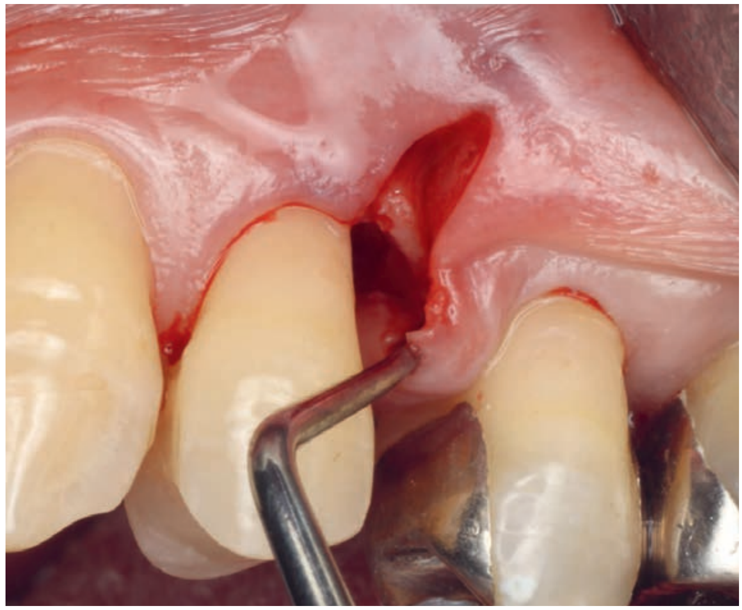

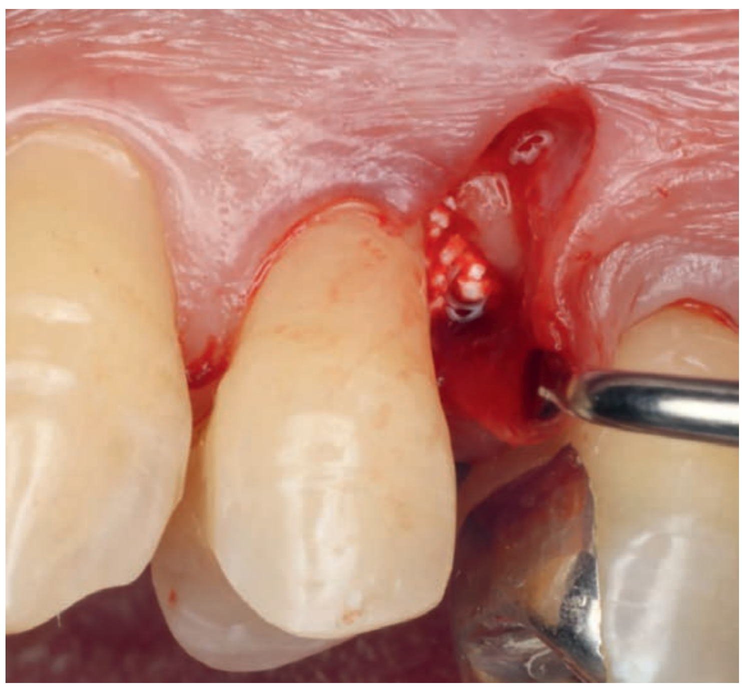

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Clinical Outcomes of Periodontal Regenerative Therapy Utilizing the Double-Sided Entire Papilla Preservation (DEPP) Technique for Infrabony Defects: A 12-Month Follow-up Case Series

The Double-sided Entire Papilla Preservation (DEPP) technique was designed to allow access into a bone defect without compromising the integrity of the papilla when the defect extends to the palatal/lingual side. This case series aimed to evaluate the clinical and radiographic outcomes of periodontal regenerative therapy using the DEPP technique for infrabony defects. DEPP was performed with vertical incisions on both the buccal and palatal sides to access the bone defect. After debridement, recombinant human fibroblast growth factor-2 or enamel matrix derivative was used in combination with carbonate apatite or deproteinized bovine bone mineral to treat the defect. Periodontal parameters were evaluated at baseline and at 6 and 12 months postoperatively. Clinical attachment level (CAL) and probing depth (PD) values were significantly improved compared to baseline at 6 months ($P < .05$) and 12 months ($P < .01$). At 12 months, the mean PD reduction was 5.0 ± 1.4 mm and CAL gain was 5.3 ± 1.8 mm. According to the composite outcome measure, the outcomes of the treated sites were considered successful. This case series demonstrates that DEPP can be effectively combined with regenerative therapy for the treatment of infrabony defects that extend to the palatal/lingual side, yielding favorable clinical outcomes with minimal surgical complications.
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Keywords: *double-sided entire papilla preservation technique, fibroblast growth factor-2, infrabony defects, periodontal regeneration*

Periodontal regenerative therapy is an evidence-based approach that can significantly improve the prognosis of teeth affected by periodontitis.[1] The three principles of successful regenerative therapy are cells, growth factors, and scaffolds.[2,3] In addition to fulfilling these factors, space-making represents a vital determinant for achieving clinical success. Additionally, optimal wound healing and blood clot stability are considered crucial. Minimally invasive surgical technique (MIST) and modified-MIST (M-MIST) have been proposed as flap designs to ensure flap closure, greatly reducing the risk of flap dehiscence.[4,5] These surgical techniques are options for 3-wall and multiple adjacent intrabony defects.

In recent years, the Entire Papilla Preservation (EPP) technique has been developed.[6] This technique allows an approach to bone defect treatment without incising the interdental papillae, thus reducing the risk of interdental papilla dehiscence during healing.[7] EPP has shown promising results in the treatment of 1- or 2-wall infrabony defects with buccal bone loss.[8–11] Clinically, bone defects extending to the palatal/lingual side are often encountered. Currently, the recommended procedure for these defects is to extend a flap through an incision of the papilla and approach the defect, which carries the risk of interdental papilla dehiscence and decreased wound stability.[7] Recently, the double-sided EPP (DEPP) technique has been proposed for the treatment of cases with palatal/lingual involvement.[12] The DEPP uses a buccopalatal/-lingual (double-sided) vertical incision on the intact bone to approach the bone defect while achieving entire papilla preservation.[12]

This case series presents the clinical outcomes of seven cases in which DEPP was applied during regenerative therapy. Of these, two representative cases are described in detail.

Materials and Methods

This report was written according to the Preferred Reporting of Case Series in Surgery (PROCESS) guidelines.

Population

Seven systemically healthy patients with periodontitis were included in this case series. All patients were well informed about the treatment and gave their written informed consent to be included in this report.

Patients were included in the study if they met the following criteria: *(1)* having Stage III or IV, Grade A to C periodontitis[13]; *(2)* having a probing depth (PD) > 5 mm and infrabony defect depth > 3 mm; *(3)* presence of a 1- and/or 2-walled defect that extends buccolingually; and *(4)* adequate level of plaque control (O'Leary Plaque Control record < 20%). Subjects were excluded from the study if they had a smoking habit, allergies to various regenerative materials or medicines, and/or systemic diseases.

Clinical Examination

At baseline (after initial periodontal therapy; see next section) and at 6 and 12 months postoperatively, the following clinical measurements were evaluated: PD, bleeding on probing (BOP), gingival recession (GR), and clinical attachment level (CAL) at six points per tooth using a Williams probe. The changes on the radiogrpahic images from baseline to 6 and 12 months postoperatively were calculated using radiographic bone fill (RBF) by one operator (K.I.) following the previously described method .[14] Briefly, the difference in tooth axis length between the defect bottom and the cementoenamel junction was defined as linear bone growth (LBG), which was the postoperative measurement. The percentage of RBF was determined by dividing the LBG by the baseline defect depth. The outcomes of periodontal regenerative therapy were also assessed using the composite outcome measure (COM),[15] which is based on the combined assessment of PD closure and CAL gain. According to COM, a CAL gain ≥ 3 mm and a residual PD ≤ 4 mm at 12 months postoperatively are considered successful treatments.

Initial Periodontal Therapy (Steps 1 and 2)

Initial periodontal therapy (Steps 1 and 2), including oral hygiene instructions, scaling, and root planing, was performed before the periodontal surgery. If the residual BOP was detected at the planned surgical site, gentle scaling and root planing were performed 2 weeks before the surgery. In case of a preoperative mobility of degree 2 or higher, the teeth were splinted preoperatively.

Surgical Procedure (Step 3)

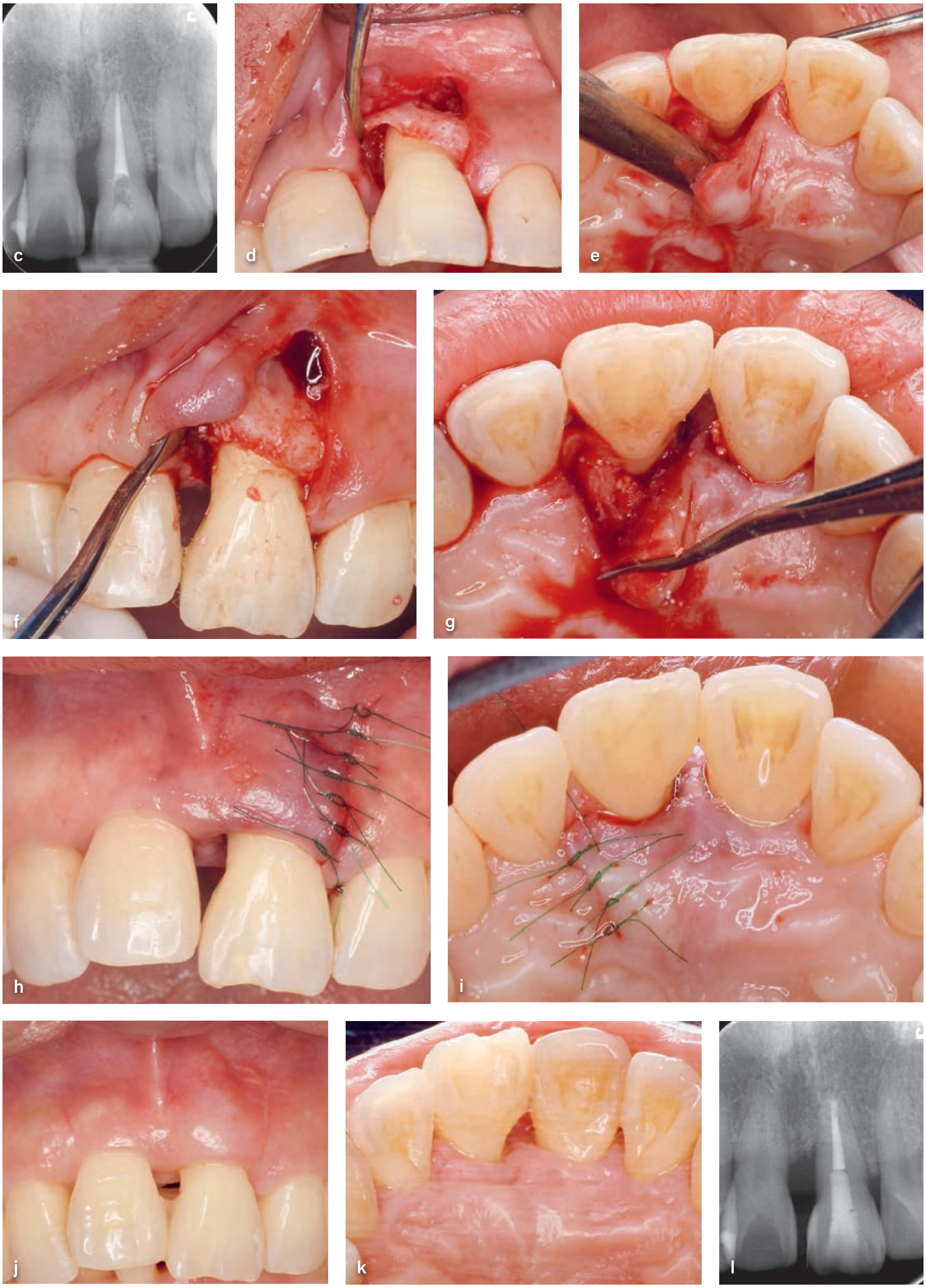
Five periodontists (Y.O., H.G., K.I., D.K., and T.N.), whose clinical experience ranged from 4 to 14 years, performed the surgeries 2 to 3 months after Step 2. Patient ages ranged from 40 to 71 years, with a mean age of 55.1. The treated sites

▲ **Figs 1a to 1e** Case 1. Representative case of a 62-year-old woman with Stage III, Grade B periodontitis. *(a and b)* Buccal and palatal preoperative clinical views, respectively. At the distal aspect of the maxillary left first premolar, PD was 6.0 mm and CAL was 6.0 mm. *(c)* Preoperative radiograph. *(d and e)* A vertical incision was made on the distobuccal and mesiopalatal line angles, respectively, of the left first premolar.

were maxillary premolars in four cases, maxillary incisors in two cases, and mandibular lateral incisors in one case. Following local anesthesia (2% xylocaine with 1: 80,000 adrenaline), bone sounding was performed on the site accessed by DEPP. Specifically, a vertical incision was made, avoiding the interdental papilla. Slightly curved vertical incisions were made at the mesial or distal line angles of the teeth, perpendicular to the gingival margin, and extending to the mucogingival junction on the buccal side. A full-thickness flap was elevated to expose the buccal bone crest completely. During this procedure, a releasing incision was made on the periosteum to allow flap extension. The interdental papilla was then carefully elevated with micro-elevators. The granulomatous tissue was removed gently from the buccal side of the defect. Subsequently, a vertical incision was made on the palatal/lingual side, avoiding the defect and interdental papilla. After elevating the flap, the granulomatous tissue was removed from the palatal side. Root planing was performed for both the buccal and palatal/lingual sides. Once it was confirmed that the inflammatory tissues had been completely removed from the root surface and the bone surface of the defect, a biologic agent was applied to the root surface and the defect: either recombinant human fibroblast growth factor-2 (rhFGF-2: REGROTH Dental Kit, 600 µg, Kaken Pharmaceutical) or enamel matrix derivative (EMD; Emdogain Gel, 0.3 mL, Straumann). For the bone graft material, either carbonate apatite (CO_3Ap: Cytrans Granules, particle size 0.6 to 1.0 mm, GC) or deproteinized bovine bone mineral (DBBM; Bio-Oss, particle size 0.25 to 1.0 mm, Geistlich) was premixed with the biologic agent and used to fill the infrabony components. Finally, the flap was immediately closed using 5-0 and 6-0 nylon sutures (Softretch, GC, or Monocryl, Ethicon). Representative cases are shown in Figs 1 and 2.

▲ **Figs 1f to 1m** *(f and g)* Flaps were minimally elevated, and defects were debrided. *(h)* rhFGF-2 and CO_3Ap were applied to the bony defect. *(i and j)* Clinical views after suturing. *(k and l)* Clinical views at 12 months. The PD was 2.0 mm and CAL was 2.0 mm (CAL gain from baseline was 4.0 mm). *(m)* Radiographic view at 12 months.

▲ **Figs 2a and 2b** Case 2. Representative case of a 40-year-old woman with Stage IV, Grade C periodontitis. *(a and b)* Buccal and palatal preoperative clinical views. At the mesial aspect of the maxillary left central incisor, PD was 7.0 mm and CAL was 9.0 mm.



▲ **Figs 2c to 2l** *(c)* Preoperative radiograph. *(d and e)* Views of the site after flap reflection and defect debridement. *(f and g)* EMD and DBBM were applied to the bony defect. *(h and i)* Clinical views after suturing. *(j and k)* Clinical views at 12 months. The PD was 3.0 mm and CAL was 5.0 mm (CAL gain from baseline was 4.0 mm). *(l)* Radiographic view at 12 months.

Table 1 Patient Demographics and Baseline Parameters

Variable	
Age	
Mean ± SD	55.1 ± 12.6 y
Range	40–71 y
Gender, n	
Male	4
Female	3
PD	7.6 ± 1.6 mm
GR	1.3 ± 1.4 mm
CAL	8.9 ± 2.8 mm
Infrabony component	
Depth	6.4 ± 2.7 mm
Width	3.2 ± 0.6 mm
Defect type, n	
2 wall	2
1–2 wall	4
1 wall	1

CAL = clinical attachment level; GR = gingival recession; PD = probing depth.
Data are comprised from seven sites in seven patients.
PD, GR, CAL, and infrabony component data are presented as mean ± SD.

Postsurgical Procedure

To prevent postoperative infection, amoxicillin (750 mg/day) was given to the patient for 3 days postsurgery. Loxoprofen sodium hydrate (120 mg) was administered as needed to mitigate pain. During the 2 weeks postsurgery, oral hygiene was maintained by rinsing with a mouthwash (0.15% chlorhexidine gluconate; ConCool F, Weltec; the product was diluted to 0.0006% chlorhexidine at each use) three times daily. Professional hygiene care was provided as needed. All sutures were removed after 7 to 10 days. Patients were then instructed to start brushing using a soft toothbrush. After 1 month, they were instructed to begin normal brushing. Patients were recalled for professional prophylaxis weekly for the first month then monthly until 12 months postoperatively.

Statistical Analysis

A total of seven sites in seven patients were included in the data analyses. Therefore, the sites were regarded as the statistical unit. Data are expressed as mean ± standard deviation (SD). The changes in PD, GR, CAL, and RBF over time were evaluated by Friedman test with post hoc test. The level of significance was set at 5%.

Results

Patient demographics and defect characteristics are summarized in Table 1. rhFGF-2 with CO_3Ap granules, rhFGF-2 with DBBM, and EMD with DBBM were applied to the defect sites in three, two, and two cases, respectively (Table 2). In all cases, no soft tissue dehiscence occurred. Primary closure was observed in all cases at 1 week postsurgery.

All patients followed the instructions for postoperative care, attended scheduled appointments, and received professional care. See Table 1 for the baseline and 12-month clinical parameters of the seven treated sites. Compared to baseline, CAL and PD values were statistically significantly improved at 6 months ($P < .05$) and 12 months ($P < .01$). At 12 months postoperative, the mean PD reduction was 5.0 ± 1.4 mm, and the mean CAL gain was 5.3 ± 1.8 mm (Fig 3). The mean GR reduction was 0.3 ± 0.5 mm. All treated sites showed no BOP at any time point. At 12 months postopetaive, an increase in RBF was observed in all sites (see Table 2), and the RBF value ranged from 67% to 100% (mean: 85.9% ± 12.9%). All sites displayed a CAL gain > 3 mm and PD ≤ 4 mm at 12 months, indicating successful treatment according to COM (Fig 4).

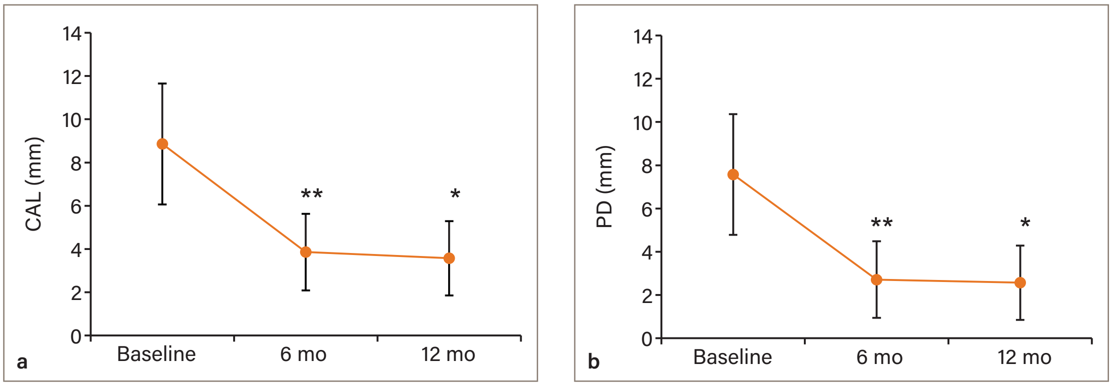
Discussion

In this case series, significant improvements in CAL and PD were observed at 12 months postsurgery: The mean CAL gain was 5.3 mm, and the mean PD reduction was 5.0 mm. These values were higher than those reported in the previous study of regenerative therapy using EMD with DBBM for a noncontained intrabony defect (CAL gain was 3.8 mm, PD reduction was 4.6 mm),[16] although direct comparisons between different studies can be difficult. The favorable outcomes observed in the present study may be partly

Table 2 Baseline and Postoperative Clinical Parameters

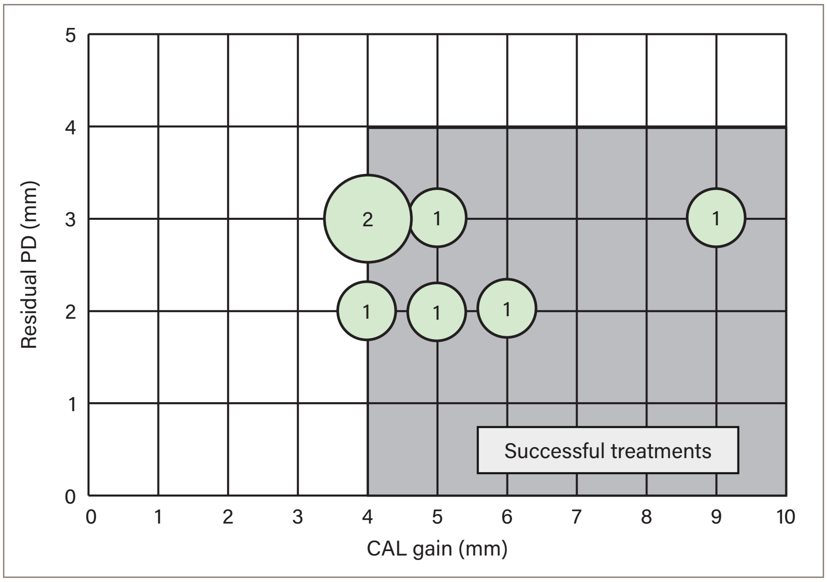
	Case no.							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Mean ± SD**
Site no.[a]	24	21	11	25	25	24	32	N/A
Defect morphology	1–2 wall	2 wall	1–2 wall	1–2 wall	1–2 wall	2 wall	1 wall	N/A
Graft material	CO_3Ap	DBBM	DBBM	CO_3Ap	CO_3Ap	DBBM	DBBM	N/A
Biologic material	rhFGF-2	EMD	EMD	rhFGF-2	rhFGF-2	rhFGF-2	rhFGF-2	N/A
PD, mm								
Baseline	6	7	7	7	7	11	8	7.6 ± 1.6
6 mo	2	3	2	3	4	3	3	2.9 ± 0.7*
12 mo	2	3	2	3	2	3	3	2.6 ± 0.5**
GR, mm								
Baseline	0	2	0	0	1	3	3	1.3 ± 1.4
6 mo	0	2	0	0	0	2	3	1.0 ± 1.3
12 mo	0	2	0	0	0	2	3	1.0 ± 1.3
CAL, mm								
Baseline	6	9	7	7	8	14	11	8.9 ± 2.8
6 mo	2	5	2	3	4	5	6	3.9 ± 1.8*
12 mo	2	5	2	3	2	5	6	3.6 ± 1.7**
RBF, %								
6 mo	100	60	65	100	100	80	85	84.2 ± 16.9
12 mo	100	67	77	100	94	87	76	85.9 ± 12.9
Surgeon	Y.O.	H.G.	K.I.	Y.O.	Y.O.	D.K.	T.N.	N/A

N/A = not applicable.
*$P < .05$ and **$P < .01$ compared to baseline (Friedman test with post hoc test).
[a]FDI numbering system.



▲ **Fig 3** *(a and b)* Changes in CAL and PD, respectively. Data are presented as mean ± SD (n = 7). *$P < .05$ and **$P < .01$ compared to baseline (Friedman test with post hoc test).

influenced by the DEPP technique's ability to approach 1- or 2-walled buccopalatal defects without the need for a papillary incision. However, further studies are required to confirm the precise role of this approach in achieving these outcomes. Anatomically, the interdental papillae have a poor blood supply due to their narrowness, leading to compromised postoperative flap stability.[17] Like the EPP, the DEPP avoids incisions of the interdental papillae, minimizing the

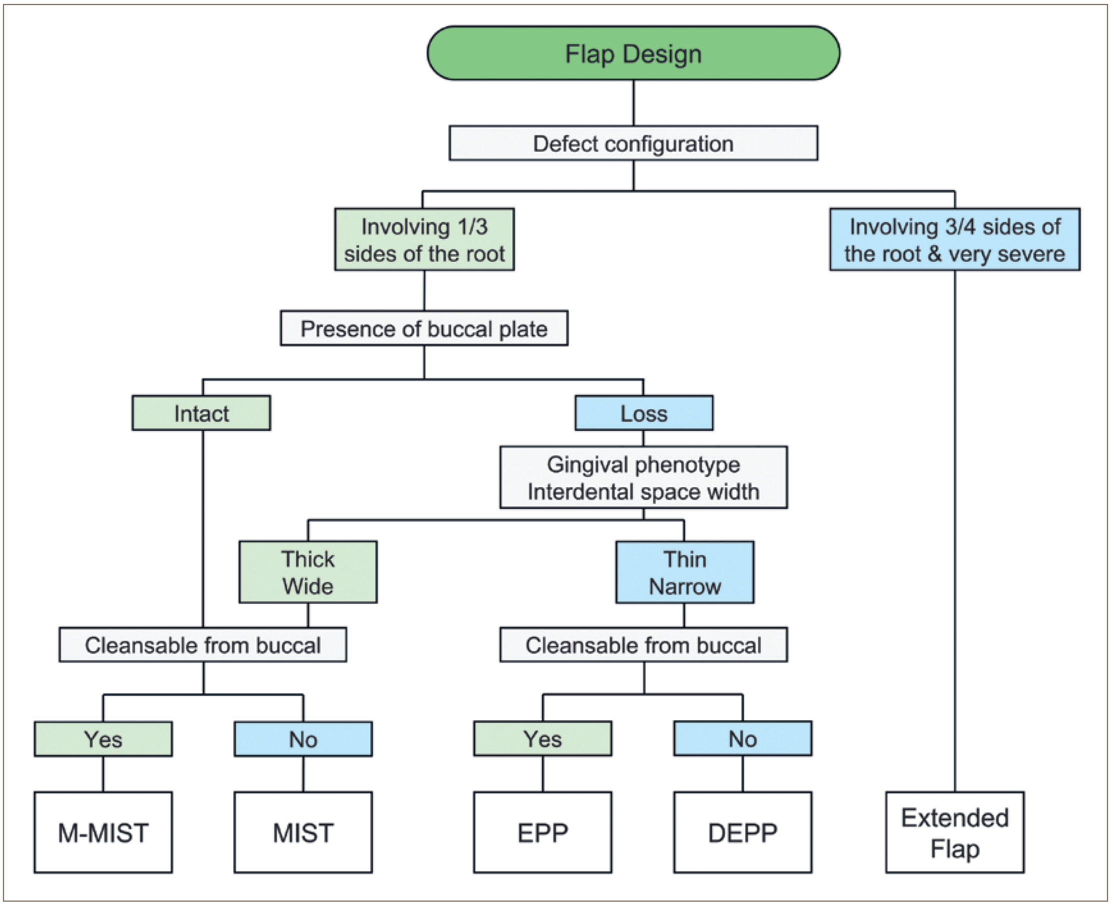


◀ **Fig 4** Treatment outcomes according to COM. COM evaluation of outcomes on the basis of 12-month CAL gain (reported on the X-axis) with the residual PD (reported on the Y-axis). The numbers in the circle and the size of the circle represent the number of sites. The sites in the gray area represent successful treatments, where a CAL gain ≥ 3 mm is associated with a residual PD ≤ 4 mm.

risk of postoperative dehiscence and promoting complete wound closure and blood stability,[8–11] making regenerative therapy more likely to be successful. Additionally, because no incision is made on the papilla, the roof of the papilla can be coronally elevated, increasing the space for regeneration and potentially contributing to supra-attachment gain.[12,18,19] Furthermore, the vertical incision on the buccopalatal/-lingual side allows for lateral retraction of the flap, facilitating visualization of the bone defect and providing a stress-free view of the defect and root surface.[12] To enhance the mobility of the buccal flap, a releasing incision in the periosteum is essential. These techniques allow for tension-free flap manipulation, reducing apical forces on the flap and promoting healing.[20]

Because DEPP is best indicated for regenerative therapy for noncontained bone defects extending to the buccopalatal/-lingual aspect, combination therapy with bone graft materials and growth factors is recommended to minimize the flap collapse.[21] In the present case series, DBBM and CO_3Ap were used as bone materials, and rhFGF-2 and EMD were used as biologic agents. The results may have been favorable regardless of the selected material. However, this case series focuses on incision design rather than the effectiveness of the materials themselves. Success in regenerative therapy depends on clear visualization of the bone defect and root, thorough removal of inflammatory tissue, creation of a noninfectious regenerative space, selection of appropriate drugs or materials based on defect configuration, and proper postoperative wound healing and management.[22] In this context, the choice of graft material or growth factors may not significantly impact the outcomes of the DEPP technique.

The buccal and palatal/lingual incision designs are illustrated in the surgical procedure (see Figs 1 and 2). Particularly for palatal and lingual incisions, the vertical position of the incision should be determined by paying attention to the anatomical structures,[23,24] and, considering the blood supply[25,26] and access, the incision should avoid the bone defect mesiodistally and curve toward the defect. However, due to anatomic length limitations, if access is difficult with a single curved incision, it may be necessary to make an additional vertical incision distally across the defect to allow for flap advancement. DEPP is indicated for maxillary and mandibular incisors to premolars but may also be applicable for molars if the anatomy is carefully considered and the releasing flap technique is utilized. However, from an access standpoint, distal bone defects in molars are often difficult to access due to the difficulty of achieving a direct view as well as anatomic limitations. However, one advantage of this technique is that,



▲ **Fig 5** Modified decision tree for treatment of isolated infrabony defects.

if access is deemed difficult during surgery, the interdental papillae can be incised and switched to a conventional flap.

Cortellini and Tonetti proposed a decision tree for flap design in regenerative therapy, introducing innovative techniques that have advanced the field.[22] In the previous decision tree, the flap design for the intrabony defect was selected from three different surgical approaches: the MIST,[4] the M-MIST,[5] and the extended flap.[27] Based on the clinical outcomes of the present report, the authors propose modifying the decision tree to include both EPP and DEPP techniques that avoid interdental papilla incisions (Fig 5). These two techniques are selected when there is a loss of buccal bone plate. This is because the intact buccal plate makes access to the bone defect difficult. The soft tissue condition of the interdental space is also essential. Specifically, the advantage of these techniques increases when there are considerable negative factors for achieving primary healing of the incised interdental papillae, such as a thin phenotype and a narrow width of interdental space. Further, this procedure may provide favorable clinical outcomes in areas with high esthetic demands. However, severe crowding with extremely narrow interdental spaces may present a significant challenge and could potentially limit the use of DEPP. Furthermore, the surgical technique should be selected depending on whether it is cleansable from the buccal side. In addition to these conditions, the surgeon's skill and experience in debridement and flap management should also be considered in determining the incision design. Also, patient adherence to postoperative care and recall appointments are important factors in the favorable outcomes of any regenerative therapy.

Like all case reports, this case series has limited generalizability. The sample size is small, and it lacks standardization in regenerative materials and techniques. Despite these limitations, this report provides clinicians with a novel flap design option for periodontal regenerative therapy in treating 1- or 2-wall infrabony defects. Further large-scale, randomized control trials and long-term follow-up studies are necessary to validate these findings.

Conclusions

This case series reported the outcomes of the combination regenerative therapy, using DEPP for buccopalatal/-lingual bone defects. Within the limitations of the case series, the results suggest that DEPP can be effectively applied in the regenerative therapy for the treatment of infrabony defects, with minimal surgical complications.

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Author contributions: Y.O., S.A., S.M., T.I., P.C., and K.I.: conception and design of case series; Y.O., H.G., D.K., T.N., and K.I.: data acquisition; Y.O. and K.I.: data analysis and interpretation; Y.O., A.S., and K.I.: drafting of the manuscript. All authors reviewed the manuscript.

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