Treatment of Supra-Alveolar-Type Defects by a Simplified Papilla Preservation Technique for Access Flap Surgery With or Without Enamel Matrix Proteins

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Background: In this study, we compare the effectiveness of enamel matrix derivative (EMD) associated with a simplified papilla preservation flap (SPPF) technique to SPPF alone when surgically treating supra-alveolar-type defects.

Methods: Fifty patients, from 54 initially selected, presenting horizontal bone loss around ≥4 adjacent teeth, were treated by an SPPF technique; 25 participants also received EMD (test group) and 25 patients underwent flap surgery alone (control group). A complete clinical and radiographic examination was performed at baseline and 12 months after treatment. Pre- and post-therapy probing depth (PD), clinical attachment level (CAL), gingival recession (GR), and radiographic bone level (BL) were compared between treatments.

Results: After 12 months, PD, CAL, and GR in both groups showed significant differences from baseline (P <0.001). No differences in BL scores were observed within the groups at the 12-month examination. After 1 year, the test group showed significantly (P <0.001) greater PD reduction (3.4 ± 0.7 mm) and CAL gain (2.8 ± 0.8 mm) and a smaller GR increase (0.6 ± 0.4 mm) compared to the control group (PD, 2.2 ± 0.8 mm; CAL, 1.0 ± 0.6 mm; GR, 1.2 ± 0.7 mm.) BL changes did not significantly differ between the experimental groups.

Conclusion: The results of this study suggest that combining EMD and SPPF in the treatment of suprabony defects may lead to a greater clinical improvement compared to SPPF alone. *J Periodontol 2013;84:1100-1110.*

KEY WORDS

Amelogenin; clinical trial; periodontitis; regeneration; surgical flaps; wound healing.

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Several treatment modalities have been used as surgical approaches after the infection control phase of periodontal therapy.[1-5] Induced periodontal regeneration, using enamel matrix derivative (EMD), mimics the biologic processes taking place during odontogenesis.[6-8] EMD showed clinical and histologic evidence for regeneration when treating intrabony periodontal defects.[6,9-11] A number of procedures are used in the treatment of periodontal intrabony defects,[1-5] and horizontal bone loss represents the least predictable periodontal defect type in the regenerative approaches and it is an unsolved challenge for clinicians. Currently used regenerative procedures are not routinely applicable to this type of lesion and there are only experimental studies in animals[12,13] or case reports in humans[14-18] showing unpredictable results.

Based on the properties of EMD in actively stimulating periodontal ligament mesenchymal cells, it is possible to hypothesize that the use of EMD in suprabony defects could lead to better clinical results; i.e., greater clinical attachment level (CAL) gain, even in the absence of vertical bone growth.[19]

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To date, two human studies[20,21] reported on the clinical use of EMD in suprabony defects; in these studies, traditional flap designs with intracrevicular incisions and/or reverse bevel incisions were used, with no specific care in preserving the interproximal soft tissues.

In the past, emphasis has been given to flap design and suturing techniques; in fact, soft-tissue preservation and good primary closure of the surgical site may lead to better clinical results.[22,23] The aim of this study is to assess the clinical effectiveness of EMD application in suprabony defects by a surgical access procedure preserving the integrity of interproximal soft tissues with a simplified papilla preservation flap (SPPF)[22] compared to the treatment of suprabony defects undergoing SPPF alone.

MATERIALS AND METHODS

Experimental Design

This was a prospective, randomized and controlled clinical trial designed to evaluate the clinical and radiographic outcomes 12 months after two treatment modalities of suprabony periodontal defects.

The patients study exhibited supra-alveolar-type defects; all experimental sites were accessed with an SPPF procedure.[22] EMD§ was applied to the debrided root surface in the test group; the control group did not receive the regenerative material (Fig. 1).

Study Population

Fifty-four patients (25 males and 29 females) aged 39 to 65 years old (mean: 52 ± 22 years) seeking treatment at the Unit of Periodontology of the G. D'Annunzio University of Chieti, Pescara, Italy, and affected by moderate-to-severe chronic periodontitis, were selected for the study.

The inclusion criteria were: 1) no systemic diseases; 2) no medications affecting periodontal status during the previous 6 months; 3) not pregnant or lactating; 4) non-smoker; and 5) the following dental and periodontal factors: a full-mouth plaque score (FMPS)[24] and a full-mouth bleeding score (FMBS)[25] <20% at the time of surgery, no periodontal therapy in the 2 previous years, no inadequate endodontic treatment, no dental mobility, ≥20 teeth, exhibit horizontal bone loss detected by radiographic examination (alveolar crest level [ACL] – cemento-enamel junction [CEJ] distance ≥4 mm), and a probing depth (PD) ≥5 mm in ≥1 site per tooth at four adjacent single-rooted teeth [Figs. 2A and 2B]. If >4 adjacent teeth exhibited the above clinical and radiographic conditions, the four adjacent teeth showing the greatest overall loss of periodontal attachment were included.

The participants volunteered for the study after they received verbal and written information and signed a consent form approved by the Ethical Committee of the G. D'Annunzio University of Chieti medical faculty. The study protocol was in accordance with the Declaration of Helsinki of 1975, revised in Tokyo in 2004. This study was performed from June 2008 to October 2010.

Four months before the surgical treatment, all 54 patients underwent non-surgical periodontal treatment consisting of supragingival and subgingival scaling and root planing (SRP) by ultrasonic instruments‖ and hand curets¶ and motivational instructions on oral home care.

Sample Size and Randomization

The primary outcome of the study was CAL gain at 12 months. Changes in PD, gingival recession (GR), and bone level (BL) were secondary outcomes.

According to a previous study,[21] a sample size of 22 patients per group was calculated to detect at the 1-year follow-up a minimum difference of 1 mm in CAL between the groups with an expected standard deviation of 0.92 mm, an α set at 0.05, and a power of 0.95. However, taking into account the possibility of the eventual need for adjustment because of confounders in a multivariable analysis, a number of 27 patients per group was set. The confirmation of the adequacy of the sample size for multivariate test was sought by post hoc calculation of the power of the test. The balancing of experimental groups by age and sex was tested by Student t test for unpaired samples and χ^2 analysis, respectively.

Each patient was given a number and was randomly assigned to one of the two treatment regimens. Assignment was performed by a custom-made computer-generated table. To conceal assignment, opaque envelopes assigned to the patients were opened during surgery.

Clinical Measurements

Complete oral and periodontal examinations were performed for each patient 3 months after the non-surgical treatment. These included FMPS, FMBS, PD, CAL, and GR for six sites per tooth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual/palatal, mid-lingual/palatal, and disto-lingual/palatal sites).

Clinical measurements at experimental sites were taken immediately before surgical treatment (baseline) and 1 year after treatment, by the same experienced examiner (MDT), who was masked to the treatment. A calibration exercise was performed to

§ Emdogain, Institute Straumann, Basel, Switzerland.
‖ Cavitron Select, DENTSPLY, Rome, Italy.
¶ Hu-Friedy, Milan, Italy.

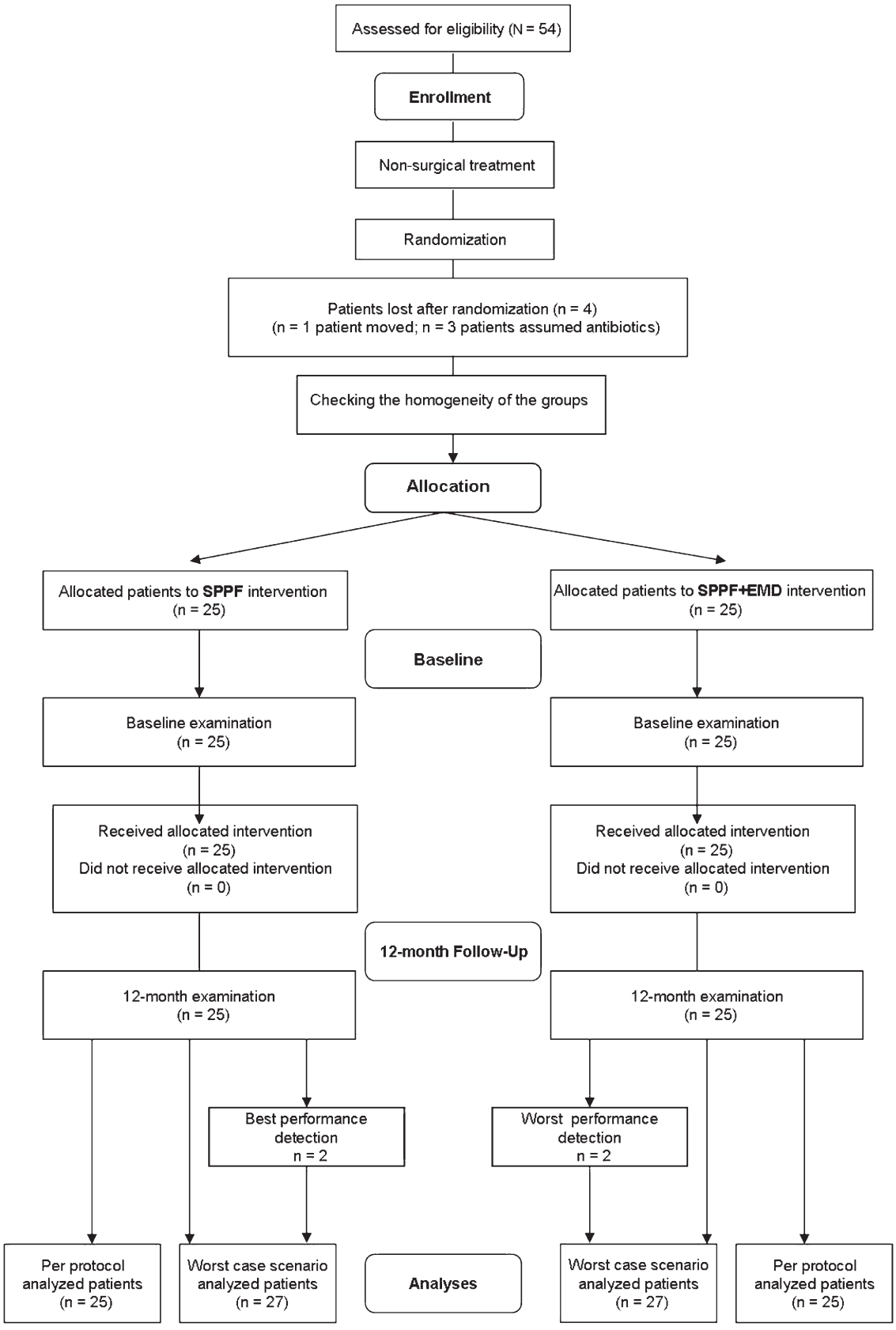

Figure 1.
CONSORT diagram showing the study layout.

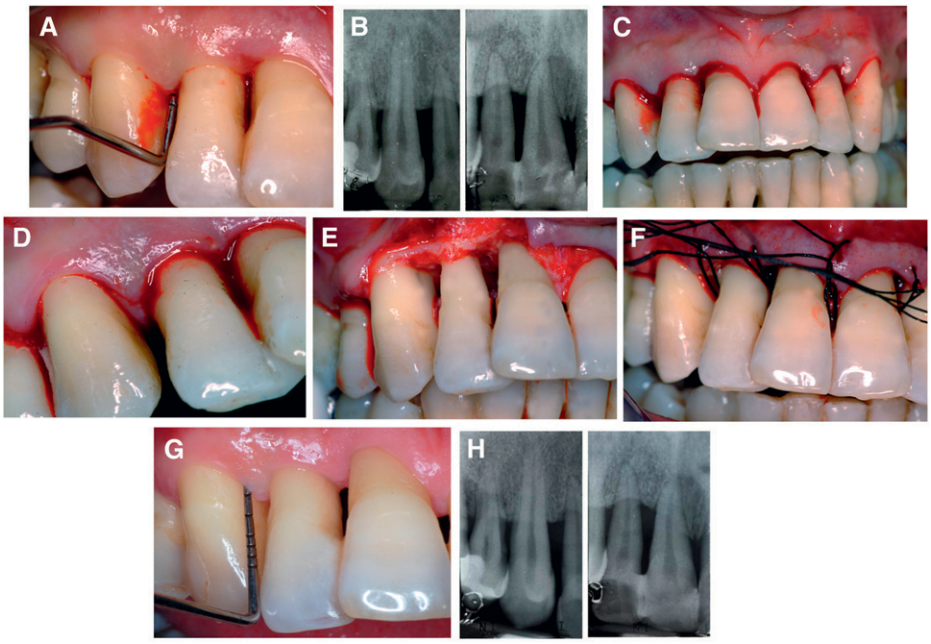

Figure 2.
Test group (EMD + SPPF) patient. ***A)*** *Probing of the surgical site before treatment.* ***B)*** *Radiographs taken at baseline.* ***C)*** *Intracrevicular incision at the vestibular site.* ***D)*** *Oblique incision across the papilla starting from the gingival margin at the buccal line angle of tooth #6 to the mid-interproximal portion of the papilla below the contact point of tooth #7.* ***E)*** *Intraoperative view of the horizontal defect.* ***F)*** *After preparing single modified internal mattress suture at the defect-associated interdental area, EMD was applied.* ***G)*** *Probing at the surgical site 12 months after treatment.* ***H)*** *Radiographs taken at the 12-month follow-up.*

obtain intraexaminer reproducibility. This was evaluated as the standard deviation of the difference of triplicate measurements. The investigator reached the target of a standard deviation <0.5 mm for the CAL.

Radiographic Measurements

Preoperative and 12-month postoperative intraoral standardized radiographs[#] were taken by the paralleling technique using an individual film-holder device consisting of a bite block[**] rigidly connected to an acrylic dental splint to achieve identical film placement at each evaluation. Pre- and postoperative radiographs were evaluated by two experienced clinicians (LR and CDA) who were masked with respect to the provenience of the radiographs and the clinical measurements.

When measuring radiographic BL, the two investigators had to reach agreement on the location of both ACL and CEJ.[26] The CEJ position was identified according to Schei et al.[27]

The positions of ACL and CEJ were marked by a pencil on the radiographs and the distance ACL – CEJ (BL) was measured by a millimeter grid. Linear distances between the most coronal interproximal BL and the CEJ were obtained by counting the grids.[28]

Surgical Technique

All the surgeries were performed by the same experienced clinician (MP). Test defects were accessed using SPPF and treated with EMD; the control procedure was identical, except no EMD was applied (Fig. 2).

After local anesthesia, mucoperiosteal flaps were raised according to the SPPF technique.[22] Briefly, the buccal incision was intracrevicular (Fig. 2C) with an oblique incision across the papilla starting from the gingival margin at the buccal line angle of a tooth to the mid-interproximal portion of the papilla below the contact point of the adjacent tooth (Fig. 2D).

The oblique interdental incision was continued intrasulcularly along the buccal aspect of the neighboring teeth; the flap was extended to the teeth mesial and distal to the four-tooth area to be treated. In this way, it was possible to expose 2 to 3 mm of alveolar bone (Fig. 2E).

The palatal incision was discontinuous, consisting of an intrasulcular incision limited to the mid-palatal aspect of each tooth.

A full-thickness buccal flap was gently elevated. A full-thickness palatal flap including the greatest amount of the interdental tissues was then elevated. The granulation tissue adherent to the alveolar bone was removed to provide full access and visibility to the root surfaces; SRP was performed by ultrasonic and hand instruments.

In both the test and control sites, the root surfaces from four adjacent teeth were conditioned for 2 minutes with 24% EDTA[††] and then thoroughly rinsed with saline solution.

Before EMD application, single modified internal mattress suture at the defect-associated interdental area to reach primary closure of the papilla in the absence of any tension[29] was prepared by 4-0 sutures[‡‡] and left loose to apply the EMD (Fig. 2F).

EMD was applied to the entire root surfaces of the test teeth as well as to the alveolar bone. The

Kodak Ultra Speed, Carestream Health, Milan, Italy.
** RINN XCP Film Holding Instruments, DENTSPLY Rinn, Elgin, IL.
†† Prefgel, Institute Straumann.
‡‡ Ethicon, Johnson & Johnson, Pomezia, Italy.

flaps were then repositioned, the suture was completed, and the patients were given post-surgical instructions. The same procedure was performed for the control group except for EMD application.

Postoperative Care

The post-surgical care was directed at maintenance of wound stability and infection control. All patients were administered 2 g/day amoxicillin plus clavulanic acid for 6 days;[§§] pain was controlled by 400 mg oral ibuprofen twice a day, if needed.[‖‖] Patients were advised to rinse twice a day with 0.12% chlorhexidine digluconate[¶¶] solution for 3 weeks after surgery.

Sutures were removed 14 days after the surgery. Patients were recalled once a week for the first 6 weeks after the surgery where they underwent gentle supragingival professional tooth cleaning and reinforcement of oral hygiene. Then, the patients were enrolled into a 3-month maintenance program. At each follow-up visit (Fig. 2G), supragingival debridement was performed, teeth were polished, and oral hygiene instructions were reinforced. Treated teeth were not probed during this period.

Data Processing

Statistical software[##] was used to perform the data analyses. A patient-based statistical analyses were performed for each variable. Four teeth were treated for each patient in the study. The mean value of PD, CAL, GR, and BL were calculated for each individual, with the patient's means of measurements for each treatment the experimental units for the statistical analysis. Mean values, standard errors, and proportions of sites within various categories of scoring units were calculated for data description. The mean score of the primary outcome variable (CAL gain) was calculated in each patient; its frequency distribution was then evaluated in both experimental groups. Parametric methods were used after testing for the normality of the data, using a Shapiro–Wilk test and *Q*–*Q* normality plots. The homogeneity of variances was assessed by the Levene test. A Student *t* test for unpaired samples was performed to assess the significance of the differences for each of the FMPS and FMBS between the groups at each time point.

General linear models were fitted, and repeated-measures multivariate analysis of variance (ANOVA) was used to evaluate the existence of any significant difference with regard to PD, CAL, GR, and defect bone level (DBL) between techniques (SPPF and EMD versus SPPF alone), time (1 year versus baseline), and the interaction of treatments × time.

Through treatments × time interaction, the changes in each clinical parameter between the time points were calculated and tested for the significance of the differences between the groups. The changes in PD (PD reduction), CAL (CAL gain), GR (GR increase), and DBL (DBL changes) were evaluated by 95% confidence intervals (CIs).

Finally, the overall mean proportions of "closed pockets" (i.e., the percentage of pockets with a final PD ≤3 mm,) for both modalities were calculated; the results were evaluated based on their baseline depth: moderate pockets (PD = 4 to 6 mm) and deep pockets (PD ≥7 mm).

The proportions of deep remaining pockets (i.e., the percentage of pockets with a final PD ≥7 mm) were also calculated. Differences in mean proportions of closed pockets were analyzed using the Mann-Whitney *U* test. The data analysis was originally designed according to "intent-to-treat" principle.

In the case of patients lost during the course of the study, which would make a correct analysis according to intent-to-treat principle impossible, and to overcome the possible bias resulting from patient dropout, an additional analysis including the missing patients' data were performed, simulating the "worst case scenario" (WCSA). In this type of analysis, lacking data were imputed, including the most unfavorable results in relation to the primary outcome when analyzing the test group and, conversely, the most favorable data when evaluating the control group. $P < 0.05$ was used to reject the null hypothesis.

RESULTS

Study Population

At the 1-year follow-up, the mean age in the test and control groups was 51.2 ± 5.2 and 53.3 ± 5.7 years, respectively. There were 15 female patients in the test group and 14 in the control group. The experimental groups were balanced by age and sex ($P = 0.85$).

A total of 54 patients were initially enrolled, but only 50 completed the study and included in the "per protocol" analysis (PPA). Despite being assured that they would be included in the trial and that the treatment would performed, four patients withdrew from the study before the baseline examination: three patients (two from the test group and one from the control group) underwent antibiotic therapy as a result of serious illness that prevented them from participating, and one patient (from the control group) moved away; consequently,

§§ Augmentin, SmithKline Beecham, Milan, Italy.
‖‖ Nurofen Express 400 mg, Reckitt Benckiser Group, Slough, Berkshire, UK.
¶¶ Dentosan 0.12 Trattamento Mese, Johnson & Johnson,.
SPSS v.13; IBM, Chicago, IL.

since baseline evaluation, no data from these individuals were available for analysis according to the intent-to-treat. An alternative WCSA was also performed to overcome the possible bias resulting from patient dropout.

Clinical and Radiographic Outcomes

After 12 months, none of the experimental sites showed bleeding on probing. Accordingly, the FMPS and FMBS remained <20% throughout the entire study and no significant differences were seen for them between the groups at each time point or between the time points within each group (data not shown).

No postoperative complications were reported by the patients. After testing for the normality of the data, FMPS and FMBS showed a homogeneous distribution. Conversely, PD, CAL, GR, and BL did not show a normal distribution, but these parameters demonstrated a negligible asymmetry in the distribution. Also taking into account that the Levene test for homogeneity of variances was not significant, relying on the robustness of the test, a multivariate ANOVA was used.

Clinical and radiographic parameters did not significantly differ at baseline (Table1). Table 1 shows that, statistically significant differences between the two l groups were seen at 1 year for the clinical parameters, with the control group having poorer scores. However, BL scores did not significantly differ between the groups.

The within-group analysis showed significant differences over time in each clinical parameter, for both; conversely, BL scores did not show significant differences between baseline and the 12-month examination in the groups.

Similar results were obtained when analyzing data from 50 patients completing the study (PPA) and data originating from 54 patients according to the WCSA.

Table 2 shows that changes in clinical parameter scores during the experimental period were significantly different between groups. The test group showed significantly greater improvements in all clinical parameters, with the only exception being the BL changes, showing no significant differences between groups.

Similar results were obtained from PPA and WCSA. The power of the multivariate test was 1.0. The frequency distribution on the CAL gain outcome is shown in Figure 3, showing that the greater CAL gain scores were obtained in the test group. The proportions (percentage) of pockets with a final PD ≤3 mm (closed pockets) are shown in Figure 4. The proportion of closed pockets was significantly greater in the test group. No pockets with a final PD ≥7 mm were observed in either group.

DISCUSSION

Results from the present study show that both surgical treatments (SPPF + EMD and SPPF alone) significantly improved the clinical parameters compared to the presurgical conditions; however, the addition of EMD resulted in a significantly greater gain in PD and CAL and a significantly lower GR.

The added benefit provided by EMD is also suggested by the CAL gain frequency distribution (greater CAL gain scores) and the overall proportion of pockets undergoing complete closure (significantly greater).

Similarly, clinical studies report that the surgical treatment of periodontal intrabony defects with EMD results in a significant added benefit when compared to OFD alone;[6,10,11,30] however, it should be noted that the present results were obtained in the treatment of periodontal suprabony defects.

In this regard, it should be noted that horizontal alveolar bone loss is a problem that periodontists often face; in fact, in a radiographic study, Jayakumar et al.[31] reported that horizontal bone loss represents 92% of the total bone loss from periodontal patients. Conversely, the prevalence of intrabony defects has been shown to be significantly lower, ranging from 8% to 30.2%.[32-34]

It is generally accepted that after suprabony defects are treated, the gain in clinical healing is the result of epithelial and connective adhesion to the root surface;[14,35-39] therefore, horizontal bone loss is characterized by a very low predictability of the result when treated by regenerative techniques.

Indeed, in supracrestal periodontal defects new attachment formation is entirely dependent on the coronal growth of the periodontal ligament stem cells from the apical portion of the wound; conversely, in angular bony defects, the lateral borders of the defects may also provide a source for granulation tissue formation.[13] In this regard, experimental animal studies investigating regenerative treatment of periodontal suprabony defects combining membranes and filling materials led to conflicting results.[12,13]

To date, in humans, only case reports[14-18] using different regenerative devices have been published on the treatment of supra-alveolar-type defects. A histologic study showed that the amount of regenerated periodontal attachment was limited and considerable variations in the extent of new attachment were seen.[14] Therefore, in clinical practice, OFD represents the non-resective surgical treatment of choice for horizontal bone defects. Yilmaz et al.[20] performed a study to assess the clinical and

Table 1.

Clinical and Radiographic Parameter Scoring (mm ± SE) (n = 25 in each PPA group; n = 27 in each WCSA group)

Parameter	Baseline	Baseline 95% CI	12 Months	12 Months 95% CI	Baseline to 12 Months*
PD					
Test					
PPA	5.96 ± 0.84	5.58 to 6.33	2.48 ± 0.65	2.17 to 2.78	$P = 0.000$
WCSA	5.88 ± 0.17	5.53 to 6.24	2.51 ± 0.14	2.22 to 2.81	$P = 0.000$
Control					
PPA	6.40 ± 1.00	6.02 to 6.77	4.12 ± 0.83	3.81 to 4.42	$P = 0.000$
WCSA	6.37 ± 0.17	6.01 to 6.72	4.03 ± 0.14	3.74 to 4.32	$P = 0.000$
Difference between groups					
PPA	NS		$P = 0.000$		
WCSA	NS		$P = 0.000$		
CAL					
Test					
PPA	6.76 ± 1.01	6.33 to 7.18	3.96 ± 0.67	3.64 to 4.27	$P = 0.000$
WCSA	6.63 ± 0.20	6.21 to 7.04	3.96 ± 0.15	3.66 to 4.26	$P = 0.000$
Control					
PPA	7.16 ± 1.10	6.73 to 7.58	6.12 ± 0.88	5.80 to 6.43	$P = 0.000$
WCSA	7.148 ± 0.206	6.73 to 7.56	6.03 ± 0.15	5.73 to 6.34	$P = 0.000$
Difference between groups					
PPA	NS		$P = 0.000$		
WCSA	NS		$P = 0.000$		
GR					
Test					
PPA	0.83 ± 0.70	0.53 to 1.06	1.48 ± 0.82	1.18 to 1.77	$P = 0.000$
WCSA	0.74 ± 0.12	0.49 to 0.99	1.44 ± 0.13	1.16 to 1.72	$P = 0.000$
Control					
PPA	0.79 ± 0.58	0.49 to 1.02	2.00 ± 0.64	1.70 to 2.29	$P = 0.000$
WCSA	0.77 ± 0.12	0.52 to 1.02	2.00 ± 0.13	1.72 to 2.27	$P = 0.000$
Difference between groups					
PPA	NS		$P = 0.016$		
WCSA	NS		$P = 0.006$		
BL					
Test					
PPA	8.28 ± 1.10	7.84 to 8.71	8.02 ± 1.04	7.55 to 8.45	NS
WCSA	8.18 ± 0.20	7.77 to 8.60	7.85 ± 0.22	7.41 to 8.29	NS
Control					
PPA	8.36 ± 1.07	7.92 to 8.79	8.40 ± 1.19	7.95 to 8.85	NS
WCSA	8.333 ± 0.207	7.91 to 8.74	8.44 ± 0.22	8.00 to 8.88	NS
Difference between groups					
PPA	NS		NS		
WCSA	NS		NS		

NS = not significant.
* Statistical significance of difference.

radiographic outcomes over a period of 8 months after periodontal surgery with the adjunctive use of EMD compared to conventional flap debridement alone in horizontal bone defects. Clinical improvement with EMD application was found to be superior when it was compared to OFD procedures; [20] similar results were obtained by Jentsch and Purschwitz:[21] Results from the present study confirm those from Jentsch and Purschwitz[21] and Yilmaz et al.,[20] showing that the adjunct of EMD to an access flap surgical procedure significantly improves changes in clinical parameters.

In these studies,[20,21] conventional flap designs were used; in this clinical trial, a greater improvement of clinical parameters is observed when compared to the results of Jentsch and Purschwitz[21] and Yilmaz et al.[20]

Table 2.

Clinical and Radiographic Parameter Changes (mm ± SE) From Baseline to 12 Months (n = 25 in each group in PPA; n = 27 in each group in WCSA)

Parameter	Changes Baseline to 12 Months	95% CI
PD reduction		
Test		
PPA	3.48 ± 0.77	3.14 to 3.81
WCSA	3.37 ± 0.16	3.03 to 3.70
Control		
PPA	2.28 ± 0.89	1.94 to 2.61
WCSA	2.33 ± 0.16	2.00 to 2.66
Difference*		
PPA	*P* = 0.000	
WCSA	*P* = 0.000	
CAL gain		
Control		
PPA	1.04 ± 0.61	0.73 to 1.34
WCSA	1.11 ± 0.157	0.796 to 1.426
Test		
PPA	2.80 ± 0.86	2.49 to 3.10
WCSA	2.66 ± 0.157	2.35 to 2.98
Difference		
PPA	*P* = 0.000	
WCSA	*P* = 0.000	
GR increase		
Control		
PPA	1.24 ± 0.72	0.99 to 1.48
WCSA	1.22 ± 0.11	0.99 to 1.45
Test		
PPA	0.68 ± 0.47	0.43 to 0.92
WCSA	0.70 ± 0.114	0.47 to 0.93
Difference		
PPA	*P* = 0.016	
WCSA	*P* = 0.006	
BL change		
Control		
PPA	–0.04 ± 0.79	–0.31 to 0.23
WCSA	0.111 ± 0.133	–0.15 to 0.377
Test		
PPA	0.28 ± 0.54	0.00 to 0.55
WCSA	0.33 ± 0.133	0.06 to 0.59
Difference		
PPA	NS	
WCSA	NS	

NS = not significant.
* Statistical significance of the difference.

In fact, in the test patients, a 2.80 mm mean CAL gain and a 3.48 mm mean PD reduction was obtained; the Jentsch and Purschwitz study[21] reported 0.97 mean mm CAL gain and 1.55 mm mean PD reduction. In the Yilmaz et al.[20] study, a mean CAL gain of 2.16 to 2.27 mm and a mean PD reduction of 2.87 to 2.94 mm were observed in pockets ≥4 mm, depending on the flap design used.

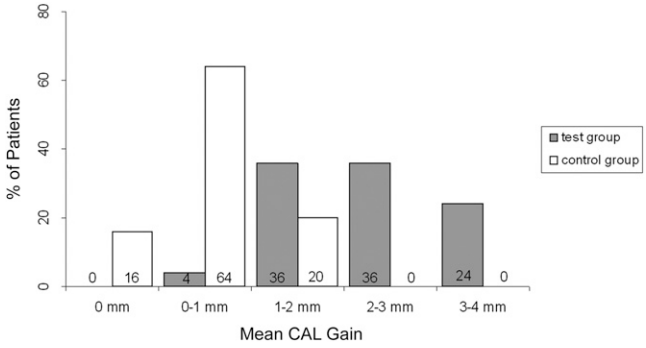

Figure 3.
Frequency distribution of CAL gain in both groups at the 12-month follow-up.

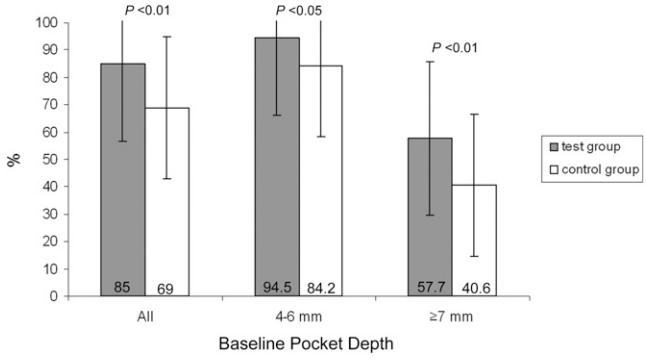

Figure 4.
Proportion (percentage) of closed pockets (PD ≤3 mm) at the 12-month reexamination based on initial PD.

The authors can hypothesize that the greater CAL gain and PD reduction from the present data may be related to the very conservative surgical technique used when approaching the suprabony defects. The newly designed access flaps result in a higher percentage of interproximal areas healing in a stable and closed environment and led to significantly greater CAL gain and less GR compared to the modified Widman flap procedure.[22,23] Some studies[22,23,40] demonstrated that CAL gain and GR are significantly influenced by the amount of interdental supracrestal tissues available to cover the surgical site.

Furthermore, the SPPF technique minimizes the damage of the microvasculature and allows a better preservation of the supra-periosteal gingival vascular plexus, producing a faster organization of the granulation tissue.[41]

The added benefit produced by an SPPF technique in treating suprabony defects may also be supported by the comparison of our results to those

from Jentsch and Purschwitz[21] and Yilmaz et al.[20] in the control groups treated without the adjunct of EMD.

The CAL gain and PD reduction from controls (1.04 and 2.28, respectively) were greater than those from the patients in the study of Jentsch and Purschwitz[21] (mean overall changes, 0.07 and 0.41, respectively) and the control sites treated with intrasulcular incisions in the study of Yilmaz et al.[20] (0.54 and 1.53, respectively).

This observation on treating suprabony defects confirms similar results from intrabony defect studies; Cortellini et al.[42] obtained a mean 2.6 mm CAL gain with an SPPF access flap alone; conversely, in a meta-analysis of 28 studies in which conventional access flaps were performed for the treatment of intrabony defects, Lang[43] reported a mean 1.78 mm CAL gain. Graziani et al.[44] reported that, when the results of access flap surgery are compared to those obtained after papilla preservation flaps, greater amounts of CAL gain and lower amounts of GR are observed in the more conservative techniques.

Moreover, the influence of the flap design in the treatment of horizontal defects with or without EMD addition may be confirmed by the results of Yilmaz et al.,[20] reporting differences between sites treated by intrasulcular or reverse bevel incisions.

The present study results may suggest that EMD can improve the results from a flap design preserving the integrity of the interdental tissues also in suprabony defects; this may be attributable to its regenerative properties and its anti-inflammatory,[45] antibacterial,[46] and angiogenetic[47] effects.

In accordance with Jentsch and Purschwitz[21] and Yilmaz et al.,[20] the present data confirm that EMD-treated patients show less GR compared to controls; this may produce a positive esthetic outcome when treating upper anterior teeth. According to Jentsch and Purschwitz,[21] most PD reduction is produced as a consequence of a greater gain in periodontal attachment.

It is possible to hypothesize that the greater CAL gain observed in this study may be the consequence of supracrestal connective periodontal attachment formation, according to the animal study from Nemcovsky et al.[19] on supra-infrabony periodontal defects. This study[19] showed that EMD allows the organization of a well-oriented collagen fiber attachment on the root surface at the supracrestal level. Human histologic evidence will be needed to verify this hypothesis.

The lack of significant supracrestal bone growth observed in this study confirms the data from Jentsch and Purschwitz[21] and Yilmaz et al.[20] This observation is expected when taking into account that, in supra-alveolar-type defects, there is no available space under the gingival flap to allow new bone formation. However, according to Heijl et al.[5] and Yilmaz et al.,[20] the authors can speculate that EMD may prevent the marginal bone loss that may be expected after periodontal surgical procedures. It is interesting to note that, although treated by a conservative surgical technique, some marginal bone loss was also reported in the control group from the present study.

The clinical significance of the differences in improvements between the l groups reported in this study is evidenced by the 95% CIs of the comparison of the mean differences between test and control groups in the treatment × time interaction. In the present study, the 95% CIs of mean difference in the CAL changes after 12 months between test and control groups ranges from 1.15 to 2.36 mm for PPA and from 0.92 to 2.18 mm for WCSA. The magnitude of these differences is greater than those reported between non-surgical and surgical treatment.[48] The similarity of results between PPA and WCSA further strengthens the conclusions of the study.

A limitation of this study may be that the authors did not use a placebo gel; therefore, the surgeon was masked only to the opening up of the opaque envelopes assigning the patient to the test or control group. Furthermore, this is not a split-mouth designed study; this may have led to underestimating some factors influencing the outcome of the regenerative therapy.

CONCLUSION

The use of EMD in addition to SPPF may represent a good clinical choice for treating teeth with horizontal bone loss, particularly when treating esthetically sensitive sites, through a consistent reduction of the marginal tissue recession compared to SPPF alone.

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