J Periodontal Implant Sci. 2022 Dec;52(6):466-478
https://doi.org/10.5051/jpis.2105760288
pISSN 2093-2278·eISSN 2093-2286

JPIS
Journal of Periodontal & Implant Science

Research Article
Periodontal Science

Check for updates

OPEN ACCESS

Received: Nov 4, 2021
Revised: Apr 27, 2022
Accepted: Jun 2, 2022
Published online: Jul 27, 2022

***Correspondence:**
Ulrike Schulze-Späte
Section of Geriodontics, Department of Conservative Dentistry and Periodontology, Center of Dental Medicine, University Hospital Jena, Friedrich-Schiller University, An der Alten Post 4, 07743 Jena, Germany.
Email: Ulrike.Schulze-Spaete@med.uni-jena.de
Tel: +49-3641-9-323813
Fax: +49-3641-9-34582

ORCID iDs
Chun-Teh Lee
https://orcid.org/0000-0001-7812-5637
Marlena Lange
https://orcid.org/0000-0002-8687-3552
Alain Jureidini
https://orcid.org/0000-0003-4610-3657
Nurit Bittner
https://orcid.org/0000-0002-4876-1453
Ulrike Schulze-Späte
https://orcid.org/0000-0002-8046-0394

Funding
This study was supported by Geistlich Pharma AG, Wolhusen, Switzerland, the

Clinical and patient-reported outcomes after recession coverage using modified vestibular incision subperiosteal tunnel access with a volume-stable collagen matrix as compared to a coronally advanced flap with a subepithelial connective tissue graft

Chun-Teh Lee [1,2], **Marlena Lange** [3], **Alain Jureidini** [2,4], **Nurit Bittner** [2], **Ulrike Schulze-Späte** [2,3,*]

[1]Department of Periodontics and Dental Hygiene, The University of Texas Health Science Center at Houston School of Dentistry, Houston, TX, USA
[2]Columbia University College of Dental Medicine, New York, NY, USA
[3]Section of Geriodontics, Department of Conservative Dentistry and Periodontology, Center of Dental Medicine, University Hospital Jena, Friedrich Schiller University, Jena, Germany
[4]Private Office, Arlington, VA, USA

ABSTRACT

Purpose: Coronally advanced split-or full-thickness (CAST or CAFT) flaps in combination with subepithelial connective tissue grafts (SCTGs) are commonly used in root-coverage procedures despite postoperative pain and bleeding from the graft donor site. Therefore, the modified vestibular incision subperiosteal tunnel access procedure (VISTAX) uses a novel collagen matrix (VCMX) instead of autogenous tissue to address the limitations associated with autogenous tissue grafting. This retrospective study compared the clinical outcomes of VISTAX to the results obtained after using a CAST or CAFT flap in combination with SCTG for root coverage.
Methods: Patients with single or multiple adjacent recession I/II defects were included, with 10 subjects each in the VISTAX, CAFT, and CAST groups. Defect coverage, keratinized tissue width, esthetic scores, and patients' perceived pain and dentinal hypersensitivity (visual analogue scale [VAS]) were assessed at baseline, 3 months, and 6 months.
Results: All surgical techniques significantly reduced gingival recession (P<0.0001). Defect coverage, esthetic appearance, and the reduction in dentinal hypersensitivity were comparable. However, the VAS scores for pain were significantly lower in the VISTAX group than in the CAFT and CAST groups, which had similar scores (P<0.05). Furthermore, the clinical results of VISTAX and CAFT/CAST generally remained stable at 6 months.
Conclusions: The clinical outcomes of VISTAX, CAFT, and CAST were comparable. However, patients perceived significantly less pain after VISTAX, indicating a potentially higher patient acceptance of the procedure. A prospective trial with a longer follow-up period and a larger sample size should therefore evaluate VISTAX further.

Interdisciplinary Center of Clinical Research of the Medical Faculty Jena (IZKF UKJ FF02) and the German Federal Ministry of Education and Research (BMBF: 01EC1901B).

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Conceptualization: Chun-Teh Lee, Ulrike Schulze-Späte; Formal analysis: Chun-Teh Lee, Marlena Lange, Alain Jureidini, Nurit Bittner, Ulrike Schulze-Späte; Investigation: Chun-Teh Lee, Alain Jureidini, Nurit Bittner, Ulrike Schulze-Späte; Methodology: Chun-Teh Lee, Ulrike Schulze-Späte; Project administration: Chun-Teh Lee, Ulrike Schulze-Späte; Writing - original draft: Chun-Teh Lee, Ulrike Schulze-Späte; Writing - review & editing: Chun-Teh Lee, Marlena Lange, Alain Jureidini, Nurit Bittner, Ulrike Schulze-Späte.

Keywords: Collagen; Connective tissue; Gingival recession; Patient reported outcome measures; Retrospective studies

INTRODUCTION

Gingival recession (GR) defects are a prevalent finding in dental patients. Approximately half of adults above 30 years of age have at least 1 intraoral site with a GR in different populations [1-3]. GR defects are associated with root sensitivity, root caries, and/or non-caries cervical lesions [4,5]. Untreated recession defects might result in further GR in the long term [4]. In addition, recession defects can be visible in the aesthetic zone in patients with a medium or high smile line and thus could impair the red-white aesthetics of the gingival margin (GM) [6,7].

To correct recession defects, a gingival flap in combination with a subepithelial connective tissue graft (SCTG) is generally considered the most predictable coverage procedure [8,9]. However, postoperative wound healing pain, swelling, and bleeding are commonly associated with harvesting autogenous tissue from the donor site [10]. Furthermore, simultaneously grafting recession defects of multiple teeth might not be possible because of the limited amount of palatal or other autogenous tissue that can be harvested during a single procedure. Therefore, using graft substitutes as an alternative to SCTG has been proposed to address postoperative discomfort and surgical limitations in recession coverage procedures [11,12]. Additionally, minimally invasive surgical techniques have been developed to further minimize postoperative discomfort, potentially decrease the procedure time, and improve patients' satisfaction [13-15].

The porous volume-stable porcine collagen matrix (VCMX) is a newly developed tissue graft substitute (Fibro-Gide®; Geistlich Pharma AG, Wolhusen, Switzerland) for soft-tissue regeneration. VCMX is made of reconstituted cross-linked collagen to enhance volume stability, and its porous network supports angiogenesis and the formation of new connective tissue [16,17]. Preclinical studies of VCMX demonstrated volumetric stability and histomorphometric structures similar to those of SCTG [18,19]. It has been used to treat GR defects in combination with a coronally advanced flap [20] or a minimally invasive tunnel flap [21]. Specifically, the modified vestibular incision subperiosteal tunnel access procedure with VCMX (VISTAX) is a novel minimally invasive technique [21] that can reduce patient morbidity and the risk of wound complications because of the design and location of its vestibular access incision, full-thickness flap tunnel preparation, and the use of a non-autogenous graft substitute.

The aim of this retrospective root coverage study was to compare clinical and esthetic results and patient-centered outcomes such as pain and dentinal hypersensitivity after using VISTAX as opposed to a coronally advanced flap (full thickness [22] or split-thickness [23]) in combination with a palatal SCTG, the root coverage procedure with the most evidence supporting its effectiveness [9,24,25].

MATERIALS AND METHODS

The study was approved by the Institutional Review Board of Columbia University Medical Center and the Institutional Review Board of University Hospital Jena (2020-1756-Daten), and it was carried out according to the code of ethics of the World Medical Association (Declaration of Helsinki). All patients provided written informed consent.

https://doi.org/10.5051/jpis.2105760288

This retrospective study compared: 1) the VISTAX procedure, 2) the use of a coronally advanced full-thickness (CAFT) flap with an SCTG, and (3) the use of a coronally advanced split-thickness (CAST) flap with an SCTG. Since VISTAX utilizes a full-thickness tunnel preparation, the CAFT group was included in addition to the commonly used CAST flap preparation when using a palatal SCTG. The primary outcome was the recession defect change at the 3-month follow-up. Secondary outcomes included changes in keratinized tissue width (KW), probing depth (PD), gingival phenotype (GP), esthetic score, and postoperative pain and sensitivity. The clinical outcomes were retrospectively collected from existing records and adhered to inclusion and exclusion criteria. Three-month follow-up outcomes of 10 subjects in each group were available, whereas 6-month outcomes were only available in 8 subjects in the VISTAX group, 1 subject in the CAFT group, and 5 subjects in the CAST group.

VISTAX is a novel technique, whereas CAFT and CAST are widely performed and studied root coverage procedures [26]. Since there is currently no comparable study, this retrospective data analysis represents a pilot study and required 10 subjects per group to detect a significant difference in recession defect changes at the 3-month follow-up between groups based on the assumptions of alpha error = 0.05, effect size = 0.60, and power = 80% [27].

Patients older than 18 years with no active periodontal disease, single or multiple adjacent recessions of type 1 (RT 1) [28] (Miller class I/II) [29] that showed a detectable cementoenamel junction (CEJ) and no cervical defect [29], had a PD ≤4 mm, KW ≥1 mm, adjacent teeth, and no restorations that may compromise surgical outcomes, were included. Patients were excluded if they were smokers (>10 cigarettes/ per day), had uncontrolled systemic diseases (e.g., diabetes with hemoglobin A1c >7%), or used medications that are known to cause gingival enlargement. All patients had received professional teeth cleaning and oral hygiene instructions to eliminate any habits related to the etiology of GR. These patients had good oral hygiene and controlled periodontal conditions as indicated by clinical parameters (full mouth bleeding on probing [BOP] sites <30%, full mouth plaque index [PI] <30%) [30,31].

Surgical procedures

VISTAX procedure

The modified VISTAX technique was recently developed [21] based on the original VISTA procedure [14]. Briefly (**Figure 1**), following the administration of local anesthesia, exposed root surfaces of treated teeth were scaled with curettes to reduce root convexity and undercuts. Using a 15c blade, a small vestibular incision was made close to the mucogingival junction (MGJ) in the non-keratinized mucosa mesial to the tooth/teeth with the GR defect(s). A full-thickness subperiosteal tunnel was released through the vestibular access incision using a small mucogingival elevator (Buser #6; Hu-Friedy, Chicago, IL, USA). Papillae adjacent to the treated teeth were also elevated. The tunnel flap had to be sufficiently movable to allow coronal displacement of at least 2 mm above the CEJ. Dry VCMX was cut into pieces with an appropriate size (e.g., approximately 5 mm in length and 3 mm in width) to facilitate insertion through the small access incision and to allow individual placement of the pieces towards the recession area and underneath the papillae. Multiple pieces were used until the flap was coronally advanced and the gingiva was augmented sufficiently [21]. Where gingiva had to be stabilized, 5-0 polypropylene sutures were inserted 2–3 mm below the GM and coronally fixated on the respective teeth using flowable composite. The final buccal GM of each tooth was at least 1 mm above the expected level or the CEJ level. All matrix material was completely covered by the gingiva. Postoperatively, ibuprofen (600 mg, 1 tablet every 6

https://doi.org/10.5051/jpis.2105760288

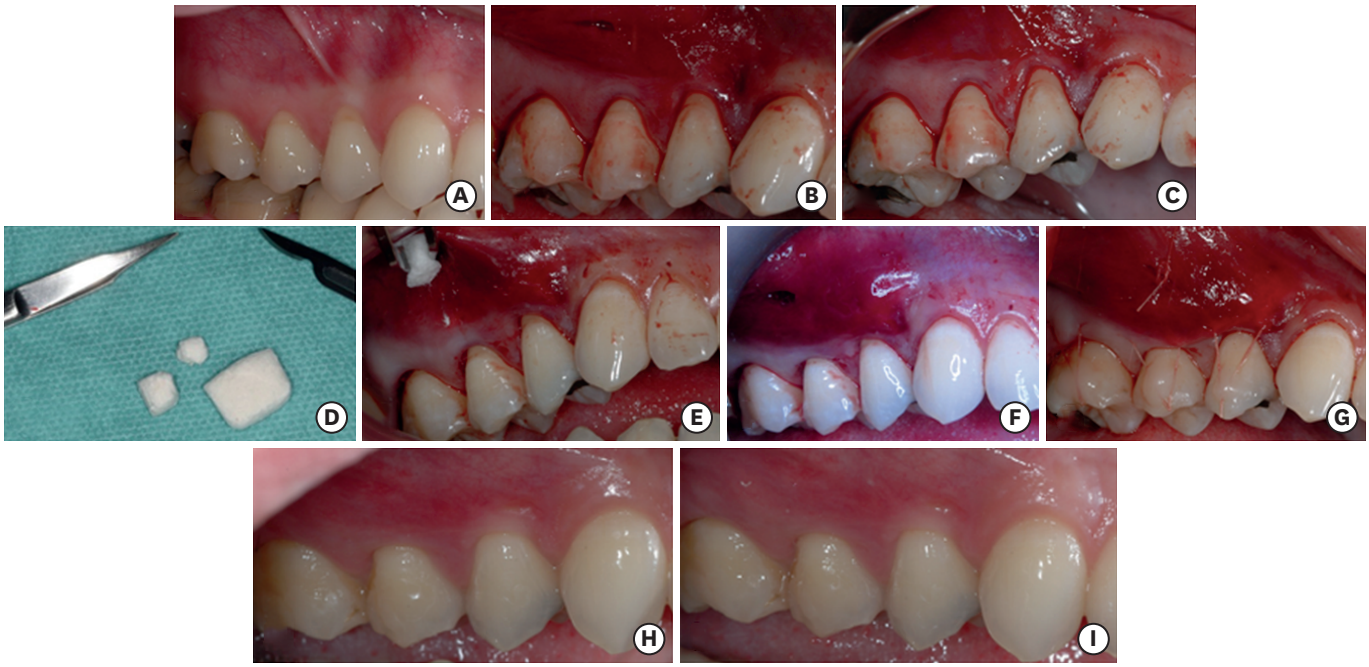

Figure 1. Modified vestibular incision subperiosteal tunnel access with volume-stable collagen matrix procedure: a surgical overview. (A) Baseline recession: 2-mm recession defects at teeth #14, #15. (B, C) Preparation of a full-thickness flap through a vestibular access incision around the teeth with the gingival recession and adjacent teeth. (D) Preparation of small VCMX pieces. (E) Pieces of VCMX were inserted into the subperiosteal tunnel. (F) The gingival margin was coronally advanced without suturing after pieces of VCMX were placed. (G) Anchoring sutures (polypropylene 5.0) were coronally stabilized using flowable composite. (H) Complete root coverage was achieved at the 3-month follow-up visit. (I) Gingival levels were stable at 6 months.
VCMX: volume-stable porcine collagen matrix.

hours for 7 days) and chlorhexidine gluconate mouthwash (0.12%, 1 bottle, one-half ounce, twice daily for 2 weeks) were prescribed if the patient was not allergic to these medications. Patients were recommended to consume a soft diet and avoid brushing the treated teeth for at least 2 weeks, and to avoid intentional pressure on the surgical area for at least 2 months. Sutures were removed 2 weeks after surgery.

CAFT/CAST with SCTG

Following the administration of local anesthesia, exposed root surfaces were scaled with sharp curettes. Two oblique, divergent beveled incisions were performed on the interdental papillae mesially and distally to the treated teeth (**Figure 2**). These incisions were connected by intrasulcular incisions [32]. The flap was reflected without vertical incisions using the envelope technique. Flap elevation was performed by either a full-thickness technique using a periosteal elevator (CAFT) or a split-thickness technique using a 15c blade (CAST). Interdental papillae adjacent to the treated teeth were deepithelialized using a diamond bur to create a connective tissue bed, to which the surgical papillae of the flaps were sutured. An SCTG was harvested from the palate using the single incision technique [33] and trimmed to approximately 1.5-mm thickness. Afterward, the donor site was sutured with 4-0 silk. The SCTG was placed over the recession defect, stabilized with sling and periosteal 5-0 chromic gut sutures and covered with the coronally advanced flap that was positioned at least 2 mm above the CEJ and stabilized using the sling and interrupted suturing techniques with 6-0 polypropylene sutures. The postoperative instructions were given as described above. The donor site and recipient site sutures were removed 1 week and 2 weeks after surgery, respectively.

https://doi.org/10.5051/jpis.2105760288

JPIS
Journal of Periodontal & Implant Science

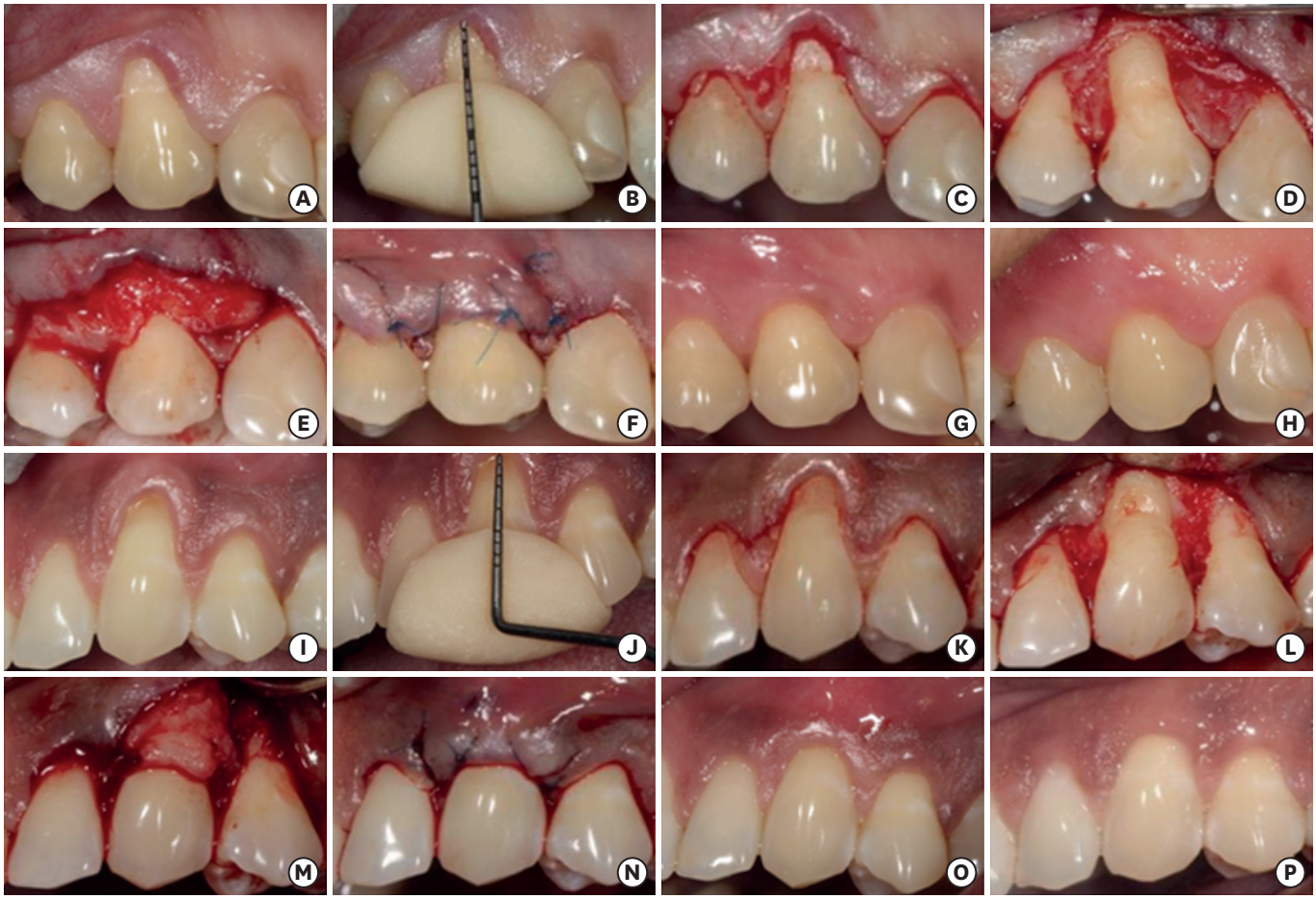

Figure 2. Coronally advanced flaps—split-thickness (A-H) and full-thickness (I-P)—with an SCTG: a surgical overview. (A, I) Baseline recession: 2.5-mm recession defects at tooth #13 and tooth #23, respectively. (B, J) Performing measurements with a customized stent. (C, K) Sulcular and oblique incisions were used to elevate a flap. (D, L) Partial or full flap elevation was used to expose the root surface. (E, M) The SCTG was harvested from the palate, placed underneath the elevated flap and sutured. (F, N) The coronally advanced flap was securely sutured. (G, O) Complete root coverage was achieved at the 3-month follow-up visit. (H, P) Gingival levels were stable at the 6-month follow-up visit.
SCTG: subepithelial connective tissue graft.

Clinical measurements

Clinical measurements and esthetic outcomes were determined at baseline and at 3 months after surgery by calibrated examiners (USS, NB). Measurements were repeated in available cases at 6 months after VISTAX, CAFT, and CAST to evaluate the stability of the clinical results. Clinical measurements were performed using a conventional 15 UNC color-coded periodontal probe:

1. GR: distance from the CEJ to the GM at the mid-buccal of treated teeth.
2. Defect coverage rate: percentage of coverage relative to the baseline GR.
3. PD: distance from the GM to the gingival sulcus bottom.
4. KW: distance from the MGJ to the GM.
5. GP: thin versus thick, based on periodontal probe visibility in the mid-buccal sulcus [34]. If the probe was visible through the gingival sulcus, the phenotype was defined as thin. If the probe was not visible through the gingival sulcus, the phenotype was classified as thick.

https://doi.org/10.5051/jpis.2105760288

Esthetic outcomes of the treated sites were evaluated using the root coverage esthetic score (RES) system [35]: 1) degree of root coverage, 2) marginal tissue contour, 3) soft tissue texture, 4) MGJ alignment, and 5) gingival color. The highest score is 10 and the lowest score is 0. Three-month and 6-month clinical pictures of all patients, without any specification of which type of surgical procedure was performed, were evaluated and assigned RES scores by an independent examiner (NB) not involved in any surgical procedure.

Patient-centered outcomes, including postoperative pain and hypersensitivity, were assessed using a questionnaire. Postoperative pain was demonstrated on a 10-cm visual analog scale (VAS) [36], in which 0 indicated ''none'' and 10 ''plenty" on the day of surgery and at 1- and 2-week follow-up visits [37]. Spontaneous dentinal hypersensitivity was recorded on a VAS of 0 to 10, on the day of surgery, 3 months after surgery, and at 6 months after surgery. The measurement values are presented as mean ± standard deviation. The Shapiro–Wilk test was performed to assess the normality of the data. Baseline and follow-up measurements within groups were analyzed using the paired Student's *t*-test or the Wilcoxon signed-rank test depending on data normality (normally distributed data: paired Student's *t*-test; non-normally distributed data: Wilcoxon signed-rank test). Comparisons between groups were analyzed using one-way analysis of variance. Differences were considered statistically significant at $P<0.05$. Due to the small number of subjects in the CAFT and CAST groups for the 6-month outcomes, data from these 2 groups were combined for the 6-month analyses.

RESULTS

Ten patients with single or multiple adjacent gingival recession defects were analyzed in each group for the 3-month results. These 30 patients contributed in total 32, 19, and 15 sites to the VISTAX, CAFT, and CAST groups, respectively. At 6 months, 8 patients in the VISTAX group and 6 patients in the CAFT/CAST group contributed 25 and 8 sites, respectively. The mean age of the patients in the VISTAX, CAFT, and CAST groups was 38.7 (range: 30–45), 37.4 (range: 29–47) and 40.4 years (range 26–62), respectively (**Table 1**). The distribution of gingival recession defects was comparable in all 3 groups, with most defects being located in the maxilla (**Table 1**). In addition, the gingival phenotype was not significantly different among the 3 groups (thin vs. thick: 8/2 [CAFT], 9/1 [CAST], 7/3 [VISTAX]; $P=0.54$). No statistically significant differences were observed among the 3 groups at baseline in any considered parameter (baseline GR [mm]: 1.84±0.67 [CAFT], 2.0±0.76 [CAST], 1.6±0.8 [VISTAX]; $P=0.15$); baseline PD [mm]: 1.6±0.52 [CAFT], 1.65±0.75 [CAST], 1.94±0.76 [VISTAX]; $P=0.32$; baseline KW [mm]: 2.75±0.86 [CAFT], 3.25±0.86 [CAST], 2.98±1.15 [VISTAX]; $P=0.57$). Intragroup analysis revealed that all root coverage procedures produced a statistically significant reduction in recession depth (**Table 2**). Furthermore, a reduction in recession depth as well as the percentage of defect coverage was comparable in all 3 groups

Table 1. Baseline characteristics of the subjects and treated sites

Characteristics	Split-thickness (CAST)	Full-thickness (CAFT)	VISTAX
Number of patients	10	10	10
Number of surgically treated teeth	15	19	32
Age (yr)	40.4 (26–62)	37.4 (29–47)	38.7 (30–45)
Sex (female/male)	7/3	6/4	5/5
Teeth in maxilla/mandible	10/5	11/8	19/13

Values are presented as number or mean (range).
CAST: coronally advanced split-thickness, CAFT: coronally advanced full-thickness, VISTAX: vestibular incision subperiosteal tunnel access procedure with volume-stable porcine collagen matrix.

https://doi.org/10.5051/jpis.2105760288

Table 2. Clinical parameters

Parameters	Split-thickness (CAST)			Full-thickness (CAFT)			VISTAX		
	Baseline	3 months	*P* value	Baseline	3 months	*P* value	Baseline	3 months	*P* value
GR (mm)	2.0±0.76	0.47±0.61	<0.0001	1.84±0.67	0.32±0.56	<0.0001	1.6±0.8	0.22±0.4	<0.0001
PD (mm)	1.65±0.75			1.6±0.52			1.94±0.76		
KW (mm)	3.25±0.86	2.17±0.87	0.0078[a]	2.75±0.86	2.57±0.84	0.500	2.98±1.15	2.8±0.96	>0.9999

Values are presented as mean ± standard deviation.
CAST: coronally advanced split-thickness, CAFT: coronally advanced full-thickness, VISTAX: vestibular incision subperiosteal tunnel access procedure with volume-stable porcine collagen matrix, GR: gingival recession, PD: probing depth, KW: keratinized tissue width.
[a]Statistically significant difference at $P \leq 0.05$.

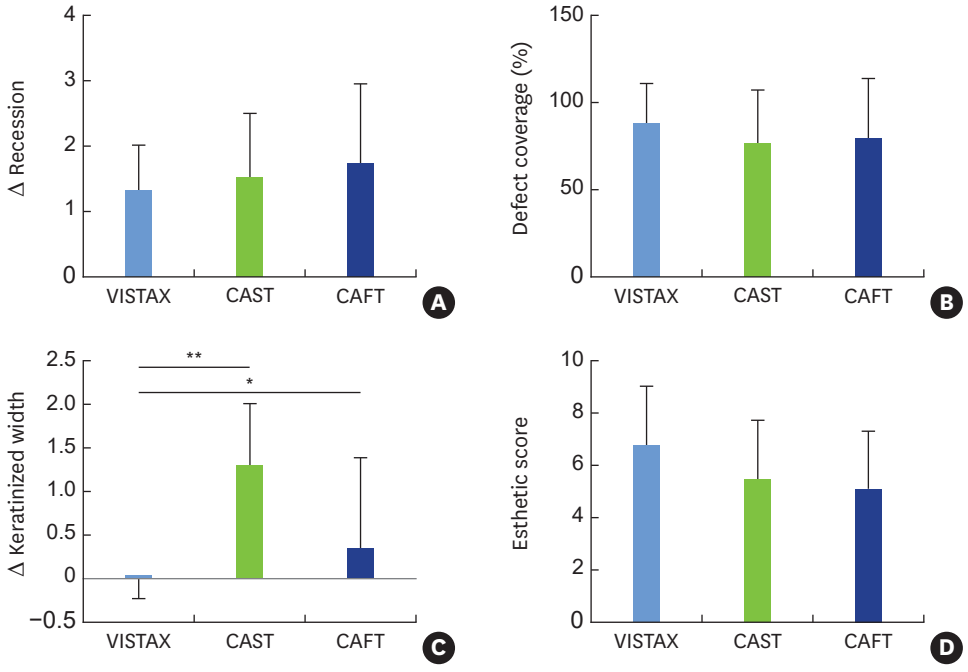

Figure 3. Clinical outcomes between baseline and the 3-month follow-up (mean ± standard deviation). (A) Change in recession depth. Positive values depict recession depth reduction (P=0.3). (B) Defect coverage in percentage (P=0.75). (C) Change in keratinized tissue width. Positive values depict width reduction. (D) Esthetic score (P=0.24).
*P<0.05, **P<0.01.

(**Figure 3A and B**). The defect coverage rates at the 3-month visit were 88.54%±22.48%, 76.67%±30.57%, and 79.82%±34.06% in the VISTAX, CAST, and CAFT groups, respectively. To address the unequal defect numbers contributed by each subject, cases in all 3 groups were stratified into multiple and single recession sites, which showed no difference in defect coverage (percentage of defect coverage for single vs. multiple recessions: 85%±24.15% vs. 80.56%±26.67%; P=0.28). Further, stratification of all patients according to gingival phenotype did not reveal any significant impact on the rate of root coverage in any of the groups (P=0.86).

Both VISTAX and CAFT showed stable KW; however, KW was significantly reduced in the CAST group 3 months after surgery (**Table 2**, **Figure 3C**). The changes in KW between baseline and the 3-month follow-up were −0.008±0.22, 0.36±1.03, and 1.30±0.71 mm in the VISTAX, CAFT, and CAST groups, respectively (**Figure 3C**, positive values depict width reduction). Overall, esthetic outcomes were not significantly different among the 3 groups (mean RES score in VISTAX: 6.80±2.25, CAFT: 5.50±2.22, CAST: 5.11±2.21; P=0.24) (**Figure 3D**). However, when stratified according to the individual aspects that resulted in the esthetic score, soft

https://doi.org/10.5051/jpis.2105760288

tissue texture scores were significantly higher in the VISTAX group than in the CAST/CAFT group (mean difference between VISTAX and CAST: 0.70±0.14; between VISTAX and CAFT: 0.90±0.14; P<0.0001).

Of note, the mean VAS score for pain was significantly lower in the VISTAX group than in the CAFT and CAST groups, which experienced similar scores (VAS for pain at 1 week of follow-up: VISTAX vs. CAST vs. CAFT: 1.78±1.64 vs. 4.7±1.89 vs. 5.22±2.54, P<0.05). Not all patients had complained about dentinal hypersensitivity at baseline. Nevertheless, a clear decrease in dentinal hypersensitivity in all 3 groups between baseline and the 3-month follow-up was detected (baseline VISTAX, CAST, and CAFT: 3.75±2.82, 7.6±1.9, and 5.13±3.8; 3 months: VISTAX, CAST, and CAFT: 1±1.42, 0.8±1.1*, and 0.78±1.72*; *P<0.05). The intergroup analysis detected no statistically significant difference in VAS hypersensitivity scores at baseline and the 3-month follow-up among the 3 groups (P=0.7/P=0.4).

In the VISTAX group, the gingival levels of treated teeth were stable over 6 months, with a slightly increased defect coverage rate (3 vs. 6 months: 88.54%±22.48% vs. 92.33%±16.3%, P=0.25; mean residual recession defect at 3 vs. 6 months: 0.32±0.06 mm vs. 0.26±0.05 mm, P=0.25). In the 6 subjects of the CAFT/CAST group, gingival levels were also stable over time at 6 months (mean root coverage rate at 3 months vs. 6 months: 81.25%±37.20% vs. 81.25%±37.20%, P>0.99; mean residual recession defect at 3 months vs. 6 months: 0.33±0.82 mm vs. 0.33±0.82 mm, P>0.99). Compared to the 3-month outcomes, the KW and esthetic scores in the VISTAX and CAFT/CASF groups did not significantly change at 6 months (KW: P>0.99 and P=0.50 respectively; RES score: P=0.50 and P>0.99 respectively). As compared to the 3-month results, hypersensitivity remained the same at 6 months after surgery in both the VISTAX and CAFT/CAST groups (P>0.99, P>0.99).

DISCUSSION

Tissue graft substitutes, such as acellular dermal matrix, xenogeneic collagen matrix, and collagen membranes, have been used in root coverage and soft tissue augmentation procedures to overcome the limitations associated with autogenous tissue grafting [13-15,24]. These limitations include postoperative discomfort, additional surgical time due to harvesting an autogenous graft, and the grafting of multiple adjacent teeth during a single procedure [38]. VCMX could, therefore, be an option for treating gingival recession defects [18,19]. To date, only 2 articles have reported the outcomes of using VCMX in root coverage procedures. A VISTAX case series demonstrated a mean root coverage of 98.9% and complete root coverage rate of 87.5% in a 7- to 12-month follow-up period [21]. In a study that investigated VCMX in combination with a coronally advanced flap [20], the mean root coverage was 96.8% and the complete root coverage rate was 90% in a 6-month follow-up period. The mean KW increased approximately 0.4 mm in both studies. The current VISTAX data demonstrated comparable results with those studies. Additionally, VISTAX defect coverage showed a nonsignificant tendency for better rates than observed in the CAFT and CAST groups. These outcomes might have been related to the possibility of better vascularization of the area due to the minimally invasive access, the individual VCMX pieces that were pliable and easily moveable underneath the flap, or necrosis of the tissue graft in some cases in the CAFT and CAST groups. However, these findings and speculations require further study in a prospective trial with a larger sample size and a longer follow-up period.

https://doi.org/10.5051/jpis.2105760288

Using a coronally advanced flap with an SCTG to cover exposed roots is an established procedure that renders predictable clinical outcomes [9,24], and both full-thickness and split-thickness flap designs have been used in root coverage procedures [32,39]. Similarly to another study, our findings revealed no significant difference in defect coverage between dissecting a split-thickness flap or elevating a full-thickness mucoperiosteal flap in coronally advanced flap procedures [40]. As compared to a full-thickness flap, the tissue graft can receive blood supply from both the split-thickness flap and the connective tissue bed. However, split-thickness flap dissection could excessively thin flap tissue, which could result in sloughing, necrosis and compromised clinical results. In line with this, the current study revealed a significant reduction of KW in the split-thickness flap group, which has not been frequently reported in the literature [9]. This finding needs to be validated in a prospective study in the future.

Esthetically, the VISTAX group had higher mean RES scores than the CAFT and CAST groups, but without statistical significance. However, the marginal tissue contour appeared more regular and scalloped than in the 2 coronally advanced flap groups, as reflected in the soft tissue texture scores that were significantly different between the VISTAX and CAST/CAFT groups. A partially exposed SCTG during the healing phase might have contributed to the irregular marginal tissue contour in the CAST and CAFT groups.

Recent studies have not only addressed clinical outcomes, but also evaluated the impact of procedures on patients' perceptions of well-being and pain as an important aspect of clinical success [24]. These parameters can be an essential aspect of the clinician's and patient's perspective and the subsequent decision of whether to use autogenous tissue or a graft substitute. The perceived experience, in addition to clinical results, might indicate whether a patient would want to undergo an additional procedure in the future [41]. Since the wound at the SCTG donor site most likely caused additional postoperative pain, it is not surprising that patients in the 2 coronally advanced flap groups reported more postoperative pain than patients in the VISTAX group. Overall, patients tend to accept surgical procedures better that eliminate second surgical sites [24]. The decline of dentinal hypersensitivity, however, was scored similarly in all groups. It is known that a root coverage procedure can reduce dentinal hypersensitivity augmented by gingival recession, although the predictability still has to be validated in more well-controlled studies [42]. Still, overall perception of hypersensitivity in this study was minimal to moderate, and not all included sites were associated with the presence of hypersensitivity.

The limitations of the current study are due to the format of retrospective data collection and the short follow-up period. In a retrospective study design, factors such as the number of treated sites per patient, the position of the treated teeth, tissue phenotype, and care providers can often not be well controlled. However, a general analysis after stratifying data by the gingival phenotype and number of treated sites revealed that these factors did not seem to impact clinical results in the current cases, although this possibility cannot be excluded [24]. The insignificant impact of flap thickness on root coverage outcomes might have been because all 3 groups had their flap thickened by the placement of VCMX or SCTG. An additional comparison of VISTA in combination with an SCTG could have been included as a group to specifically compare SCTG and VCMX. However, CAST/CAFT flaps were purposely selected as comparative treatment to VISTAX since they were considered to be among the most performed and predictable procedures for recession coverage. Additionally, the VISTA flap design with its 1 minimally invasive access incision would have had to be

https://doi.org/10.5051/jpis.2105760288

modified (e.g., enlargement and an additional access incision) in order to insert and move the SCTG underneath the flap to augment the recession and papillae area. Nevertheless, further studies could address this comparison.

Due to data availability and the focus on short-term postoperative pain results, 3-month outcomes were emphasized in the present study. Although the short-term follow-period and the small number of CAFT/CAST cases with 6-month results are a concern, it has been demonstrated multiple times that performing a coronally advanced flap in combination with SCTG for root coverage results in stable clinical outcomes over time [26]. Similarly, a randomized controlled clinical study comparing VCMX to SCTG for soft tissue augmentation at implant sites used the 3-month time point as a stable end point [43]. In line with these results, Roman et al. pointed out that at 3 months tissue integration can be sufficient to confer a good esthetic appearance at sites that had been grafted with a coronally advanced flap in combination with SCTG [44]. This was further emphasized by a previous study evaluating 3-month outcomes after surgery using coronally advanced flaps [45], which pointed out that most soft tissue shrinkage might occur during the first month and that the soft tissue margins might then be stable [46,47]. Furthermore, our data revealed that using VISTAX or CAFT/CAST for root coverage resulted in stable coverage rates over 6 months. According to the current evidence, VCMX long-term results are presently unknown, whereas the short- and long-term (≥2 years) outcomes after using coronally advanced flaps in combination with SCTG have been described multiple times in the literature [26].

Taken together, the results of this retrospective study suggest that VISTAX and the use of a collagen matrix could be an alternative to SCTG flap procedures with the advantage of avoiding the harvesting of autogenous palatal tissue. However, a prospective randomized controlled trial with a longer follow-up and larger sample size should be conducted in the future to validate the benefits of VCMX in root coverage procedures as compared to coronally advanced flaps in combination with SCTG.

REFERENCES

1. Albandar JM, Kingman A. Gingival recession, gingival bleeding, and dental calculus in adults 30 years of age and older in the United States, 1988-1994. J Periodontol 1999;70:30-43.
PUBMED | CROSSREF
2. Sarfati A, Bourgeois D, Katsahian S, Mora F, Bouchard P. Risk assessment for buccal gingival recession defects in an adult population. J Periodontol 2010;81:1419-25.
PUBMED | CROSSREF
3. Serino G, Wennström JL, Lindhe J, Eneroth L. The prevalence and distribution of gingival recession in subjects with a high standard of oral hygiene. J Clin Periodontol 1994;21:57-63.
PUBMED | CROSSREF
4. Chambrone L, Tatakis DN. Long-term outcomes of untreated buccal gingival recessions: a systematic review and meta-analysis. J Periodontol 2016;87:796-808.
PUBMED | CROSSREF
5. Jepsen S, Caton JG, Albandar JM, Bissada NF, Bouchard P, Cortellini P, et al. Periodontal manifestations of systemic diseases and developmental and acquired conditions: consensus report of workgroup 3 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol 2018;89 Suppl 1:S237-48.
PUBMED | CROSSREF
6. Ker AJ, Chan R, Fields HW, Beck M, Rosenstiel S. Esthetics and smile characteristics from the layperson's perspective: a computer-based survey study. J Am Dent Assoc 2008;139:1318-27.
PUBMED | CROSSREF

https://doi.org/10.5051/jpis.2105760288

7. McLeod C, Fields HW, Hechter F, Wiltshire W, Rody W Jr, Christensen J. Esthetics and smile characteristics evaluated by laypersons. Angle Orthod 2011;81:198-205.
PUBMED | CROSSREF
8. Cairo F, Nieri M, Pagliaro U. Efficacy of periodontal plastic surgery procedures in the treatment of localized facial gingival recessions. A systematic review. J Clin Periodontol 2014;41 Suppl 15:S44-62.
PUBMED | CROSSREF
9. Chambrone L, Tatakis DN. Periodontal soft tissue root coverage procedures: a systematic review from the AAP Regeneration Workshop. J Periodontol 2015;86 Suppl:S8-51.
PUBMED | CROSSREF
10. Harris RJ, Miller R, Miller LH, Harris C. Complications with surgical procedures utilizing connective tissue grafts: a follow-up of 500 consecutively treated cases. Int J Periodontics Restorative Dent 2005;25:449-59.
PUBMED
11. Harris RJ. A comparative study of root coverage obtained with an acellular dermal matrix versus a connective tissue graft: results of 107 recession defects in 50 consecutively treated patients. Int J Periodontics Restorative Dent 2000;20:51-9.
PUBMED
12. McGuire MK, Scheyer ET. Long-term results comparing xenogeneic collagen matrix and autogenous connective tissue grafts with coronally advanced flaps for treatment of dehiscence-type recession defects. J Periodontol 2016;87:221-7.
PUBMED | CROSSREF
13. Allen AL. Use of the supraperiosteal envelope in soft tissue grafting for root coverage. I. Rationale and technique. Int J Periodontics Restorative Dent 1994;14:216-27.
PUBMED
14. Zadeh HH. Minimally invasive treatment of maxillary anterior gingival recession defects by vestibular incision subperiosteal tunnel access and platelet-derived growth factor BB. Int J Periodontics Restorative Dent 2011;31:653-60.
PUBMED
15. Chao JC. A novel approach to root coverage: the pinhole surgical technique. Int J Periodontics Restorative Dent 2012;32:521-31.
PUBMED
16. Mathes SH, Wohlwend L, Uebersax L, von Mentlen R, Thoma DS, Jung RE, et al. A bioreactor test system to mimic the biological and mechanical environment of oral soft tissues and to evaluate substitutes for connective tissue grafts. Biotechnol Bioeng 2010;107:1029-39.
PUBMED | CROSSREF
17. Caballé-Serrano J, Zhang S, Sculean A, Staehli A, Bosshardt DD. Tissue integration and degradation of a porous collagen-based scaffold used for soft tissue augmentation. Materials (Basel) 2020;13:E2420.
PUBMED | CROSSREF
18. Thoma DS, Hämmerle CH, Cochran DL, Jones AA, Görlach C, Uebersax L, et al. Soft tissue volume augmentation by the use of collagen-based matrices in the dog mandible -- a histological analysis. J Clin Periodontol 2011;38:1063-70.
PUBMED | CROSSREF
19. Thoma DS, Jung RE, Schneider D, Cochran DL, Ender A, Jones AA, et al. Soft tissue volume augmentation by the use of collagen-based matrices: a volumetric analysis. J Clin Periodontol 2010;37:659-66.
PUBMED | CROSSREF
20. 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;24:3181-91.
PUBMED | CROSSREF
21. Schulze-Späte U, Lee CT. Modified vestibular incision subperiosteal tunnel access procedure with volume-stable collagen matrix for root coverage: report of three cases. Int J Periodontics Restorative Dent 2019;39:e181-7.
PUBMED | CROSSREF
22. Nelson SW. The subpedicle connective tissue graft. A bilaminar reconstructive procedure for the coverage of denuded root surfaces. J Periodontol 1987;58:95-102.
PUBMED | CROSSREF
23. Harris RJ. The connective tissue and partial thickness double pedicle graft: a predictable method of obtaining root coverage. J Periodontol 1992;63:477-86.
PUBMED | CROSSREF

24. Chambrone L, Ortega MA, Sukekava F, Rotundo R, Kalemaj Z, Buti J, et al. Root coverage procedures for treating single and multiple recession-type defects: an updated Cochrane systematic review. J Periodontol 2019;90:1399-422.
PUBMED | CROSSREF

25. Tavelli L, Barootchi S, Nguyen TV, Tattan M, Ravidà A, Wang HL. Efficacy of tunnel technique in the treatment of localized and multiple gingival recessions: a systematic review and meta-analysis. J Periodontol 2018;89:1075-90.
PUBMED | CROSSREF

26. Dai A, Huang JP, Ding PH, Chen LL. Long-term stability of root coverage procedures for single gingival recessions: a systematic review and meta-analysis. J Clin Periodontol 2019;46:572-85.
PUBMED | CROSSREF

27. Thombre V, Koudale SB, Bhongade ML. Comparative evaluation of the effectiveness of coronally positioned flap with or without acellular dermal matrix allograft in the treatment of multiple marginal gingival recession defects. Int J Periodontics Restorative Dent 2013;33:e88-94.
PUBMED | CROSSREF

28. Cairo F, Nieri M, Cincinelli S, Mervelt J, Pagliaro U. The interproximal clinical attachment level to classify gingival recessions and predict root coverage outcomes: an explorative and reliability study. J Clin Periodontol 2011;38:661-6.
PUBMED | CROSSREF

29. Miller PD Jr. A classification of marginal tissue recession. Int J Periodontics Restorative Dent 1985;5:8-13.
PUBMED

30. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. Acta Odontol Scand 1963;21:533-51.
PUBMED | CROSSREF

31. O'Leary TJ, Drake RB, Naylor JE. The plaque control record. J Periodontol 1972;43:38.
PUBMED | CROSSREF

32. Bruno JF. Connective tissue graft technique assuring wide root coverage. Int J Periodontics Restorative Dent 1994;14:126-37.
PUBMED

33. Lorenzana ER, Allen EP. The single-incision palatal harvest technique: a strategy for esthetics and patient comfort. Int J Periodontics Restorative Dent 2000;20:297-305.
PUBMED

34. Kan JY, Morimoto T, Rungcharassaeng K, Roe P, Smith DH. Gingival biotype assessment in the esthetic zone: visual versus direct measurement. Int J Periodontics Restorative Dent 2010;30:237-43.
PUBMED

35. Cairo F, Rotundo R, Miller PD Jr, Pini Prato GP. Root coverage esthetic score: a system to evaluate the esthetic outcome of the treatment of gingival recession through evaluation of clinical cases. J Periodontol 2009;80:705-10.
PUBMED | CROSSREF

36. Jensen MP, Karoly P. Self-report scales and procedures for assessing pain in adults. In Turk DC, Melzack R, editors. Handbook of pain assessment. New York (NY): The Guilford Press; 2011. p.19-44.

37. Griffin TJ, Cheung WS, Zavras AI, Damoulis PD. Postoperative complications following gingival augmentation procedures. J Periodontol 2006;77:2070-9.
PUBMED | CROSSREF

38. Gargallo-Albiol J, Barootchi S, Tavelli L, Wang HL. Efficacy of xenogeneic collagen matrix to augment peri-implant soft tissue thickness compared to autogenous connective tissue graft: a systematic review and meta-analysis. Int J Oral Maxillofac Implants 2019;34:1059-69.
PUBMED | CROSSREF

39. Langer B, Langer L. Subepithelial connective tissue graft technique for root coverage. J Periodontol 1985;56:715-20.
PUBMED | CROSSREF

40. Mazzocco F, Comuzzi L, Stefani R, Milan Y, Favero G, Stellini E. Coronally advanced flap combined with a subepithelial connective tissue graft using full- or partial-thickness flap reflection. J Periodontol 2011;82:1524-9.
PUBMED | CROSSREF

41. Tavelli L, Barootchi S, Di Gianfilippo R, Kneifati A, Majzoub J, Stefanini M, et al. Patient experience of autogenous soft tissue grafting has an implication for future treatment: a 10- to 15-year cross-sectional study. J Periodontol 2021;92:637-47.
PUBMED | CROSSREF

42. Douglas de Oliveira DW, Oliveira-Ferreira F, Flecha OD, Gonçalves PF. Is surgical root coverage effective for the treatment of cervical dentin hypersensitivity? A systematic review. J Periodontol 2013;84:295-306.
PUBMED | CROSSREF

43. Zeltner M, Jung RE, Hämmerle CH, Hüsler J, Thoma DS. Randomized controlled clinical study comparing a volume-stable collagen matrix to autogenous connective tissue grafts for soft tissue augmentation at implant sites: linear volumetric soft tissue changes up to 3 months. J Clin Periodontol 2017;44:446-53.
PUBMED | CROSSREF

44. Roman A, Balazsi R, Câmpian RS, Soancă A, Moldovan R, Sculean A, et al. Patient-centered outcomes after subepithelial connective tissue grafts and coronally advanced flaps. Quintessence Int 2012;43:841-51.
PUBMED

45. Zucchelli G, Mele M, Stefanini M, Mazzotti C, Mounssif I, Marzadori M, et al. Predetermination of root coverage. J Periodontol 2010;81:1019-26.
PUBMED | CROSSREF

46. Cortellini P, Tonetti M, Baldi C, Francetti L, Rasperini G, Rotundo R, et al. Does placement of a connective tissue graft improve the outcomes of coronally advanced flap for coverage of single gingival recessions in upper anterior teeth? A multi-centre, randomized, double-blind, clinical trial. J Clin Periodontol 2009;36:68-79.
PUBMED | CROSSREF

47. Pini Prato GP, Baldi C, Nieri M, Franseschi D, Cortellini P, Clauser C, et al. Coronally advanced flap: the post-surgical position of the gingival margin is an important factor for achieving complete root coverage. J Periodontol 2005;76:713-22.
PUBMED | CROSSREF

https://doi.org/10.5051/jpis.2105760288