



Ridge Augmentation

Selection of Applicable Abstracts and Posters

OSTEOGENICS

B I O M E D I C A L

Using Titanium-Reinforced PTFE Membranes

Gultekin BA, Cansiz E, Borahan MO. **Clinical and 3-Dimensional Radiographic Evaluation of Autogenous Iliac Block Bone Grafting and Guided Bone Regeneration in Patients With Atrophic Maxilla.** J Oral Maxillofac Surg. 2017 Apr;75(4):709-722.

Objective: To evaluate the rate of graft resorption in autogenous iliac bone grafting (IBG) and guided bone regeneration (GBR) in patients with atrophic maxillae.

Material and methods: We performed a retrospective study involving patients requiring implant placement who underwent IBG or GBR. Volumetric changes of the graft sites were evaluated by imaging studies. The primary predictor and outcome variables were augmentation technique and rate of volumetric resorption, respectively. Secondary outcome variables included bone gain, success of grafting, insertion torque of implants, and requirement for vestibuloplasty.

Results: The sample comprised 39 patients (21 with GBR and 18 with IBG). One patient in the IBG group had temporary sensory disturbance at the donor site, and one patient in the GBR group had late exposure of the nonresorbable membrane. The average values of percent volume reduction in the GBR and IBG groups were $12.26\% \pm 2.35\%$ and $35.94\% \pm 7.94\%$, respectively, after healing and $15.87\% \pm 1.99\%$ and $41.62\% \pm 6.97\%$, respectively,

at last follow-up. The IBG group exhibited a significantly higher reduction in bone volume than the GBR group at both time points ($P = .001$). The mean values of horizontal and vertical bone gain after healing in the IBG group were significantly higher than those in the GBR group ($P = .006$ and $P = .001$, respectively). The mean implant torque during implant placement in the GBR group was significantly higher than that in the IBG group ($P = .024$). There was no significant difference in the requirement for vestibuloplasty between the two groups ($P > .05$).

Conclusion: Although both hard tissue augmentation approaches provide an adequate volume of bone graft for implant insertion, IBG results in greater graft resorption at maxillary augmented sites than GBR. Clinicians should consider the differences in the extent of graft resorption between the two methods while choosing the treatment approach.

Urban IA, Monje A, Nevins M, Nevins ML, Lozada JL, Wang HL. **Surgical Management of Significant Maxillary Anterior Vertical Ridge Defects.** Int J Periodontics Restorative Dent. 2016 May-Jun;36(3):329-37.

Severe vertical ridge deficiency in the anterior maxilla represents one of the most challenging scenarios in bone regenera-

tion. Under ideal circumstances, guided bone regeneration in combination with soft tissue management has shown predictable esthetic and functional outcomes. Success largely relies on primary wound closure during and after the surgical procedure. Surgical sites present different challenges that need to be considered when designing the flap. The goal of this article is to propose a classification of flap designs that considers vestibular depth and scar formation around the periosteum when performing vertical ridge augmentation in the atrophic anterior maxilla. The four clinical conditions proposed under this classification are (1) shallow vestibule with healthy periosteum, (2) deep vestibule with healthy periosteum, (3) shallow vestibule with scarred periosteum, and (4) deep vestibule with scarred periosteum. The classification will allow clinicians to achieve tension-free closure and more predictable vertical bone gain.

Ronda M, Stacchi C.

A Novel Approach for the Coronal Advancement of the Buccal Flap. *Int J Periodontics Restorative Dent.* 2015 Nov-Dec;35(6):795-801.

An adequate flap release is necessary to perform a tension-free suture over an augmented area. This is a fundamental requisite to attain and maintain a reliable biological seal, protecting the graft from bacterial contamination during the healing period. In the posterior mandible, in particular, the use of conventional periosteal incisions is not always sufficient for a proper buccal flap passivation, as they are often limited by anatomical factors. This article reports a series of 76 consecutive cases of vertical guided bone regeneration in the posterior mandible introducing a novel surgical technique to enhance the coronal advancement of the buccal flap in a safe and predictable way.

Urban IA, Monje A, Wang HL.

Vertical Ridge Augmentation and Soft Tissue Reconstruction of the Anterior Atrophic Maxillae: A Case Series. *Int J Periodontics Restorative Dent.* 2015 Sep-Oct;35(5):613-23.

Severe vertical ridge deficiency in the anterior maxilla represents one of the most challenging clinical scenarios in the bone regeneration arena. As such, a combination of vertical bone augmentation using various biomaterials and soft tissue manipulation is needed to obtain successful outcomes. The present case series describes a novel approach to overcome vertical deficiencies in the anterior atrophied maxillae by using a mixture of autologous and anorganic bovine bone. Soft tissue manipula-

tion including, but not limited to, free soft tissue graft was used to overcome the drawbacks of vertical bone augmentation (eg, loss of vestibular depth and keratinized mucosa). By combining soft and hard tissue grafts, optimum esthetic and long-term implant prosthesis stability can be achieved and sustained.

Urban I, Jovanovic SA, Buser D, Bornstein MM.

Partial Lateralization of the Nasopalatine Nerve at the Incisive Foramen For Ridge Augmentation in the Anterior Maxilla Prior to Placement of Dental Implants: A Retrospective Case Series Evaluating Self-Reported Data and Neurosensory Testing. *Int J Periodontics Restorative Dent.* 2015 Mar-Apr;35(2):169-77.

The objective of this study was to assess implant therapy after a staged guided bone regeneration procedure in the anterior maxilla by lateralization of the nasopalatine nerve and vessel bundle. Neurosensory function following augmentative procedures and implant placement, assessed using a standardized questionnaire and clinical examination, were the primary outcome variables measured. This retrospective study included patients with a bone defect in the anterior maxilla in need of horizontal and/or vertical ridge augmentation prior to dental implant placement. The surgical sites were allowed to heal for at least 6 months before placement of dental implants. All patients received fixed implant-supported restorations and entered into a tightly scheduled maintenance program. In addition to the maintenance program, patients were recalled for a clinical examination and to fill out a questionnaire to assess any changes in the neurosensory function of the nasopalatine nerve at least 6 months after function. Twenty patients were included in the study from February 2001 to December 2010. They received a total of 51 implants after augmentation of the alveolar crest and lateralization of the nasopalatine nerve. The follow-up examination for questionnaire and neurosensory assessment was scheduled after a mean period of 4.18 years of function. None of the patients examined reported any pain, they did not have less or an altered sensation, and they did not experience a "foreign body" feeling in the area of surgery. Overall, 6 patients out of 20 (30%) showed palatal sensibility alterations of the soft tissues in the region of the maxillary canines and incisors resulting in a risk for a neurosensory change of 0.45 mucosal teeth regions per patient after ridge augmentation with lateralization of the nasopalatine nerve. Regeneration of bone defects in the anterior maxilla by horizontal and/or vertical ridge augmentation and lateralization of the nasopalatine nerve prior to dental implant placement is a predictable surgical technique. Whether or not there were

clinically measurable impairments of neurosensory function, the patients did not report them or were not bothered by them.

Ronda M, Rebaudi A, Torelli L, Stacchi C.

Expanded vs. Dense Polytetrafluoroethylene Membranes In Vertical Ridge Augmentation Around Dental Implants: A Prospective Randomized Controlled Clinical Trial. Clin Oral Implants Res. 2014 Jul;25(7):859-66.

Objective: This prospective randomized controlled trial was designed to test the performance of titanium-reinforced dense polytetrafluoroethylene (d-PTFE) membrane vs. titanium-reinforced expanded polytetrafluoroethylene (e-PTFE) membrane in achieving vertical bone regeneration, both associated with a composite grafting material.

Material and methods: The study enrolled 23 patients requiring bone augmentation with guided bone regeneration (GBR) procedures for placing implants in atrophic posterior mandibles (available bone height <7 mm). Implants were inserted and left to protrude from the bone level to achieve the programmed amount of vertical regeneration. Defects were filled with a composite bone graft (50% autologous bone and 50% mineralized bone allograft) and randomly covered with either an e-PTFE membrane (control) or a d-PTFE membrane (test). Membrane removal was performed after 6 months, and changes in bone height were recorded.

Results: Seventy-eight implants were inserted in 26 mandibular sites contextually to vertical ridge augmentation procedures. The healing period was uneventful in all sites, and the vertical defects were satisfactorily filled with a newly formed hard tissue. Mean defect fill after 6 months was 5.49 mm (SD \pm 1.58) at test sites and 4.91 mm (SD \pm 1.78) at control sites. The normalized data (percentage changes against baseline) did not show any statistically significant difference between test and control groups (P = NS).

Conclusion: Based on the data from this study, both d-PTFE and e-PTFE membranes showed identical clinical results in the treatment of vertical bone defects around implants, using the GBR technique. The membrane removal procedure was easier to perform in the d-PTFE group than in the e-PTFE group.

[Poster]

Belleggia, F.

Treatment of An Infected Exposure of a Dense Polytetrafluoroethylene Membrane in a Vertical Guided Bone Regeneration Procedure: A Protocol Proposal. Poster presented at the

European Academy of Osseointegration (EAO) in Rome, Italy. September 25-27, 2014.

Background: Non resorbable membrane exposure has always been considered the main cause for guided bone regeneration (GBR) failure. Although the introduction of dense polytetrafluoroethylene (d-PTFE) membranes have significantly reduced the incidence of infection with respect to expanded PTFE membranes since the pore size does not allow bacteria penetration through their thickness; nevertheless, infection can occur when bacteria contaminate the grafting material passing underneath the edge of the membrane. Soft tissue dehiscence, and the consequent membrane exposure, can be caused by poor flap coronal mobilization and suture with tension, sharp edges of the membrane, sharp food impaction, compressing removable prostheses, or the cusp of an extruded opposing tooth as in the clinical case reported. Removal of the membrane as well as the graft, the implants, or the tenting screws inserted, is recommended to be done as soon as possible. Usually, the resulting clinical situation is worse than the starting one.

Aim: The aim of this report is to describe a protocol to treat the exposure of a d-PTFE membrane when infection has already occurred without removing all the graft particles and coronally mobilize the flaps for an unpredictable closure because of inflammation and epithelization of the flaps.

Materials & Methods: A staged approach GBR procedure was performed for the correction of a mandibular vertical ridge deficiency in the right premolar and molar region. Two tenting screws helped the titanium-reinforced d-PTFE membrane (Cytoplast Ti-250 PL, Osteogenics Biomedical, Lubbock, TX, USA) not to collapse over a graft composed by autogenous cortical bone, collected locally with a disposable bone collector (Safescraper, Meta, Reggio Emilia, Italy) mixed with a synthetic nano-crystalline hydroxyapatite (NanoBone, Artoss, Germany) in a 1:1 ratio. PTFE sutures were removed 2 weeks later, and after 2 more weeks the membrane exposure happened because of the cusp impaction of the opponent upper right second molar. The patient was instructed to clean the site gently and to rinse with 0.2 chlorhexidine every 8 hours. Nevertheless, the margins of the exposure were close to the distal edge of the membrane, and two days later the pus presence suggested the membrane removal that was performed a few days later. The membrane, the distal tenting screw, and part of the graft in the distal area with clear signs of infection were removed. The remaining graft was washed with chlorhexidine and covered by a cross-linked collagen membrane (Cytoplast RTM 2030, Osteogenics Biomedical) and stabilized with titanium tacks. A collagen fleece (Medicipio C, Medichema Germany) filled the gap of the muco-

sal dehiscence. No attempt of coronal flap advancement was done, but sutures stabilized the collagen fleece that guided the mucosal repair.

Results: Healing was uneventful. Eight and a half months after d-PTFE membrane removal the site was re-opened. The bulk of regenerated bone, as shown by the post-operative computed tomography allowed the insertion of 3 Laser-Lok Tapered implants (BioHorizons, Birmingham, AL, USA) in the region of the second premolar and the first and second molar. A biopsy of the regenerated area was harvested during implant site preparation of the first molar. Histologic examination revealed new bone formation, almost totally lamellar mature bone, in direct contact with the graft remnants. No sign of inflammation was observed. The patient received a free gingival graft for keratinized tissue band augmentation before she was restored with fixed crowns. Upper molar intrusion allowed normal dimension of the restorations.

Conclusions & Clinical Application: D-PTFE membrane substitution, with a collagen membrane and a collagen fleece, allowed an almost complete vertical bone regeneration and mucosal repair without any coronal flap advancement. The little bone volume removed in the distal area did not jeopardize implant insertion. The staged approach helped the clinical management and has to be suggested: simultaneous approach with implant insertion during GBR would have led to the implant surface contamination and the removal of the implant, a bigger bone volume loss, and a difficult soft tissue management.

[Poster]

Belleggia, F.

The Pros of the Staged Approach in Vertical Guided Bone and Soft Tissue Reconstruction of the Mandibular Atrophy.

Poster presented at the European Academy of Osseointegration (EAO) in Rome, Italy. September 25-27, 2014.

Background: Tooth loss leads to the atrophy of both the hard and soft tissues of the jaws. Guided bone regeneration (GBR) is an effective technique that can reconstruct hard tissues of the vertical bony defects with PTFE membranes. Nevertheless, since coronal flap mobilization is an indispensable requirement for covering the augmented site, it reduces the thin band of keratinized tissue. Based on current evidence, a lack of adequate keratinized mucosa around implants is associated with more plaque accumulation, tissue inflammation, mucosal recession, and loss of attachment. Simultaneous implant insertion seems to reduce the number of interventions and the overall treatment time. In reality, the implant reduces bone surface and its mar-

row space as a source of osteogenic cells, slowing down bone maturation and extending healing time to 9-12 months, while the mucoperiosteal full-thickness flap raised at reentry does not allow a vascular supply to a gingival graft in order to augment the keratinized tissue.

Aim: The aim of this report is to describe how a staged approach can reach predictable bone and soft tissue reconstruction without extending the overall treatment time in comparison with simultaneous application of implants and membranes. The staged approach provides a larger bone surface to contribute to new bone formation that is activated twice by the local release of growth factors (1st during membrane surgery, 2nd during implant placement) and a better bone apposition to the titanium surface.

Materials & Methods: A staged approach GBR procedure was performed for the correction of a mandibular vertical ridge deficiency in the right premolar and molar region. Two tenting screws helped the titanium reinforced dense-PTFE membrane (Cytoplast Ti-250 PL, Osteogenics Biomedical, Lubbock, TX, USA) not to collapse over a graft composed by autogenous cortical bone, collected locally with a disposable bone collector (Safescraper, Meta, Reggio Emilia, Italy), and mixed with an allograft composed by 70% mineralized bone and 30% demineralized bone (EnCore, Osteogenics Biomedical) in a 1:1 ratio. After a 5 month healing time, the site was re-opened for membrane removal and implant insertion. The bulk of vertically regenerated bone (4-6 mm), as shown by the post-operative CBCT, allowed the insertion of 2 Laser-Lok Tapered Implants (BioHorizons, Birmingham, AL, USA) in the region of the second premolar and the first molar. A biopsy of the regenerated area was harvested for histologic examination. A cross-linked collagen membrane (Cytoplast RTM 2030, Osteogenics Biomedical) covered the implants in order to extend the barrier function. Submerged healing allowed for a split-thickness flap providing blood supply to a free gingival graft, which was harvested from the palate to augment the width of the keratinized mucosa, which was reduced to about 1 mm after bone augmentation. Healing abutments were connected with a subsequent intervention after a 3 month healing time and graft shrinkage.

Results: The overall treatment time was 10 and a half months from membrane application to healing abutment connection - about the same time needed by a simultaneous implant insertion approach. Histologic examination revealed excellent new bone formation - almost totally lamellar mature bone - after a 5 month healing time. Free gingival graft allowed a keratinized tissue band augmentation of 12 mm that was equally divided for the lingual and buccal flaps during the re-entry for healing abutment application. Porcelain fused to metal crowns were sur-

rounded by sound, still and thick keratinized tissue that helped the maintenance at 1-year clinical and radiographic follow-up. Conclusions and Clinical Application: The staged approach offers several advantages compared with the simultaneous application of implants and barrier membrane: better bone formation and maturation with double activation of growth factors, better bone-implant contacts, simplified implant positioning with better implant stability and easier preparation of the recipient site, and better soft tissue management, since a split-thickness flap is necessary for the blood supply of a gingival graft, in order to reconstruct the soft tissues.

Urban IA, Lozada JL, Jovanovic SA, Nagursky H, Nagy K. **Vertical Ridge Augmentation with Titanium-Reinforced, Dense-PTFE Membranes and a Combination of Particulated Autogenous Bone and Anorganic Bovine Bone-Derived Mineral: A Prospective Case Series in 19 Patients.** *Int J Oral Maxillofac Implants.* 2014 Jan-Feb;29(1):185-93.

Objective: This prospective case series evaluated the use of a new titanium-reinforced nonresorbable membrane (high-density polytetrafluoroethylene), in combination with a mixture of anorganic bovine bone-derived mineral (ABBM) and autogenous particulated bone, for vertical augmentation of deficient alveolar ridges.

Materials and methods: A mixture of ABBM and autogenous particulated bone was used for vertical ridge augmentation and covered with a new titanium-reinforced nonresorbable membrane. Ridge measurements were obtained before and after the procedure, complications were recorded, and biopsy specimens were taken for histologic examination.

Results: Twenty vertical ridge augmentation procedures were carried out in 19 patients. All treated defect sites exhibited excellent bone formation, with an average bone gain of 5.45 mm (standard deviation 1.93 mm). The healing period was uneventful, and no complications were observed. Eight specimens were examined histologically; on average, autogenous or regenerated bone represented 36.6% of the specimens, ABBM 16.6%, and marrow space 46.8%. No inflammatory responses or foreign-body reactions were noted in the specimens.

Conclusion: The treatment of vertically deficient alveolar ridges with guided bone regeneration using a mixture of autogenous bone and ABBM and a new titanium-reinforced nonresorbable membrane can be considered successful.

Annibali S, Bignozzi I, Sammartino G, La Monaca G, Cristalli MP.

Horizontal and vertical ridge augmentation in localized alveolar deficient sites: A retrospective case series. *Implant Dent.* 2012 Jun;21(3):175-185.

Objective: This study reviews the clinical outcomes of ridge augmentations performed via horizontal- or vertical-guided bone regeneration (h-GBR, v-GBR) or edentulous ridge expansion. **Materials and methods:** The degree of defect correction, the marginal bone level, and the horizontal stability of the augmented bone (five patients) were examined with a new proposed rigid resin survey template.

Results: Thirty ridge defects ranging from 1 to 8 mm were corrected, and 56 implants were positioned. The percentages of alveolar defect correction were $91.85\% \pm 22.30\%$, $97.13\% \pm 4.48\%$, and $90.42\% \pm 11.93\%$ for h-GBR, edentulous ridge expansion, and v-GBR, respectively; a limited amount of marginal bone level was reported for all three groups, while a large amount of horizontal bone resorption was detected.

Conclusion: All surgical techniques considered in this study are predictable procedures, and the proposed survey template measurement system showed to be a reliable method of evaluating horizontal bone stability of the augmented ridges.

Urban IA, Monje A, Lozada JL, Wang HL. **Long-term Evaluation of Peri-Implant Bone Level after Reconstruction of Severely Atrophic Edentulous Maxilla via Vertical and Horizontal Guided Bone Regeneration in Combination with Sinus Augmentation: A Case Series with 1 to 15 Years of Loading.** *Clin Implant Dent Relat Res.* 2016 May 30. [Epub ahead of print]

Background: To the best of the authors' knowledge, there is very limited clinical data on the outcomes of simultaneous guided bone regeneration (GBR) for horizontal and/or vertical bone gain for the reconstruction of severely atrophic edentulous maxilla. Therefore, the purpose of the clinical series presented herein was to clinically evaluate long-term horizontal and vertical bone gain, as well as implant survival rate after reconstruction of severely atrophic edentulous maxillary ridges.

Material and methods: Sixteen patients (mean age: 64.6 ± 14.6 years of age) were consecutively treated for vertical and/or horizontal bone augmentation via GBR in combination with bilateral sinus augmentation utilizing a mixture of autologous and anorganic bovine bone. Implant survival, bone gain, intraoperative/postoperative complications and peri-implant bone loss were calculated up to the last follow-up exam.

Results: Overall, 122 dental implants were placed into augment-

ed sites and have been followed from 12 to 180 months (mean: 76.5 months). Implant survival was 100% (satisfactory survival rate of 97.5%). Mean bone gain was 5.6mm (max: 9mm; min: 3mm), while vertical bone gain was 5.1 ± 1.8 mm; horizontal bone gain was 7.0 ± 1.5 mm. No intraoperative/postoperative complications were noted. Mean peri-implant bone loss values were consistent within the standards for implant success (1.4 ± 1.0 mm). At patient-level, only one patient who had three implants presented with severe peri-implant bone loss.

Conclusion: Complete reconstruction of an atrophied maxilla can be successfully achieved by means of guided bone regeneration for horizontal and/or vertical bone gain including bilateral sinus augmentation using a mixture of anorganic bovine bone and autologous bone.

[Poster]

Belleggia F.

Clinical Evaluation of Guided Bone Regeneration Procedures Using a Dense-Polytetrafluoroethylene Membrane.

A Preliminary Report. Presented at the XX International SIO Congress in Milan, Italy. January 27 - 28, 2012.

Objectives: To analyze the clinical outcome of guided bone regeneration (GBR) with a newly developed dense-polytetrafluoroethylene (d-PTFE) membrane.

Materials and methods: Twenty consecutive GBR procedures were performed in 18 consenting patients, 8 males and 10 females, mean age 49.5 years (range 21-75), from January 2010 till October 2011, utilizing a d-PTFE membrane (Cytoplast) with or without titanium reinforcement, and a graft of particulated autogenous bone or deproteinized bovine bone mineral (Bio-Oss) or nanocrystalline hydroxyapatite embedded in a silica gel matrix (Nanobone) alone or mixed together. Twenty implants (10 Camlog, 9 Straumann, 1 Alpha-Bio) were placed at the time of GBR in 16 procedures. A staged approach, with 6 implant placements (5 Camlog, 1 Straumann) at the time of membrane removal, was performed in 4 procedures.

Results: All GBR procedures except one healed uneventfully.

Only one late exposure of the membrane happened in a single simultaneous implant placement procedure after 11 weeks. The membrane was removed one week after the exposure, and no sign of inflammation or infection was observed beneath the membrane within the regenerated bone. The other 19 membranes were removed after a 29.7 week healing period (range 19-44). All 26 implants were osseointegrated and completely surrounded by regenerated bone. Graft material did not affect the clinical outcome, while the limited number of treated cases did not allow statistical analysis within the groups.

Conclusions: This preliminary report of an ongoing study indicates that d-PTFE membranes may be used with high predictability (95% procedure success, 100% implant survival and success) in GBR procedures. The one late exposure did not cause wound infection. ■

Using Tenting Screws

Caldwell GR, Mills MP, Finlayson R, Mealey BL.

Lateral Alveolar Ridge Augmentation Using Tenting Screws, Acellular Dermal Matrix, and Freeze-Dried Bone Allograft Alone or with Particulate Autogenous Bone. Int J Periodontics Restorative Dent. 2015 Jan-Feb;35(1):75-83.

This randomized prospective study evaluated the clinical benefits of using a corticocancellous mixture of freeze-dried bone allograft alone or in combination (1:1) with particulated autogenous bone for horizontal ridge augmentation and subsequent implant placement. Twenty-four patients with atrophic ridges received lateral ridge augmentations with particulate grafts placed around tenting screws and covered with a fixed acellular dermal matrix membrane. Thirty-three standard-diameter implants were successfully placed in 21 patients after a 24-week graft healing period. Three patients experienced early postoperative infections following the grafting procedure (12.5% of sites). At reentry, the allograft alone group showed similar average horizontal ridge width gains (3.33 ± 0.83 mm) to the combination group (3.09 ± 0.63 mm; $P = .44$). The mean graft resorption between baseline and reentry averaged 13.89%. ■



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