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# Different Surgical Approach for Periodontal Regeneration

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## INTRODUCTION

At the beginning of the 1980s the need to modify standard periodontal surgical procedures to favor periodontal regeneration became apparent. In particular, the need to preserve soft tissues in order to attempt primary closure of the interdental space to contain grafts or coronally advanced flaps to cover furcation entrances led to the development of specific flap designs for periodontal regeneration (Takei et al. 1985; Gantes & Garret 1991). In fact, graft exfoliation and membrane exposure with consequent bacterial contamination during healing represented the major complications of periodontal regenerative procedures at the time. Membrane exposure was reported to be a major complication with prevalence in the range of 50–100% (Becker et al. 1988; Cortellini et al. 1990, 1993b; Selvig et al. 1992, 1993; Murphy 1995a; DeSanctis et al. 1996a,b; Falk et al. 1997; Trombelli et al. 1997; Mayfield et al. 1998). Cortellini et al. (1995c,d) reported that the prevalence of membrane exposure could be greatly reduced with the use of access flaps, specifically designed to preserve the interdental tissues (modified papilla preservation technique) . Many studies have shown that the exposed membranes are contaminated with bacteria (Selvig et al. 1990, 1992; Grevstad & Leknes 1992; Machtei et al. 1993; Mombelli et al. 1993; Tempro & Nalbandian 1993; Nowzari & Slots 1994; Novaes et al. 1995; Nowzari et al. 1995; DeSanctis et al. 1996a,b). Contamination of exposed non-bioabsorbable as well as bioabsorbable membranes was associated with lower probing attachment level gains in intrabony defects (Selvig et al. 1992; Nowzari & Slots 1994; Nowzari et al. 1995; DeSanctis et al. 1996a,b). The impaired clinical results in some studies were associated with high counts of bacteria and with the presence of P. gingivalis and A. actinomycetemcomitans (Machtei et al. 1994; Nowzari & Slots 1994; Nowzari et al. 1995). Bacterial contamination of the membrane may occur during surgery, but also during the postoperative healing phase. After placement, bacteria from the oral cavity may colonize the coronal part of the membrane. Frequently, this results in recession of the gingival tissues, which allows colonization of the membrane material further apically. In addition, “pocket” formation may occur on the outer surface of the membrane due to apical migration of the epithelium on the inner surface of the covering gingival tissue. This may allow bacteria from the oral cavity to colonize the subgingival area.

The significance of bacterial contamination was addressed in an investigation in monkeys (Sander & Karring 1995). The findings of this study showed that new attachment and bone formation occurred consistently when bacteria were prevented from invading the membrane and the wound during healing. In order to prevent wound infection, some investigators have administered systemic antibiotics to patients before and during the first weeks after membrane application (Demolon et al. 1993; Nowzari & Slots 1994). However, despite the application of systemic antibiotics, occurrence of post-operative wound infection related to implanted barrier membranes was noticed. This indicates that either the drug administered is not directed against the microorganisms responsible for the wound infection, or that the drug does not reach the infected site at a concentration sufficiently high to inhibit the target microorganisms. An improved effect on periodontal healing after GTR in association with local application of metronidazole was reported by Sander et al. (1994). Twelve patients with one pair of intrabony defects participated in the study. Metronidazole in a gel form was placed in the defects and on the membrane prior to wound closure, while the controls were treated with a membrane alone. Six months following membrane removal the medium gain in probing attachment level, presented as a percentage of the initial defect depth, was 92% for test defects versus 50% for the control defects. Other clinical parameters, like plaque index, bleeding on probing, pocket depth reduction or recession of the gingival margin, were similar in the test and control sites. Although the use of local or systemic antibiotics may reduce the bacterial load on exposed membranes, it seems ineffective in preventing the formation of a microbial biofi lm (Frandsen et al. 1994; Nowzari et al. 1995). Apart from the erythema and swelling related to such infection of the wound, more severe post-operative complications such as suppuration, sloughing or perforation of the flap, membrane exfoliation, and post-operative pain have been reported (Murphy 1995a,b). Another important issue associated with the clinical results is the coverage of the regenerated tissue after removal of a non-bioabsorbable membrane. Many authors have reported that the frequent occurrence of a gingival dehiscence over the membrane is likely to result in insufficient protection of the

interdental regenerated tissue (Becker et al. 1988; Selvig et al. 1992; Cortellini et al. 1993b; Tonetti et al. 1993a). Exposure of the regenerated tissue to the oral environment entails the risks of mechanical and infectious insults that in turn may prevent complete maturation of the regenerated tissue into a new connective tissue attachment. In fact, incomplete coverage of the regenerated tissue was associated with reduced attachment and bone gain at 1 year (Tonetti et al. 1993a). Recently, the positioning of a saddleshaped free gingival graft over the regenerated interdental tissue was suggested to offer better coverage and protection than a dehiscent gingival flap (Cortellini et al. 1995a). In this randomized controlled study, more gain of attachment was observed in the 14 sites where a free gingival graft was positioned after membrane removal (5.0 ± 2.1 mm), than in the 14 sites where conventional protection of the regenerated tissue was accomplished (3.7 ± 2.1 mm).

**Papilla preservation flaps**

The modified papilla preservation technique (MPPT) was developed in order to increase the space for regeneration, and in order to achieve and maintain primary closure of the flap in the interdental area (Cortellini et al. 1995c,d). This approach combines special soft tissue management with use of a self supporting titanium-reinforced membrane capable of maintaining a supra-alveolar space for regeneration. The MPPT allows primary closure of the interdental space, resulting in better protection of the membrane from the oral environment (Cortellini et al. 1995d). The technique involves the elevation of a full-thickness palatal flap which includes the entire interdental papilla. The buccal flap is mobilized with vertical and periosteal incisions, coronally positioned to cover the membrane, and sutured to the palatal flap through a horizontal internal crossed mattress suture over the membrane. A second internal mattress suture warrants primary closure between the flap and the interdental papilla. In a randomized controlled clinical study on 45 patients (Cortellini et al. 1995c), significantly greater amounts of attachment gain were obtained with the MPPT (5.3 ± 2.2 mm), in comparison with either conventional GTR (4.1 ± 1.9 mm) or flap surgery (2.5 ± 0.8 mm), demonstrating that a modified surgical approach can result in improved clinical outcomes. In this study 100% of the sites were closed on top of a titanium-reinforced membrane and 73% remained closed for up to 6 weeks, when the barrier membrane was removed. This study provided proof of principle of the benefit of specific flap designs for periodontal regeneration. A recent meta-analysis (Murphy & Gunsolley 2003) showed the existence of a trend associating better clinical outcomes in studies using flap designs and closing techniques considered conducive to the achievement and maintenance of primary closure of the flap The reported procedure can be successfully applied in sites where the interdental space width is at least 2 mm at the most coronal portion of the papilla. When interdental sites are narrower, the reported technique is difficult to apply. In order to overcome this problem, a different papilla preservation procedure (the simplified papilla preservation flap) has been proposed for narrower interdental spaces (Cortellini et al. 1999). This approach includes an oblique incision across the defect-associated papilla, starting from the buccal angle of the defect-associated tooth to reach the mid-interdental part of the papilla at the adjacent tooth under the contact point. In this way, the papilla is cut into two equal parts of which the buccal is elevated with the buccal flap and the lingual with the lingual flap. In the cited study, 100% of the narrow interdental papillae could be closed on top of bioresorbable barriers, and 67% maintained primary closure over time, resulting in 4.9 ± 1.8 mm of clinical attachment level gains.

**Modified papilla preservation technique**

The rationale for developing this technique was to achieve and maintain primary closure of the flap in the interdental space over the membrane (Cortellini et al. 1995d) (Figs. 43-16 to 43-18). Access to the interdental defect consists of a horizontal incision traced in the buccal keratinized gingiva at the base of the papilla, connected with mesio-distal buccal intrasulcular incisions. After elevation of a full-thickness buccal flap, the residual interdental tissues are dissected from the neighboring teeth and the underlying bone and elevated towards the palatal aspect. A full thickness palatal flap, including the interdental papilla, is elevated and the interdental defect exposed. Following debridement of the defect, the buccal flap is mobilized with vertical and periosteal incisions, when needed. This technique was originally designed for use in combination with self-supporting barrier membranes. In fact, the suturing technique requires a supportive (or supported) membrane to be effective. To obtain primary closure of the interdental space over the membrane, a first suture (horizontal internal crossed mattress suture) is placed beneath the mucoperiosteal flaps between the base of the palatal papilla and the buccal flap. The interdental portion of this suture hangs on top of the membrane allowing the coronal displacement of the buccal flap. This suture relieves all the tension of the flaps. To ensure primary passive closure of the interdental tissues over the membrane, a second suture (vertical internal mattress suture) is placed between the buccal aspect of the interdental papilla (i.e. the most coronal portion of the palatal flap which includes the interdental papilla) and the most coronal portion of the buccal flap. This suture is free of tension. An alternative type of suture to close the interdental tissues has been proposed by Dr Lars Laurell. This modified internal mattress suture starts from the external surface of the buccal flap, crosses the interdental area and gets through the lingual flap at the base of the papilla. The suture runs back through the external surface of the lingual flap and the internal surface of the buccal flap, about 3 mm apart from the first two bites. Finally, the suture is passed through the interdental area above the papillary tissues, passed through the loop of the suture on the lingual side, and brought back to the buccal side, where it

is tied. This suture is very effective in ensuring stability and primary closure of the interdental tissues. In a randomized controlled clinical study on 45 patients (Cortellini et al. 1995c), significantly greater amounts of PAL were gained with the MPPT (5.3 ± 2.2 mm), in comparison with either conventional GTR (4.1 ± 1.9 mm) or access flap surgery (2.5 ± 0.8 mm), demonstrating that a modifi ed surgical approach can result in improved clinical outcomes. The sites accessed with the MPPT showed primary closure of the flap in all but one case, and no gingival dehiscence until membrane removal, in 73% of the cases. This surgical approach has also been used in combination with non-supported bioresorbable barrier membranes (Cortellini et al. 1996c), with positive results. derivative (EMD) (Tonetti et al. 2002) or growth factors and bone replacement grafts


Fig. 43-12 Clinical case illustrating the management of the most common complication following application of non-resorbable barrier membrane: membrane exposure and consequent loss of interdental soft tissue. Upon completion of cause-related periodontal therapy, regenerative periodontal surgery was performed to resolve a deep pocket associated with a deep intrabony defect (a,b). The 7-mm intrabony defect was accessed with a modified papilla preservation flap (c) and a non-resorbable barrier membrane was placed (d). Primary closure with multilayered sutures was obtained, but 5 weeks after surgery, the membrane became exposed to the oral cavity (e). Upon membrane removal (f), a newly regenerated tissue completely filled the space below the membrane but inadequate amounts of soft tissue were available to completely cover the regenerated tissue in the interdental space. In order to protect the maturation of this tissue, a saddle-shaped interdental free gingival graft was harvested from the palate and shaped to precisely fit the interdental area (g). The graft healed well on the highly vascularized recipient bed and allowed good healing of the interdental tissues. Six years after completion of therapy, the clinical and radiographic outcomes show healing with shallow probing depths and elimination of the defect (h,i).

**Simplified papilla preservation flap**

To overcome some of the technical problems encountered with the MPPT (difficult application in narrow interdental spaces and in posterior areas, suturing technique not appropriate for use with nonsupportive barriers) a different approach (simplified papilla preservation flap, SPPF) was subsequently developed (Cortellini et al. 1999). This different and simplified approach to the interdental papilla includes a first incision across the defect-associated papilla, starting from the gingival margin at the buccal-line angle of the involved tooth to reach the mid-interdental portion of the papilla under the contact point of the adjacent tooth. This oblique incision is carried out keeping the blade parallel to the long axis of the teeth in order to avoid excessive thinning of the remaining interdental tissues. The first oblique interdental incision is continued intrasulcularly in the buccal aspect of the teeth neighboring the defect. After elevation of a full-thickness buccal flap, the remaining tissues of the papilla are carefully dissected from the neighboring teeth and the underlying bone crest. The interdental papillary tissues at the defect site are gently elevated along with the lingual/palatal flap to fully expose the interdental defect. Following defect debridement and root planing, vertical releasing incisions and/or periosteal incisions are performed, when needed, to improve the mobility of the buccal flap. After application of a barrier membrane, primary closure of the interdental tissues above the membrane is attempted in the absence of tension, with the following sutures:

A first horizontal internal mattress suture (offset mattress suture) is positioned in the defect associated interdental space running from the base (near to the mucogingival junction) of the keratinized tissue at the mid-buccal aspect of the tooth not involved with the defect to a symmetrical location at the base of the lingual /palatal flap. This suture frictions against the interdental root surface, hangs on the residual interdental bone crest and is anchored to the lingual/palatal flap. When tied, it allows the coronal positioning of the buccal flap. A relevant notation is that this suture, lying on the interdental bone crest, does not cause any compression at the mid-portion of the membrane, therefore preventing its collapse into the defect. 2. The interdental tissues above the membrane are then sutured to obtain primary closure with one of the following approaches: (a) one interrupted suture whenever the interdental space is narrow and the interdental tissues thin; (b) two interrupted sutures, when the interdental space is wider and the interdental tissues thicker; (c) an internal vertical/oblique mattress suture, when the interdental space is wide and the interdental tissues are thick. Special care has to be paid to ensure that the first horizontal mattress suture would relieve all the tension of the flaps, and to obtain primary passive closure of the interdental tissues over the membrane with the last suture. When tension is observed, the sutures should be removed and the primary passive closure attempted a second time. This approach has been preliminarily tested in a case series of 18 deep intrabony defects in combination with bioresorbable barrier membranes (Cortellini et al. 1999). The average clinical attachment level gain observed at 1 year was 4.9 ± 1.8 mm. In all the cases it was possible to obtain primary closure of the fl ap over the membrane, and 67% of the sites maintained primary closure over time. The same approach was then tested in a multi-center controlled randomized clinical trial involving 11 clinicians from seven different countries and a total of 136 defects (Tonetti et al. 1998). The average clinical attachment gain observed at 1 year in the 69 defects treated with the SPPF and a resorbable barrier membrane was 3 ± 1.6 mm. More than 60% of the treated sites maintained primary closure over time. It is important to underline that these results were obtained by different clinicians treating different populations of patients and defects, also involving narrow spaces and posterior areas of the mouth. The SPPF was successfully applied in conjunction with a variety of regenerative materials including biologically active materials such as EMD (Tonetti et al. 2002) and bone replacement grafts (Tonetti et al. 2004b; Cortellini & Tonetti 2004).

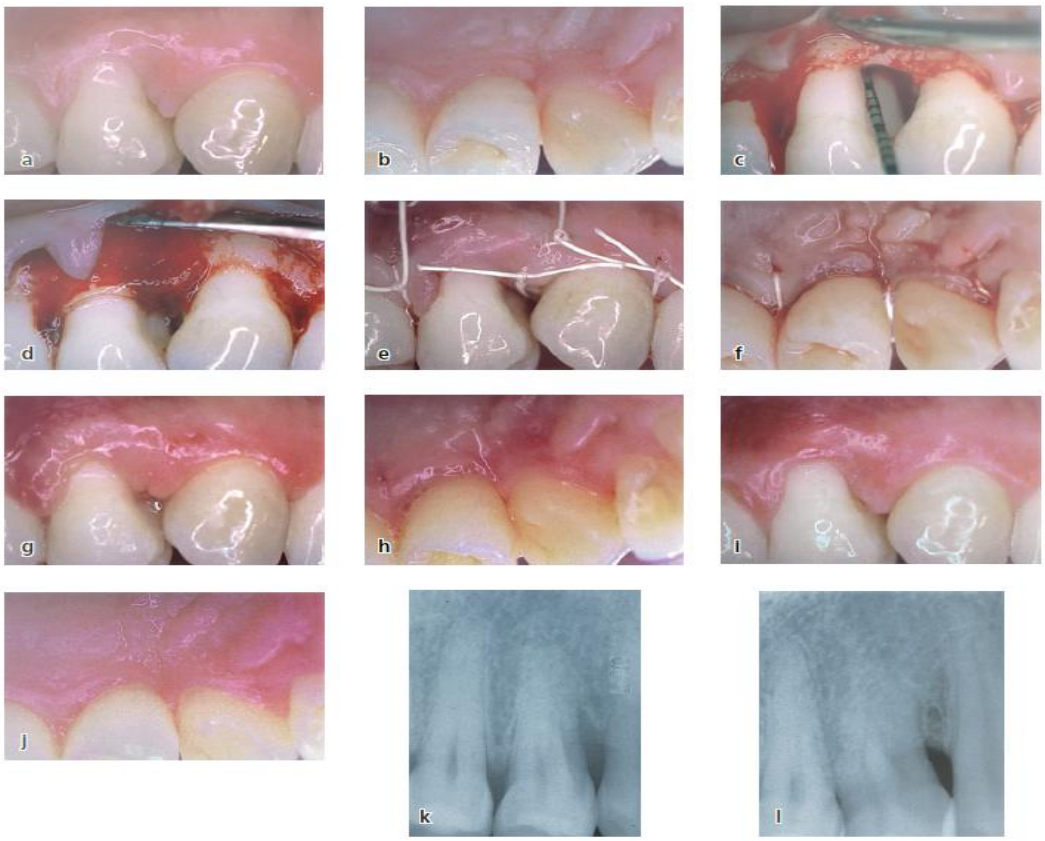
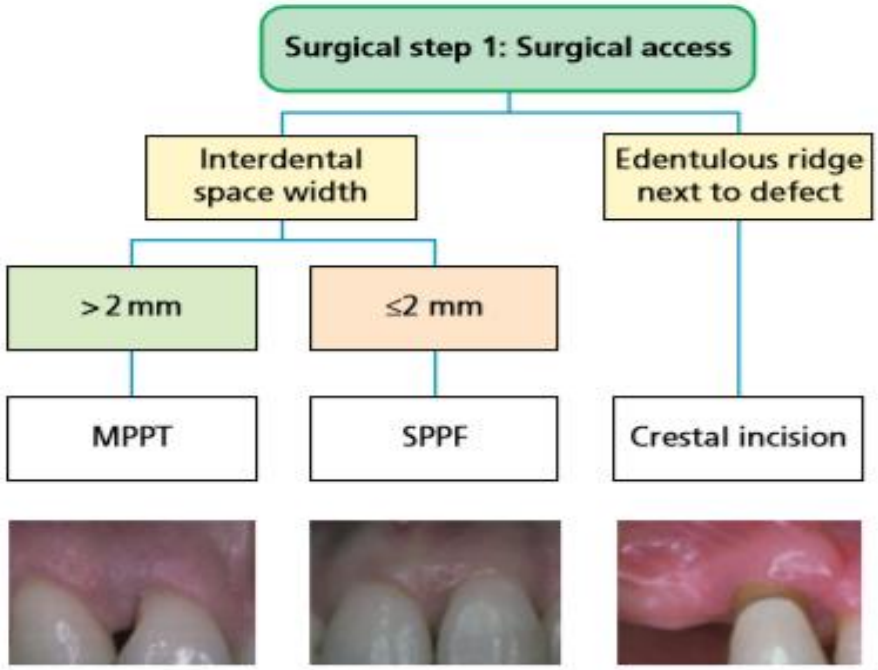



Fig. 43-15 (a) Right first maxillary premolar with a 7-mm pocket on the mesial surface. The interdental space (b) is very narrow (>2 mm), and is accessed with a simplified papilla preservation flap. The 5-mm deep intrabony defect (c) is covered with a bioresorbable barrier membrane (d). Primary closure of the flap over the membrane (e,f) is maintained over time (g,h). After 1 year, the interdental papilla is completely preserved and the residual pocket depth is 3 mm (i,j). The radiograph taken at baseline (k) compared with that taken 1 year after treatment (l) shows that the intrabony defect has healed completely.




**Minimally invasive surgical technique**

In order to provide even greater wound stability and to further limit patient morbidity, a papilla preservation flap can be used in the context of a minimally invasive, high-power magnifi cation-assisted surgical technique (Cortellini & Tonetti 2007a). Such a minimally invasive approach is particularly suited for treatment in conjunction with biologically active agents such as EMD or growth factors. The defect-associated interdental papilla is accessed either with the simplified papilla preservation flap (SPPF) (Cortellini et al. 1999) or the modified papilla preservation technique (MPPT) (Cortellini et al. 1995d). The SPPF is performed whenever the width of the interdental space is 2 mm or narrower, while the MPPT is applied at interdental sites wider than 2 mm. The interdental incision (SPPF or MPPT) is extended to the buccal and lingual aspects of the two teeth adjacent to the defect. These incisions are strictly intrasulcular to preserve all the height and width of the gingiva, and their mesio-distal extension is kept at a minimum to allow the corono-apical elevation of a very small full-thickness flap with the objective of exposing just 1–2 mm of the defect-associated residual bone crest. When possible, only the defect-associated papilla is accessed and vertical releasing incisions are avoided. With these general rules in mind, different clinical pictures can be encountered in different defects. The shortest mesio-distal extension of the incision and the minimal flap reflection occurs when the intrabony defect is a pure three-wall, or has shallow two- and/or one-wall subcomponents allocated entirely in the interdental area. In these instances the mesio-distal incision involves only the defect-associated papilla and part of the buccal and lingual aspects of the two teeth neighboring the defect. The full thickness flap is elevated minimally, just to expose the buccal and lingual bone crest delineating the defect in the interdental area. A larger corono-apical elevation of the fullthickness flap is necessary when the coronal portion of the intrabony defect has a deep two-wall component. The corono-apical extension of the flap is kept to a minimum at the aspect where the bony wall is preserved (either buccal or lingual), and extends more apically at the site where the bony wall is missing (lingual or buccal), the objective being to reach and expose 1–2 mm of the residual bone crest. When a deep one-wall defect is approached, the full-thickness fl ap is elevated to the same extent on both the buccal and the lingual aspects. When the position of the residual buccal/lingual bony wall(s) is very deep and difficult or impossible to reach with the above described minimal incision of the defect-associated interdental space, the flap(s) is (are) further extended mesially or distally involving one extra interdental space to obtain a larger flap reflection. The same approach is used when the bony defect also extends to the buccal or the palatal side of the involved tooth, or when it involves the two interdental spaces of the same tooth or two approximal teeth. In the latter instance a second interdental papilla is accessed, either with a SPPF or a MPPT, according to indications. Vertical releasing incisions are performed when flap reflection causes tension at the extremities of the flap(s). The vertical releasing incisions are always kept very short and within the attached gingiva (never involving the mucogingival junction). The overall aim of this approach is to avoid using vertical incisions whenever possible or to reduce their number and extent to a minimum when there is a clear indication for them. Periosteal incisions are never performed. The defects are debrided with a combined use of mini curettes and power-driven instruments and the roots carefully planed. During the instrumentation the flaps are slightly reflected, carefully protected with periosteal elevators and frequent saline irrigations. At the end of instrumentation the biologically active agent is applied. Then the flaps are

repositioned. The suturing approach in most of the instances consists of a single modified internal mattress suture at the defect-associated interdental area to achieve primary closure of the papilla in the absence of any tension (Cortellini & Tonetti 2001, 2005). When a second interdental space has been accessed, the same suturing technique is used to obtain primary closure in this area. Vertical releasing incisions are sutured with simple passing sutures. The buccal and lingual flaps are re-positioned at their original level, without any coronal displacement to avoid any additional tension in the healing area.