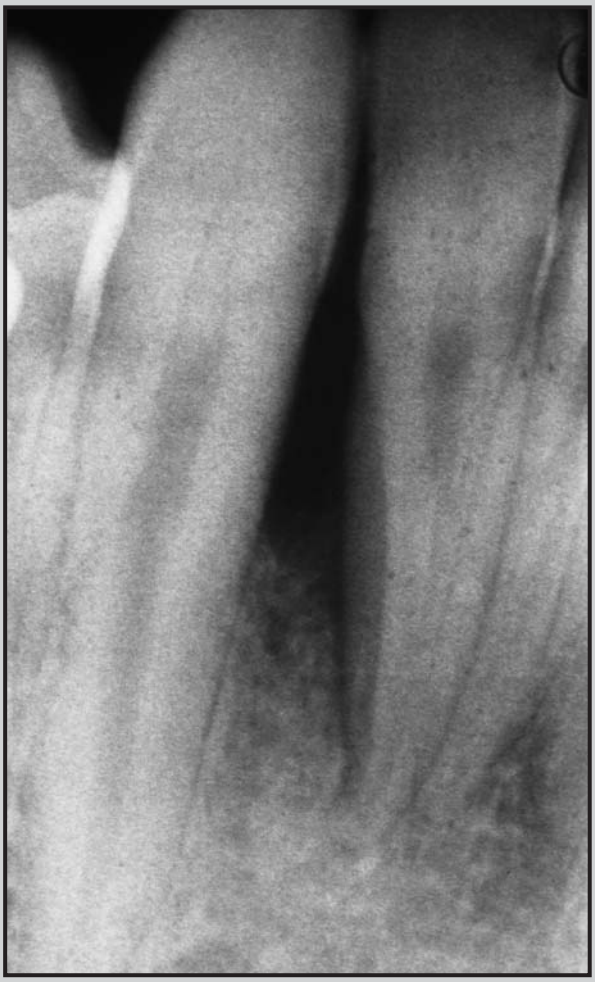
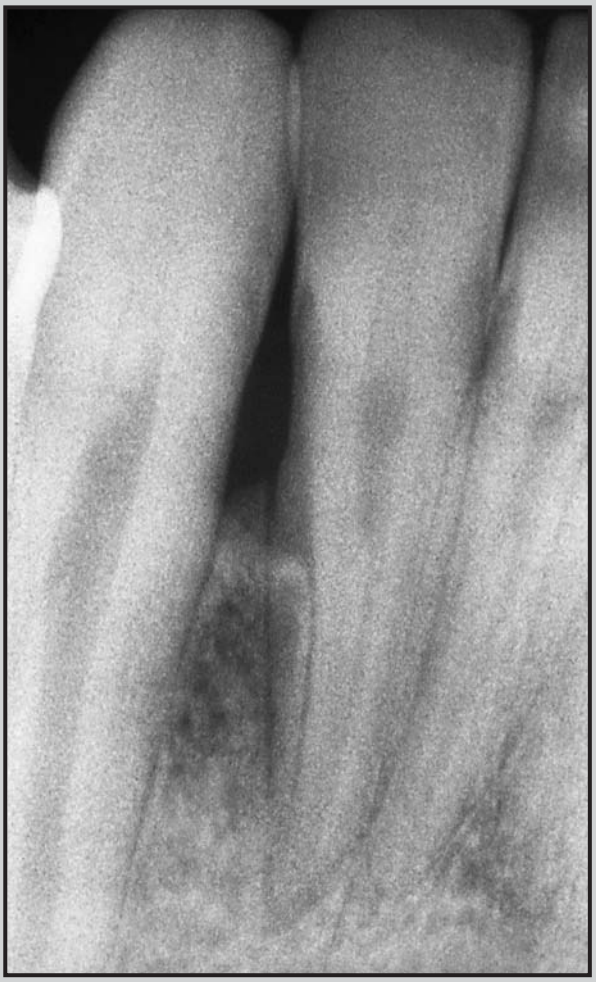
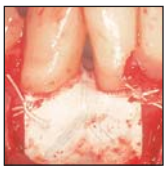




The Papilla Amplification Flap: A Surgical Approach to Narrow Interproximal Spaces in Regenerative Procedures



*Giovanni Zucchelli, DDS, PhD**
*Massimo De Sanctis, MD, PhD***

A modified surgical approach to interproximal guided tissue regeneration procedures (GTR) was used when anatomic conditions at the defect-associated interdental area rendered papilla preservation techniques very difficult. The main goal of this study was to evaluate the effectiveness of the papilla amplification flap (PAF) in obtaining and maintaining primary soft tissue closure of the interdental space above nonresorbable, titanium-reinforced, expanded polytetrafluoroethylene (e-PTFE) membranes and to quantify the regenerative outcomes obtained using this procedure. Seventeen patients with one deep intrabony defect associated with a narrow interproximal space were selected for this case-series clinical study. The application of the PAF in combination with e-PTFE membranes resulted in clinically and statistically highly significant gains in clinical attachment levels (4.7 ± 1.4 mm) and reductions in probing pocket depth (6.3 ± 1.3 mm) after 1 year. Primary soft tissue closure of the interdental space was obtained in 100% of cases after completion of the surgery and maintained in 65% of cases during the initial healing period (6 weeks). Results from the present study indicate that the PAF can be considered a suitable soft tissue surgical approach for GTR treatment of intrabony defects when papilla preservation techniques are not recommended because of unfavorable local anatomic conditions interproximally. (Int J Periodontics Restorative Dent 2005;25:483–493.)

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Membrane exposure has been reported as the major complication of guided tissue regeneration (GTR) procedures.[1–11] Exposed membrane material is rapidly colonized by oral bacteria, which may interfere with blood clotting and thus jeopardize the ongoing regenerative process.[1,2] Various studies[3–10] have demonstrated an inverse correlation between the amount of bacteria colonizing both resorbable and nonresorbable membrane materials and the amount of clinical attachment gained with the regenerative surgical procedure. Furthermore, a microbiologic study[11] evaluating the relationship between bacteria present on barrier material and the clinical outcomes of GTR procedures pointed to not only the total microbial count but also the presence of specific periodontopathic bacteria (*Porphyromonas gingivalis, Prevotella intermedia, Capnocytophaga, Peptostreptococcus micros*) on membrane surfaces as one of the most significant negative predictors of clinical attachment gain. In the same study[11] it was shown that the jeopardizing effect of membrane exposure on the regen-

erative process was also time-related: for each week the membrane remained covered by soft tissue, an increased 0.5 mm of clinical attachment was expected after GTR surgery. These data indicate that one of the main goals in periodontal regenerative procedures is to obtain and maintain primary soft tissue closure above the membrane material during the healing period and thus ensure protection during the healing process.

The reported prevalence of membrane exposure was in the 70% to 80% range (for review, see Cortellini and Tonetti[12]). It should be emphasized that in all these studies, access flaps and suturing techniques were not specifically designed to achieve and maintain soft tissue closure over the barriers. To overcome this problem, new surgical techniques specifically designed for application with regenerative procedures in the interdental area have been recently developed and used in clinical trials: *(1)* the modified papilla preservation (MPP) technique,[13] which was reported to be successful in wide interproximal spaces and in the anterior and premolar regions; *(2)* the interdental tissue maintenance approach,[14] the application of which was reported to be limited in the maxilla and between teeth with wide (≥ 2 mm) interradicular spaces; and *(3)* the simplified papilla preservation (SPP)[15] flap, which was developed to facilitate the manipulation of the interdental tissues not only in wide and anterior interdental spaces but also in narrow and/or posterior areas. With the use of these surgical approaches, membrane exposure has been reported to have been greatly reduced (range, 40% to 50%).[12]

A common aspect to the above-mentioned surgical approaches is that the buccolingual continuity of the interdental soft tissues is preserved and the entirety of the supracrestal soft tissue is moved buccally or lingually and elevated, together with the flap, to gain access to the bony defect. Unfortunately, it is not always possible to maintain and move the entire interdental soft tissue as it is; in some clinical situations, the buccolingual continuity must be interrupted to permit adequate access to the intrabony lesion. This is the case of intrabony defects associated with narrow interdental spaces as a result of the rotation of one or both teeth neighboring the defect-associated interdental area. In this situation, either the interdental anatomic papilla or the isthmus connecting the buccal with the lingual/palatal papilla is often lacking, and there is a soft tissue crater below the contact area. Other clinical circumstances in which papilla preservation surgical approaches[13–15] can rarely be performed are intrabony defects associated with a small suprabony component and covered by a small anatomic papilla or located between molars with a wide buccolingual dimension. It should be emphasized that the above-mentioned unfavorable conditions sometimes may be associated with the same interdental area.

In the clinical situations previously described, intrasulcular incisions were generally performed to maintain the interdental soft tissue to the maximum extent. When this surgical approach was used, a certain amount of interdental soft tissue located below the contact point or area was lost because it was not possible to reach it, even with the smallest blade. Thereafter, in most of the cases treated with intrasulcular incisions, complete soft tissue closure above the membranes was not achievable and/or maintainable over the healing period.

Therefore, it is important to identify a more efficacious and reproducible method to obtain and maintain complete closure of the interdental tissue over the barrier materials, even in the presence of anatomic conditions at the defect-associated interdental space that might otherwise preclude the use of papilla preservation approaches. This report describes the application of a modified interdental soft tissue management technique to achieve this goal.

Method and materials

Subject population

The subject population consisted of 17 systemically healthy, nonsmoking subjects (6 men and 10 women) affected by chronic adult periodontitis (mean age 48 years old, range 36 to 58). All patients were treated between June 1999 and April 2000 in the Department of Periodontology,

University of Bologna. The population consisted of a longitudinal cohort of eligible patients selected after completion of an initial cause-related phase of periodontal therapy that included oral hygiene instruction, scaling, and root planing.

In each patient, an experimental site that met the following selection criteria was identified:

1. Clinical and radiographic evidence of the presence of a deep interproximal defect with an intrabony component of at least 4 mm
2. Clinical attachment loss greater than 7 mm
3. Unfavorable anatomic conditions of the defect-associated interdental area, including: *(a)* lack of continuity of the soft tissue isthmus connecting the buccal with the lingual/palatal papilla; *(b)* narrow interproximal spaces as a result of rotation/malposition of one or both teeth neighboring the defect area; *(c)* narrow interproximal space with an inconsistent suprabony component associated with the intrabony defect; *(d)* narrow interproximal spaces with wide buccolingual dimension (interdental area between molars); or *(e)* two or more of the above-mentioned conditions
4. No furcation involvement
5. Presence of at least 4 mm of buccal keratinized tissue at both teeth neighboring the defect area that would allow surgical amplification of the defect-associated interdental papilla

The tooth population consisted of four lateral incisors (one maxillary and three mandibular), four canines (two maxillary and two mandibular), three maxillary premolars, and six molars (1 maxillary and 5 mandibular).

Experiment design

Clinical measurements were recorded at baseline (2 weeks before GTR therapy) and at the 1-year follow-up visit.

Clinical characterization of patients and selected sites

Full-mouth plaque scores (FMPS) were recorded as the percentage of total surfaces (four aspects per tooth) revealing the presence of plaque.[16] Bleeding on probing was assessed dichotomously at a force of 0.3 N with a manual pressure-sensitive probe. Full-mouth bleeding score (FMBS) was recorded as the percentage of total surfaces (four aspects per tooth) that revealed the presence of bleeding upon probing.

The following clinical measurements were taken 1 week before surgery and at the 1-year follow-up:

- Clinical attachment level (CAL), measured from the cemento-enamel junction (CEJ)
- Probing pocket depth (PPD), measured from the gingival margin
- Marginal gingival recession (REC), measured from the CEJ to the gingival margin

A single investigator, blinded with respect to the treatment, performed the clinical measurements at baseline and at 1 year.

Measurements were performed at six sites around all teeth. The study, however, reports only local measurements at the deepest interproximal point of the selected defect. All measurements were performed by means of a manual pressure-sensitive probe and were recorded to the nearest millimeter.

Coverage of the membrane and primary soft tissue closure of the defect-associated interdental space were determined dichotomously (interdental space closed or open) immediately after the surgical procedure and weekly until membrane removal (6 weeks).

Clinical measurements at the time of surgery

The following clinical measurements were taken at the time of surgery immediately after debridement of the defects[17]: *(1)* distance from the CEJ to the bottom of the defect (CEJ-BD); *(2)* distance from the CEJ to the most coronal extension of the bone crest (CEJ-BC). The intraosseous component of the defects (INFRA) was defined as follows: INFRA = (CEJ-BD) – (CEJ-BC).

Data analysis

Data were expressed as mean ± standard deviation. Differences between baseline and 1-year follow-up measurements were evaluated using the paired *t* test.

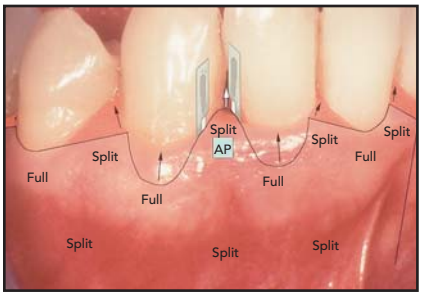


Fig 1a (left) *Buccal view of the PAF. The soft tissue between the two highly scalloped submarginal incisions is the amplified papilla (AP), which will be moved lingually during the coronal advancement of the buccal flap. The facial portion of the anatomic papillae* (dotted areas) *neighboring the defect area is de-epithelialized to create a connective tissue bed to which the surgical papillae adjacent to the defect area will be sutured.*

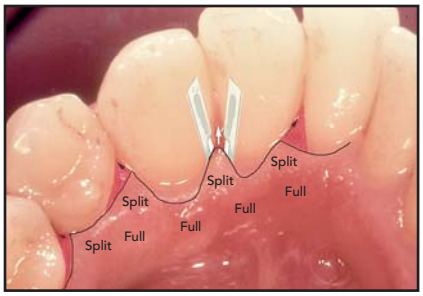


Fig 1b (right) *Lingual view of the PAF. A small amplification of the defect-associated lingual interdental papilla is performed to improve its adaptation to the buccal amplified papilla at time of suturing.*

Surgical procedure

Schematic drawings of the papilla amplification flap (PAF) are shown in Figs 1a and 1b. A clinical example of a patient treated with the technique is shown in Figs 2a to 2j.

Following local anesthesia, a submarginal highly scalloped incision was traced at the buccal aspect of the tooth, mesial to the defect-associated interdental space. The incision started from the gingival margin at the distal line angle of the tooth distal to the defect area, continued in a parabola design at the buccal aspect, and entered into the gingival sulcus at the mesial line angle of the same tooth. Care was taken to confine the submarginal incision within the buccal gingival tissue so that at least 1 mm of keratinized tissue was preserved within the flap. The same incision was performed at the buccal aspect of the tooth distal to the defect (see Figs 1a and 2d). The soft tissue of the defect-associated interdental anatomic papilla was fully preserved, with the blade in the sulcus kept almost parallel to the long axis of both teeth neighboring the defect. The soft tissue coronal to the two submarginal incisions was eliminated, while the tissue created between them became the "amplified papilla"; its length and width were modified according to the buccolingual and mesiodistal dimensions of the defect-associated interdental space, with the only limiting anatomic factor being the apicocoronal amount of buccal keratinized tissue. In the presence of a high band of buccal keratinized tissue, the dimension of the amplified papilla was even two or three times that of the corresponding anatomic papilla; hence the denomination *papilla amplification flap* for this soft tissue surgical approach.

At the level of the other teeth included in the flap design, the incision was continued intrasulcularly at the buccal surfaces and submarginally in the interdental areas. At this level, split-thickness surgical papillae were elevated, while the remaining facial portion of the anatomic papillae was de-epithelialized to create connective tissue beds to which the surgical papillae of the coronally advanced buccal flap were secured at time of suturing (see Fig 1a).

Vertical releasing incisions to facilitate coronal displacement of the buccal flap were performed only when necessary. At the lingual aspect of the defect-associated interdental space, intracrevicular incisions were performed to preserve interdental soft tissues to the maximum possible extent. A small amplification of the defect-associated lingual interdental papillla was performed only in the presence of a high band of lingual keratinized tissue at the two teeth neighboring the defect (see Fig 1b). This was not done in the maxilla because coronal advancement of the palatal flap was not possible. Even in the lingual flap, the papillae mesial and distal to the defect area were dissected with a submarginal split-thickness incision, with care taken to maintain the interdental soft tissue in situ. These tis-

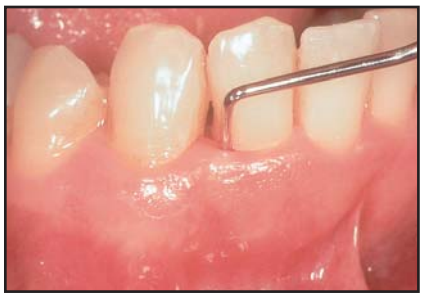


Fig 2 *Male patient, 36 years old, affected by periodontitis.*

Fig 2a (left) *The mandibular right lateral incisor shows a deep pocket (PPD > 15 mm) at the distal surface. The interdental space between it and the canine is very narrow as the result of rotation of the lateral incisor. A high band of keratinized tissue is present at the buccal aspect of both teeth.*

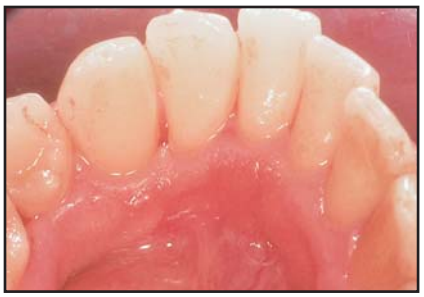
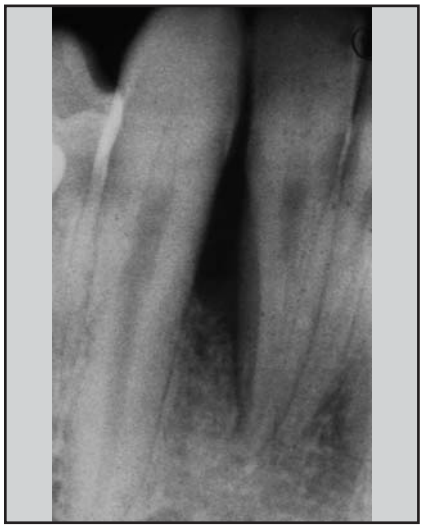
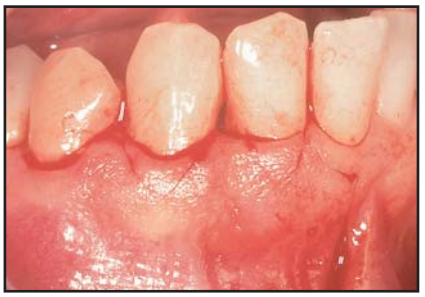


Fig 2b (right) *The lingual view confirms the extremely narrow interdental space above the periodontal lesion. The distal surface of the lateral incisor and the mesial surface of the canine are in contact at the lingual aspect. There is no continuity of the isthmus connecting the buccal with the lingual anatomic papilla.*





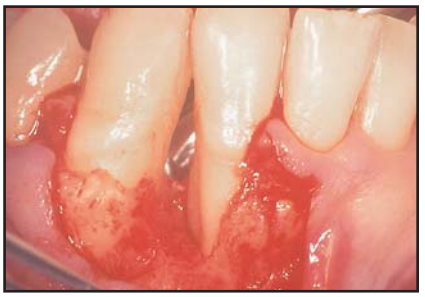


Fig 2c (left) *The radiograph shows a deep intrabony defect distal to the lateral incisor.*

Fig 2d (above) *The buccal incision consists of the submarginal highly scalloped incisions at the two teeth neighboring the defect, the submarginal split-thickness incisions at the interdental papillae mesial and distal to the defect area, and one mesial vertical releasing incision.*

Fig 2e (above right) *A deep intrabony defect is evident after flap elevation and degranulation of the defect.*

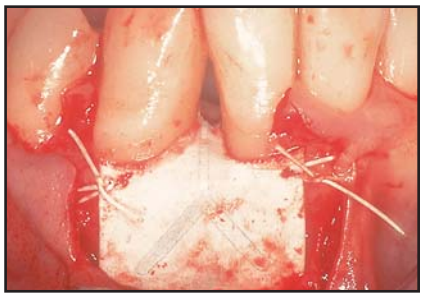


Fig 2f *The membrane is positioned at the level of the bone crest and sutured at the periosteum left in place during buccal flap elevation. Note the space available above the membrane and below the contact area; this is adequate for soft tissue coverage of the membrane material.*

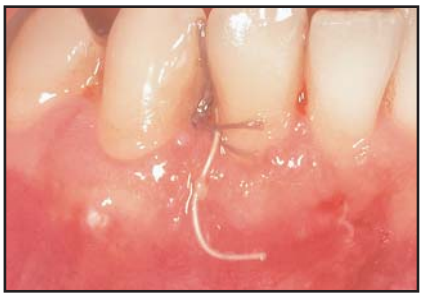


Fig 2g *Complete soft tissue coverage above the membrane has been achieved. At time of suture removal (14 days), the membrane was still covered.*

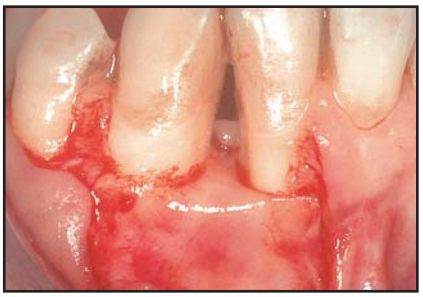


Fig 2h *At time of membrane removal (6 weeks), newly formed tissue completely fills the space available below the membrane. Note the good maturation of the regenerated tissue and the absence of clinical signs of inflammation.*

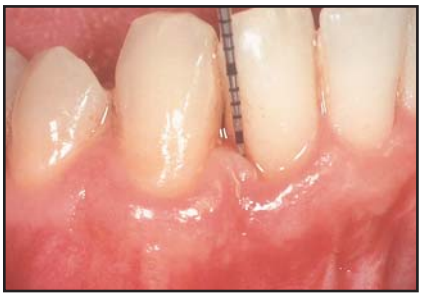


Fig 2i *Clinical aspect at 1 year. The lateral incisor shows a shallow residual probing pocket (3 mm) with minimal increase in the amount of gingival recession. A 2-mm-high band of buccal keratinized tissue is still present at both teeth neighboring the defect area.*

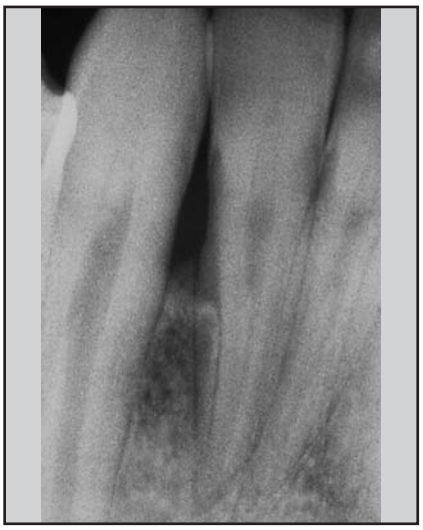


Fig 2j *The 1-year follow-up radiograph shows complete filling of the intrabony defect.*

sues, in fact, provided anchorage for the surgical papillae on the lingual aspect at time of suturing (see Fig 1b).

The buccal flap, together with the amplified papilla, was elevated full thickness to expose at least 2 to 3 mm of alveolar buccal bone. Split-thickness flap elevation was continued apically to facilitate coronal displacement of the flap itself. The palatal/lingual flap was elevated full thickness. Elevation of flaps (buccal and lingual) was considered adequate when the entire vertical bone defect was accessible for instrumentation (see Fig 2e).

Following degranulation of the defect and careful scaling and root planing, an interproximal titanium-reinforced, nonresorbable, expanded polytetrafluoroethylene (e-PTFE) membrane (Gore-Tex, W.L. Gore) was cut and reshaped to permit its precise adaptation to the interdental zone and to the bony defect. The membrane was positioned at the level of the bone crest to completely cover the defects and overlap at least 3 mm of the residual bone. It was secured with nonresorbable e-PTFE sutures at the periosteum that was left in place during flap elevation (see Fig 2f). Great care was taken not to position the membrane too coronally (at the level of the CEJ), because this would have reduced the available space for the interdental soft tissues covering the membrane. The positioning of the membrane at the bone crest, rather than close to the CEJ, in fact, facilitated primary soft tissue closure above the membrane, particularly in the presence of narrow interdental spaces.[14]

A blunt dissection into the vestibular lining mucosa was carried out to eliminate muscle tension and to permit coronal displacement of the buccal flap. Flap mobilization was considered adequate when the marginal portion of the flap was able to passively reach a level coronal to the CEJ at every single tooth included in the flap design and when the amplified papilla was able to reach the palatal/lingual aspect of the defect-associated interdental space and to join the lingual/palatal papilla without any tension.

The amplified papilla was moved lingually through the interdental space below the contact point or area. A horizontal internal mattress suture[13] was performed at the defect-associated interdental space to improve flap adaptation above the bony defect and to bring the amplified papilla as close as possible to the palatal/lingual one. After this suture, all surgical papillae in the flap were anchored to the corresponding de-epithelialized anatomic papillae and lingual surgical papillae with single interrupted sutures. Once completed, these sutures stabilized the flaps, so that the last interrupted suture, connecting the amplified buccal papilla to the lingual one, could be performed without any tension acting on it (see Fig 2g).

An example of the PAF technique in the maxilla is shown in Figs 3a to 3f.

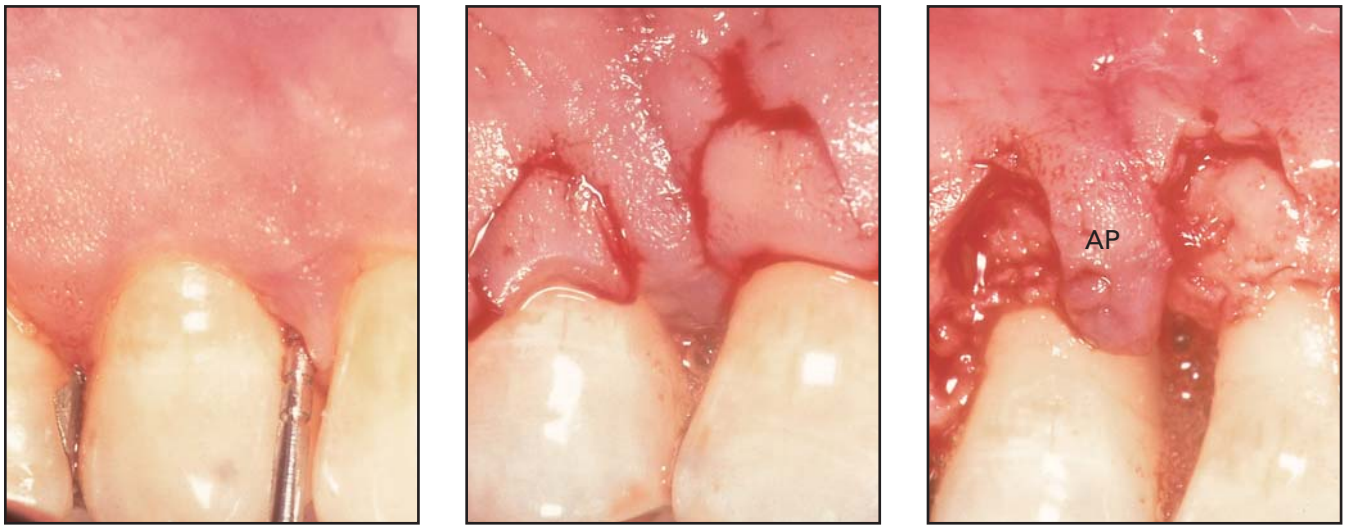


Fig 3 *The papilla amplification approach in the maxilla.*

Fig 3a (above left) *The maxillary right second premolar shows a deep pocket (PPD = 8 mm) at the mesial surface. The interdental space between it and the first premolar is very narrow, and the covering interdental anatomic papilla is very small. A high band of keratinized tissue is present at the buccal aspect of both teeth.*

Fig 3b (above center) *Submarginal highly scalloped incisions are traced at the buccal aspect of both teeth neighboring the defect-associated interdental space. The soft tissue of the anatomic papilla is fully preserved.*

Fig 3c (above right) *The soft tissue coronal to the two submarginal incisions is eliminated, while the one created between them is the amplified papilla (AP).*

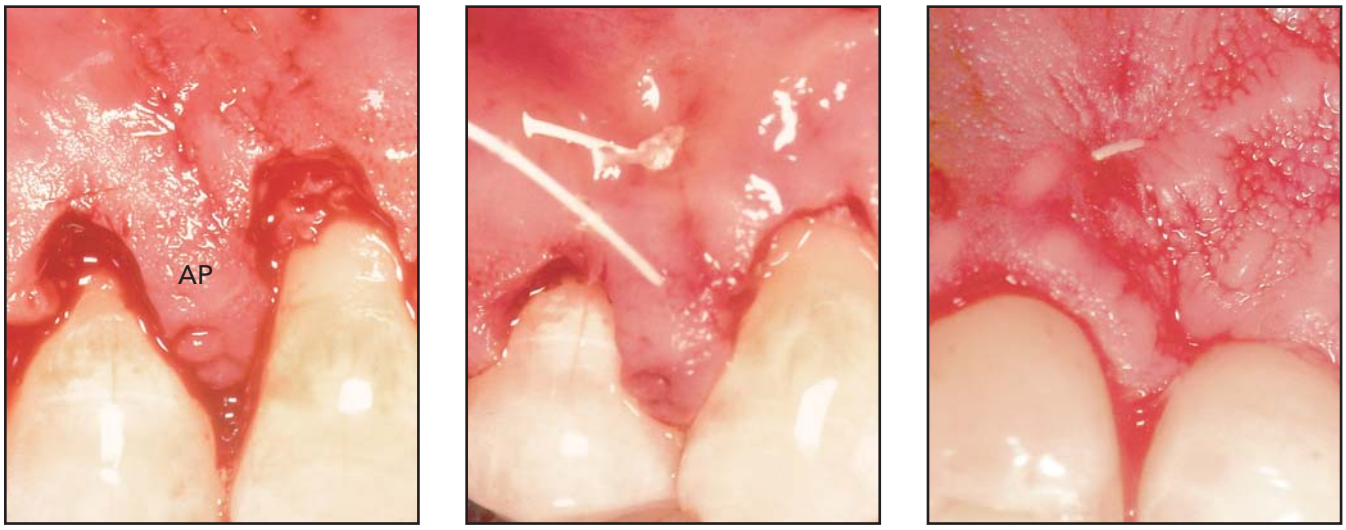


Fig 3d (above left) *The buccal flap is coronally advanced, and the amplified papilla (AP) is moved palatally below the contact area.*

Fig 3e (above center) *A horizontal internal mattress suture is performed at the defect-associated interdental space to improve flap adaptation above the bony defect and to place the amplified papilla as close as possible to the palatal/lingual flap. A single interrupted suture is used to facilitate papilla movement in the palatal direction.*

Fig 3f (above right) *The amplified papilla reaches the palatal aspect, and complete soft tissue closure above the defect is achieved.*

Table 1 Characteristics of patient oral hygiene at baseline and at 1 year

Parameter	Baseline	1 year	Difference	*P**
FMPS (%)	11.2 ± 1.6	9.5 ± 1.4	1.7 ± 1.0	.003
FMBS (%)	9.9 ± 1.5	9.0 ± 1.6	0.9 ± 1.2	.56 (NS)
CAL (mm)	10.0 ± 1.2	5.3 ± 1.3	4.7 ± 1.4	< .001
PPD (mm)	8.7 ± 1.2	2.4 ± 0.6	6.3 ± 1.3	< .001
REC (mm)	1.3 ± 0.8	2.9 ± 1.1	1.6 ± 0.9	< .001

*Paired *t* test; NS = not significant.

FMPS = full-mouth plaque score; FMBS = full-mouth bleeding score; CAL = clinical attachment level; PPD = pocket probing depth; REC = marginal gingival recession.

Postsurgical instruction and infection control

Patients received systemic antibiotics (amoxicillin + clavulanic acid 1 g/twice a day) starting 1 day prior to surgery and continuing for another 7 days. After completion of the surgical procedure, all subjects were instructed to rinse 3 times a day for 1 minute with a 0.12% chlorhexidine solution. No mechanical oral hygiene procedures in the treated area were allowed for 11 weeks.

Professional supragingival tooth cleaning with a rubber cup was performed weekly for 11 weeks. After this period, patients were instructed to gradually resume mechanical oral hygiene with the use of a soft toothbrush and a roll-brushing technique.

All patients were maintained in a supportive care program at monthly intervals; this included full-mouth prophylaxis, oral hygiene remotivation, and reinstruction for 1 year. No deep subgingival instrumentation or probing procedures were performed in the treated sites until the 1-year follow-up visit. Sutures were removed 2 weeks after surgery, and membranes were removed at 6 weeks.

Results

Baseline and 1-year patient oral hygiene defect characteristics are shown in Table 1.

The selected defects presented with a mean CAL of 10.0 ± 1.2 mm and a mean PPD of 8.7 ± 1.2 mm. The mean distance from the CEJ to the bottom of the defect was 11.5 ± 1.3 mm, the mean distance from the CEJ to the bone crest was 4.9 ± 0.7 mm, and the mean intrabony component was 6.5 ± 0.8 mm.

Membrane coverage

Immediately postsurgery, primary soft tissue closure over the membrane was obtained in all treated cases (100%). Exposure occurred in two cases at 1 week, in three cases at 2 weeks, and in one more case at 5 weeks. In all cases, the amount of barrier exposure did not exceed 2 mm^2. Plaque accumulation over the exposed e-PTFE membrane was controlled with topical application of chlorhexidine. In all sites with membrane exposure, gingival inflammation was minimal; thus, membrane removal could be postponed to 6 weeks. At the time of membrane removal (6 weeks), 11 sites (64.7%) still showed complete soft tissue coverage of the membrane.

Clinical outcome at 1 year

The mean CAL gain was 4.7 ± 1.4 mm. The difference between base-

line and 1-year CAL was clinically and statistically significant ($P < .001$). The 1-year CAL (5.3 ± 1.3 mm) was 0.4 mm greater than the suprabony component of the baseline defect (mean distance between the CEJ and the bone crest at time of the surgery).

The mean reduction of PPD was 6.3 ± 1.3 mm. The difference between baseline and 1-year PPDs was clinically and statistically significant ($P < .001$). The mean residual pocket depth at 1 year was 2.4 ± 0.6 mm.

A statistically ($P < .001$) and clinically significant increase in gingival recession (1.6 ± 0.9 mm) at the experimental sites between baseline and 1 year was observed.

Discussion

The cases treated in the present study were selected from those in whom it was not recommended to perform papilla preservation techniques[13–15] because of unfavorable anatomic features at the defect-associated interdental space: narrow interproximal spaces with lack of an isthmus connecting the buccal with the lingual/palatal papilla, presence of interdental soft tissue craters, inconsistent suprabony component associated with the intrabony defect, and/or small interdental anatomic papillae with wide buccolingual dimension (interdental spaces between molars).

The results of the present study suggest that by means of the PAF, it is possible to predictably achieve and maintain primary closure of the interdental tissues above titanium-reinforced nonresorbable membranes, even in the presence of the above-mentioned unfavorable anatomic characteristics of the defect-associated interdental area. Complete soft tissue closure at the time of suturing was accomplished in all (100%) of the 17 treated sites, and it was maintained over time (6 weeks) in 65% of the selected clinical cases. These results favorably compare with the 20% to 40% primary closure reported in studies[12] in which conventional incision techniques not specifically designed for use with barrier membranes were used. Furthermore, the overall result of the present study, in terms of maintenance over time of soft tissue coverage, is similar to that reported for the SPP technique (67%).[15] On the other hand, the percentage of primary closure maintained over time is less than that obtained with the MPP flap (73%[13] and 80%[18]) and with interdental tissue maintenance techniques (92%[14]). It must be considered, however, that the above-mentioned techniques were restricted to anterior and/or wide interdental spaces, while the present study population included defects with less favorable conditions at the defect-associated interdental area for accomplishing soft tissue coverage above the membrane materials.

The same authors who developed the MPP flap[13] and the interdental tissue maintenance technique[14] indicated that when the interdental space was very narrow or located in the posterior segments, the manipulation of a large buccal[13] or palatal "saddle shaped"[14] flap incorporating the interdental tissue was technically very demanding, and the risk of papilla necrosis was very high. To overcome these problems, the SPP flap[15] was developed. In this surgical approach, the amount of interdental tissue elevated through the interdental space did not exceed the amount of tissue originally present in that space, thereby rendering the procedure easier and less traumatic for the interdental soft tissue. According to the authors' suggestions,[15] this technique was particularly indicated in the presence of narrow interdental space and/or posterior sites with intrabony defects. It is our opinion that in some clinical situations the SPP approach cannot be performed. This is the case with intrabony defects associated with particularly narrow interdental areas as a result of rotation/malposition of one or both teeth facing the defect (see Fig 2). In such a situation, in fact, the two root surfaces facing the defect might come into contact at the buccal or lingual aspect, leaving an insufficient space between the contact area and the bone crest for passage of the supracrestal soft tissues. This lack of space available for the interdental soft tissues is even more critical when, in addition to narrow interproximal space, there is an incon-sistent suprabony component associated with the intrabony defect. Other situations in which the SPP technique can rarely be performed are: *(1)* the absence of an isthmus connecting the buccal and lingual/

palatal papillae resulting from the presence of a soft tissue interdental crater and *(2)* a wide buccolingual dimension in the posterior interdental area (space between molars) .

In all these circumstances, the risk of trauma or loss of the interdental soft tissue during surgical manipulation is very high. Furthermore, even if it is entirely preserved during the surgical manipulation, the supracrestal soft tissue covering the membrane would be too thin or narrow and thus inadequate to guarantee soft tissue coverage during the healing period.

The main anatomic limitation with the use of the PAF technique is the height of the keratinized tissue at the buccal aspect of the two teeth neighboring the defect; the presence of at least 4 mm of keratinized tissue is advocated. However, it is important to emphasize that the absence of such an amount of keratinized tissue must not be considered an absolute contradiction to the use of the proposed surgical approach, since adequate buccal keratinized tissue can be easily obtained by means of an epithelialized or connective tissue graft taken from the palate.

A comparative analysis between the baseline and the 1-year follow-up clinical variables indicated that the proposed soft tissue surgical approach associated with the use of titanium-reinforced nonresorbable membranes was able to improve (both clinically and statistically) the clinical parameters. The clinical outcome in terms of CAL gain and PPD reduction obtained in the present study were similar to those reported in previous studies where the same membrane material but a different surgical approach (MPP) was used.[19] However, in contrast to that reported by Cortellini and coworkers,[19] the 1-year CAL of the present study remained within the original intrabony component of the defect. This difference can be explained, at least in part, by variation in the membrane position at time of surgery. In fact, in the present study, membranes were positioned at the level of the bone crest; conversely, in the study by Cortellini et al,[19] membranes were positioned much closer to the CEJ. In the clinical cases treated in this study, membrane positioning at the level of the CEJ would have reduced the available space for the interdental soft tissues covering the barrier material and thus increased the risk of membrane exposure during the healing period.

In conclusion, this study showed that the PAF may be a suitable surgical approach for interproximal regenerative procedures when local anatomic conditions render papilla preservation flap techniques[13–15] very difficult and risky. The present surgical approach was easy to perform and made it possible to obtain and maintain primary soft tissue closure above the membrane material in the presence of unfavorable anatomic conditions at the interdental space with the intrabony defect. The efficacy and predictability of application of the PAF, however, should be further evaluated in controlled multicenter clinical studies.

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