



# Ridge Preservation

Selection of Applicable Abstracts and Posters

## OSTEOGENICS

B I O M E D I C A L

### Cytoplast™ Technique

Laurito D, Lollobrigida M, Gianni F, Bosco S, Lamazza L, De Biase A.

**Alveolar Ridge Preservation with nc-HA and d-PTFE Membrane: A Clinical, Histologic, and Histomorphometric Study.** Int J Periodontics Restorative Dent. 2017 Mar/Apr;37(2):283-290.

Alveolar ridge preservation has become a very common procedure following tooth extraction. This study presents a clinical, histologic, and histomorphometric analysis of postextraction bone changes using nanocrystalline hydroxyapatite (nc-HA) and exposed high-density polytetrafluoroethylene (d-PTFE) membrane. A total of 10 extraction sockets were treated. Clinical measurements were taken after tooth extraction with a customized acrylic stent to ensure the same measurement points. At 6 months, clinical measurements were repeated and bone specimens taken. An overall bone reduction was observed. The histologic and histomorphometric analysis revealed newly formed bone (25.92% ± 18.78%), soft tissue (28.55% ± 9.73%), and residual graft particles (15.43% ± 11.08%). Further studies are necessary to evaluate the efficacy of this technique over the long term.

Walker CJ, Prihoda TJ, Mealey BL, Lasho DJ, Noujeim M, Huynh-Ba G.

**Evaluation of Healing at Molar Extraction Sites With and**

### Without Ridge Preservation: A Randomized Controlled Clinical Trial.

J Periodontol. 2017 Mar;88(3):241-249..

**Background:** To date, limited evidence is available specifically evaluating ridge preservation (RP) and implant placement in molar sites. The primary aim of this study is to radiographically compare alveolar ridge changes with and without RP with cone-beam computed tomography (CBCT).

**Methods:** This parallel, two-arm randomized clinical trial included 40 patients evenly distributed between two treatment groups. After molar extraction, sites were allowed to heal naturally or received RP with freeze-dried bone allograft covered by a non-resorbable dense polytetrafluoroethylene membrane. CBCT scans were taken immediately and 3 months postextraction, and then a dental implant was placed. Width and height measurements were made radiographically.

**Results:** Significantly greater loss in alveolar ridge height was found in molar sites allowed to heal without RP on the buccal aspect of the socket (RP:  $-1.12 \pm 1.60$  mm versus no RP:  $-2.60 \pm 2.06$  mm,  $P = 0.01$ ). No significant difference in ridge width loss was found between groups. Two-thirds ridge width reduction was experienced on the buccal aspect in sites without RP, but width loss was evenly distributed between buccal and lingual aspects when RP was performed. Bone grafting at time of placement was required in 25% of implants in the group without RP versus 10% of implants in the RP group.

**Conclusion:** In molar extraction sites without RP, significantly more reduction in ridge height occurred, and the majority of

ridge width loss was localized to the buccal aspect. When RP was performed, ridge width loss was not significantly decreased, but the loss was evenly distributed between facial and lingual aspects of the extraction site.

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Laurito D, Cugnetto R, Lollobrigida M, Guerra F, Vestri A, Gianni F, Bosco S, Lamazza L, De Biase A.

**Socket Preservation with d-PTFE Membrane: Histologic Analysis of the Newly Formed Matrix at Membrane Removal.** *Int J Periodontics Restorative Dent.* 2016 Nov/Dec;36(6):877-883.

This study aimed to evaluate the efficacy of an exposed high-density polytetrafluoroethylene (d-PTFE) membrane in preventing epithelial migration in postextraction sockets. For this purpose, a histologic description of the newly formed soft tissue underlying the membrane is presented. The periodontal status of the adjacent teeth was also evaluated to assess the gingival response. Ten premolar extraction sockets were treated. After tooth extraction, the sockets were filled with nanocrystalline hydroxyapatite and covered with d-PTFE membranes. Subperiosteal pockets were created to ensure the stability of the membranes. Membranes were left intentionally exposed and were atraumatically removed after 28 days. At that time, a bioptic specimen of the newly formed soft tissue under the membranes was taken. All the histologic samples showed a dense connective tissue without epithelial cells and no signs of foreign body reaction. No significant variation of the periodontal indices was observed on the teeth adjacent to the extraction sites. The study results indicate that exposed d-PTFE membranes can prevent epithelial migration in healing sockets without consequences on the periodontal health.

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Borg TD, Mealey BL.

**Histologic Healing Following Tooth Extraction with Ridge Preservation Using Mineralized Versus Combined Mineralized-Demineralized Freeze-Dried Bone Allograft: A Randomized Controlled Clinical Trial.** *J Periodontol.* 2015 Mar;86(3):348-55.

Background: Mineralized and demineralized freeze-dried bone allografts (FDBAs) are used in alveolar ridge (AR) preservation; however, each material has advantages and disadvantages. Combinations of allografts aimed at capitalizing on the advantages each offers are available. To date, there is no evidence to indicate if a combination allograft is superior in this application. The primary objective of this study is to histologically evaluate and compare healing of non-molar extraction sites grafted with either mineralized FDA or a 70:30 mineralized:demineralized FDA combination allograft in AR preservation. The secondary objective is to compare dimensional changes in ridge height and width after grafting with these two materials. Methods: Forty-two patients randomized into two equal groups received ridge preservation with either 100% mineralized FDA (active control group) or the combination 70% mineralized:

30% demineralized allograft (test group). Sites were allowed to heal for 18 to 20 weeks, at which time core biopsies were obtained and dental implants were placed. AR dimensions were evaluated at the time of extraction and at implant placement, including change in ridge width and change in buccal and lingual ridge height. Histomorphometric analysis was performed to determine percentage of vital bone, residual graft, and connective tissue/other non-bone components.

Results: There was no significant difference between groups in AR dimensional changes. Combination allograft produced increased vital bone percentage (36.16%) compared to the FDA group (24.69%;  $P = 0.0116$ ). The combination allograft also had a significantly lower mean percentage of residual graft particles (18.24%) compared to FDA (27.04%;  $P = 0.0350$ ).

Conclusion: This study provides the first histologic evidence showing greater new bone formation with a combination mineralized/demineralized allograft compared to 100% mineralized FDA in AR preservation in humans. Combination allograft results in increased vital bone formation while providing similar dimensional stability of the AR compared to FDA alone in AR preservation.

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Fotek PD, Neiva RF, Wang HL.

**Comparison of Dermal Matrix and Polytetrafluoroethylene Membrane for Socket Bone Augmentation: A Clinical and Histologic Study.** *J Periodontol.* 2009;80:776-785.

Background: Remodeling and resorption of the alveolar crest, specifically at the buccal aspect, characterize the healing extraction socket. These result in narrowing and shortening of the alveolar ridge, which compromise esthetics and complicate restoration. Alveolar ridge augmentation has been proposed to facilitate future site restoration by minimizing ridge resorption. Therefore, the purpose of this study was to compare extraction socket healing and alveolar ridge alteration after socket augmentation using bone allograft covered with an acellular dermal matrix (ADM) or polytetrafluoroethylene (PTFE) membrane. Methods: Twenty non-smoking healthy subjects were selected. Each subject required maxillary premolar, canine, or central incisor tooth extraction. The extraction sites were debrided and grafted with a mineralized bone allograft that was covered with an ADM or PTFE membrane. Postoperative appointments were scheduled at 2, 4, and 8 weeks. After 16 weeks of healing, final measurements were performed, and trephine core biopsies were obtained for histomorphometric analysis. Implants were placed immediately after biopsy harvesting.

Results: Eighteen subjects completed the study. All sites healed without adverse events and allowed for implant placement. PTFE membranes exfoliated prematurely, with an average retention time of 16.6 days, whereas the ADM membranes appeared to be incorporated into the tissues. Buccal plate thickness loss was 0.44 and 0.3 mm, with a vertical loss of 1.1 and 0.25 mm, for ADM and PTFE, respectively. Bone quality assessment indicated D3 to be the most prevalent (61%). Histomorphometric analysis revealed 41.81% versus 47.36% bone,

58.19% versus 52.64% marrow/fibrous tissue, and 13.93% versus 14.73% particulate graft remaining for ADM and PTFE, respectively. No statistical difference was found between the two treatment groups for any of the parameters.

Conclusion: All sites evaluated showed minimal ridge alterations, with no statistical difference between the two treatment modalities with respect to bone composition and horizontal and vertical bone loss, indicating that both membranes are suitable for alveolar ridge augmentation.

Hoffman O, Bartee BK, Beaumont C, Kasaj A, Deli G, Zafiroopoulos GG.

**Alveolar Bone Preservation in Extraction Sockets Using Non-Resorbable dPTFE Membranes: A Retrospective Non-Randomized Study.** J Periodontol. 2008;79:1355-1369.

Background: The aim of this study was to investigate the clinical regeneration of extraction sockets using high-density polytetrafluoroethylene (dPTFE) membranes without the use of a graft material.

Methods: A total of 276 extraction sockets were evaluated in 276 subjects (151 males and 125 females; mean age, 50.2 years; age range: 24 to 73 years). After extraction, flaps were elevated and a dPTFE membrane was placed over the extraction site. The flaps were repositioned and sutured into place. Primary closure was not obtained over the membranes. The cemento-enamel junctions of the adjacent teeth were used as reference points. Measurements were taken postextraction and 12 months after surgery in the same areas with the help of a stent and were defined as the distance from the reference points to the bone level. Hard tissue biopsies were taken from 10 representative cases during implant placement 12 months after socket preservation. The bone core samples were submitted for histologic evaluation. A stringent plaque-control regimen was enforced in all subjects during the 12-month observation period.

Results: A significant regeneration of the volume of sockets could be noted by histologic evaluation, indicating that the newly formed tissue in extraction sites was mainly bone. No influence of gender, smoking, age, or clinical bone level before treatment was found on the percentage of bone gain.

Conclusion: The use of dPTFE membranes predictably led to the preservation of soft and hard tissue in extraction sites.

[Poster]

Chesnoiu-Matei I, Texeira HS, Tovar N, Marin C, Dragan IF, Coelho PG.

**Alveolar Bone Dimensional Changes Following Tooth Extraction in Sites Treated with or without PTFE Membranes: A Histological Study in Dogs.** Presented at the 2012 Research Forum Poster Session. Annual Meeting of the American Academy of Periodontology (AAP) in Los Angeles, CA. September 29 - October 2, 2012.

Introduction: The alveolar ridge experiences significant dimen-

sional changes following tooth extraction due to normal bone healing pattern. Both vertical and horizontal directions undergo important modifications, in particular the bucco-oral dimension of the remaining alveolar crest. The resorption of the buccal plate poses several concerns, especially when implant restoration is planned in the esthetic area. Various techniques and materials have been developed and utilized in order to help maintain the buccal plate and bone volume. Maintaining the space and protecting the blood clot, thus allowing osseous proliferation and maturation, are the principal objectives for the bone augmentation procedures. The aim of this study was to evaluate the changes in alveolar bone morphology that occur after extraction at the buccal bone level following socket preservation procedures with membrane. Also, the effect of a flap or flapless procedure was taken into account.

Methods: Bilateral extractions of first mandibular molars were performed for eight beagle dogs included in this study. On the right side, extractions were performed without elevating a flap and no membrane was used to cover the sockets (Figure 1). On the contra-lateral side, a full-thickness flap was elevated prior to extraction. The resulting sockets were split into two groups: one socket was covered with a non-resorbable PTFE membrane while the other group was left to heal uncovered. Primary closure was not intended in the sites covered with the PTFE membrane. The membrane was removed two weeks after placement (Figure 1). The sockets were left to heal for a total of eight weeks. Nondecalcified, histologic slides of ~30µm were stained with toluidine blue and referred for optical microscopy. Histologic qualitative analysis was performed.

Conclusions: Full-thickness flap negatively influenced buccal plate resorption, however this phenomenon can be avoided by protecting the extraction site with a membrane. The data from the current study demonstrates that a nonresorbable PTFE membrane can not only prevent horizontal ridge modifications following extraction, but enhance the buccal bone quantity at that site possibly by maintaining the space.

[Poster]

Yamashita M, Horita S, Takei N, Sasada Y, Shibato W, Ishikawa Y, Takao K, Maki K, Funakoshi E.

**Minimally Invasive Alveolar Ridge Preservation/Augmentation Procedure (Open Barrier Membrane Technique).**

Presented at the 2010 Research Forum Poster Session. Annual Meeting of the American Academy of Periodontology (AAP) in Honolulu, HI. October 30 - November 2, 2010.

Introduction: Conventionally, expanded polytetrafluoroethylene (e-PTFE) has been widely used for guided bone regeneration (GBR). In implant dentistry, e-PTFE membrane became a standard for GBR in 1980s and early 1990s. However, several disadvantages of the membranes has been recognized. A major complication with e-PTFE membranes is wound dehiscence and membrane exposure. Early membrane exposure causes infection and results in severely compromised amount of bone regeneration. In 2005, Funakoshi introduced "Open Barrier Mem-

brane Technique" as novel minimally invasive GBR technique using non-expanded, high-density PTFE (d-PTFE) membrane. A significant advantage of d-PTFE membranes is impenetrable for bacteria because of its surface characteristics (0.2µm low porosity). Because of this smooth surface, this membrane can be left intentionally exposed and primary closure is not required. Because no primary coverage is necessary, there is no need for periosteal releasing incisions causes swelling and pain. The aim of this retrospective study was to evaluate the clinical regeneration of alveolar ridge preservation/augmentation using d-PTFE membranes with the use of bone graft materials.

Clinical findings: None of the patients reported any unusual pain, swelling or discomfort during the treatment. No infection or inflammation was present, although the membranes were exposed partially and plaque adhered on surfaces of the membranes at almost cases. After membrane removal, premature bone covered by smooth red non-epithelialized soft tissue was observed. The tissue re-epithelialized completely within 1 month. Keratinized gingiva was preserved at all sites, and furthermore, some cases showed enhancement. All sites had successfully placed implants and osseointegration was clinically obtained.

Alveolar crest change measurement: Complete results are shown in Table 2 and Fig 3. Both socket and ridge type sites showed excellent bone gain as 100.9% and 95.8% respectively, with no significant

differences between the types ( $P = .12$ ). A little amount of bone loss (0.8 mm total) was found at implant placement. A total of 60 sites (47%) were overfilled. These results indicated that this technique using d-PTFE membrane predictably provided stable regenerated bone volume. To achieve reconstruct complete alveolar ridge is often required three dimensional bone overfilling. This technique facilitates the overfilling because primary coverage is not required. The advantages of the technique are reported in Table 3. Interestingly, the volume of bone loss corresponded approximately to the volume of overfill (0.9mm total).

Avila-Ortiz G, Rodriguez JC, Rudek I, Benavides E, Rios H, Wang HL.

**Effectiveness of Three Different Alveolar Ridge Preservation Techniques: A Pilot Randomized Controlled Trial.** *Int J Periodontics Restorative Dent.* 2014 Jul-Aug;34(4):509-21.

The aim of this pilot study was to obtain preliminary data regarding the effectiveness of three different alveolar ridge preservation modalities as compared with a control. Subjects in need of single-rooted tooth extraction were recruited and randomly allocated to one of four treatment groups: group 1 (control)-collagen plug; group 2—socket grafting and polytetrafluoroethylene (PTFE) barrier; group 3—socket grafting, buccal overbuilding, and PTFE barrier; group 4—socket grafting, collagen barrier, and PTFE barrier. The grafting material used in all groups was an allograft. At 16 weeks, surgical reentry was performed, and a bone core biopsy was harvested for histomorphometric analysis. A cone beam computed tomography scan was obtained at

baseline and before surgical reentry. Clinical (keratinized mucosa [KM] and buccolingual ridge width [RW] changes) and volumetric outcomes were statistically analyzed. A total of 20 patients were recruited (5 patients per group). KM and buccolingual RW changes were minimal during the 16-week healing period for all groups, with no statistically significant differences. Volumetric analyses revealed comparable alveolar ridge resorption values for groups 1, 2, and 4 (3%, 7%, and 5%, respectively), while group 3 exhibited more reduction (16%). Histomorphometric analysis revealed the presence of adequate average values of mineralized tissue (group 1, 46.4%; group 2, 28.88%; group 3, 48.81%; group 4, 41.13%). Based on the clinical and volumetric outcomes, none of the ridge preservation modalities was superior to the control. The combination allograft (freeze-dried bone allograft and demineralized freeze-dried bone allograft) employed in this study appears to be a safe and adequate biomaterial for intraoral grafting.

Carbonell JM, Martín IS, Santos A, Pujol A, Sanz-Moliner JD, Nart J.

**High-Density Polytetrafluoroethylene Membranes in Guided Bone and Tissue Regeneration Procedures: A Literature Review.** *Int J Oral Maxillofac Surg.* 2014 Jan;43(1):75-84.

Expanded polytetrafluoroethylene (e-PTFE) has been used successfully as a membrane barrier for regeneration procedures. However, when exposed to the oral cavity, its high porosity increases the risk of early infection, which can affect surgical outcomes. An alternative to e-PTFE is non-expanded and dense polytetrafluoroethylene (n-PTFE), which results in lower levels of early infection following surgical procedures. The aim of this literature review was to analyze and describe the available literature on n-PTFE, report the indications for use, advantages, disadvantages, surgical protocols, and complications. The medical databases Medline-PubMed and Cochrane Library were searched and supplemented with a hand search for reports published between 1980 and May 2012 on n-PTFE membranes. The search strategy was limited to animal, human, and in vitro studies in dental journals published in English. Twenty-four articles that analyzed the use of n-PTFE as a barrier membrane for guided tissue regeneration and guided bone regeneration around teeth and implants were identified: two in vitro studies, seven experimental studies, and 15 clinical studies. There is limited clinical and histological evidence for the use of n-PTFE membranes at present, with some indications in guided tissue regeneration and guided bone regeneration in immediate implants and fresh extraction sockets.

Vittorini Orgeas G, Clementini M, De Risi V, de Sanctis M.  
**Surgical Techniques for Alveolar Socket Preservation: A Systematic Review.** *Int J Oral Maxillofac Implants.* 2013 Jul-Aug;28(4):1049-61.

**Objective:** To evaluate, through a systematic review of the literature, the efficacy of different surgical techniques in maintaining residual bone in the alveolar process following tooth extractions. **Materials and methods:** MEDLINE/PubMed was searched through January 2010 and papers were selected according to the CONSORT statement and an independent three-stage screening process. The selected outcome variables were clinical width and height changes of the socket, and means and standard deviations were calculated from the included studies. For those studies that were randomized controlled trials, six meta-analyses were performed by dividing studies into three groups with regard to the use of barriers and grafting (barriers alone, graft alone, or both).

**Results:** Thirteen papers met the eligibility criteria and were included in the analyses. Statistically significant ridge preservation was found for studies that used barriers alone; the pooled weighted mean was 0.909 mm (95% confidence interval, 0.497554 to 1.320732 mm) for bone height, while the mean for bone width was 2.966 mm (95% confidence interval, 2.334770 to 3.598300 mm).

**Conclusion:** Socket preservation procedures are effective in limiting horizontal and vertical ridge alterations in postextraction sites. The meta-analysis indicates that the use of barrier membranes alone might improve normal wound healing in extraction sites.

Barber HD, Lignelli J, Smith BM, Bartee BK.  
**Using a Dense PTFE Membrane Without Primary Closure to Achieve Bone and Tissue Regeneration.** *J Oral Maxillofac Surg.* 2007;65:748-752.

The most common types of barrier membranes used for bone or tissue regeneration are made of expanded-polytetrafluoroethylene (e-PTFE) or resorbable materials, such as collagen. Both the e-PTFE and resorbable membranes require primary soft tissue coverage. This article explores the use of a dense-polytetrafluoroethylene (d-PTFE) membrane, which does not require primary soft tissue coverage. The advantages of d-PTFE in contrast to the other more commonly used types of barrier membranes and the clinical significance of these advantages for implant surgical and restorative treatment are discussed.

Barboza EP, Stutz B, Mandarino D, Rodrigues DM, Ferreira VF.  
**Evaluation of a Dense Polytetrafluoroethylene Membrane To Increase Keratinized Tissue: A Randomized Controlled Clinical Trial.** *Implant Dent.* 2014 Jun;23(3):289-94.

**Background:** The presence of an adequate zone of keratinized tissue has been associated with implant health. This study evaluated the increasing of the zone of keratinized tissue using

dense polytetrafluoroethylene (d-PTFE) membranes over extraction sites, without primary closure.

**Materials and methods:** Fifteen sites received d-PTFE membranes. The control sites received no membranes. All cases were sutured with no attempt to achieve primary closure. Before surgery, initial measurements of buccal and lingual keratinized tissue were taken from the mucogingival line (MGL) to the most coronal gingival margins. Final measurements were taken from the buccal MGL to the lingual MGL, 60 and 90 days after extractions. **Results:** In the test group, a mean increase in the zone of keratinized tissue of  $7.06 \pm 2.63$  mm and  $6.6 \pm 2.84$  mm was observed in 60 and 90 days, respectively. In the control group, a mean increase of  $2.46 \pm 1.59$  mm and  $1.40 \pm 1.40$  mm was observed in 60 and 90 days, respectively.

**Conclusion:** Nonexpanded d-PTFE membranes can predictably be used to increase the zone of keratinized tissue in preparation to implant placement.

Barboza EP, Stutz B, Ferreira VF, Carvalho W.  
**Guided Bone Regeneration Using Nonexpanded Polytetrafluoroethylene Membranes in Preparation for Dental Implant Placements- A Report Of 420 Cases.** *Implant Dent.* 2010;19:2-7.

The biologic principle of guided bone regeneration has been successfully used to prevent bone loss in extraction sites. This study comprises 420 cases of alveolar ridge maintenance in preparation for dental implant placements. Nonexpanded polytetrafluoroethylene membranes were positioned over all extraction sites and left intentionally exposed. Lyophilized mineralized bone allografts were used to prevent membrane collapse when buccal bone walls were lost. Membranes were removed at week 4. At the time of implant placements, all sites presented soft tissue compatibility with keratinized gingiva. The mucogingival junction position seemed to be preserved. Exposed nonexpanded polytetrafluoroethylene membranes associated, or not, with bone graft provide tissue formation suitable for implant placement.

Waasdorp, J., Feldman, S.  
**Bone Regeneration Around Immediate Implants Utilizing A Dense Polytetrafluoroethylene Membrane Without Primary Closure: A Report Of 3 Cases.** *J Oral Implantol.* 2013;39:355-361

Case reports document successful use of a high-density polytetrafluoroethylene membrane to augment horizontal defects associated with immediately placed implants. This membrane, which is designed to withstand exposure (not require primary closure) to the oral cavity because it is impervious to bacteria, reduces the need for advanced flap management to attain primary closure. Thus, the surgical aspect is less complex and the mucogingival architecture of the area can be maintained. These cases demonstrate successful use of this application and provide evidence for controlled clinical trials to further evaluate this technique.

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Zafiroopoulos GG, Kasaj A, Hoffmann O.

**Immediate Implant Placement in Fresh Mandibular Molar Extraction Socket: 8 Year Results.** J Oral Implantol. 2010;36(2):145-151.

Recently, successful implant placement in fresh extraction sockets has been reported. In this case report, we present the results of an immediate implant placement in a fresh extraction socket of a mandibular molar with simultaneous bone regeneration using a nonresorbable membrane and no other graft materials. Clinical and radiographic findings acquired 8 years after implant placement demonstrated a stable peri-implant situation and confirmed a satisfactory treatment result.

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Bartee BK.

**Extraction Site Reconstruction for Alveolar Ridge Preservation. Part 2: Membrane-Assisted Surgical Technique.** J Oral Implantol. 2001;27:194-197.

Alveolar ridge resorption has long been considered an unavoidable consequence of tooth extraction. Guided bone regeneration techniques and the use of bone replacement materials have both been shown to enhance socket healing and to potentially modify the resorption process. This article will describe a surgical technique using textured, high-density polytetrafluoroethylene (PTFE) membrane and particulate bone replacement materials for graft containment and prevention of soft tissue ingrowth into healing extraction sites. The technique described does not require primary closure, facilitating the preservation of keratinized mucosa and gingival architecture.

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Greenstein G, Carpentieri JR.

**Utilization of d-PTFE Barriers for Post-Extraction Bone Regeneration in Preparation for Dental Implants.** Compend Contin Educ Dent. 2015 Jul-Aug;36(7):465-73.

Guided bone regeneration (GBR) can be used to restore a defective alveolar ridge after extractions before or in combination with implant placement. It may also be employed after extractions to reduce crestal bone resorption and maximize bone fill of sockets. Resorbable or nonresorbable barriers (eg, expanded polytetrafluoroethylene [e-PTFE]) can be used when performing GBR procedures, but they need to be completely submerged to attain optimal results. Dense polytetrafluoroethylene (d-PTFE) is a type of nonresorbable barrier that circumvents the necessity to attain primary closure after placement of bone grafts, thereby reducing patient morbidity. This article addresses topics pertaining to d-PTFE utilization, including characteristics and advantages of d-PTFE barriers, time needed for osteoid tissue to become impervious to penetration by flap connective tissue, relevant clinical studies, and limitations of available data. Clinical photographs and radiographs of successfully treated cases are

presented to illustrate the efficacy of d-PTFE barriers in regenerating defective bony plates after extractions.

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Bartee BK.

**Evaluation of a New Polytetrafluoroethylene Guided Tissue Regeneration Membrane in Healing Extraction Sites.** Compend Contin Educ Dent. 1998;19:1256-1264.

The biological principles underlying guided tissue regeneration (GTR) are apparently well understood, and many of the molecular events involved in bone regeneration are being investigated. Much controversy exists, however, as to which membrane biomaterial is ideal for use in these procedures. Adding to the confusion, new applications of GTR membranes continue to evolve, such as extraction site reconstruction, implant site development, ridge augmentation, and the use of membranes in conjunction with the placement of dental implants. These innovative techniques place demands on the membrane that were unforeseen when the first generation of devices was developed. The present study suggests that the ideal design characteristics of a barrier membrane, such as pore size and polymer type, may depend on the intended use of the membrane, and are not fixed criteria that should be applied to all membrane devices. This article describes the clinical results in a series of case studies using a high-density, microporous polytetrafluoroethylene membrane (Cytoplast Regentex GBR-200). To evaluate the clinical efficacy of this membrane and technique, clinical and histological evaluation of the regenerated tissue are presented. ■

### Cytoplast™ Technique: Dual Layer

Al-Hezaimi K, Rudek I, Al-Hamdan KS, Javed F, Nooh N, Wang HL. **Efficacy of Using a Dual Layer of Membrane (dPTFE Placed Over Collagen) for Ridge Preservation in Fresh Extraction Sites: A Micro-Computed Tomographic Study in Dogs.** Clin Oral Implants Res. 2013 Oct;24(10):1152-7.

**Objective:** To assess if overbuilding the buccal plate or using a dual-layer socket grafting technique prevents alveolar bone resorption and enhances final ridge width, height, and volume after tooth loss in an animal model.

**Materials and methods:** In eight beagle dogs bilateral second (P2)-, third (P3)-, and fourth (P4) premolars were endodontically treated. All bilateral mandibular first premolars and distal roots of P2, P3, and P4 were hemisectioned and atraumatically extracted. Animals were randomly divided into four groups: (i) Control-Socket alone, (ii) Particulate allograft in the alveolus, socket covered with high-density polytetrafluoroethylene (dPTFE) membrane and sutured over the alveolus, (iii) Particulate allograft in the alveolus and overbuilding the buccal plate, socket covered with dPTFE membrane and sutured over the alveolus, (iv) Particulate allograft in the alveolus and covered with dual layer (dPTFE placed over collagen membrane), and sutured over the alveolus. After 16 weeks, the animals were sacrificed. Man-

dibular blocks of the jaws were assessed for bone volume (BV), vertical bone height (VBH), alveolar ridge thickness, and bone mineral density (BMD) using micro-computed tomography. Results: The BV in groups 1, 2, 3, and 4 was 169.5, 207.57, 242.4, and 306.1 mm<sup>3</sup>, respectively. The VBH in groups 1, 2, 3, and 4 was 4.2, 6.4, 6.2, and 7.3 mm, respectively. Ridge widths in groups 1, 2, 3, and 4 were  $5.45 \pm 0.75$ ,  $5.91 \pm 0.86$ ,  $6.05 \pm 0.63$ , and  $6.28 \pm 1.01$  mm, respectively. There was no significant difference in BMD between the groups.

Conclusion: The RP using a dual layer of membrane following tooth extraction results in more BV, VBH, and alveolar ridge width as compared to when a single layer of membrane is used.

Yun JH, Jun CM, Oh NS.

**Secondary Closure of An Extraction Socket Using the Double-Membrane Guided Bone Regeneration Technique with Immediate Implant Placement.** J Periodontal Implant Sci. 2011;41:253-258

Objective: Immediate implantation presents challenges regarding site healing, osseointegration, and obtaining complete soft-tissue coverage of the extraction socket, especially in the posterior area. This last issue is addressed herein using the double-membrane (collagen membrane+high-density polytetrafluoroethylene [dPTFE] membrane) technique in two clinical cases of posterior immediate implant placement.

Methods: An implant was placed immediately after atraumatically extracting the maxillary posterior tooth. The gap between the coronal portion of the fixture and the adjacent bony walls was filled with allograft material. In addition, a collagen membrane (lower) and dPTFE membrane (upper) were placed in a layer-by-layer manner to enable the closure of the extraction socket without a primary flap closure, thus facilitating the preservation of keratinized mucosa. The upper dPTFE membrane was left exposed for 4 weeks, after which the membrane was gently removed using forceps without flap elevation.

Results: There was considerable plaque deposition on the outer surface of the dPTFE membrane but not on the inner surface. Moreover, scanning electron microscopy of the removed membrane revealed only a small amount of bacteria on the inner surface of the membrane. The peri-implant tissue was favorable both clinically and radiographically after a conventional dental-implant healing period.

Conclusion: Secondary closure of the extraction socket and immediate guided bone regeneration using the double-membrane technique may produce a good clinical outcome after immediate placement of a dental implant in the posterior area.

Al-Hezaimi K, Iezzi G, Rudek I, Al-Daafas A, Al-Hamdan K, Al-Rasheed A, Javed F, Piatelli A, Wang HL.

**Histomorphometric Analysis of Bone Regeneration Using a Dual-Layer of Membranes (dPTFE Placed Over Collagen) In Fresh Extraction Sites: In Canine Model.** J Oral Implantol. 2015 Apr; 41(2); 188-195.

In untreated extraction sockets, buccal bone remodeling compromises the alveolar ridge width. The aim of this study was to histologically assess the efficacy of using a dual layer of membranes (high-density polytetrafluoroethylene [dPTFE] placed over collagen) for ridge preservation in fresh extraction sites. Eight beagle dogs were used. After endodontic treatment of mandibular bilateral second (P2), third (P3), and fourth (P4) premolars, mandibular bilateral first premolars and distal roots of P2, P3, and P4 were extracted atraumatically. Animals were randomly divided into 4 treatment groups. group 1, the control group, received no treatment; in group 2, allograft was placed in the alveolus and the socket covered with dPTFE membrane; in group 3, allograft was placed in the alveolus, the buccal plate was overbuilt with allograft, and the socket was covered with dPTFE membrane; in group 4, allograft was placed in the alveolus and covered with dual layer of membranes (dPTFE placed over collagen). No intent of primary closure was performed for all groups. After 16 weeks, the animals were sacrificed and mandibular blocks were assessed histologically for buccolingual width of alveolar ridge, percentage of bone formation and bone marrow spaces, and the remaining bone particles. The buccolingual width of the alveolar ridge was significantly higher among sockets in group 4 than in group 1 ( $P < .05$ ). the amount of newly formed bone in each socket was higher in extraction sockets in group 4 than in groups 1, 2, and 3 ( $P < .001$ ). A significant difference was found in the percentage of bone marrow spaces among all groups ( $P < .001$ ). No significant difference was found in the number of nonresorbed bone particles among the groups. Using a dual layer of membrane was more effective in ridge preservation than conventional socket augmentation protocols. ■

## Ridge Preservation with NovaBone®

Kotsakis G, Joachim F, Saroff S, Mahesh L, Prasad H, Rohrer M. **Histomorphologic Evaluation of a Calcium-Phosphosilicate Putty Bone Substitute in Extraction Sockets.** Int J Periodontics Restorative Dent. 2014 Mar-Apr; 34(2)233-9.

The objective of this study was to evaluate bone regeneration in 24 sockets grafted with a calcium phosphosilicate putty alloplastic bone substitute. A core was obtained from 17 sockets prior to implant placement for histomorphometry at 5 to 6 months post extraction. Radiographic analysis during the same post extraction healing period showed radiopaque tissue in all sockets. Histomorphometric analysis revealed a mean vital bone content of 31.76% ( $\pm 14.20\%$ ) and residual graft content of 11.47% ( $\pm 8.99\%$ ) after a mean healing period of 5.7 months. The high percentage of vital bone in the healed sites in combination with its timely absorption rate suggest that calcium phosphosilicate putty can be a reliable choice for osseous regeneration in extraction sockets.

Kotsakis G, Salama M, Chrepa V, Hinrichs JE, Gaillard P.

**A Randomized Blinded Controlled Clinical Study of Particulate Anorganic Bovine Bone Mineral and Calcium Phosphosilicate Putty Bone Substitutes for Socket Preservation.** Int. J Oral Maxillofacial Implants. Jan-Feb 2014; 29(1):141-51

**Purpose:**The purpose of this study was to compare the clinical efficacy of an anorganic bovine bone graft particulate to that of a calciumphosphosilicate putty alloplast for socket preservation.  
**Materials and methods:**Thirty teeth were extracted from 24 patients. The sockets were debrided and received anorganic bovine bone mineral (BOV, n=12), calcium phosphosilicate putty (PUT, n=12), or no graft (CTRL, n=6). The sockets were assessed clinically and radiographically 5 months later. Eight sockets in the BOV group and nine in the PUT group received implants 5 to 6 months post grafting. The maximum implant insertion torque (MIT) was measured as an index of primary implant stability. The data were analyzed with the Mann-Whitney test.

**Results:** Both test groups had statistically significantly less reduction in mean ridge width (BOV: 1.39±0.57 mm; PUT: 1.26±0.41 mm) in comparison to the control group (2.53±0.59 mm). No statistically significant difference was identified between the test groups. MIT for PUT was  $\leq 35$  N/cm<sup>2</sup> (MIT grade 4) for seven of the nine implants. MIT values in the BOV group ranged from grade 1 (10 to 19 N/cm<sup>2</sup>) to grade 4, which was statistically significantly lower than for the PUT group. The overall implant success rate was 94.1% (16 of 17 implants were successful). No implants were lost in the PUT group; one implant failed in the BOV group.

**Conclusion:** Both tested bone substitutes can be recommended for preservation of alveolar ridge width following extraction. PUT might be more suitable for achieving primary stability for implants placed at 5 to 6 months post extraction.

Mahesh L, Kotsakis G, Venkataraman N, Shukla S, Prasad H.  
**Ridge Preservation with Socket Plug Technique Utilizing an Alloplastic Putty Bone Substitute or a Particulate Xenograft.** J Oral Implantol. 2015 Apr;41(2):178-83.

Following tooth extraction, ridge preservation procedures are employed to regenerate bone in the extraction socket, limit consequent ridge resorption, and provide a stable base for implant placement. The purpose of this study is to histologically evaluate and compare bone regeneration in extraction sockets grafted with either a putty alloplastic bone substitute or particulate anorganic bovine xenograft utilizing the socket-plug technique. Nineteen patients underwent 20 tooth extractions and ridge preservation following a standardized protocol. Ten sites were grafted with calcium phosphosilicate putty (CPS group) and the remaining 10 with anorganic bovine bone substitute (BO group). Patients were recalled after 4-6 months to evaluate the bone regeneration and to proceed with implant placement. A bone core was obtained during the implant procedure from each site and was used for histologic analysis. Histomorphometry revealed that residual graft values were significantly higher in the BO

group (25.60% ± 5.89%) compared to the CPS group (17.40% ± 9.39%) (P < .05). The amount of new bone regenerated was also statistically significant higher in the alloplast group (47.15% ± 8.5%) as compared to the xenograft group (22.2% ± 3.5%) (P < .05). Results suggest that ridge preservation using a putty calcium phosphosilicate alloplastic bone substitute demonstrates more timely graft substitution and increased bone regeneration when compared to an anorganic bovine bone xenograft.

Babbush CA, Kanawati A.

**Clinical Evaluation of 262 Osseointegrated Implants Placed in Sites grafted with Calcium Phosphosilicate Putty: A Retrospective Study.** J Oral Implantol. 2015 Feb;41(1):63-9.

Along with the widespread use of dental implants, regenerative procedures have become an indispensable tool for implant surgeons in managing residual ridges and the surrounding bone. Putty bone grafts have significantly superior handling characteristics in comparison to particulates. These include ease of placement, enhanced particle containment, and a viscous consistency that has allowed for unique delivery systems to be developed. The aim of this study was to report the clinical efficacy of calcium phosphosilicate (CPS) putty in a wide variety of indications related to implant reconstruction and to report the survival rate of implants placed in these grafted sites. The CPS putty was used as the graft material of choice. Treatments were categorized into following groups: extraction graft, extraction with immediate implant placement, all-on-four concept, peri-implantitis treatment, bone augmentation before implant placement, implant replacement graft, and grafting around implant placed in resorbed ridges. Included in the analysis were 65 patients (36 men, 29 women) with a mean age of 63 ± 12 years. In total, 262 implants were placed. Four implants were diagnosed with peri-implantitis and were treated as described in category 4, for a total of 266 grafted sites. Two implants from the extraction graft category and 3 implants from the all-on-four group were lost and replaced with successfully osseointegrated implants during a mean study follow-up period of 12.24 ± 2.32 months. The implant success rate at 1 year was 98.1% (257/262). Based on results of this large-scale, retrospective study we conclude that (1) the use of putty bone grafts can simplify bone-grafting procedures and reduce intraoperative time in various grafting indications, (2) this study verified the efficacy of a CPS putty bone graft biomaterial in a large array of implant-related surgical indications, and (3) implants placed in sites grafted with CPS putty yield very high survival rates.



Salama MA, Lanka M, Kurtzman GM, Joachim FPC  
**Socket Grafting with Calcium Phosphosilicate Alloplast Putty: A Histomorphometric Evaluation.** Compendium. Sept 2012; 33(8): 109-115.

Background: Socket grafting with a bone graft substitute immediately after extraction is essential to preserve the ridge architecture for implant placement. Several bone graft substitutes have been tested for their ability to effectively regenerate osseous tissue in the sockets. Evidence suggests that socket bone typically regenerates during a period of 6 to 8 months or longer, depending on several factors including the original ridge dimensions, type of graft, and the overall systemic health of the individual. The purpose of this study is to histologically evaluate the bone regeneration potential of a novel synthetic calcium phosphosilicate putty (CPS) graft substitute.

Methods: After extraction of the involved teeth, CPS putty graft was placed, and the sockets were covered with a collagen plug. Cores were taken from 20 patients for histological evaluation prior to implant placement. Ten cores were processed decalcified with hematoxylin and eosin (H&E) stain and the remaining 10 were processed undecalcified. Histomorphometric data obtained from both sets is presented.

Results: Histomorphometric analysis revealed an average vital bone content of 49.5 ( $\pm$  20.7). A residual graft content of 4.3% ( $\pm$  7.8) was observed following a healing time of 4.9 ( $\pm$  0.8) months.

Conclusions: Clinical and histomorphometric data suggests that CPS putty is a good choice for socket bone regeneration in implant-related surgeries. ■







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