 0.94</td>
<td>1.16 ± 0.30</td>
<td>−2.25 ± 0.98</td>
</tr>
<tr>
<td>KTW, mm</td>
<td>1.94 ± 0.73</td>
<td>2.09 ± 0.64</td>
<td>0.16 ± 0.35</td>
</tr>
<tr>
<td>GT, mm</td>
<td>1.05 ± 0.18</td>
<td>1.73 ± 0.14</td>
<td>0.72 ± 0.15</td>
</tr>
<tr>
<td>mRC, %</td>
<td>–</td>
<td>94.73 ± 13.32</td>
<td>–</td>
</tr>
<tr>
<td>CRC, %</td>
<td>–</td>
<td>81.25</td>
<td>–</td>
</tr>
<tr>
<td>RES, no. of points</td>
<td>–</td>
<td>9.0 ± 1.3</td>
<td>–</td>
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</table>

BL = baseline; 6 mo = 6-month follow-up; CAL = clinical attachment level; CRC = complete root coverage; GT = gingival thickness; KTW = keratinized tissue width; mRC = mean root coverage; PD = pocket depth; REC = recession depth; RES = Root Coverage Esthetic Score.

All values are presented as mean ± SD except for CRC, which is presented as a mean value.

*A negative number indicates that the value of the assessed parameter at the 6-month follow-up was lower than the value at baseline.
formation of scars but requires the incision of all the papillae (or almost all) of the treated sites, with possible sloughing of the flap during the healing. Undermining the papillae and preserving their integrity may provide favorable esthetic outcomes, accelerate wound healing, and reduce patient discomfort. On the other hand, limitations of TUN include the limited access, the insertion of the graft underneath the flap (especially if the graft has a fibrous and spongy consistency, like the VXCM), and its stabilization. Although CAF and TUN have always been regarded as alternatives, one excluding the other, the combination of these two techniques may overcome their above-mentioned limitations.

The described minimally invasive approach (TCAF) aims to preserve as much vascularization of the flap as possible, with a maximum of one vertical incision and two incised papillae. The vertical incision allows for better access and flap mobility, and it is recommended when one recession is substantially deeper than the adjacent one(s). In this scenario, the mesial or distal area of the flap, together with the non-incised papilla(e), is elevated as described for TUN for the best possible preservation of blood supply. Indeed, the flap vascularization plays a key role in graft survival. The access provided by the minimally invasive approach, either with a single vertical incision or with the envelope design, is crucial for introducing a graft material like the VXCM underneath the flap. Due to its nature, the VXCM tends to lacerate if inserted into a tunnel flap through the sulcus, as described for other graft materials. The incision of two surgical papillae also allows for an adequate stabilization of the VXCM (that can be sutured both to the deep epithelialized anatomical papillae and to the periosteum), which is, on the other hand, challenging and unlikely to be accomplished with conventional TUN.

In the present case series, the minimally invasive approach (TCAF) in combination with VXCM showed an average mRC and CRC of 94.7% and 81.3%, respectively. These findings are in line with previous reports assessing the efficacy of trapezoidal split-full-split CAF and envelope CAF. While direct comparisons with those articles would not be appropriate due to the different study design and population, it can be speculated that this surgical approach may have the potential to promote faster healing, reduce postoperative discomfort (average VAS: 1.75), and enhance esthetics compared to conventional CAF. In addition, if these preliminary results are confirmed in future studies with larger populations, it would be possible to confirm that the presented minimally invasive approach can also enhance the mRC and CRC of TUN, which a systematic review estimated to be 82.8% to 87.9% and 47.1% to 57.5%, respectively. It must be mentioned that the RES obtained in the present study (average: 9.0) is superior to the RES values reported by other studies treating MAGRs with a xenogeneic collagen matrix either with conventional CAF or TUN. Nevertheless, more studies are needed to further explore this aspect. Lastly, it can be speculated that the minimally invasive concept can be further enhanced by soaking the VXCM with platelet concentrates or biologic agents, such as enamel matrix derivatives or recombinant human platelet-derived growth factor.

Conclusions

The present case series suggests that the described minimally invasive approach (TCAF) is a suitable technique for treating MAGRs with a VXCM. The technique may have the potential to enhance flap blood supply and graft vascularization and to improve clinical, esthetic, and patient-reported outcomes compared to conventional surgical approaches. Nevertheless, future studies with larger sample sizes and comparative groups are needed to support these preliminary results.

Acknowledgments

The authors declare no conflicts of interest.

References