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Effect of a Connective Tissue Graft in Combination With *Single Flap Approach* in the Regenerative Treatment of Intraosseous Defects

Leonardo Trombelli[*†], Anna Simonelli[*], Luigi Minenna[*], Giulio Rasperini[‡§], Roberto Farina[*†]

[*]Research Centre for the Study of Periodontal and Peri-Implant Diseases, University of Ferrara, Ferrara, Italy.

[†]Operative Unit of Dentistry, University-Hospital, Ferrara, Italy.

[‡]Department of Biomedical, Surgical, and Dental Sciences, University of Milan, Milan, Italy.

[§]Institute for Inpatient Treatment and Scientific Studies Foundation, Ca' Granda Polyclinic, Milan, Italy.

Background: In the attempt to limit the post-surgery increase in buccal gingival recession (bREC), the effect of a connective tissue graft (CTG) when combined with a buccal *Single Flap Approach* (SFA) in the regenerative treatment of intraosseous defects was evaluated.

Methods: Data related to 30 patients with an intraosseous defect treated with buccal SFA with (SFA+CTG group; n= 15) or without (SFA group; n= 15) the placement of a CTG and regenerative treatment were retrospectively derived at three clinical centers. bREC and probing parameters were assessed at pre-surgery and 6 months post-surgery.

Results: In addition to a significant attachment gain and probing depth reduction, the adjunctive use of a CTG to a buccal SFA in the regenerative treatment of periodontal intraosseous defects associated with a buccal bone dehiscence resulted in a limited post-surgery bREC, a lower prevalence of defects with a clinically-detectable apical displacement of the gingival margin and an increase in gingival width and thickness.

Conclusions: The adjunctive use of a CTG in the regenerative treatment of intraosseous defects associated with buccal bone dehiscence accessed by buccal SFA may support the stability of the gingival profile.

KEY WORDS

Periodontitis; alveolar bone loss; reconstructive surgical procedures; surgical flaps; gingival recession; bone dehiscence.

Post-surgery increase in gingival recession (REC) is a highly prevalent, undesired side effect of the surgical treatment of intraosseous defects, partly depending on flap design [1]. Since REC significantly affects the oral-health related quality of life [2-4], the use of simplified procedures that may limit post-surgery REC increase while maximize treatment outcomes should be encouraged [5].

In this context, we proposed the *Single Flap Approach* (SFA), a simplified surgical procedure for the treatment of intraosseous defects [5-15]. The basic underlying principle of the SFA consists of the elevation of a limited mucoperiosteal flap to allow access to the defect from either the buccal or oral aspect only, depending on the main buccal/oral extension of the lesion (as assessed by pre-operative bone sounding), allowing the interproximal supracrestal gingival tissues to remain intact. The SFA was shown to be associated with low mean postoperative REC increase, with six over seven prospective clinical trials reporting mean REC variations within 1 mm at 6 months after surgery [7-12,15]. Also, lower post-surgery REC increase was observed following SFA compared to papilla preservation techniques in either conservative or regenerative therapy of intraosseous lesions [9,15].

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A recent study has demonstrated that buccal SFA to access an intraosseous defect associated with a buccal bone dehiscence results in a post-surgery buccal REC, and that the severity of such REC is directly correlated with the severity of the bone dehiscence [12]. The possibility to prevent REC increase following SFA at challenging intraosseous lesions by modifying the original flap design has been reported, including the coronal advancement of the SFA [16] or the combination of the SFA with an autologous soft tissue graft [17,18] or a collagen matrix [13]. These procedures have demonstrated encouraging clinical outcomes in terms of both defect resolution and prevention of postoperative REC increase (or root coverage), even when tested at challenging intraosseous defects associated with Miller's class IV gingival recession [18]. Their efficacy in controlling postoperative REC increase, however, has never been investigated in controlled clinical studies.

The present study is based on the hypothesis that the adjunctive use of a connective tissue graft (CTG) may contrast the postoperative REC increase following regenerative procedures. Therefore, the adjunctive effect of a CTG to a buccal SFA was evaluated in the enamel matrix derivative (EMD) + xenograft treatment of deep intraosseous defects associated with a buccal bone dehiscence.

MATERIALS AND METHODS

Study Design and Ethical Aspects

The present study is a retrospective analysis of patient cohorts treated with either buccal SFA (SFA group) or buccal SFA in combination with CTG (SFA+CTG group). For each patient treated with SFA+CTG, a patient treated with SFA was selected with identical (or, if not available, as similar as possible) depth of the buccal bone dehiscence associated with the intraosseous defect. In both groups, the intraosseous lesion was treated with deproteinized bovine bone mineral (DBBM) and EMD. The study was approved by the Local Ethical Committee of Ferrara, Italy (date of approval: March 17, 2016; protocol number: 151290). All the clinical procedures were performed in accordance with the Declaration of Helsinki and the Good Clinical Practice Guidelines (GCPs). Each patient signed an informed consent form before surgical treatment.

Study Population

A Database was created on de-identified data retrieved from record charts of periodontal patients treated with SFA from July, 2013 to November, 2015 at the Research Centre for the Study of Periodontal and Peri-Implant Diseases, University of Ferrara, Italy, a private dental office in Ferrara, Italy, and the Department of Biomedical, Surgical, and Dental Sciences, University of Milan, Italy.

Patients were included if positive for all the following criteria: diagnosis of chronic or aggressive periodontitis; presence of at least one interproximal periodontal intraosseous defect with pre-surgical probing depth (PD) ≥ 5 mm and radiographic depth (as assessed on periapical radiograph) ≥ 3 mm; limited to no extension of the periodontal intraosseous defect on the lingual/palatal side as assessed by pre-operatory bone sounding; full-mouth plaque score [19] and full-mouth bleeding score [20] <20% at the time of surgical procedure; depth of the buccal bone dehiscence (measured immediately after surgical debridement of the lesion as the distance between the cement-enamel junction and the buccal bone crest) ≥ 3 mm; surgical treatment with buccal SFA, a combination of DBBM and EMD, with or without the adjunctive use of CTG; compliance with the scheduled post-surgical recall sessions.

Patients were excluded from the analysis if positive for one or more of the following criteria: pregnancy or lactation; using of medication affecting periodontal status (i.e. bisphosphonates, cyclosporine, phenytoin, nifedipine and other calcium channel blockers and corticosteroids); furcation involvement of the tooth presenting the intraosseous defect; inadequate endodontic treatment of the tooth presenting the intraosseous defect; inadequate restoration of the tooth presenting the intraosseous defect; third molars.

Clinical Procedures

Pre-surgery and surgical procedures were performed by expert periodontal surgeons (L.T., L.M., R.F., G.R.) involved in previous clinical trials on SFA [7-12,15].

Pre-surgery procedures. Each patient underwent single or multiple sessions of scaling and root planing using mechanical and hand instruments, and received personalized oral hygiene instructions. The surgical phase was delayed until a minimal residual inflammation and optimal soft tissue conditions were obtained at the defect site. When needed, temporary splinting and/or occlusal adjustment were performed.

Surgical treatment. All surgeries were performed using 2.5x magnifying loops. The site of surgery was first anesthetized using articaine-epinephrine 1:100,000 avoiding trans-papillary infiltrations. Transcrevicular probing (bone sounding) was performed pre-surgically to evaluate defect morphology and extension. The surgical access was performed according to the principles of the buccal SFA [6,7] (Figure 1a-c, supplementary video 1 in online *Journal of Periodontology*). Briefly, a sulcular incision was performed following the gingival margin of the teeth included in the surgical area. At the level of the interdental papilla overlying the intraosseous defect, an oblique or horizontal butt-joint incision was made. The greater the distance from the tip of the papilla to the underlying bone crest, the more apical (i.e., close to the base of the papilla) the buccal incision in the interdental area. A buccal, mucoperiosteal, envelope flap was elevated, leaving the oral portion of the interdental supracrestal soft tissues undetached.

Once debrided using both manual and hand instruments, defects were treated using EMD gel [‖] in combination with DBBM [¶†]. The exposed root surface was treated with 24% ethylenediaminetetraacetic acid (EDTA) gel for 2 minutes in order to remove the smear layer. After rinsing the surgical area with saline, a sandwich technique was applied to stratify EMD and DBBM as previously described [21,22].

At the operator's discretion, defects were directly sutured according to the original description of SFA [6,7] or underwent the adjunctive application of a CTG (Figure 1d, supplementary video 1 in online *Journal of Periodontology*). For defects treated with SFA alone, a horizontal internal mattress suture was performed at the base of the papilla and a second internal mattress suture (vertical or horizontal) was performed between the most coronal portion of the flap and the most coronal portion of the oral papilla. When needed (e.g., in case of a large, thick interdental papilla), an interrupted suture was performed to ensure primary intention healing at the incision line [6,7]. For the other defects, a CTG, derived from the de-epithelization of a free gingival graft harvested from the omolateral palate or a contiguous edentulous area, was obtained. The mesio-distal length of the CTG was at least 2 mm larger than the width of the buccal bone dehiscence of the tooth presenting the intraosseous defect, the apico-coronal dimension was about 4-5 mm and the thickness was about 1 mm. At the operator's discretion, the CTG was fixed to the envelope flap at the level of the buccal bone dehiscence using two vertical internal mattress sutures or was fixed to the inner portion of the connective tissue of the interdental papillae after their slight elevation with a microperiosteal elevator. The CTG was entirely covered by the buccal flap or left exposed with its most coronal portion. Finally, the buccal flap was repositioned and sutured according the original SFA technique [6,7].

Post –surgery procedures. Sutures were removed at 2 weeks after surgery. The patients were asked to abstain from mechanical oral hygiene procedures in the surgical area for 4 weeks. A 0.12% chlorhexidine mouthrinse (10 mL BID/6 wks) was used to support local plaque control. Each

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patient was enrolled in a monthly recall program for 3 months and was reviewed according to personal needs thereafter. Each session included reinforcement of oral hygiene procedures and supragingival plaque removal. Subgingival scaling was performed following completion of the study at 6 months post-surgery.

Study Parameters

Immediately before surgery and 6-months after surgery, the following measurements were collected at the site showing the greatest loss of clinical attachment by each periodontal surgeon using a manual pressure sensitive probe [#‡] with 1-mm increments:

- probing depth (PD), measured from the gingival margin to the bottom of the pocket;

- local bleeding score (BS): recorded as positive when bleeding on probing was present at the surgical site;

- clinical attachment level (CAL), measured from the cemento-enamel junction (CEJ) to the bottom of the pocket;

- interdental gingival recession (iREC): measured from the gingival margin to the CEJ or the apical margin of a restoration.

On digital photographs taken as much perpendicular as possible to the long axis of the tooth presenting the intraosseous defect at pre-surgery, an examiner (A.S.) assessed the following parameters using a dedicated software [**§] [10-12]:

- thickness of the buccal gingival tissue: the transparency of a periodontal probe through the gingival tissues when probing the buccal aspect of the tooth was evaluated according to a previously described method [23]; if the probe was visible through the gingival tissues, the tissue was defined as ''thin,'' otherwise, it was defined as ''thick'';

- buccal REC (bREC), measured from the CEJ to the gingival margin (bREC was recorded as 0 when the gingival margin was located coronal to the CEJ);

- keratinized tissue width (KT), measured from the gingival margin to the mucogingival junction.

To account for photographic magnification, bREC and KT were referred to the increments of a periodontal probe [#‡]as depicted in the same photograph. Measurements were roundest to the nearest 0.1 mm. All measurements were repeated on photographs taken at the 6-month visit. The examiner had been involved in a calibration session (intraclass correlation coefficient for bREC: 0.989) [12].

Immediately after the completion of root and defect debridement, the following defect-related characteristics had been assessed (in mm) using a periodontal probe [#‡]:

- severity of bone loss, measured as the distance between the CEJ and the base of the defect;

- intrabony component, measured as the distance between the most coronal point of the alveolar crest and the base of the defect;

- suprabony component, measured as the distance between the CEJ and the most coronal extension of the interproximal bone crest;

- buccal dehiscence, measured as the distance between the CEJ and the most coronal extension of the buccal bone crest.

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Statistical Analysis

Derived parameters. For each treated defect, the 6-month change in each clinical parameter was calculated by subtracting the 6-month value from the pre-surgery value. Therefore, a positive 6-month change indicated a reduction in PD or KT, a gain in CAL, or a decrease in iREC or bREC.

Descriptive and inferential statistics. Data were entered in a statistical software [††l]. Each patient contributed one intraosseous defect, therefore, the patient was the statistical unit. The 6-month change in bREC was considered as the primary outcome variable of the study, while the 6-month changes in iREC, PD, CAL, and KT were considered as the secondary outcome variables. Data were expressed as mean and standard deviation (SD). Within-group comparisons (presurgery versus 6 months) were performed with Wilcoxon test, and Likelihood Ratio χ^2 test with correction for small samples or Fisher's exact test. Linear correlation was used to evaluate the relationship between the depth of the buccal dehiscence (D) and the 6-month change in bREC in SFA and SFA+CTG groups. Inter-group comparisons were performed with Mann-Whitney U test, and Likelihood Ratio χ^2 test with correction for small samples or Fisher's exact test.

Statistical power calculation. No data could be retrieved to allow for an *a priori sample* size calculation. Therefore, the present study population is a convenience sample. A *post-hoc* power calculation was performed, assuming a standard deviation in the primary outcome of 1.1 mm, as derived from a previous study [11] on SFA in combination with DBBM and EMD, and an inter-group difference of 1.0 mm. A *per protocol* study population of 30 patients (15 treated with SFA, 15 treated with SFA+CTG) had a power of 78.2% in detecting a significant inter-group difference at a p-level of 0.05.

RESULTS

Study Population

Thirty patients, each contributing one intraosseous defect, were included in the study. Fifteen defects were treated with SFA, whereas 15 defects were treated with SFA+CTG. In all cases, buccal SFA ensured an adequate surgical access for root and defect debridement. In the SFA+CTG group, a limited exposure of the most coronal portion of the CTG was observed at 8 defect sites at flap suturing. All patient fully complied with the study protocol until final re-evaluation.

Patient and defect (or site) characteristics at pre-surgery visit are summarized in Tables 1-3. No significant inter-group differences were observed for mean age, gender distribution, and prevalence of smokers and diabetic subjects (Table 1). Treatment groups showed a significantly different distribution of defects according to tooth type, with defects treated with SFA+CTG being mainly located in the incisor and canine area (Table 1). In the SFA and SFA+CTG groups, the depth of the intrabony component was 6.5 ± 2.9 mm and 5.0 ± 2.0 mm, respectively. The depth of the buccal bone dehiscence ranged between 3 and 12 mm, with a mean of 6.0 ± 2.7 mm and 6.2 ± 3.0 mm in SFA and SFA+CTG group, respectively. No significant differences in defect-related characteristics were observed between groups either before or during surgery (Tables 1-3).

Recession and Thickness of the Buccal Gingival Tissue

Data on bREC, KT, their 6-month changes, and gingival thickness are reported in Table 2.

Gingival recession. At 6 months, a significant increase in bREC (1.2 ± 1.1 mm) was observed in SFA group whereas a slight, non-significant increase in bREC of 0.4 ± 1.2 mm was observed in SFA+CTG group. A trend towards a better stability of the gingival profile in the SFA+CTG group was observed, although the difference in bREC change did not reach the statistical significance

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(p=0.081). The number of defect sites showing an increase in bREC $\geq$ 1 mm, an increase in bREC < 1 mm or stable bREC, or a decrease in bREC at 6 months compared to pre-surgery was 10, 5, and 0, respectively, in SFA group, and 5, 5, and 5, respectively, in SFA+CTG group, the distribution being significantly different between groups (p= 0.028).

In defects with a shallow (3÷5 mm) dehiscence of the buccal bone, defects treated with SFA and SFA+CTG showed a similar, mean 6-month increase in bREC of 0.8 and 0.5 mm, respectively. In defects with deep (> 5 mm) buccal dehiscence, the mean increase in bREC was pronounced in the SFA group (1.6 mm) while was limited in the SFA+CTG group (0.3 mm), although the inter-group difference in bREC change did not reach statistical significance (Table 4).

Keratinized tissue width. While a slight, non-significant loss in KT was observed at 6 months compared to pre-surgery in SFA group, a significant 6-month increase in KT (2.3 $\pm$ 1.7 mm) was observed in the SFA+CTG group. The 6-month change in KT was significantly different between groups (p< 0.001, respectively).

Gingival thickness. In the SFA group, sites classified as having thin or thick tissues at pre-surgery (n= 7 and 8, respectively) were reconfirmed as having the same gingival thickness (thin or thick) at 6 months. Irrespectively of the gingival thickness at pre-surgery (thin, n= 7; thick, n= 8), all sites treated with SFA+CTG were classified as having thick gingival tissues at 6 months post-surgery.

The 6-month change in bREC according to treatment group and baseline gingival thickness is reported in Table 5. At sites with thin gingival tissues at baseline, the adjunctive use of a CTG significantly limited the 6-month increase in bREC (p= 0.038), while no significant differences in bREC change were observed between sites with thick gingival tissues with or without CTG (Table 5).

Clinical Attachment Gain and Probing Depth Reduction

Baseline and 6-month probing parameters as well as their changes are reported in Table 3. Both procedures resulted in significant CAL gain (4.0 $\pm$ 1.5 mm and 3.2 $\pm$ 1.5 mm in the SFA and SFA+CTG group, respectively) and PD reduction (4.8 $\pm$ 2.0 mm and 4.3 $\pm$ 1.8 mm in the SFA and SFA+CTG group, respectively). No significant differences in 6-month CAL and PD values as well as their changes were observed between groups. At 6 months, a significant increase in iREC was observed in both SFA group (0.8 $\pm$ 1.2 mm) and SFA+CTG group (1.1 $\pm$ 1.1 mm), with no significant inter-group differences in iREC change.

DISCUSSION

The present study was performed to compare the 6-month clinical outcomes of a simplified surgical procedure (i.e., the Single Flap Approach, SFA [6,7]) for the regenerative treatment of periodontal intraosseous defects when used either with or without a connective tissue graft (CTG). Retrospective data relate to defects treated with buccal SFA in combination with EMD and DBBM. The results indicate that the adjunctive use of a CTG resulted in a limited post-surgery recession and an increase in gingival dimensions in addition to a substantial CAL gain.

In both treatments groups, buccal SFA was combined with a bovine-derived xenograft and EMD, resulting in a similar, significant improvement in probing parameters as assessed at 6 months following surgery. The magnitude of the clinical outcomes observed in our study is consistent with the treatment effects reported by previous meta-analyses on the combined use of a xenograft and EMD [24,25].

The adjunctive clinical efficacy of a CTG placed at the buccal aspect was evaluated at deep intraosseous lesions associated with a buccal bone dehiscence, since these osseous lesions have shown a marked apical migration of the gingival margin following buccal SFA [12]. The selection of a CTG to stabilize the position of the gingival margin was based on its well-established efficacy in Miller class I and II recessions [26-30] and the clinical improvements observed at Miller class III and IV recessions [30] following root coverage procedures. Our data showed that the use of a CTG was associated with a limited increase in bREC at 6-months post-surgery. A trend towards a better stability of the gingival profile in the SFA+CTG group was observed although the difference in bREC change did not reach the statistical significance (p=0.081). The effect of CTG became particularly evident in case of severe buccal bone dehiscence (Table 4). Moreover, the SFA+CTG group showed a decreased proportion of sites with clinically detectable (≥ 1mm) gingival recession compared to the SFA group.

The differences in bREC change between groups as observed in thin and thick gingival tissues (Table 5) seems to suggest that the beneficial effect of CTG may partly reside in the increase in gingival thickness. Consistently, previous studies have shown that thick gingival tissues showed a greater resistance to recession due to surgical trauma and tissue remodeling following different surgical procedures, including regenerative surgery [31-34]. It may also be speculated that the conversion from a thin to a thick phenotype may have a beneficial effect on the long-term stability of the gingival profile, since thick biotypes were shown less prone to develop gingival recessions [35].

Previous RCTs have clearly demonstrated that SFA may optimize the clinical outcomes compared to a conventional double flap approach when used with [15] or without [9] regenerative devices, while limiting the level of post-surgery pain and discomfort [15]. The adjunctive use of a CTG unavoidably results in a more technically-demanding procedure, and increases the intra- and post-operative morbidity due to the need for an additional surgical site for graft harvesting. Data from our analysis suggest that the addition of CTG to SFA is particularly beneficial at defects with thin gingival tissues and severe buccal bone dehiscence, however, of limited relevance in thick biotypes and a shallow buccal dehiscences. Moreover, the stability of the buccal gingival profile may represent a treatment goal particularly when the regenerative procedure is performed in esthetically-sensitive areas of the dentition. Therefore, the appropriateness of the SFA+CTG procedure should be carefully evaluated in light of specific clinical indications.

Despite the effectiveness of CTG in contrasting the post-surgery gingival remodeling, a certain variability in bREC change was observed in the SFA+CTG group. This variability may be partly related to defect characteristics, such as the severity of the buccal and interproximal bone loss, which may impair the vascular support for the CTG. Also, the effect of technical aspects, such as the position of the flap (repositioned, coronally-advanced) and the graft (submerged, partially exposed), on clinical outcomes needs be further elucidated in order to optimize the procedure.

The present study was designed as a retrospective, controlled study. Although patient cohorts treated with buccal SFA with and without CTG were selected on the base of depth of the buccal bone dehiscence associated with the intraosseous defect, the risk of cases selection bias could not be excluded. Moreover, the number of centers/operators as well as the unbalanced distribution of cases within each center/operator may have represented a source of heterogeneity and influenced the results. Along with the study design, these aspects may hinder the generalizability of the present findings.

CONCLUSIONS

In addition to a significant CAL gain and PD reduction, the adjunctive use of a CTG to a buccal SFA in the regenerative treatment of periodontal intraosseous defects associated with a buccal bone dehiscence resulted in a limited post-surgery buccal gingival recession, a lower prevalence of defects with a clinically-detectable apical displacement of the gingival margin and an increase in gingival width and thickness.

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CONFLICT OF INTERESTS

The Authors have not received financial support related to this study, and have no conflict of interests to declare.

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Corresponding Author: Prof. Leonardo Trombelli, Research Centre for the Study of Periodontal and Peri-Implant Diseases, University of Ferrara, Corso Giovecca 203, 44100 Ferrara, Italy. Tel. +39 0532 205277; Fax +39 0532 202329; e-mail: leonardo.trombelli@unife.it

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Figure 1.

Treatment of a periodontal intraosseous defect according to the buccal SFA in combination with CTG.

Table 1.

Patient-related and site-specific characteristics in SFA and SFA+CTG groups.

Patient-related characteristics	**SFA group (n= 15)**	**SFA+CTG group (n= 15)**	***p* value**
Age (years) (mean±SD)	50.3 (± 10.8)	52.9 (± 7.8)	0.536
Gender (males/females)	11/4	9/6	0.700
Smoking Status (smokers/non-smokers)	6/9	6/9	1
Diabetes (diabetic/non diabetic)	0/15	1/14	1
Site-specific characteristics	**SFA group (n= 15)**	**SFA+CTG group (n= 15)**	**p value**
Thickness of buccal gingival tissue (thin/thick)	7/8	7/8	1
Dental arch (maxillary/mandibular)	10/5	10/5	1
Tooth type (incisors/canines/premolars/molars)	2/7/6/0	9/4/1/1	0.029
Intrabony component (mm) (mean ± SD)	6.5 (± 2.9)	5.0 (± 2.0)	0.098
Suprabony component (mm) (mean ± SD)	4.5 (± 1.6)	5.8 (± 2.7)	0.217
Severity of bone loss (mm) (mean ± SD)	11.0 (± 4.3)	10.8 (± 3.2)	1
Depth of buccal bone dehiscence (mm)			
0 ÷ 2 mm (n)	0	0	
3 ÷ 5 mm (n)	8	8	
6 ÷ 8 mm (n)	4	3	0.990
9 ÷ 11 mm (n)	2	3	
12 ÷ 13 mm (n)	1	1	
mean (± SD; range min-max)	6.0 (± 2.7; 3 - 12)	6.2 (± 3.0; 3 - 12)	0.935

Table 2.

Buccal gingival recession (bREC), keratinized tissue width (KT), gingival thickness and their 6-month changes in SFA (n= 15) and SFA+CTG (n= 15) groups. A positive 6-month change indicates a reduction in KT, and a decrease in bREC.

Parameter	**pre-surgery**	**6 months**	***p* value**	**6-month change**
bREC (mm)				
SFA	2.0 ± 1.8	3.2 ± 2.2	*0.003*	-1.2 ± 1.1
SFA+CTG	2.0 ± 1.7	2.4 ± 1.5	*0.134*	-0.4 ± 1.2
p value	*0.967*	*0.367*		*0.081*
KT (mm)				
SFA	4.2 ± 1.9	3.8 ± 2.5	*0.110*	0.4 ± 1.4
SFA+CTG	3.2 ± 2.0	5.5 ± 2.6	*< 0.001*	-2.3 ± 1.7
p value	*0.098*	*0.116*		*< 0.001*
Gingival thickness (n° thin/n° thick)				
SFA	7/8	7/8	*1*	
SFA+CTG	7/8	0/15	*0.006*	
p value	*1*	*0.006*		

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Table 3.

Clinical attachment level (CAL), probing depth (PD), interdental gingival recession (iREC) values and their 6-month changes in SFA (n= 15) and SFA+CTG (n= 15) groups. A positive 6-month change indicates a gain in CAL, or a reduction in PD or iREC.

Parameter	pre-surgery	6 months	*p* value	6-month change
CAL (mm)				
SFA	10.9 ± 2.9	6.9 ± 2.3	*< 0.001*	4.0 ± 1.5
SFA+CTG	10.0 ± 2.3	6.8 ± 1.6	*< 0.001*	3.2 ± 1.5
p value	*0.412*	*0.806*		*0.106*
PD (mm)				
SFA	8.2 ± 2.4	3.4 ± 0.8	*< 0.001*	4.8 ± 2.0
SFA+CTG	7.9 ± 1.8	3.6 ± 0.8	*< 0.001*	4.3 ± 1.8
p value	*0.967*	*0.595*		*0.595*
iREC (mm)				
SFA	2.7 ± 2.5	3.5 ± 1.8	*0.039*	-0.8 ± 1.2
SFA+CTG	2.1 ± 1.5	3.2 ± 1.7	*0.005*	-1.1 ± 1.1
p value	*0.683*	*0.653*		*0.806*

Table 4.

Six-month change in buccal gingival recession (bREC) according to treatment group and depth of the buccal bone dehiscence.

Treatment group and depth of the buccal bone dehiscence	n	6-month change in bREC
SFA, buccal dehiscence 3÷5 mm	8	-0.8 ± 0.5
SFA+CTG, buccal dehiscence 3÷5 mm	8	-0.5 ± 0.6
p value		*0.505*
SFA, buccal dehiscence >5 mm	7	-1.6 ± 1.5
SFA+CTG, buccal dehiscence >5 mm	7	-0.3 ± 1.7
p value		*0.073*

Table 5.

Six-month change in buccal gingival recession (bREC) according to treatment group and baseline gingival thickness.

Treatment group and thickness of gingival tissues at pre-surgery	n	6-month change in bREC
SFA, thin gingival tissues [†]	7	-1.8 ± 1.3
SFA+CTG, thin gingival tissues [*]	7	-0.4 ± 1.0
p value		*0.038*
SFA, thick gingival tissues [†]	8	-0.6 ± 0.6
SFA+CTG, thick gingival tissues [†]	8	-0.3 ± 1.5
p value		*0.721*

* all converted to thick at 6 months post-surgery

† reconfirmed as having the same gingival thickness (thin or thick) at 6 months post-surgery

[‖] Emdogain gel, Institute Straumann, Basel, Switzerland

[¶] Bio-Oss spongiosa granules, 0.25-1.0 mm, Geistlich Pharma, Wolhusen, Switzerland

[#] UNC15, Hu-Friedy, Chicago, IL, USA

[**] NIS elements v4.2; Nikon Instruments, Campi Bisenzio, Firenze, Italy

[#] UNC15, Hu-Friedy, Chicago, IL, USA

[††] STATISTICA v.8.0, StatSoft, Vigonza, Italy

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