The Soft Tissue Wall Technique for the Regenerative Treatment of Non-contained Infrabony Defects: A Case Series

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The ability to stabilize the blood clot is crucial in achieving predictable periodontal regeneration in infrabony defects. Unfortunately, micromovements may cause degradation of the clot-root interface and result in suboptimal wound healing. Current surgical and suturing techniques are aimed at reducing flap micromovement because flap management is one of the main factors influencing the stability of the clot. The aim of this paper is to describe the use of the soft tissue wall technique to enhance periodontal tissue regeneration outcomes of challenging non-contained infrabony defects. Nine one-wall infrabony defects were treated with a combination of a papilla preservation technique and a coronally advanced flap. Enamel matrix derivative was delivered to the defect, but no bone grafting materials or membranes were employed. Mean 1-year probing depth reduction was 6.3 ± 2.0 mm (P < .001) and mean clinical attachment gain was 7.1 ± 1.0 mm (P < .001). All treated sites showed a mean reduction of exposed root surface equal to 1.0 ± 0.4 mm (P = .05). The results suggest the possibility of improving the regenerative potential of a one-wall infrabony defect by the creation of a stable soft tissue wall while also enhancing the esthetic outcome of the surgical procedure. Further studies with a larger number of patients are needed to support these preliminary data. (Int J Periodontics Restorative Dent 2013;33:e79–e87. doi: 10.11607/prd.1628)

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The definitive goal of periodontal regeneration is the regeneration of new cementum, new bundle bone, and a functionally oriented periodontal ligament. [1–3] Clinically, periodontal regeneration aims to gain clinical attachment and minimize soft tissue recession (a common drawback of traditional periodontal therapy). Several techniques have been described and tested, including the use of nonresorbable and resorbable membranes (guided tissue regeneration [GTR])[1,4,5]; autogenous bone grafts[6,7]; different bone fillers such as allografts, xenografts, and synthetic materials; and bioactive molecules including enamel matrix derivative[8,9] and growth factors.[10,11] Recently, more sophisticated scaffolding techniques, cell therapy, and gene therapy approaches have been proposed to boost the reparative potential of the wound tissues.[12–14]

Critical clinical components for successful outcomes are: wound and clot stability during the early healing phase,[15,16] space provision to allow the migration and proliferation of cells from the periodontal ligament and alveolar bone along the exposed root,[17] and completion of primary closure to ensure healing without bacterial contamination or infection.[18] Despite advances in the field of tissue engineering and its application to periodontal regeneration, no biologic construct will ever allow optimal wound healing if the surgical technique is inadequate.

From a clinical standpoint, different techniques have been described, all aimed at obtaining primary wound closure and flap stabilization. Takei et al[19] suggested the papilla preservation technique with the intent of retaining the interproximal soft tissues for better control of flap adaptation. This technique included a palatal semilunar incision to retain the papillary tissue in the buccal flap. An external horizontal crossed mattress suture was suggested to approximate the flaps. Cortellini et al modified the papilla preservation technique and suggested dissecting the papilla from the buccal flap and attaching it to the palatal flap.[20] An internal horizontal cross mattress suture at the base of the palatal papilla was suggested to facilitate the coronal repositioning of the buccal flap. An internal vertical mattress suture was used to approximate the papilla to the buccal flap for primary wound closure. Furthermore, the same group also proposed a simplified papilla preservation technique for the treatment of narrow and posterior interdental spaces.[21]

These techniques were initially suggested for use in combination with nonresorbable expanded polytetrafluoroethylene (e-PTFE) membranes in GTR. They have since been adapted for use with resorbable membranes as primary wound closures, and the stability of the grafted material was improved with their use.

Despite the absence of scientific investigations, it may be speculated that blood clots attach more easily to soft tissues than mineralized tissues such as the alveolar bone and the root surface. Wikesjö and Nilvéus[15] demonstrated how clot adhesion interference could alter the outcome of the healing process by significantly reducing connective tissue repair after GTR.

Since flap and clot stabilization are more challenging when a defect's bony walls are absent (two- and one-wall defects compared to three-wall defects), diminished results can be expected when adopting regenerative techniques. In the treatment of these challenging defects, the use of stabilizing materials such as titanium reinforcements or mineralized bone substitutes can enhance the surgical outcome, but may also have an osteoinductive effect.[7]

To address these drawbacks of common regenerative flap management techniques, Trombelli et al proposed a reconstructive surgical procedure based on the single flap approach, wherein a single flap (either buccal or lingual) keeps the tissues of the other flap intact.[22] Concurrently, to reduce surgical trauma and increase flap stability, Cortellini et al adapted their modified papilla preservation techniques to limit the elevation and mesiodistal extension of the flap.[20,21]

These latter flap designs represent the state-of-the-art flap stabilization techniques. However, they are limited in their ability to provide a stable soft tissue wall over the presurgical gingival margins. Moreover, these techniques are able to limit, but not reduce, the gingival recession that often accompanies periodontal attachment loss in the esthetic area.

The aim of this study is to describe a novel surgical technique (Fig 1) for the treatment of non-contained infrabony defects by creating stable soft tissues and reaching both biologic and esthetic clinical success.

Method and materials

Study design

Nine systemically healthy subjects from a single private practice in Milan, Italy, were selected consecutively for this study. Patients exhibited generalized or localized chronic periodontitis with areas of severe loss of attachment. Clinical and radiographic investigation enabled the clinician to select only non-contained angular bony defects (radiographic infrabony vertical component ≥ 4 mm). Only sites associated with root surface exposure resulting in impaired esthetics were included (Fig 2a). Patients with uncontrolled systemic diseases, patients who had been previously treated with periodontal surgical or nonsurgical procedures, and heavy smokers (> 20 cigarettes/day) were excluded from the

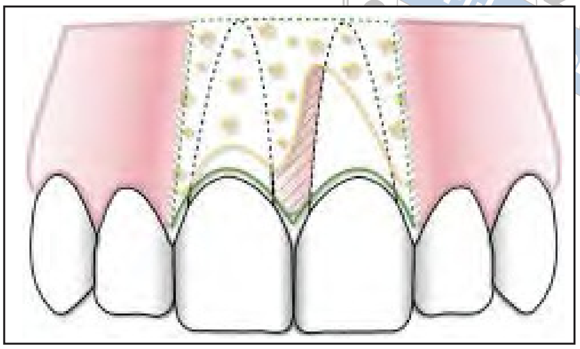

Fig 1 *The soft tissue wall technique aims to change the three-dimensional morphology of an infrabony defect from non-contained (one walled) to well contained (three walled). The defect is delimited from a bone wall* (yellow line) *and palatal/lingual flap* (pink shade); *the third wall* (green line) *is surgically created to coronally advance the buccul flap.*

Fig 2a *Preoperative view of the maxillary left lateral incisor.*

Fig 2b *Baseline probing depth of the interproximal defect on the mesial surface of the maxillary left lateral incisor.*

Fig 2c *Flap design to gain proper access to the infrabony defect.*

Fig 2d *Surgical view of the infrabony defect.*

Fig 2e *Creation of a soft tissue wall by coronally advancing the flap.*

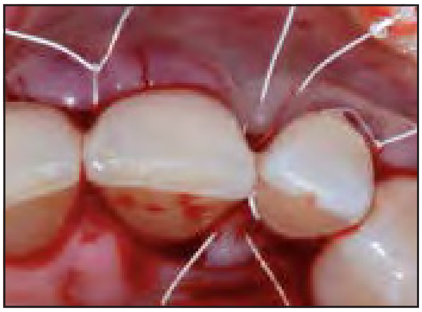

Fig 2f *Sling suture set in place to create a stable soft tissue wall; internal horizontal mattress sutures for primary wound closure of the interdental papilla over the defect.*

Fig 2g *Application of enamel matrix derivative.*

Fig 2h *Postsurgical view of the treated area.*

Fig 2i *Papilla regeneration and probing depth of the interproximal defect 12 months after surgery.*

Fig 3a (left) *Preoperative radiograph.*

Fig 3b (right) *Radiograph 12 months postsurgery.*

study. Following a thorough explanation of the nature, risks, and benefits of the clinical investigation and associated procedures, all subjects who agreed to participate to this study signed an informed consent form.

Study population and selected site characteristics

The full-mouth plaque score (FMPS) was recorded as the percentage of sites covered with plaque over the total number of surfaces (four sites per tooth).[23] Bleeding on probing (BoP) was assessed dichotomously at a force of 0.3 N with a manual periodontal probe (PCP-UNC 15, Hu-Friedy). The full-mouth bleeding score (FMBS) was recorded as the percentage of bleeding sites over the total number of tooth surfaces (four sites per tooth). The following clinical parameters were evaluated at the treated infrabony defects and recorded at the time of surgery and at the 12-month follow-up visit: probing depth (PD), measured from the gingival margin to the tip of the probe; clinical attachment level (CAL), measured from the cementoenamel junction (CEJ) to the tip of the probe; and gingival recession (REC), measured from the CEJ to the gingival margin (Fig 2b). Radiographic evaluation of the selected sites was performed at baseline (Fig 3a) and 12 months after surgery (Fig 3b) to evaluate the bone fill of the infrabony component of the defect.

All measurements were performed by a single operator using a manual periodontal probe and rounded up to the nearest millimeter.

Cause-related therapy and modification of oral hygiene habits

The regenerative surgical procedure was scheduled approximately 4 weeks after completing full-mouth etiologic therapy, including supragingival and subgingival scaling and root planing and oral hygiene training. The primary objectives of the hygienic phase were to reduce the patients' FMPS and FMBS and to decrease PD values. No regenerative surgical procedure was scheduled until the FMPS and FMBS values were < 15% and no BoP was present at both the surgical site and adjacent areas to the infrabony defect.

Surgical procedure

All surgeries were performed by the same experienced periodontist (GR). A horizontal incision was made at the level of the base of the interdental papillae and extended one tooth mesially and distally from the infrabony defect (Fig 2c). A full-thickness trapezoidal flap (with the wider base apically positioned) was elevated. The remaining facial portion of the anatomical papillae was maintained in situ and de-epithelialized to create a connective tissue bed to which the flap was secured at the time of suturing. The papilla over the infrabony defect was dissected at its base, and the entire interproximal supracrestal soft tissue was elevated to gain proper access to the defect. The non-contained anatomy of the defect was clinically confirmed.

After flap elevation, the granulation tissue was removed from the defects by means of metal curettes, followed by scaling and root planing using metal curettes and power-driven instrumentation (Fig 2d).

Sharp and blunt dissection into the vestibular lining mucosa was performed to eliminate muscle tension and permit coronal displacement of the flap.[24] Flap mobilization was considered adequate when the marginal portion of the flap was able to passively reach a level more coronal to the CEJ and covered the de-epithelialized anatomical papillae (Fig 2e).

Two 5-0 nonresorbable e-PTFE sling sutures were used to stabilize the coronal displacement of the buccal flap (Fig 2f). The root surface was then conditioned with 24% ethylenediaminetetraacetic acid gel for 2 minutes to remove any smear layer and to obtain a surface devoid of organic debris. Subsequently, the root surface was carefully and copiously rinsed with sterile saline solution for 20 seconds.[25] An enamel matrix protein (Emdogain, Biora, Straumann) gel was then applied into the defect (Fig 2g). At this point, a tension-free primary closure of the interdental papilla upon the bony defect was achieved using a 7-0 nonresorbable e-PTFE internal horizontal mattress suture. The vertical releasing incisions were closed with interrupted sutures (Fig 2h).

Maintenance care program

All patients received systemic antibiotic therapy (amoxicillin, 1 g twice daily) for 6 days and analgesic therapy (ibuprofen, 400 mg twice a day) to prevent postoperative pain and edema. Sutures were checked and removed 8 days after surgery.

Local plaque control was maintained by a 0.2% chlorhexidine digluconate rinse (three times a day) for 8 weeks. During this period, patients were recalled weekly for professional prophylaxis. At home mechanical cleaning of the treated area was allowed 4 weeks after completion of the surgical procedure using an ultrasoft toothbrush and a roll technique in an apicocoronal direction. Interpoximal mechanical cleaning with dental floss was allowed 2 months after the regenerative procedure. After the initial 8 weeks, recall appointments for professional supragingival tooth cleaning were scheduled at 1-month intervals for 1 year posttreatment. No attempt to probe or subgingival scale was made before the 12-month follow-up examination (Fig 2i).

Following study completion, supportive periodontal therapy was performed according to each patient's needs.

Statistical analysis

Descriptive statistics were used to present the subject population and characteristics of the infrabony defects (mean ± SD). Clinical parameters were expressed in millimeters with the exception of FMBS and FMPS, which were expressed in percentages. Intrapatient analysis was performed using the paired t test to compare quantitative clinical indices, while the χ^2 test was used to compare proportion. Data analysis was performed using commercially available statistical software (JMP, version 5.0.1a, SAS). An α error of 0.05 was accepted as a statistically significant difference.

Results

Baseline characteristics

Demographic characteristics of the subject population at baseline are presented in Table 1. The mean age of patients enrolled was 40.2 ± 2.4 years, and 6 subjects were women and 3 were men. The tooth population consisted of one maxillary and three mandibular incisors, three maxillary canines, and two maxillary premolars. Baseline FMPS and FMBS values were 10.4% ± 1.1% and 11.0% ± 1.7%, respectively.

Table 2 illustrates infrabony defect characteristics at baseline. The selected defects presented with a mean CAL of 11.7 ± 3.7 mm and a mean PD value of 8.7 ± 2.7 mm. Baseline mean gingival recession was 3.0 ± 1.8 mm.

Table 1 Study subjects at baseline

Parameter	
Age (mean ± SD)	40.2 ± 2.4 y
Sex	
Men	3
Women	6
Type of tooth	
Incisors	4 (44.5%)
Canines	3 (33.3%)
Premolars	2 (22.2%)
FMBS (mean ± SD)	11.0% ± 1.7%
FMPS (mean ± SD)	10.4% ± 1.1%

SD = standard deviation; FMBS = full-mouth bleeding score; FMPS = full-mouth plaque score.

Table 2 Changes in clinical indices between baseline and 1-year follow-up

Parameter	Baseline (mean ± SD)	1-year (mean ± SD)	Change (mean ± SD)	*P*
PD (mm)	8.7 ± 2.7	2.4 ± 0.8	6.3 ± 2.0	< .001
REC (mm)	3.0 ± 1.8	2.0 ± 1.1	1.0 ± 0.4	.05
CAL (mm)	11.7 ± 3.7	4.6 ± 1.5	7.1 ± 1.0	< .001

SD = standard deviation; PD = probing depth; REC = recession depth; CAL = clinical attachment level.

Clinical outcome at 12-month follow-up

Changes in recorded clinical parameters between baseline and the 12-month follow-up are presented in Table 2. Mean 1-year PD reduction was 6.3 ± 2.0 mm and was statistically significant ($P < .001$). Mean CAL gain was 7.1 ± 1.0 mm. The difference between baseline and 1-year CAL was statistically significant ($P < .001$). All treated sites showed a clinical reduction of exposed root surface with a mean REC reduction equal to 1.0 ± 0.4 mm ($P = .05$)

Discussion

During the last decade, many regenerative treatments have been proposed, encompassing a wide variety of surgical approaches such as barrier membranes, a series of bone grafts and other osteoconductive and/or osteoinductive materials or protein mixtures, exogenous growth factors, and cell-based technology and genes from recombinant technology. Regenerative therapy has also been presented to provide a high percentage of long-term success.[26]

The strategy of isolating the periodontal defect with different materials (resorbable or nonresorbable) that function as physical barriers to avoid gingival cell invasion of the clot led to the development of GTR membranes.[27,28] These GTR membranes need to exhibit *(1)* biocompatibility to allow integration with the host tissues without eliciting an inflammatory response, *(2)* a proper degradation profile to match those of new tissue formation, *(3)* adequate mechanical and physical properties to allow its placement in vivo, and *(4)* a space-maintaining function by providing sufficient sustained strength to avoid the membrane from collapsing into the defect. Current resorbable and nonresorbable membranes possess many structural (ie, rate of degradation), mechanical (ie, prevention of soft tissue invasion into the defect), and biofunctional (ie, inflammatory and immunological reactions) limitations. Thus, it is clear that the "ideal" membrane for use in periodontal regenerative therapy has yet to be developed.

Various approaches aimed at periodontal regeneration should be predictable in their clinical outcomes, minimally invasive for patients, free from side effects such as membrane exposure, and economical. GTR of multiple adjacent infrabony defects has been attempted recently with a novel surgical technique in adjunction with enamel matrix derivative (EMD) and performed without the use of membranes or grafting materials.[29] Because of its viscous consistency, EMD has been considered inadequate for GTR procedures by some authors in relation to its limited space-maintaining potential.[30,31] However, Cortellini and coauthors obtained a 1-year clinical attachment level gain equal to 4.4 ± 1.4 mm ($P <$ .001 compared to baseline), and 73% of treated defects showed CAL improvement ≥ 4 mm corresponding to a mean resolution of the infrabony defect equal to 83% ± 20% (15 of 44 defects were completely filled).[29] It can be proposed that a proper surgical technique specifically designed to stabilize the clot while achieving and maintaining soft tissue closure at the infrabony defect may allow optimal clinical results despite the lack of a biomaterial and/or membranes.

Non-contained one-wall infrabony defects are prevalent in clinical practice. Therefore, the development of predictable periodontal regeneration for such defects is of great importance. Within the limits of this investigation, the authors tried to determine if this space-maintaining effect can only be accomplished using membranes for GTR procedures, or if stabilization of the clot could be achieved using a biomaterial without a scaffold effect and a novel surgical technique.

The soft tissue wall technique aims to improve clinical outcomes by combining the benefits of two highly predictable surgical procedures: the papilla preservation technique[19–21] and the coronally advanced trapezoidal-type flap. The papilla preservation technique is characterized by preservation of the entire interproximal supracrestal soft tissue, thus promoting soft tissue primary wound closure over the bone defect. This simplifies the flap management and suturing techniques and reduces the risk for soft tissue collapse into the bone defect, thereby optimizing the space for regeneration. The key role of supracrestal soft tissue preservation in GTR procedures has been demonstrated for membrane-supported[20,21,29] and EMD-based[32] surgical procedures. It was confirmed further by several studies indicating a significant positive correlation between CAL and bone level gains and the amount of regenerated interdental supracrestal soft tissues.[19–21] The coronally advanced flap (CAF) is a surgical procedure based on the coronal shift of soft tissues proposed in 1989 by Allen and Miller for the treatment of isolated gingival recessions.[33] The original design has since undergone several modifications. Pini Prato et al[34] described a flap with divergent releasing incisions to obtain a broad base to include a larger blood supply. The suggestion of implementing a full-thickness elevation of the flap introduced the significance of gingival thickness in improving clinical outcome. The importance of gingival biotype was reiterated by Baldi et al in 1999.[35] The CAF technique alone has been defined as the most predictable and least invasive surgical procedure for the treatment of gingival recessions, the outcomes of which could be improved both in the short and long term by adding a connective tissue graft or EMD.[36,37] The coronal advancement of the buccal flap has been previously suggested in the treatment of contained intrabony defects.[38] However, the proposed surgical technique aimed to minimize buccal gingival recessions due to soft tissue shrinkage during the healing process by using an envelope-type flap design[39] stabilized with single interrupted sutures.[38] The soft tissue wall technique has been proposed for the treatment of non-contained infrabony defects and is aimed at reducing the coronal advance of buccal gingival recession using a trapezoidal–type flap stabilized with sling sutures. Moreover, no palatal flap was elevated, thereby minimizing the surgical exposure of the bony defect to promote the stabilization of the clot during the early healing phase.

In this study, the amount of PD reduction obtained using the soft tissue wall technique (6.3 ± 2.0 mm) was higher than that reported in a similar study using EMD with nonresorbable titanium-reinforced membrane for the treatment of one-wall infrabony defects (5.5 ± 1.0 mm).[40] Furthermore, data from the present investigation showed that successful outcomes in terms of CAL gain can be achieved in the treatment of non-contained infrabony defects even with the use of a non-space-maintaining material like EMD. Results in terms of CAL gain, in an historical comparison, are comparable to those obtained with the use of rigid, space-maintaining regenerative materials such as membranes, bone substitutes,[41] or a combination of both.[41] The comparison of baseline and 12-month follow-up radiographs shows how the infrabony portion of the bony defect was completely filled after treatment. Thus, the use of a regenerative approach combined with a mucogingival surgical procedure (CAF technique) for soft tissue management seems to promote the regeneration of the infrabony component of the bony defect while repairing the supraosseous region with the formation of new CALs and the reduction of PD. A minimal increase in gingival recession was reported in the literature after GTR procedures,[40] even after using a microsurgical approach for the treatment of vertical bony defects.[42] In this study, the soft tissue wall technique was used to reduce gingival recession and achieve marginal soft tissue stability over a period of 12 months.

Thus, the soft tissue wall technique appears to be a reliable alternative to other surgical procedures[22,42] in the treatment of non-contained infrabony defects associated with impaired esthetics.

Conclusions

Within the limitations of this study, the proposed surgical technique yielded favorable clinical outcomes in terms of CAL gain and PD reduction that remained stable over a 12-month period. The coronal advancement of the flap led to improved esthetics by reducing gingival recession. Further studies with a larger number of patients are needed to support these preliminary data.

Acknowledgment

The authors reported no conflicts of interest related to this study.

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