Surgical predictability of vertical GBR in the posterior mandible: flap design, management and passivation of soft tissues as principal keys for success

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The effectiveness of guided bone regeneration (GBR), a technique used to promote horizontal or vertical bone regeneration, has been well-documented since the early 1990s. The stability of the regenerated bone and its positive response in time, once functioning, has also been well-demonstrated.

Vertical GBR is a technique with great potential but one that requires both the precise adherence to surgical protocols and application by operators with the appropriate knowledge and manual skills to ensure optimum management of soft tissues. In addition to achieving primary closure of the flaps, maintaining this closure during the entire period necessary for the formation and maturation of the new bone is a pre-requisite for the avoidance of membrane exposure, which inevitably leads not only to bacterial contamination but, nearly always, to the impairment of the surgical procedure of regeneration.

Numerous studies have described various clinical protocols regarding the management of soft tissues in both the upper and lower arches. This retrospective analysis describes the surgical technique of the management of soft tissues applied during GBR with non-resorbable membranes in 127 cases of vertical defects of the posterior mandible and evaluates the clinical results obtained.

**Materials and techniques**

Between 2000 and 2012, a total of 127 cases...
of vertical bone defects in edentulous posterior mandibles were treated with the use of GBR with non-resorbable membranes.

The technique was applied by following a surgical protocol, which has undergone few variations during the years.

From 2000 to 2008, expanded polytetrafluoroethylene (e-PTFE) titanium-reinforced non-resorbable membranes (Gore-Tex TR9, W.L. Gore & Associates, Flagstaff, Ariz.) were used as a barrier device in 72 cases (Fig. 1).

From 2009 to 2012, high-density polytetrafluoroethylene (d-PTFE) titanium-reinforced non-resorbable membranes (Cytoplast TI250XL, Osteogenics Biomedical, Lubbock, Texas) were used as a barrier device in 55 cases (Fig. 2).

All the membranes were fixed mesially and distally on the lingual side with the use of titanium pins (Helmut Zepf Medizintechnik, Seitingen, Germany) or mini-screws (Pro-Fix, Osteogenics Biomedical, Lubbock, Texas) (Fig. 3).

After positioning the graft material around the implants, which were left protruding from the crest (Fig. 4), the membranes were also stabilized on the buccal side with the same fixation devices (Fig. 5).

Preparation of the implant sites, for the most coronal portion of the osteotomy, involved the use of twist drills and, for the most apical portion, near the mandibular nerve, a piezoelectric OT4 insert (Piezosurgery, Mectron, Carasco, Italy) (Fig. 6).

Implants (Spline Twist and Tapered Screw-Vent, Zimmer Dental, Carlsbad, Calif.) were inserted, leaving their most coronal portion protruding from the crest for a length equivalent to the vertical bone regeneration planned. In certain cases — those in which it was not possible to obtain adequate primary stability in low quantities of residual bone — the vertical bone regeneration preceded the positioning of the implants (Figs. 7, 8).

Multiple cortical perforations, which created openings for osteopromotion, were then made with a piezoelectric OP5 insert (Piezosurgery, Mectron, Carasco, Italy) in order to stimulate blood and cell migration from the bone marrow spaces to the regeneration area.18,19

During the period of time analyzed, various graft materials, alone or combined, were used together with the membranes: autologous bone; tricalcium phosphate; DBM (Dynagraft, Keystone Dental, Burlington, Mass.); MFDBA (Puros, Zimmer Dental, Carlsbad, Calif.); or combinations of mineralized and demineralized allograft bone (MFDBA & DFDBA, enCore, Osteogenics Biomedical).

Surgical management of soft tissue

All surgeries as well as postoperative care are carried out by a single operator. For each patient, treatment includes the analysis of a diagnostic wax-up and CT or CBCT scan performed with a template. The objective is not only to position the implants where the quantity of residual bone allows but to position their platforms on the ideal line situated approximately 2 mm under the cement-enamel junction of the adjacent teeth.

After performing local anesthesia, (articaine hydrochloride 4 percent with epinephrine 1:100,000, Septanest, Ogna, Muggiò, Italy), a horizontal, mid-crestal, full thickness incision is performed in keratinized tissue. The incision extends from the distal margin of the last tooth adjacent to the treatment area to the ramus of the mandible, ending with a releasing incision on its buccal surface.

In the second molar area, to preserve the integrity of the lingual nerve, the scalpel should be inclined at an approximately 45-degree angle with the tip in vestibular direction, and the blade should touch the external oblique line while the incision is made in distal and buccal direction.

In the proximal vestibular zone, the incision continues intrasurally involving the last two teeth adjacent to the area to be treated and concludes with a vertical hockey stick releasing incision.

Lingually, the incision continues intrasurally until the gingival zenith of the last tooth and continues along the crest of the ridge for approximately 1 cm in the thickness of the keratinized...
gingiva. Full thickness flaps are then elevated and the mental nerve is isolated. The mobilization and release of the buccal flap is obtained with a horizontal periosteal incision performed with a new blade for the entire length of the flap, from the distal to the mesial release.

This longitudinal incision is performed approximately 5 mm apically from the crestal incision and should only affect the periosteal fibers. The passivation of the vestibular flap, thus obtained, allows for a mean coronal elevation of the flap of approximately 20 mm: this is the sum of the amount of tissue present above the periosteal line of incision (5 mm) and the stretching of the flap following the periosteal incision (15 mm) (Figs. 9, 10).

The lingual flap is also full thickness, elevated until the mylohyoid line is reached. This maneuver allows for the obtaining of a mean coronal elevation of approximately 15 mm (Fig. 11). At this point, following the technique previously described by Ronda and Stacchi\textsuperscript{17}, the mylohyoid muscle insertion on the inner surface of the lingual flap is identified, approximately 5 mm apically from the crestal line of incision.

This insertion, with the use of a blunt instrument, is first isolated (Fig. 12) and then separated from the flap by applying light tensile force. This maneuver allows for the near doubling of the lingual flap passivation and brings the coronal elevation from approximately 15 mm to approximately 30 mm (Figs. 13, 14).

The flaps thus passivated can be sutured, covering the membrane without tension, using two different suture lines: one horizontal mattress suture with 3-0 PTFE approximately 5 mm apically from the crestal line of incision (Cytoplast Suture, Osteogenics Biomedical) and a series of interrupted sutures with 4-0 PTFE to complete the flap closure. The releasing incisions are closed with resorbable sutures (6-0, 7-0) (Serafit, Serag Wiessner, Naila, Germany).

The sutures are removed after approximately 12-15 days and, during this period, the patient uses a chlorhexidine 0.2 percent mouthrinse twice a day for one minute. In addition, antibiotics (amoxicillin/clavulanic acid 875+125mg) and NSAIDs (ibuprofen 600 mg) are prescribed for one week.

After a period of approximately six months,
_about the authors_

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during which new bone formation is obtained and completed, the patient undergoes a second procedure for the removal of the membrane and fixation system, completing soft-tissue management (Figs. 15, 16).

_Results_

The goal of this study was to describe the results and complications that occurred both during and after surgery in 127 cases of vertical GBR with non-resorbable membranes, until their removal. Certain complications in a considerable percentage of cases can lead to the failure of the entire regenerative procedure. In order to list and analyze them, the classification proposed by Fontana et al. (2011)20 was used.

Beyond the normal sequelae associated with surgery (edema, blood extravasation and hematoma), neurological complications (B, Fontana 2011) occurred in three cases (2.4 percent). Paresthesia is believed to have been related to the release and elevation of the vestibular flap, which most likely caused the stretching of mental nerve fibers. In all three cases, the symptoms of paresthesia subsided one month after the surgery.

During the healing period, no membrane exposure occurred in any of the cases (no Class I, II or III complications, Fontana 2011). In nine cases (7.1 percent), graft sepsis occurred in the absence of membrane exposure (Class IV, Fontana 2011). All Class IV complications occurred during the first month after the regenerative procedure.

_Discussion_

The objective of this retrospective analysis is to focus on the complications associated with the surgical technique of vertical regeneration with non-resorbable membranes in order to evaluate the level of surgical predictability associated with this procedure in view of the complexity and difficulty in augmenting the posterior ridge.

From the analysis of the results described, the general percentage of failure was 7.1 percent.

However, it is evident that with the application of conventional passivation techniques, and the introduction of the new lingual flap management technique, the extent of coronal displacement of the flaps guarantees the specialist a sufficient quantity of tissue to perform a tension-free suture above the regeneration area.

This is confirmed by the fact that no membrane exposure occurred in the 127 cases analyzed. The primary cause of failure of this technique, from the analysis of our data, is the bacterial contamination of the graft-membrane-implant complex in its entirety.

Contamination can already occur during surgery (inappropriate handling of surgical instruments, graft contamination as a result of bacteria present in saliva) or during the postoperative phase (failed primary closure of the flaps or early exposure of the membrane). As seen, the appropriate management of soft tissue allows for an entirely passive and hermetic primary closure of the flaps, as well as its maintenance, for the entire duration of the healing period.

The problem yet unresolved is that of the cases in which graft sepsis occurs, despite flap closure being perfectly maintained.

In this situation, which always manifests itself during the first month after the procedure, intra-operative graft contamination plays a fundamental role. Given the difficulty in keeping the surgical area completely isolated from salivary contamination during the GBR procedure (above all, in the posterior mandible), the reduction of surgical time is one of the keys for minimizing the risk of infection.

In this regard, it could be useful to harvest autologous bone from a donor site, which is not from the actual area of regeneration, prior to the GBR procedure (with an inevitable increase in morbidity), or use commercial bone grafts alone, with the objective of entirely eliminating both autologous bone harvesting and the risk of infection associated with prolonged operating times.21

_Conclusions_

The current flap passivation techniques available to the specialist have significantly reduced the percentage of failure associated with early exposure of the membrane.

Therefore, we can surmise that vertical GBR is a realistically feasible solution in regard to surgical success (treatment results’ stability over time has already been extensively demonstrated), despite the technique being considered highly “operator-sensitive.”

The fact that vertical GBR is a difficult procedure is not, by any means, to be underestimated. It requires extensive knowledge and should be carried out after appropriate training, which must enable the specialist to acquire a complete theoretical and practical knowledge both in the fields of periodontology and implant dentistry.

References are available upon request from the publisher.