Space Provision Ensures Bone Formation in Gingival Recession Defects Treated by GTR: A Case Report

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This case report will show the potential of space provision for bone regrowth underneath a non-resorbable barrier device in a recession defect where the concept of cell exclusion was intentionally neglected. A deep and wide gingival recession defect associated with a 10mm-deep bone dehiscence was treated by a coronally advanced flap in conjunction with a titanium-reinforced ePTFE membrane. At the time of membrane positioning, the device was intentionally perforated to allow for tissue ingrowth and colonization of the space between the membrane and the root surface by means of cell lines that are usually excluded under GTR provision. Clinical evaluation after tissue maturation phase revealed a substantial bone regeneration and attachment gain onto the previously exposed root surface, which were maintained long-term.

Key words: guide tissue regeneration, space provision, cell exclusion, periodontal regeneration, perforated membrane

INTRODUCTION

Guided tissue regeneration (GTR) is defined as a controlled stimulation of new connective tissue attachment and bone formation by means of mechanical barriers in areas where a periodontal defect exists, re-establishing both structural and functional characteristics. The use of barrier membranes to facilitate periodontal regeneration has proven to be successful in a variety of periodontal defects, included gingival recessions (Trombelli et al, 1994; Trombelli et al, 1995; Trombelli et al, 1997; Trombelli et al, 1998; Trombelli et al, 2005).

Underlying mechanical, cellular and molecular mechanisms supporting GTR principles are still under investigation. Placement of the physical barrier prevents the epithelium and gingival connective tissue from contacting the root surface during healing, thus providing a secluded space where cells from periodontal ligament and bone are allowed to migrate and proliferate. However, the technique may lead to the exclusion of tissue compartments from the healing process which may contribute to bone regeneration (Verna et al, 2002). It has been demonstrated that the removal or damage of the periosteum over a bone defect restrains bone regeneration (Verna et al, 2002), while its preservation enhances the healing capacity (Verna et al, 2002). Periosteum may act as a natural occurring physical barrier, which excludes the surrounding soft tissues and protects the hematoma in the bone defect (Rintala et al, 1974; Rubak, 1983). It also provides both blood supply to the cortical bone and osteoprogenitor cells for bone regeneration (Wang and Glimcher, 1999). In previous studies, where membrane-supported bone healing was investigated in calvarial bone defects, the exclusion of both brain with the surrounding meninges and extracranial soft tissues resulted in predictable bone regeneration (Verna et al, 2002). Remarkably, ingrowth of new periosteum spread-

Fig 1a–b Presurgical view of the Miller's class II recession defect present on tooth # 1.4.

ing beneath the membrane was clearly seen in sites where complete defect closure had occurred (Bosch, 1996).

Significance of space provision by barrier membranes to support bone regrowth has been demonstrated to be critical in large supraalveolar periodontal defects (Sigurdsson et al, 1994). Extent of bone regeneration significantly correlated to the amount of space created between the membrane, the root and the alveolar bone. On the other hand, experimental studies using GTR in recession defects, where membranes have been positioned in close contact to the root surface, have shown limited bone regeneration (Trombelli, 1999). Various methods to create space for tissue regeneration have been proposed with GTR in recession defects, such as mechanical reduction of the root profile, space providing barrier devices and the additional use of implant biomaterials (Trombelli, 1999). Although consistent root coverage has been observed irrespective of the space-making protocol, the relevance of space provision in promoting alveolar bone regeneration in dehiscence-type defects has not yet been determined.

This case report will show the potential of space-provision for bone regrowth underneath a non-resorbable barrier device in a recession defect where the concept of cell exclusion was intentionally neglected.

MATERIALS AND METHODS

Case History

A 23 year-old female, periodontally healthy non-smoker was referred to Research Center for the Study of Periodontal Diseases, University of Ferrara, Italy, for multiple gingival recessions causing dentine hypersensitivity and aesthetic impairment. In particular, a Miller's class II recession defect, 6mm deep and 4mm wide, was present on tooth # 1.4 (Fig. 1a, b). Clinical attachment level (CAL) was 7mm, and the apico-coronal amount of keratinized tissue (KT) was 1mm. Bone-sounding revealed a substantial bone dehiscence on the buccal aspect (10mm deep). The etiology of the gingival recession was traumatic in origin, possibly due to an overzealous toothbrushing habit. An associated cervical abrasion with loss of tooth substance was evident. Professional and self-provided treatment of dentin hypersensitivity did not lead to any considerable beneficial effect. The patient's chief request included the improvement of the aesthetic appearance and hypersensitivity reduction.

Surgical Treatment

The patient received multiple sessions of initial therapy, based on oral hygiene instruction (soft toothbrush, Roll technique, low RDA toothpaste) and supragingival polishing and scaling. Surgical treatment was performed only when the patient showed

Fig 2a–b Trapezoidal full-thickness flap risen 3–4mm apical to the bone dehiscence.

adequate proficiency in oral hygiene performance. Since the gingival recession was associated with a considerable loss of connective tissue attachment and bone support, the surgical correction was achieved by means of a non-resorbable barrier device according to GTR principles. A detailed description of the surgical procedure was described in previous reports (Trombelli et al, 1994; Trombelli et al, 1995; Trombelli et al, 1997; Trombelli et al, 1998; Trombelli et al, 2005). Briefly, following anesthesia, the exposed root surface was carefully planed with curettes and ultrasonic instruments. A horizontal right-angle incision was made into the adjacent interdental papillae at the cemento-enamel junction (CEJ) of the tooth. Two oblique releasing incisions were made, starting at least 0.5mm from the gingival margin of the adjacent teeth and extending into the alveolar mucosa. A trapezoidal full-thickness flap was raised 3-4mm apical to the bone dehiscence, then a partial-thickness dissection was performed to allow for coronal positioning of the flap (Fig 2a, b). A titanium-reinforced expanded polytetrafluoroethylene membrane (ePTFE) (Gore Tex Periodontal Material, W. L. Gore and Associates, Flagstaff, AZ) was trimmed and adapted between the flap and the root surface extending from the CEJ to 4-5mm apical to the bone crest. Before being secured in place with sling ePTFE sutures (Gore Tex Suture; CV-5, W. L. Gore and Associates, Flagstaff, AZ), macroscopic holes (macropores) were made through the membrane with a rubber dam clamp, in order to allow for the epithelial/connective tissue cell migration into the provided space during the healing process (Fig 3a). Membrane perforations, although permitting tissue ingrowth, were compatible with space provision which was warranted by means of the intact titanium frame (Fig 3b, c). Flap was coronally positioned without tension to submerge the membrane, and fixed with ePTFE sutures (Gore Tex Suture; CV-5, W. L. Gore and Associates, Flagstaff, AZ) (Fig 4).

A post-surgery protocol emphasizing wound stability and infection control, including administration of doxycycline (200mg for day one post-surgery, 100mg/day for six days), and 0.12% chlorhexidine rinse (0.5oz b.i.d. for eight weeks), was prescribed. Gingival sutures were removed two weeks postsurgery. The membrane was surgically removed five weeks later (Fig 5a). At this time, the newly formed granulation tissue (NFGT) covered the previously exposed root surface up to 2mm apical to the CEJ. Remarkably, soft tissue "plugs" penetrating from the inner aspect of the flap through the membrane were noted in relation to the location of the macropores (Fig 5b, c). The flap was secured to cover the NFGT with 4/0 Vicryl® sutures (Johnson & Johnson Inc., Pomezia, Italy).


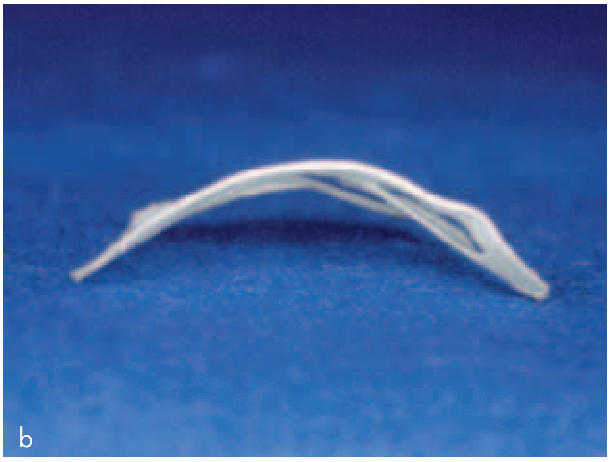


Fig 3a–c Titanium-reinforced ePTFE membrane with macroscopic holes (macropores) made in order to allow for the epithelial/connective tissue cell migration into the provided space during the healing process.

Fig 4 Coronal positioning of the flap with ePTFE sutures.

Maintenance Phase and Re-entry

Mechanical plaque control in the surgical area was reinstituted at week eight following surgery. The patient was recalled for supragingival scaling and oral hygiene instruction on a three-monthly basis for the 12-month observation interval.

At 14 months post-surgery a residual recession depth of 1mm was present (Fig 6). With respect to pre-surgery evaluation, a CAL gain of 5mm and an increase in KT of 1mm were observed. With the patient's informed consent the site was surgically re-entered. Newly formed bone covering the previously exposed root surface up to 4mm from the CEJ was observed (Fig 7). Therefore, bone regrowth amounted to 6mm from the pre-surgery level. The flap was coronally advanced to the CEJ.

Follow-up Visits

Following the 14-month re-entry, the patient was referred to her dentist for regular supportive therapy based on a six-monthly recall program. At three years post-surgery the gingival margin was still at the CEJ, with a KT of 4mm (Fig 8). However, a 2mm recurrence of the gingival recession was noted at the eight-year examination, with CAL of 3mm and KT of 3mm (Fig 9).

DISCUSSION AND CONCLUSIONS

The present case report describes the treatment of a deep and wide gingival recession defect associated with a deep bone dehiscence by means of a space-providing non-resorbable barrier mem-

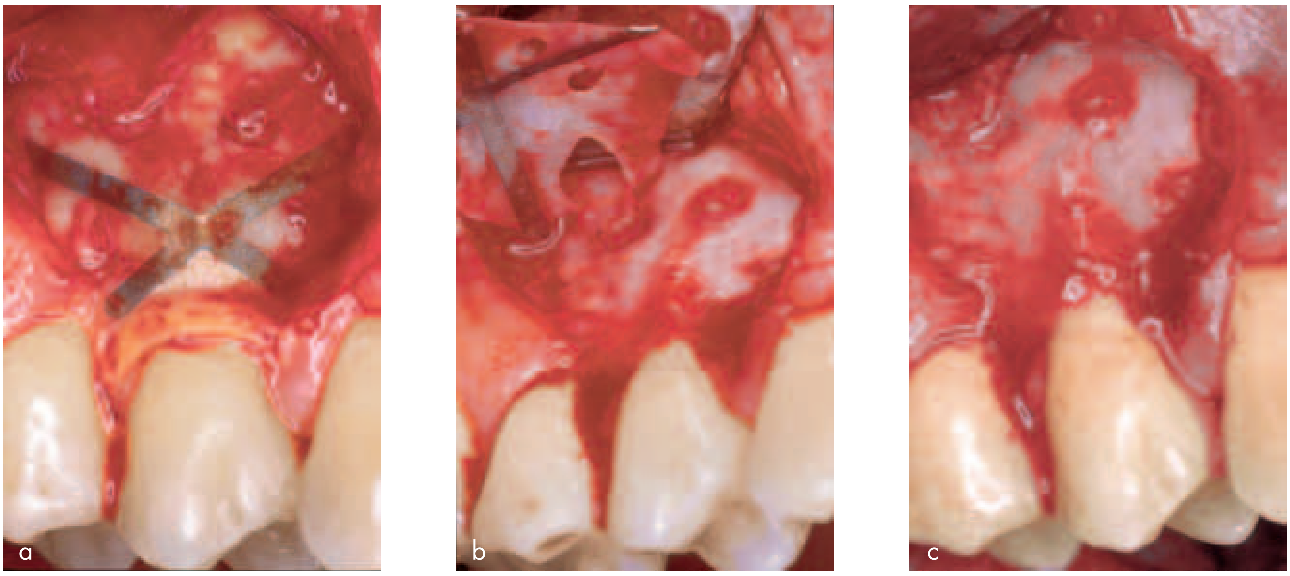

Fig 5a–c Surgical removal of the membrane five weeks postsurgery.

Fig 6 14-month postsurgery view of the treated region.

Fig 7 Newly formed bone covering the previously exposed root surface up to 4mm from the CEJ observed at 14-month postsurgery re-entry.

Fig 8 Three-year postsurgery view of the treated tooth.

Fig 9 Eight-year postsurgery view of the treated tooth.

brane. At the time of positioning, the ePTFE device was intentionally perforated to allow for tissue ingrowth and colonization of the space between the membrane and the root surface by means of cell lines that have been considered detrimental for periodontal regeneration (Nyman et al, 1987). Nevertheless, clinical evaluation after tissue maturation phase showed that this approach was capable to promote substantial bone regeneration and attachment gain onto the previously exposed root surface, which were maintained long-term. To the best of our knowledge this report represents the only available evidence that the principle of space provision in absence of tissue occlusion may lead to the reconstruction of the attachment apparatus of the tooth in non-self space-providing defects in humans.

Whether and to what extent the alveolar bone reconstruction observed at re-entry may represent a complete periodontal regeneration, including cementum, bone and periodontal ligament, could not be assessed since the clinical improvement has not been proved histologically. The presence of a long-junctional epithelium interposed between the previously exposed root surface and the newly formed alveolar bone can not, therefore, be excluded. However, histologic analysis of GTR treated recessions showed the reestablishment of a connective tissue attachment connecting the newly formed bone and the regenerated cementum in both animals (Gottlow et al, 1984; Gottlow et al, 1990) and humans (Parma Benfenati and Tinti, 1998; Vincenzi et al, 1998). An indirect evidence of the regenerative potential of the GTR procedure stems from the observation of an increase in KT observed following tissue maturation phase. In this respect gingival augmentation following GTR in recession defects has been positively correlated with the amount of regenerated tissue covering the root surface (Trombelli et al. 1995).

The importance of space provision in the vertical and horizontal reconstruction of the edentulous alveolar ridge has been extensively demonstrated. (von Arx et al 1998; Thor, 2002 ; Artzi et al, 2003; Proussaefs et al, 2003; Roccuzzo et al, 2004). However, limited evidence exists, demonstrating that space provision, other than cell exclusion, may be compatible with the reconstruction of the lost periodontal bone around teeth. A recent report in an experimental dog model has shown that periodontal regeneration, including bone formation, can predictably be obtained in absence of tissue occlusion (Wikesjo et al, 2003). Space-providing expanded ePTFE membranes, with (macroporous) or without (occlusive) 300 micron laser-drilled pores, 0.8mm apart, were implanted in critical size supra-alveolar periodontal defects to provide for GTR. After eight weeks of healing, the amount of alveolar bone regeneration was similar for animals receiving occlusive and macroporous ePTFE membranes. These results are consistent with those observed in a clinical controlled trial where the regenerative effects of a nonporous polytetrafluoroethylene periodontal membrane compared to a porous ePTFE periodontal membrane were evaluated in the treatment of vertical osseous defects in combination with a xenograft. At nine months re-entry both nonporous and porous membranes resulted in statistically significant bone defect fill, with no significant difference between treatment groups (Walters et al, 2003).

Overall these findings suggest that tissue occlusion may not be an absolute prerequisite for alveolar bone regeneration in periodontal sites. Hhowever, it cannot be excluded that the amount of regenerated bone, as observed in our specific case, would have been greater in presence of tissue occlusion. Recent experimental studies showed that both space-provision and device occlusivity have a synergistic effect in enhancing bone regeneration. Specifically, periodontal sites receiving the occlusive GTR device and those with enhanced space-provision showed significantly greater bone regeneration compared to sites receiving the porous GTR device or more limited space-provision (Polimeni et al, 2004). Further controlled studies are, therefore, needed to assess whether and to what extent the interaction between space provision and tissue occlusion may affect the outcome of regeneration in humans.

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