Peri-implant guided bone regeneration using an equine cortical bone membrane and an equine enzyme-treated bone graft: a case report

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Introduction

Prosthetic-guided restoration calls for placing osseointegrated implants in those positions that guarantee the best support for a prosthesis that, in turn, has been designed to provide the patient with the most effective functional and aesthetic rehabilitation. Such approach relies on the availability of sufficient bone quantity for placing implants at the pre-designed positions having appropriate primary stability. This condition is not always met in the clinical practice as a variety of reasons including surgery, trauma, congenital defects, and bone atrophy consequent to edentulism (Atwood, 1971; Atwood, 1979; Araujo, 2005) may lead to a lack of bone volume. All these conditions may call for bone grafting aiming at restoring volume and allow implant insertion. Even when osseointegrated fixtures can be placed, bone augmentation is often advised to achieve a stable and satisfying aesthetic restorative result (Buser, 2004). Bone augmentation may be carried out according to guided bone regeneration (GBR) (Nyman, 1990; Tinti, 1996; Esposito, 2009). The GBR procedure calls for protecting the defect site using a barrier membrane to prevent non-osteogenic cells to invade it, and allow osteogenic ones, coming from the bone wound, to proliferate, differentiate and regenerate the bone defect (Nyman, 1980; Karring, 1980). Barrier membranes for GBR must display tissue integration, cell-occlusivity, clinical manageable, space-making, and biocompatibility as stated by Scantlebury in 1993 (Scantlebury, 1993). First barriers were non-resorbable (Gotfredsen, 1991; Jovanovic, 1992). Later, resorbable membranes were

KEYWORDS

Guided bone regeneration, equine bone, cortical bone, equine membrane, barrier membrane, bone collagen.

ABSTRACT

Background: In the anterior maxilla, where patients typically have the highest expectations for implant-supported restorations, bone resorption consequent to edentulism often leads to a lack of soft tissue support and ultimately to unsatisfactory aesthetic results. When this occurs, buccal bone augmentation following guided bone regeneration principles at the time of implant placement, and appropriate, even incremental, management of soft tissues, may instead guarantee the prosthetic, clinical and aesthetic success. Regeneration is accomplished using a membrane, interposed between the soft tissue and the grafting material, acting as a barrier between the different cell types. The authors have been using since several years a membrane made of thin, flexible equine cortical bone that is rendered non-antigenic by a collagen-preserving enzymatic process. The aim is to report a successful use of equine enzyme-deantigenic cortical membrane and bone granules for guided bone regeneration in the aesthetic zone concomitant with implant placement.

Case report: This report describes the treatment of a patient who received an equine enzyme-deantigenic graft and membrane in conjunction with placement of an implant in the upper anterior left maxilla, and careful soft tissue management. The purpose was both that of regenerating the peri-implant bone tissue and that of recovering an appropriate ridge profile, to guarantee implant osseointegration as well as an excellent functional and esthetic outcome. No intra- or post-surgical complications occurred. After three years, the patient was still very satisfied with her appearance. A CBCT scan showed that the peri-implant bone levels and ridge thickness had been maintained, and possibly a novel physiological cortical ridge layer had been formed.

Conclusion: Guided bone regeneration with the concomitant use of enzyme-deantigenic membrane and graft may be a valuable and suitable option for effective implant-supported prosthetic rehabilitations in the aesthetic zone.
introduced that allowed effective bone regeneration while reducing the complication rates associated with membrane exposure and avoiding a second surgery for barrier removal. Membranes currently used to perform guided bone regeneration interventions range from resorbable collagen, animal-derived or synthetic membranes (Garg, 2011; Stoeckling-Wasmer, 2013) to non-resorbable expanded or high-density PTFE barriers (Carbonell, 2014), and non-resorbable titanium meshes (Rasia dal Polo, 2014). Homologous demineralized cortical bone sheets also have been successfully used as barrier membranes both in GBR procedures (Scher, 1992; Fugazzotto, 1995; Majzoub 1999), to manage sinus membrane perforations (Shlomi, 2004), and to treat mandibular molar furcations (Scott, 1999) but their use, to the authors’ knowledge, has not been further reported in literature despite their success. Yet, laminar bone sheets may show certain advantages over other resorbable membranes, namely a long persistence at the grafting site (Majzoub, 1999), that might favor regenerating sites that, given their size or other anatomical features, might heal slowly (Buser, 2004; Chiapasco, 2009). The authors have been using for some years (Di Stefano, 2011; Di Stefano, 2017) an equine bone membrane that closely resembles the mentioned homologous laminar bone sheet, being a thin layer of flexible, partially demineralized cortical bone. The aim of this study is therefore to describe its application in a case where peri-implant guided bone regeneration was carried out in the anterior maxilla, a highly aesthetically demanding area.

Case report

The patient was a 62-year-old woman with a non-contributory medical history who complained of pain on chewing at the canine of the upper left arch. Clinical and radiographic examination showed a root fracture involving tooth 2.3 (Figure 1).

Figure 1. Pre-surgical CBCT carried out to plan the implant positioning, showing the vestibular bone defect affecting the maxillary ridge. Implant placement, planned according to the principles of prosthetic-guided surgery, requires guided bone regeneration to give the ridge an adequate thickness.

The patient was proposed with a treatment plan involving the extraction of the compromised tooth, followed by placing a single osseointegrated implant and delivering a metal-ceramic crown. While examining the CBCT scans (Figure 1), and planning implant positioning, the complete loss of the vestibular ridge wall was observed. Given the vestibular bone loss, as well as an ongoing inflammatory process, and considering the outcome of the extraction, the patient was also proposed to undergo bone regeneration surgery concomitant to implant placement. The patient provided informed consent.

Extraction was carried out as a medical emergency procedure, given the ongoing infection and the loss of the vestibular ridge wall.

Implant surgery (Figure 2a-h) was carried out three months after extracting the tooth, to allow soft tissue to heal appropriately. For antibiotic prophylaxis, 2 g of amoxicillin/clavulanic acid (Augmentin, Glaxo-SmithKline, Verona, Italy) were administered one hour before surgery and then every 12 hours for eight...
days. The patient also rinsed for two minutes with chlorhexidine 0.20% mouth rinse (Corsodyl, Glaxo-SmithKline) and received 100 mg of a non-steroidal-anti-inflammatory drug (Aulin, Roche, Milano, Italy). Local anesthetic was administered by means of infiltration into the oral mucosa with 1% articaine with epinephrine 1:100000 (Molteni Dental, Milano, Italy).

A mid-crestal full-thickness incision was created within the keratinized mucosa of the edentulous ridge, extending it partially to the adjacent incisor and premolar through an intrasulcular incision; an envelope flap was elevated. The implant site was prepared by drilling and then using an osteotome to expand the ridge. Then a cylindrical 3.3 x 13 mm implant (Xive, Dentsply, York, PA, USA) was placed (Figure 2a-c).

The vestibular side of the implant was partially exposed. The peri-implant bone defect was then grafted using enzyme-processed 0.5-1.0 mm bone granules (Osteoxenon Mix Bone Granules, Bioteck, Arcugnano, Italy) up to give the vestibular ridge an appropriate thickness and profile (Figure 2d). The grafted site was protected using the equine cortical membrane (Osteoxenon Cortical membrane, 25 by 25 by 0.2 mm, Bioteck, Arcugnano, Italy) (Figure 2e). Such membrane is a thin cortical flexible bone layer. For its manufacture, equine cortical bone is first made non-antigenic using digestive enzymes that eliminate equine antigens yet preserve bone collagen. Then bone is made thin by mechanical abrasion. Finally, the bone sheet undergoes partial demineralization to make it flexible.

The membrane was cut to the desired shape, hydrated with sterile saline solution, and then positioned over the ridge, to cover the grafted site. Membrane stabilization was achieved using titanium pins (Figure 2f).

The flap was closed using non-resorbable sutures (Monomyd 4-0/5-0 Polyamide Monofilament Suture, Butterfly, Cavenago, Italy) (Figure 2h), leaving the implant submerged. The patient wore a provisional restoration that was supported by the incisors for the following five months. Then under the same antibiotic prophylaxis previously described, the implant was uncovered, and a healing screw was placed to allow for proper soft tissue conditioning (Figure 3). Non-resorbable sutures (Monomyd 4-0/5-0 Polyamide Monofilament Suture, Butterfly, Cavenago, Italy) were placed and removed six days later. Soft tissue conditioning was achieved over the ensuing four months with the aid of a screw-retained provisional crown. At this point the patient was definitively rehabilitated (Figure 4 and 5). She returned for follow-up controls every six months for the following three years. At that point, another CBCT (Figure 6) scan enabled assessing the bone volume that corresponded to the earlier augmentation procedure.
Results
The patient did not suffer any intra- or post-surgical complications following any of the interventions she had undergone. Soft tissue covering the membrane showed excellent healing. After three years, the appearance of the rehabilitation was still quite satisfactory with no gingival recession evident. Instead, excellent soft tissue healing and conditioning were observed. The peri-implant bone levels also had been maintained. The CBCT scan (Figure 6) showed that no ridge thickness had been lost at the recipient site and that a new cortical layer could be observed, while the cortical layer in the pristine ridge had undergone remodeling.

Discussion
The membranes used in the present study are made of cortical bone, the same type of tissue that constitutes the natural outer layer of the alveolar ridge. Cortical bone porosity is determined also by the structural and functional connections it has with the periosteum; it also modulates the exchange of nutrients and fluids at the periosteum-bone interface (Allen, 2004). It might be assumed, therefore, that these thin cortical bone sheets might display optimal porosity for guaranteeing appropriate fluid, oxygen and nutrient exchange with the underlying graft. It is therefore reasonable to assume that with the underlying graft while preventing soft tissue cells from invading the grafted site. During implantation, these membranes appeared stiff enough to prevent collapsing; the subjective perception of their stiffness was intermediate between that of soft collagen membranes, usually collapsing when not adequately supported by underlying particulate grafts, and that of titanium-reinforced e-PTFE membranes. Yet, the authors would not suggest using them for reconstructions without carrying out any concomitant grafting, in line with the observations of Majzoub et al concerning similar homologous laminar bone sheets (Majzoub, 1999). The authors have been using these membranes since years and are currently carrying out a retrospective data collection. No soft tissue fenestration and/or infection over the underlying graft. It is therefore reasonable to assume, therefore, that these thin cortical bone sheets might display optimal porosity for guaranteeing appropriate fluid, oxygen and nutrient exchange with the periosteum-bone interface (Allen, 2004). It might be assumed, therefore, that these thin cortical bone sheets might display optimal porosity for guaranteeing appropriate fluid, oxygen and nutrient exchange with the underlying graft. It is therefore reasonable to assume that with the underlying graft while preventing soft tissue cells from invading the grafted site. During implantation, these membranes appeared stiff enough to prevent collapsing; the subjective perception of their stiffness was intermediate between that of soft collagen membranes, usually collapsing when not adequately supported by underlying particulate grafts, and that of titanium-reinforced e-PTFE membranes. Yet, the authors would not suggest using them for reconstructions without carrying out any concomitant grafting, in line with the observations of Majzoub et al concerning similar homologous laminar bone sheets (Majzoub, 1999). The authors have been using these membranes since years and are currently carrying out a retrospective data collection. No soft tissue fenestration and/or infection over the cortical membrane were ever observed indicating that – provided proper soft tissue closure is achieved – these membranes are well-tolerated by the overlying tissues.

Conclusions
The equine cortical bone membrane used in the present case allowed for successful peri-implant guided bone regeneration and the augmentation of a partially atrophic ridge, allowing to achieve an excellent implant-supported rehabilitation. Guided bone regeneration with the concomitant use of enzyme-deantigenic membrane and graft may be a valuable and suitable option for effective implant-supported prosthetic rehabilitations in the aesthetic zone.

A retrospective data collection is currently being carried out to verify if such results are actually and consistently replicable.

References

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