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Original Research

Suturing techniques for a volume-stable collagen matrix in root coverage: a case series

Rafael Lazarin[1], Vitor Mota Freitas[1], Emerson Ricardo Santiago[1], Carlos Eduardo Secco Mafra[1], Giuseppe Alexandre Romito[1], João Batista César Neto[1*]

[1] Division of Periodontology, College of Dentistry, University of São Paulo, São Paulo, SP, Brazil.

Corresponding author:
João Batista César Neto
Division of Periodontology, College of Dentistry, University of São Paulo, São Paulo, SP, Brazil
Av. Prof. Lineu Prestes, 2227, São Paulo-SP, Brazil.
ZIP Code 05508-000
Fax: (+55 11) 3091-7833
Email: jbcesarneto@usp.br

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Aim: This retrospective case series aims to describe different stabilization methods for a volume-stable collagen matrix (VCMX) in multiple root coverage (RC) cases. **Methods**: Four patients with RT1 multiple gingival recessions presenting with aesthetic or sensitivity complaints were treated with a coronally advanced flap using a VCMX. The biomaterial was handled and sutured using different techniques, including interproximal interrupted sutures and horizontal mattress sutures. Follow-up periods ranged from 1 to 3 years, with clinical measurements taken at both baseline and the last follow-up visit. **Results**: A total of 10 gingival recessions were treated, with 6 receiving VCMX. Recession reduction at VCMX-treated sites ranged from 1 to 2.5 mm, with RC percentages ranging from 67% to 100%. Complete RC was achieved in 50% of the treated sites, with only one of these involving the use of the biomaterial. **Conclusion**: The addition of a VCMX to root coverage procedures yielded favorable clinical outcomes, and the method of biomaterial handling and stabilization via sutures appeared to correlate with postoperative outcomes. However, further studies are needed to assess the true impact of VCMX stabilization techniques on clinical outcomes.

Keywords: Biocompatible materials. Esthetics, dental. Gingival recession. Sutures.

Introduction

According to the literature, the gold standard surgical treatment for gingival recession (GR) is the coronally advanced flap (CAF) combined with subepithelial connective tissue graft (SCTG)[1]. Although this technique provides the best long-term outcomes, it has also been associated with increased morbidity and invasiveness[2]. Given that patients usually prefer procedures involving fewer surgical sites and reduced morbidity[3], various substitute materials have been explored for use in Periodontics.

Allogenic, alloplastic, and xenogeneic materials have demonstrated good results in terms of root coverage. Although these biomaterials may achieve clinical outcomes comparable to those of SCTG, mastering their handling is essential for favorable results. Specifically for animal-derived volume-stable collagen matrices (VCMXs), different authors have emphasized that their manipulation (trimming, application, and suturing) differs significantly from that of SCTG[4], and that the learning curve and surgeon experience may directly influence the surgical outcomes[5].

Since biomaterial stabilization and surgical wound stabilization are crucial for clinical success[6,7], clinicians must understand the role suturing plays in the final outcomes. While the literature has paid considerable attention to suture considerations related to the flap[8-13] and the optimal timing for suture removal in root coverage procedures[14,15], limited emphasis has been placed on the suturing of the biomaterial itself. Given the more porous nature and increased susceptibility to tearing of VCMXs compared to SCTGs, clinicians may need alternative suturing approaches to ensure adequate fixation.

Considering the limited number of studies evaluating suturing methods for VCMXs and the influence of the learning curve in VCMX handling, this retrospective case series aims to present different stabilization methods developed during the clinician's learning curve regarding the material, along with their corresponding clinical outcomes following root coverage procedures.

Material and Methods

This retrospective case series includes four non-consecutive, nonsmoking, ASA I, systemically and periodontally healthy patients who were treated at the School of Dentistry of the University of São Paulo postgraduate periodontics clinic between 2019 and 2023. All cases had multiple GRs with aesthetic and hypersensitivity complaints, having at least one RT1[16] maxillary gingival recession ≥ 2mm. After receiving informed consent forms, all the patients were treated by one experienced periodontist (JBCN) using the same surgical approach (CAF) associated with the VCMX (Fibrogide®, Geistlich Pharma AG, Wolhusen, Switzerland). This case series has been reported in accordance with the PROCESS (Preferred Reporting of Case Series in Surgery) Guideline[17], and the study protocol received ethical approval from the university's Institutional Review Board (n. 5.994.818).

The surgical technique for all cases followed the same principles and was characterized by the coronal advancement of the flap. One or two releasing incisions were per-

formed based on the requirements of each case. A full-thickness flap was reflected at the buccal aspect, including the mucogingival line, exposing approximately 3 to 4 mm of buccal bone. Then, a split-thickness flap was performed using a 15c blade, allowing for the coronal mobilization of the flap (covering about 1-2mm beyond the cementoenamel junction - CEJ). The anatomic papilla was de-epithelialized, the biomaterial was positioned and sutured, and the flap was coronally advanced and stabilized with sling sutures using non-resorbable sutures. Interrupted sutures were also utilized to refine the adaptation of the surgical papilla over the anatomic papilla and to close the vertical releasing incision. Some variations were observed in the handling of the biomaterials and suturing techniques, which are detailed in the following sections.

Horizontal mattress sutures anchored at the vertical incision or in the flap (Cases 1 and 2)

While trimming the matrix to the mesiodistal dimensions of gingival recession and to a thickness of 3 mm (half of the original dimension), it was observed that some irregularities were present on the surface of the matrix after trimming, which could potentially affect the biomaterial's resistance and stabilization. Nevertheless, despite these observations, the biomaterial was positioned at the surgical site and stabilized using single interrupted sutures in the interproximal regions, following the usual technique employed for SCTG. However, after the matrix was hydrated at the recipient site, it tore as the knot was tightened, compromising its stabilization (Figure 1).

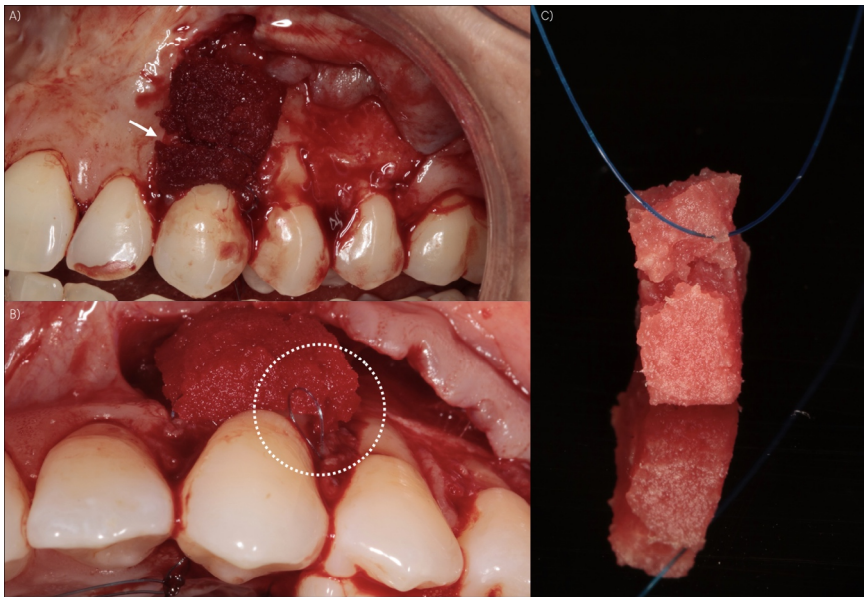

Figure 1. Examples of a lacerated matrix during or after suturing. A) Case 1: Facial view of a case in which it is possible to see that the coronal third of the matrix (arrow) is torn and 'separated' from the rest of the biomaterial; B) Case 2: Occlusal view demonstrating a simple interrupted suture that is 'loose' after matrix laceration (dotted circle); C) Case 3: Demonstrating that the suture thread can easily tear the biomaterial after hydration. It seems that the laceration happened during trimming, and it was subclinical. After hydration, the laceration became apparent.

The intraoperative alternative to overcome this issue was to utilize the second half of the matrix in a dry state and, with a resorbable suture material, to perform horizontal sutures anchored at the vertical incision (Figure 2) or within the flap itself (Figure 3).

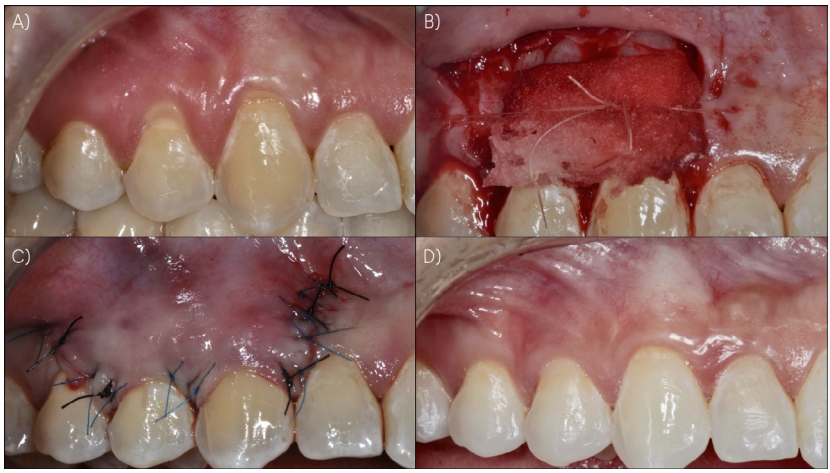

Figure 2. Case 1. A) Baseline teeth 13 and 14. B) Flap elevation, with the matrix stabilized by resorbable sutures anchored at the vertical incisions; C) Immediate post-operative; D) 3-year follow-up.

Figure 3. Case 2. A) Baseline teeth 13 and 14. B) Flap elevation, accompanied by a single distal vertical incision; C) The matrix was stabilized with resorbable sutures anchored at the vertical incision and to the flap on the opposite side.; D) Image showing the matrix post-hydration; E) Placement of sutures using 5-0 nylon to close the flap; F) 3-year follow-up.

Interproximal interrupted sutures (Case 3)

To avoid the issues observed in previous cases, it was understood that the matrix should be hydrated during or only after suturing, thus facilitating its handling and avoiding tearing during knot tightening. It was observed that single interrupted sutures, combined with correct and delicate handling, could ensure proper positioning and stabilization of the matrix at the area of interest without excessive compression (Figure 4). However, in this case, the matrix appeared to have shifted from its original position, probably due to the sutures' inability to maintain their stability (Figure 4e). The authors suggest that this could be attributed to a loose and unstable suture or a clinically undetected laceration of the biomaterial, leading to matrix displacement.

Figure 4. Case 3. A) Baseline teeth 14, 15, and 16. B) Flap elevation, accompanied by two vertical incisions; C) Matrix sutured with interproximal interrupted sutures; D) Flap closure using 5-0 nylon suture; E) 4-week follow-up showing an apparent apical displacement of the matrix; F) 1-year follow-up.

Palatal anchored horizontal mattress sutures (Case 4)

As an alternative to single interrupted sutures and based on the method of matrix stabilization in peri-implant procedures, horizontal mattress sutures by the palatal approach began to be employed (Figure 5). This alternative may reduce pressure on the more fragile regions of the biomaterial (its edges) and decrease the likelihood of tearing. Additionally, slight pressure is applied at the center of the matrix, pushing it towards the dental surface or recipient site, thereby promoting its stability.

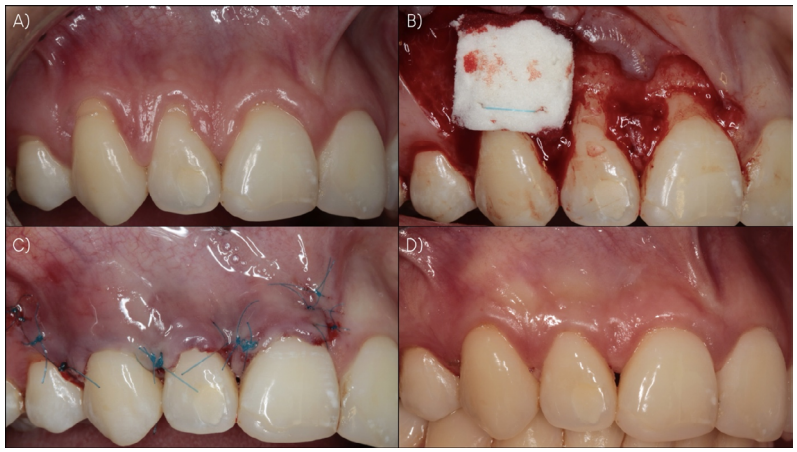

Figure 5. Case 4. A) Baseline teeth 11, 12, and 13. B) Matrix sutured with palatal anchored horizontal mattress suture; C) Flap closure using 5-0 and 6-0 nylon suture; D) 1-year follow-up.

Post-operative procedures

Post-surgery, all patients were given only analgesic medication and instructed to rinse their mouths with a 0.12% chlorhexidine solution twice daily for 28 days and to avoid brushing the surgical area for the first month. The sutures were removed after 14 days.

Follow-up visits and data collection

All patients were instructed to return every week during the first month. After that, they were instructed to return every three months during the first year. They were also included in a maintenance program of one to two annual visits. A UNC-15 periodontal probe was used to measure the following clinical parameters on the mid-buccal aspect of all treated sites at baseline and the most recent follow-up:

- Probing depth (PD): measured in millimeters from the gingival margin (GM) to the base of the gingival sulcus.
- Gingival recession (GR): measured in millimeters from the CEJ to the GM.
- Clinical attachment level (CAL): measured in millimeters from the CEJ to the base of the sulcus.
- Keratinized tissue width (KTW): measured in millimeters from the gingival margin to the mucogingival junction.
- Non-carious cervical lesion (NCCL)[18]

In addition, the percentage of root coverage (RC) and the percentage of sites that achieved complete root coverage (CRC) were calculated, based on the clinical measurements taken at baseline and at the most recent postoperative follow-up.

Results

Four participants (all female, mean age of 38 years) with a total of 10 RT1 GRs were treated. Out of these recessions, six teeth received the VCMX (one tooth in two patients and two teeth in two patients). Two cases had a 1-year follow-up, and two had a 3-year follow-up. All patients experienced an uneventful postoperative recovery. The initial clinical parameters and those after the last follow-up are presented in Table 1.

Considering all surgical sites, the RC varied between 66.7% and 100%, with half of the sites and half of the patients achieving CRC. When considering the teeth that received the biomaterial, the RC also varied between 66.7% and 100%, but the CRC was observed in only one site.

Table 1. Demographic characteristics and clinical parameters at baseline and the final post-surgical follow-up after root coverage procedure.

Case	Age (years)	Tooth number	Biomaterial	Follow-up (years)	NCCL	PD (mm)		GR (mm)			KTW (mm)	
						BL	Follow-up	BL	Follow-up	RC (%)	BL	Follow-up
#1	39	13	Yes	3	A-	2	2	1.5	0.5	66.7%	1.0	2.0
#1	39	14	Yes	3	A+	2	1	2.0	1.0	75%	1.0	2.0
#2	42	13	Yes	3	B-	2	2	1.5	0.5	66.7%	1.0	2.0
#2	42	14	Yes	3	B+	2	2	3.0	0.5	83.3%	1.0	2.0
#3	39	14	Yes	1	A-	1	2	2.0	0.5	75.0%	2.0	2.0
#3	39	15	No	1	A-	2	2	1.5	0.0	100%	2.0	2.0
#3	39	16	No	1	A-	2	2	1.0	0.0	100%	3.0	2.0
#4	32	13	Yes	1	A-	1	2	2.0	0.0	100%	1.0	2.0
#4	32	12	No	1	A-	2	2	1.5	0.0	100%	2.0	3.0
#4	32	11	No	1	A-	2	3	1.0	0.0	100%	2.5	3.0

BL: baseline; NCCL: non-carious cervical lesion; PD: probing depth, GR: gingival recession, KTW: keratinized tissue width, RC: root coverage

Discussion

As wound and blood clot stabilization are directly linked to postoperative outcomes, proficiency in suturing techniques is essential. This case series highlights the challenges involved in handling and suturing a novel biomaterial, shedding light on the difficulties clinicians may face when choosing this material over autogenous grafts.

Adopting a new surgical technique or incorporating a novel biomaterial requires a specific learning curve to achieve optimal outcomes, which is particularly true for the use of VCMX. Several studies have emphasized the clinician's experience as a critical factor influencing treatment success[3,5], and recent findings have indicated that, from the clinician's perspective, the handling of VCMX differs from that of autogenous connective tissue grafts[4]. Regarding suturing, interproximal interrupted sutures have been the most recommended method for stabilization[3,4,19-23].

However, some authors have highlighted the need for additional sutures to enhance stability[19,22,23], while others have suggested stabilizing the flap in conjunction with the sutures[24]. Althouth the only study which assessed the suture-handling characteristics of VCMX in comparison to SCTG reported minimal differences[4], VCMX's more porous nature makes it more prone to tearing than autogenous tissue. For this reason, it is recommended that both handling and suturing be performed while the matrix is still dry, to facilitate placement and reduce the risk of excessive compression and laceration. Additionally, trimming and customizing the biomaterial to better fit the recipient site, though often necessary, may further increase its susceptibility to damage.

In contrast, certain authors have advocated for the omission of sutures in the stabilization of biomaterials[25-27], a concept previously suggested for free gingival grafts[28]. In such scenarios, alternative flap designs, like the modified vestibular incision subperiosteal tunnel access[25] or the integration of the biomaterial with platelet aggregates[26], have been employed. On the other hand, it is recommended by the manufacturer that compression on the VCMX should be avoided because it decreases the capacity of VCMX to gain tissue.

Numerous studies have focused on assessing the importance of suturing in root coverage surgeries, primarily addressing flap-related issues[10-13,15]. Yet, no previous research has explored the influence of suture techniques on the underlying tissue beneath the flap. In the authors' experience, this warrants considerable attention, especially when working with biomaterials instead of autogenous soft tissue. The absence or inadequate matrix stabilization may lead to biomaterial displacement, jeopardizing clinical outcomes by reducing marginal tissue thickness gain, increasing the risk of biomaterial exposure and resorption, and ultimately limiting root coverage. The present findings underscore the relevance of this topic, as matrix displacement was observed in one of the reported cases. Given that soft tissue thickness is strongly associated with long-term successful outcomes[29], it becomes valid to further investigate the potential influence of suturing techniques on soft tissue volume gain.

Not only should matrix displacement be considered during the early stages of healing, but the suturing and overall stability of the flap must also be carefully addressed. Since the matrix can increase in volume by up to 25% upon hydration, special attention should be paid to flap handling and release to minimize the risk of suture dehiscence. In fact, the literature identifies suture dehiscence as one of the most common complications in root coverage procedures involving VCMX, which can potentially lead to premature exposure and matrix resorption[30]. It is therefore crucial to ensure a tension-free flap at the time of final suturing, as this factor is directly associated with improved outcomes in terms of recession reduction[11].

When analyzing the VCMX literature, root coverage rates have varied from 63% to 97% for cases with interproximal interrupted sutures[3,4,20,21], 75% to 88% for cases in which the VCMX was stabilized with interproximal interrupted[25-27]. Despite significant heterogeneity in the literature, including different study designs, sample sizes, inclusion criteria, surgical techniques, and follow-up periods, the method of biomaterial stabilization appears to influence postoperative outcomes; how-

ever, further clinical studies are needed to better elucidate the influence of VCMX suture on clinical outcomes.

Although the literature lacks reports evaluating the effect of biomaterial stabilization methods on postoperative outcomes, the present analysis should be interpreted with caution due to the study design and presents limited generalizability. While the findings suggest that different stabilization techniques may influence clinical outcomes, further studies with larger samples and more standardized experimental designs are needed to confirm this hypothesis. Moreover, professional experience—not only in handling the biomaterial but also in performing periodontal surgeries in general—should be considered, as less experienced clinicians may exert an even greater influence on clinical outcomes.

This case series highlights the importance of proper biomaterial stabilization in root coverage procedures using VCMX. While VCMX is a promising alternative to autogenous grafts, its handling and suturing can pose challenges that may affect clinical outcomes. Observations of matrix displacement and suture dehiscence emphasize the need for careful stabilization and tension-free flap closure. Although different suturing techniques have been reported with varying degrees of success, there is still a lack of standardized evidence on their impact. These findings suggest that the stabilization method may play a role in treatment success, underscoring the need for further well-designed clinical studies.

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Conflict of Interest

The authors have no financial interests related to the information presented in the paper.

Data Availability Statement

All data generated or analyzed during this study are included in this published article.

Author Contribution

Rafael Lazarin: Formal Analysis, Investigation, Methodology, Project Administration, Writing – Original Draft, Writing – Review & Editing. **Vitor Mota Freitas:** Formal Analysis, Investigation, Methodology, Project Administration, Writing – Original Draft. **Emerson Ricardo Santiago:** Investigation**,** Project Administration, Writing – Original Draft. **Carlos Eduardo Secco Mafra:** Investigation, Methodology, Writing – Original Draft. **Giuseppe Alexandre Romito:** Conceptualization, Methodology, Writing – Review & Editing. **João Batista César Neto:** Conceptualization, Formal Analysis, Investigation,

Project Administration Methodology, Writing – Original Draft, Writing – Review & Editing. All authors actively revised and approved the final version of the manuscript.

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