

# Dental Allograft Solutions

## Published Literature



A Review of Published Clinical  
and Pre-Clinical Evidence.



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## DENTAL COMPENDIUM REVIEW

### Periodontal Defect

**Chadwick JK, Mills MP, Mealey BL. Demineralized freeze-dried bone allograft versus platelet-rich fibrin for the treatment of periodontal intrabony defects in humans. J Periodontol. 2016 Nov; 87(11):1253-1260. PMID: 27353441**

- This randomized controlled trial compared platelet-rich fibrin (PRF) to a control of DFDBA in the treatment of periodontal intrabony defects. Both treatments resulted in improvements in clinical attachment levels and bony fill.

**Ogihara S, Tarnow DP. Efficacy of forced eruption/enamel matrix derivative with freeze-dried bone allograft or with demineralized freeze-dried bone allograft in infrabony defects: A randomized trial. Quintessence Int. 2015 Jun; 46(6):481-490. PMID: 25918759**

- In a randomized clinical trial involving 69 patients, Ogihara and Tarnow examined bony fill and soft tissue healing. The test groups were combinations of enamel matrix derivative with either demineralized freeze-dried bone allograft, or mineralized freeze-dried bone allograft. Both groups showed improvement in both hard and soft tissue healing compared to the controls.

**Agarwal A, Gupta ND. Combination of bone allograft, barrier membrane and doxycycline in the treatment of infrabony periodontal defects: A comparative trial. Saudi Dent J. 2015 Jul; 27(3):155-60. PMID: 26236130**

- This study compared two treatments for chronic periodontitis with LifeNet Health-processed decalcified freeze-dried bone allograft (DFDBA) and barrier membrane either alone, or with local doxycycline. A single surgeon treated 24 patients with one- or two-wall infrabony defects. There was no significant difference in regeneration of periodontal defects between the groups, indicating local delivery of doxycycline does not affect healing. The use of LifeNet Health DFDBA resulted in regeneration of infrabony defects in 24 patients at 6 months post-treatment compared to baseline.

**Gurinsky BS, Mills MP, Mellonig JT. Clinical evaluation of demineralized freeze-dried bone allograft and enamel matrix derivative versus enamel matrix derivative alone for the treatment of periodontal osseous defects in humans. J Periodontol. 2004 Oct; 75(10):1309-1318. PMID: 15562907**

- This randomized controlled clinical trial examined the difference in soft tissue and hard tissues following treatment with enamel matrix derivative (EMD) or enamel matrix derivative mixed with demineralized freeze-dried bone allograft (DFDBA). There was improvement of soft tissue parameters following treatment, but there was not a significant difference between each group. Meanwhile, EMD mixed with DFDBA improved bone fill and crestal resorption more than EMD alone.

**Fucini SE, Quintero G, Gher ME, Black BS, Richardson AC. Small versus large particles of demineralized freeze-dried bone allografts in human intrabony periodontal defects. J Periodontol. 1993 Sept; 64(9):844-847. PMID: 8229619**

- Authors evaluated the effect of particle size of demineralized freeze-dried bone allograft on healing of periodontal defects. Eleven patients were treated with DFDBA ranging from 250 $\mu$ -500 $\mu$  or 850 $\mu$ -1,000 $\mu$ . There was no statistical difference in bone formation between the two groups.

**Chen CC, Wang HL, Smith F, Glickman GN, Shyr Y, O'Neal RB. Evaluation of a collagen membrane with and without bone grafts in treating periodontal intrabony defects. J Periodontol. 1995 Oct; 66(10):838-847. PMID: 8537865**

- This study followed the treatment of periodontal infrabony defects with collagen membrane, or collagen membrane and demineralized freeze-dried bone allografts. In both groups there was an increase of bone regeneration. Results were comparable between the groups indicating collagen membranes and DFDBA can be effectively used together for the treatment of periodontal defects.

## Socket Preservation

**Whetman J, Mealey BL. Effect of healing time on new bone formation after tooth extraction and ridge preservation with demineralized freeze-dried bone allograft: A randomized controlled clinical trial. J Periodontol. 2016 Sept; 87(9):1022-1029. PMID: 27133791**

- In a randomized controlled trial using LifeNet Health DFDBA, Whetman and Mealey showed significantly greater new vital bone formation occurs after tooth extraction and ridge preservation when sites healed 18-20 weeks compared to 8-10 weeks prior to dental implant placement.

**Wallace SC. Histomorphometric and 3d cone-beam computerized tomographic evaluation of socket preservation in molar extraction sites using human particulate mineralized cancellous allograft bone with a porcine collagen xenograft barrier: A case series. J Oral Implantol. 2015 June; 41(3):291-7. PMID: 24987870**

- In this case series, Wallace evaluated the results of socket preservation after extraction using human particulate mineralized cancellous allograft bone and type I porcine collagen membranes as a guided bone regeneration barrier. Fourteen patients with a diagnosis of one, or more, unsalvageable teeth were treated. The results were evaluated clinically, histomorphometrically, and with cone-beam computerized tomographic scanning.

**Mastronikolas S. Case report maxillary implant. Dental Tribune Middle East & Africa Edition. 2014 May-June: 36.**

- In a case report involving a maxillary implant, Mastronikolas extracted and performed site preservation on #5 [Eu. #16]. Demineralized freeze-dried bone allograft was used at the extraction site as well as a fascia lata membrane to guide bone formation. Approximately 3 months later, the patient underwent sinus augmentation at the same site utilizing freeze-dried bone allograft. Three months later, a CT scan was prescribed which verified the successful elevation of the sinus floor.

**Eskow AJ, Mealey BL. Evaluation of healing following tooth extraction with ridge preservation using cortical versus cancellous freeze-dried bone allograft. J Periodontol. 2014 Apr; 85(4):514-524. PMID: 23725026**

- A clinical study by Eskow et al. performed histological analysis of cortical and cancellous freeze-dried bone allograft following tooth extraction and ridge preservation in a non-molar model. After an average follow-up period of 18 weeks, the study reported no significant differences in new bone formation between the two groups. The use of both cortical and cancellous FDBA from LifeNet Health resulted in successful bone formation.

**Wallace S. Guided bone regeneration for socket preservation in molar extraction sites: Histomorphometric and 3D computerized tomography analysis. J Oral Implantol. 2013; 29(4):503-509. PMID: 23530854**

- In a case series, Wallace analyzed bone regeneration using histomorphometric and 3D computerized tomography analysis. Mineralized cancellous bone allograft was used to fill each socket and decellularized dermal matrix was applied over each socket site. Both grafts were processed by LifeNet Health. Results showed 28.7% new bone formation after 12 weeks using these materials.

**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 Jun; 39(3):355-361. PMID: 21905904**

- A case series by Waasdorp et al. evaluated bone regeneration using a dense polytetrafluoroethylene membrane and, in some cases, freeze-dried cortical bone, supplied by LifeNet Health, around immediately placed implants. Results of the study demonstrated successful use of the membrane to “augment horizontal defects associated with immediately placed implants.”

**Wood RA, Mealey BL. Histologic comparison of healing after tooth extraction with ridge preservation using mineralized versus demineralized freeze-dried bone allograft. J Periodontol. 2012 Mar; 83(3):329-336. PMID: 21749166**

- In a randomized, comparative study, Wood and Mealey compared the efficacy of demineralization involving 40 patients implanted with either DFDBA, or freeze dried bone allografts (FDBA). After 19 weeks follow-up, biopsies showed significantly greater amounts of new bone formation in patients implanted with DFDBA over the FDBA patients. This study provides evidence that directly compares ridge preservation with DFDBA versus FDBA.

**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 Oct; 41(5):253-258. PMID: 22087417**

- In this case study, Yun et al. achieved good healing around immediate implant placement using a combination of allograft with dense polytetrafluoroethylene (dPTFE) membrane. Using this combinatorial technique may reduce treatment time and eliminating a second procedure can minimize patient discomfort.

**Tsai BY. A method for obtaining peri-implant soft-tissue contours by using screw-retained provisional restorations as impression copings: A clinical report. J Oral Implantol. 2011 Oct; 37(5):605-609. PMID: 20553160**

- In this case study, Tsai used an allograft (OraGraft® from LifeNet Health) to quickly correct an unanticipated defect in a common missing tooth scenario in the esthetic zone. Three months after the guided bone regeneration procedure using OraGraft®, a provisional crown was placed to model, or remodel, the peri-implant gingival architecture. After 8 weeks, bilateral screw-retained restorations were placed. New bone growth was maintained over 2 years of follow-up. The case demonstrated the ease of use and predictability of allograft.

## Fenestrations

**Rosen PS, Reynolds MA. Guided bone regeneration for dehiscence and fenestration defects on implants using an absorbable polymer barrier. J Periodontol. 2001 Feb; 72(2):250-6. PMID: 11288800**

- This study followed 9 patients with 8 fenestration and 3 dehiscence defects which were treated with a bioabsorbable polymer barrier and a composite graft of freeze-dried bone allograft and demineralized freeze-dried bone allograft. 90.9% of the defects were healed with histologic evaluation demonstrating the formation of viable bone.

**Fugazzotto PA, Shanaman R, Manos T, Shectman R. Guided bone regeneration around titanium implants: report of the treatment of 1,503 sites with clinical reentries. Int J Periodontics Restorative Dent. 1997 Jun; 17(3):292, 293-9. PMID: 9497721**

- 1,503 implants which demonstrated fenestration or dehiscence were treated with Gore-Tex membranes over demineralized freeze-dried bone allograft, freeze-dried bone allograft, an equal combination of these, or demineralized freeze-dried bone allograft combined with equal parts of resorbable tricalcium phosphate. The treatment success rate was 97%.

## Immediate Implant Placement

**Vidal R, Greenwell H, Hill M, Papageorgakopoulos G, Scheetz JP. Success rate of immediate implants placed and restored by novice operators. Implant Dent. 2010 Feb; 19(1):81-90. PMID: 20147820**

- In a prospective study, Vidal et al. reported a 100% success rate in a study consisting of 51 patients who had immediate implant placements. While the total number of patients who received FDBA was not specified, FDBA along with a collagen membrane was grafted onto sockets that had >1 mm distance to the implant surface. After one year, the appearance of the final restoration was rated as excellent for most patients, supporting the efficacy of using FDBA in an immediate implant procedure.

**West JD, Oates TW. Identification of stability changes for immediately placed dental implants. Int J Oral Maxillofac Implants. 2007 July-Aug; 22(4):623-630. PMID: 17929524**

- In a prospective study, West and Oates compared implant stability in non-grafted sites vs immediate placement into native bone with grafting. Implants placed with grafting demonstrated greater implant stability than implants placed 6 months after extraction. The study showed that immediate placement with grafting is a viable option in order to reduce treatment time.

**Nissan J, Romanos GE, Mardinger O, Chaushu G. Immediate nonfunctional loading of single-tooth implants in the anterior maxilla following augmentation with freeze-dried cancellous block allograft: A case series. Int J Oral Maxillofac Implants. 2008 Jul-Aug; 23(4):709-716. PMID: 18807569**

- In this case series, Nissan et al. published a study where they augmented deficient alveolar ridges for single-tooth implants in 9 patients with cancellous blocks. After an 18 month follow-up, survival rate of implants was 100% and there was no bone loss beyond the first thread. The authors concluded with support for the treatment stating it is a promising alternative to traditional methods.

**Li YH, Chiang TE, Chen YW. Full mouth reconstruction with immediate implant placement in multiple extraction sockets. J Dent Sci. 2019 Mar; 14(1):99-100. doi: 10.1016/j.jds.2017.12.001. Epub 2018 Mar 26. PMID: 30988886**

- In this case study, an immediate implantation was performed in 56-year old male with multiple missing teeth and residual roots. Immediate implantation procedures can minimize treatment/surgery time while preserving more of the gingiva and alveolar bone. In this case, atraumatic dental extraction with periostomes was performed and implants were placed after extraction. Freeze-dried bone allograft from LifeNet Health was used adjacent to the implant placement site to correct small osseous defects. After 6 months, full restoration was achieved with functional and esthetic outcomes.

**DeGroot BS, Villar CC, Mealey BL, Mills MP, Prihoda TJ, & Huynh-ba G. (2017). Osseous healing around immediate implants placed using contour augmentation: A prospective case series. International Journal of Periodontics and Restorative Dentistry, 37(6), 882-891. PMID: 29023622**

- This study prospectively evaluated thickness of buccal bone after immediate implantation with buccal contour augmentation. After three months of healing, all implants (n=18) had successfully osteointegrated and the mean buccal bone thickness was 2.94 +- 0.21 mm which was significantly greater than previous data. This study further supports the use of allograft for new bone formation to support the success of the immediate implant procedure.

**Zeren KJ. Use of Bone Morphogenetic Protein-2 in Molar Extraction Sockets for Immediate Implant Placement: A Prospective Case Series. Int J Periodontics Restorative Dent. 2018 Jan/Feb; 38(1):87-93. PMID: 28854288**

- In this prospective case series, patients who required immediate implant placement in larger, uncontained, fresh molar extraction sites using recombinant human bone morphogenetic protein-2/absorbable collagen sponge (rhBMP-2/ACS) combined with mineralized bone allograft were evaluated. Clinical and radiographic evaluation after 4-6 months indicated rhBMP-2/ACS combined with mineralized bone allograft from LifeNet Health supported healing, ridge preservation, and implant integration.

## Ridge Augmentation Particulate

**Checchi V, Mazzoni A, Breschi L, Felice P. Reconstruction of an atrophied posterior mandible with the inlay technique and allograft block versus allograft particulate: A case report. Int J Periodontics Restorative Dent. 2015 Mar-Apr; 35(2):e20-7. PMID: 25738350**

- This case report described the bilateral reconstruction of a severely atrophic posterior mandible in a 30-year-old woman illustrating the inlay technique. Checchi et al. successfully employed cancellous blocks, mineralized particulate and decellularized dermis to greatly improve ridge dimensions bilaterally in order to prepare the patient for future implant treatment.

**Parashis AO, Kalaitzakis CJ, Tatakis DN, Tosios K. Alveolar ridge preservation using xenogeneic collagen matrix and bone allograft. Int J Dent. 2014:172852. PMID: 25328523**

- In this clinical study, Parashis et al. corrected sites in patients (n=9) with a xenogeneic collagen membrane and LifeNet Health allograft. In all cases, the area was successfully augmented. The cases are supported with radiographic, tomography and histologic examples. This is a useful study illustrating the utility of bone grafting.



**Felice P, Checchi L, Pistilli R, Barausse C, Spinato S. The modified “Sandwich” technique: A novel surgical approach to regenerative treatment of horizontal bone defects in the posterior atrophic mandible. A case report. *Implant Dent.* 2014 Jun; 23(3):232-238. PMID: 24819804**

- Felice et al. described a case study about a novel surgical approach for the treatment of advanced defects in the posterior mandible. The technique involves a 2 stage modified “sandwich” osteotomy procedure kept in position with titanium mini-plates and mini-screws. The newly created defect area was filled with an allograft putty composed of a mixture of mineralized and demineralized human bone. Two implants were placed following a 3 month healing period with no complications reported.

**Sindler AJ, Behmanesh S, Reynolds MA. Evaluation of allogenic cellular bone graft for ridge augmentation: A case report. *Clin Adv Periodontology.* 2013; 3(3):159-165. [Click Here For Abstract](#)**

- From this case study, Sindler et al. illustrated the use of a novel cellular bone graft mixed with traditional allograft in providing a significant horizontal ridge gain prior to implantation. Recent advancements in tissue banking are illustrated and it shows how the reliability of allografts can be further enhanced.

**Beitlitum I, Artzi Z, Nemcovsky CE. Clinical evaluation of particulate allogenic with and without autogenous bone grafts and resorbable collagen membranes for bone augmentation of atrophic alveolar ridges. *Clin Oral Implants Res.* 2010 Nov; 21(11):1242-1250. PMID: 20572833**

- In a prospective study comparing allograft only with allograft and autograft combination treatment, Beitlitum et al. used FDBA to augment the alveolar ridge deficiencies of 50 patients. The authors found that not only did the FDBA alone yield good clinical results, but it was essentially equivalent to the results of the allograft and autograft combination treatment. This study supports use of allograft alone which can minimize donor site morbidity from autograph collection.

**Johnson TM, Baron D. Tunnel Access for Guided Bone Regeneration in the Maxillary Anterior. *Clin. Adv. Periodontics.* 2018; 8:27-32. doi:10.1902/cap.2017.170032 [Click here for abstract.](#)**

- In this case study, a 30-year-old patient received localized ridge augmentation using tunnel access for guided bone regeneration with a dense polytetrafluoroethylene membrane and a freeze-dried bone allograft from LifeNet Health. Favorable ridge dimensions were achieved with minimal postoperative swelling and discomfort.

**Halperin-Sternfeld M, Zigdon-Giladi H, Shapira L, Wilensky A. Lateral Guided Bone Regeneration Using a Novel Synthetic Bioresorbable Membrane: A Two Center Prospective Randomized Controlled Trial Running title: A novel membrane for ridge augmentation. *Journal of Molecular and Clinical Medicine.* 2018; 1(3):169-176 DOI: 10.31083/j.jmcm.2018.03.006 [Click here for article.](#)**

- This two-center randomized controlled clinical study aimed to determine the efficacy of resorbable synthetic polyethylene-glycol/methacrylate (PEG/MET) membrane used in conjunction with allogenic bone substitute in guided bone regeneration. Compared to collagen membranes, the synthetic membrane was as effective in lateral ridge augmentation prior to endosseous dental implant placement. However, exposure rate was higher with the synthetic membrane. LifeNet Health OraGraft® FDBA was successfully used in both groups.

**Aljhanian AS, Aldreesb AM. Orthodontic treatment of an anterior open bite with the aid of corticotomy procedure: Case report. *Saudi Dent J.* 2011 Apr; 23(2): 99–106. PMID: 24151417**

- This case study covers the treatment of a 22-year-old patient with an anterior open bite and flared and spaced upper and lower incisors. After orthodontic appliances were applied, a buccal and lingual corticotomy with alveolar augmentation procedure using LifeNet Health OraGraft® was performed. Open bite closure was achieved in 5 months with no adverse side effects. This case study demonstrates a combinatorial approach can significantly shorten the length of treatment without compromising results.



**Song IS, Lee MR, Ryu JJ, Lee UL. Reconstruction of a Severely Atrophied Alveolar Ridge by Computer-Aided Gingival Simulation and 3D-Printed Surgical Guide: A Case Report. Int J Oral Maxillofac Implants. 2018 May/June; 33(3):e73–e76. PMID: 28817741**

- This case report described the rehabilitation of a severely atrophied alveolar ridge in a 50-year-old woman with a three-dimensional (3D) computer-aided design/computer-aided manufacture (CAD/CAM) surgical guide. After several previous bone regeneration procedures failed, the patient was left with a severely atrophied alveolar ridge and unfavorably positioned dental implants. Using the 3D guide for precise positioning and fixation of LifeNet Health OraGraft® resulted in favorable positioning of the new dental implants, and alveolar bone regeneration.

**Wadhvani C, Rapoport D, La Rosa S, Hess T, Kretschmar S. Radiographic detection and characteristic patterns of residual excess cement associated with cement-retained implant restorations: a clinical report. J Prosthet Dent. 2012 Mar; 107(3):151-7. PMID: 22385690**

- Wadhvani et. al. report on four cases highlighting radiographic detection of residual excess cement and characteristic patterns of cement flow. Cement superimposition, highly radiopaque cement, the circumferential effect, and radiolucent cement patterns were found with imaging and the authors hope their description can enable clinicians to better diagnose and treat residual excess cement in implant restorations.

## Ridge Augmentation Block Grafts

**Checchi V, Mazzoni A, Breschi L, Felice P. Reconstruction of an atrophied posterior mandible with the inlay technique and allograft block versus allograft particulate: A case report. Int J Periodontics Restorative Dent. 2015 Mar-Apr; 35(2):e20-7. PMID: 25738350**

- This case report described the bilateral reconstruction of a severely atrophic posterior mandible in a 30-year-old woman illustrating the inlay technique. Checchi et al. successfully employed cancellous blocks, mineralized particulate and decellularized dermis to greatly improve ridge dimensions bilaterally in order to prepare the patient for future implant treatment.

**El-Halaby A, Becker J, Bissada NF. Autogenous bone grafting in a patient on long-term oral bisphosphonate therapy: Case report. Int J Periodontics Restorative Dent. 2009 Dec; 29(6):634-641. PMID: 20072741**

- In this case study, El-Halaby et al. treated a patient with a history of oral bisphosphonate use for 7 years for the treatment of osteoporosis. An autogenous block was used as well as allograft particulate. Implants were placed successfully after 8 months and buccolingual width of ridge increased significantly. Healing was uneventful at the donor and recipient sites.

**Sfasciotti GL, Trapani CT, Powers RM. Mandibular ridge augmentation using a mineralized ilium block: A case letter. J Oral Implantol. 2016 Apr; 42(2):215-219. PMID: 25961870**

- In this case study, Sfasciotti et al. treated a severely atrophic mandible in sextants 5 and 6. Blocks formed from an ilium strip were strategically placed and secured with titanium screws. Pre-planting was performed using computerized tomography and a surgical stent. Post-operative scans showed excellent early healing. A core was removed prior to implant placement and histology showed exceptional healing at 10 months. The case was successfully finished with implant placement.

**Fagan MC, Conte GJ, Kao RT. Implant site development with simultaneous block and soft-tissue graft. Clin Adv Periodontics. 2013; 3(4):222-228. [Click Here For Abstract](#)**

- In this case study, Fagan et al. corrected a site in the esthetic zone for a missing tooth. An ilium block was used thus allowing for subsequent implant placement. This is another example of the utility of structural grafts in compromised cases.

**Nissan J, Mardinger O, Calderon S, Romanos GE, Chaushu G. Cancellous bone block allografts for the augmentation of the anterior atrophic maxilla. Clin Implant Dent Relat Res. 2011 Jun; 13(2):104-111. PMID: 19744202**

- From this case series, Nissan et al. published a follow-up to their 2008 study where they used 46 cancellous blocks to treat alveolar ridge deficiencies in 31 patients who required implants. They noted 98% implant success after a mean 34 month follow-up. This series supports the use of block allografts for augmentation of the anterior atrophic maxilla.

**Wallace S, Gellin R. Clinical evaluation of freeze-dried cancellous block allografts for ridge augmentation and implant placement in the maxilla. Implant Dent. 2010 Aug; 19(4):272-279. PMID: 20683283**

- In this 12 patient follow-up case series, in which cancellous allograft blocks were used for ridge augmentation, Wallace and Gellin reached the same conclusion as their initial study in 2008. Cancellous allografts could be an alternative to both cortical allografts and autogenous grafts.

**Wallace S, Gellin R. Clinical evaluation of a cancellous block allograft for ridge augmentation and implant placement: A case report. Implant Dent. 2008 Jun; 17(2):151-158. PMID: 18545046**

- In this case study with a 21 month follow-up, Wallace and Gellin used cancellous blocks to augment the maxillary ridge for implant placement. Not only did the authors find the graft successful, but they supported the idea that cancellous allografts could be an alternative to both cortical allografts and autogenous grafts.

**Pendarvis WT, Sandifer JB. Localized ridge augmentation using a block allograft with subsequent implant placement: A case series. Int J Periodontics Restorative Dent. 2008 Oct; 28(5):509-515. PMID: 18991002**

- In this case series, Pendarvis and Sandifer demonstrated successful ridge augmentation using an iliac crest monocortical allograft. Nine patients in need of ridge augmentation for the placement of 16 dental implants were included in this series. Histology from one case after the 6-month healing period demonstrated newly formed woven bone with vascular ingrowth. Implants were successfully placed in all sites. The results of this demonstrate an alternative source of block allograft can be successfully used for alveolar ridge augmentation.

**Checchi V, Mazzoni A, Zucchelli G, Breschi L, Felice P. Reconstruction of Atrophied Posterior Mandible with an Inlay Technique and Allograft Block: Technical Description and Histologic Case Reports. Int J Periodontics Restorative Dent. 2017 Nov/Dec; 37(6):863-870. PMID: 29023618**

- This case series describes the inlay technique performed with LifeNet Health-processed allograft block in the reconstructions of severely atrophic posterior mandible as well as histologic analysis of the grafts in five patients. Histologic analysis showed new bone formation and cellular activity in large marrow spaces. This study supports the use of allografts as an alternative to autographs for use with the inlay technique.

**Nissan J, Mardinger O, Strauss M, Peleg M, Sacco R, Chaushu G. Implant-supported restoration of congenitally missing teeth using cancellous bone block-allografts. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011 Mar; 111(3):286-91. PMID: 20674407**

- This clinical study describes ridge augmentation using cancellous freeze-dried block bone allografts in 12 patients with congenitally missing teeth. LifeNet Health ReadiGraft® was shaped to an appropriate size for each defect and placed in the bed. Bone block and implant survival rates were 100% and 95.2%, respectively and increased bone regeneration was statistically significant ( $p < .001$ ). ReadiGraft® can be customized for each patient to achieving similar functional and esthetic results as autograph without the discomfort of a second surgery site.

**Nissan J, Kolerman R, Chaushu L, Vered M, Naishlos S, Chaushu G. Age-related new bone formation following the use of cancellous bone-block allografts for reconstruction of atrophic alveolar ridges. Clin Implant Dent Relat Res. 2018 Feb;20(1):4-8. doi: 10.1111/cid.12560. PMID: 29194937**

- This study followed ninety-three patients who were referred for implant-supported restoration of severely atrophic alveolar ridges. The study compared new bone formation in young ( $\leq 40$  years) versus older ( $> 40$  years) patients. In the anterior maxilla and the posterior mandible, there were significant differences in new bone formation between the young and older groups. However, there were no differences in the mean of marrow and connective tissues. This study concludes that age does affect new bone formation and longer healing time is recommended for older patients.

**Lyford RH, Mills MP, Knapp CI, Scheyer ET, Mellonig JT. Clinical evaluation of freeze-dried block allografts for alveolar ridge augmentation: A case series. Int J Periodontics Restorative Dent. 2003 Oct; 23(5):417-425. PMID: 14620116**

- This case series follows the use of cancellous block allograft in alveolar ridge augment procedures. Five deficient alveolar ridges were treated and 6 months later all had gained 2 to 4 mm in width. This case series demonstrates allograft blocks are an effective alternative to autograph.

## Sinus Augmentation

**Chaushu G, Mardinger O, Calderon S, Moses O, Nissan J. The use of cancellous block allograft for sinus floor augmentation with simultaneous implant placement in the posterior atrophic maxilla. J Periodontol. 2009 Mar8 (3):422-428. PMID: 19254126**

- In this prospective study, Chaushu et al. used cancellous blocks for maxilla sinus floor augmentation along with simultaneous implant placement for 28 patients. After a 27 months follow-up, the authors were encouraged by the high success rate and new bone formation with viable osteocytes. Cancellous block allografts can be used to induce bone regeneration in sinus floor augmentation procedures.

**Bernardello F, Massaron E, Spinato S, Zaffe D. Two-stage crestal sinus elevation by sequential drills in less than 4 mm of residual ridge height: A clinical and histologic case report. Implant Dent. 2014 Aug; 23(4):378-86. PMID: 25025861**

- In this case report, Bernadello et al. illustrated the correction and preparation of a severely deficient maxilla using the minimally invasive transcrestal technique and mineralized cortical allograft. This method is gaining in popularity and this case report shows how allograft can be successfully employed – even in the most challenging case.

**Kolerman R, Tal H, Moses O. Histomorphometric analysis of newly formed bone after maxillary sinus floor augmentation using ground cortical bone allograft and internal collagen membrane. J Periodontol. 2008 Nov; 79(11):2104-11. PMID: 18980519**

- In this study, 23 biopsies were taken from 19 patients in which mineralized freeze-dried bone allograft (FDBA) from LifeNet Health was used for sinus augmentation. Prior to this study, there were very few histomorphometric analyses of the effectiveness of FDBA used in sinus augmentation. Each biopsy was histologically evaluated using hematoxylin and eosin, and Mallory staining. Biopsies were found to be a mean of 29.1% new bone, 51.9% connective tissues, and 19% residual graft material. Graft particles remained close to new bone and had features of mature bone. There was no evidence of inflammatory infiltrate. This study concluded that FDBA is biocompatible, osteoconductive, and appropriate for use in sinus augmentation procedures.

**Kolerman R, Samorodnitzky-Naveh GR, Barnea E, Tal H. Histomorphometric analysis of newly formed bone after bilateral maxillary sinus augmentation using two different osteoconductive materials and internal collagen membrane. Int J Periodontics Restorative Dent. 2012 Feb; 32(1):e21-8. PMID: 22254231**

- This study compared the use of deproteinized bovine bone mineral (DBBM) with human freeze-dried bone allograft (FDBA) from LifeNet Health in bilateral maxillary sinus floor augmentation. DBBM is considered the nonautogeneous gold standard for sinus elevation procedures. In five patients, DBBM was used on one side and FDBA was used on the other side. After 9 months, authors found there was no significant difference in new bone formation, residual graft particles, or connective tissue values between the two materials. The FDBA performed as well as the nonautogeneous gold standard.

**Kolerman R, Moses O, Artzi Z, Barnea E, Tal H. Maxillary sinus augmentation by the crestal core elevation technique. J Periodontol. 2011 Jan; 82(1):41-51. PMID: 20731587**

- In this retrospectively study, authors evaluated the success of the crestal core elevation (CCE) technique for sinus augmentation. After extraction, sockets were filled with deproteinized bovine bone mineral (DBBM), or freeze-dried bone allograft (FDBA), and protected with an absorbable collagen membrane. The CCE technique was successful in 68.9% and partially successful in 13.3% of cases. Implants placed had a 100% survival rate. This study provides support that FDBA from LifeNet Health can be effectively used in the minimally invasive CCE technique for sinus augmentation.

**Boehm TK. Case report on managing incomplete bone formation after bilateral sinus augmentation using a palatal approach and a dilating balloon technique. Int J Implant Dent. 2017 Dec; 3(1):3. doi: 10.1186/s40729-017-0065-7. Epub 2017 Jan 19. PMID: 28105590**

- This case study follows the results of treatment for incomplete bone formation following lateral window sinus augmentation. The 65-year old patient also had complex sinus floor anatomy as a result of the failed first procedure. An additional sinus augmentation was performed using particulate allograft with a dilating balloon technique and palatal approach. Implants could be placed in sites restored with LifeNet Health allograft and after two years the new implants remained functional and healthy.

**Kassolis JD, Rosen Ps, Reynolds MA. Alveolar ridge and sinus augmentation utilizing platelet-rich plasma in combination with freeze- dried bone allograft: Case series. J Periodontol. 2000 Oct; 71(10):1654-1661. PMID: 11063400**

- This report provides results of alveolar ridge and sinus augmentation in 15 patients treated with platelet-rich plasma mixed with freeze-dried bone allograft (FDBA) from LifeNet Health. 89% of treatments were considered clinical success with bone coverage of the implant, no mobility, and normal radiographic appearance. Histological evaluation showed new bone formation around FDBA particles and no evidence of inflammatory cell infiltrate.

## Soft Tissue Augmentation

**Bernardello F, Bertasi G, Powers RM, Spinato S, Viaggi A, Bullock J, Felice P. Soft tissue enhancement and implant placement following partial mandibulectomy due to squamous cell carcinoma. J Oral Implantol. 2017 Jun 19. doi: 10.1563/aaid-joi-D-17-00013. [Epub ahead of print]. PMID: 28628354**

- This case report follows a patient who received radical surgery secondary to oral squamous cell carcinoma. Cancer treatment resulted in a partial mandibulectomy along with loss of soft tissue between the floor of the mouth and the vestibule. Treatment of the affected area with acellular dermis allowed for implant placement and improvement in the patient's ability to speak and eat.

## Gingival Augmentation

**Sindler A (2014). Treatment of gingival recession using Oracell decellularized dermis: Cases 1-4. Cases on file at LifeNet Health (68-20-101, 68-20-102, 68-20-103, 68-20-104).**

- In this case series, Sindler described the use of decellularized dermis in four separate cases. In each case, soft tissue healing and expectations for aesthetics were achieved, highlighting that Oracell® is effective for simple procedures. Use of the decellularized dermis eliminates the need for patient autographs, therefore minimizing patient morbidity.

## Cleft Palate Repair

**Emodi O, Ginini JG, van Aalst, Shilo D, Naddaf R, Aizenbud D, Rachmiel A. Cleft Palate Fistula Closure Utilizing Acellular Dermal Matrix. Plast Reconstr Surg Glob Open. 2018 Mar; 6(3): e1682. doi: 10.1097/GOX.0000000000001682. PMID: 29707449**

- This retrospective study examines the results of cleft palate fistula repairs using acellular dermal matrix supplied by LifeNet Health in twenty patients. Complete fistula closure was achieved in 80% of the patients, and partial closure achieved in 15% of patients. The study concludes that ADMs are safe and simple to use in the closure of cleft palate fistulas.

## Meta-Analyses and Reviews

**Salem D, Natto Z, Elangovan S, Karimbux N. Usage of bone replacement grafts in periodontics and oral implantology and their current levels of clinical evidence - A systematic assessment. J Periodontol. 2016 Aug; 87(8):872-879. PMID: 27058348**

- A literature search by Salem et al. identified the amount of clinical evidence surrounding bone replacement grafts available in the United States for periodontics and oral implantology. "The majority of materials used were allografts (26 of 93 available in the United States), followed by alloplasts (15 of 30) and xenografts (11 of 21)." With the inclusion criteria used, the authors found limited published, peer-reviewed clinical evidence regarding commercially available bone grafts in periodontics and oral implantology. Many of the allograft references used LifeNet Health materials demonstrating our dedication to providing strong clinical evidence of effectiveness of our grafts.

**Moore MA, Samsell B, Wallis G, Triplett S, Chen S, Jones AL, Qin X. Decellularization of human dermis using non-denaturing anionic detergent and endonuclease: A review. Cell Tissue Bank. 2015 Jun; 16(2):249-259. PMID: 25163609**

- An investigation by Moore and associates evaluated the effects of a novel decellularization technology (Matracell®) on the biomechanical properties of human dermis. A residual DNA content of  $\leq 4$  ng/mg wet weight indicated >97% DNA removal and resulted in an effective level of decellularization. Decellularized human dermis demonstrated biocompatibility and an ability to support cellular and vascular in-growth in a mouse skin excisional model. Clinical applications in wound healing, soft tissue reconstruction and augmentation also suggest the ability of the Matracell® process to preserve the biomechanical properties of unprocessed human dermis.

**Malinin TI, Temple HT, Garg AK. Bone Allografts in Dentistry: A Review. Dentistry 2014; 4(2):199. [Click Here For Article](#)**

- Malinin, Temple, and Garg reviewed currently available bone allograft options for implant dentistry. Specifically, they reviewed the source of donor bone, various allograft processing methods, graft preparation techniques, and material properties with a particular focus on the safety of allografts for use in implant dentistry. The importance on restricting residual calcium to not less than 2% was stressed.

**Monje A, Pikos MA, Chan HL, Suarez F, Gargallo-Albiol J, Hernández-Alfaro F, Galindo-Moreno P, Wang HL. On the feasibility of utilizing allogeneic bone blocks for atrophic maxillary augmentation. Biomed Res Int. 2014; 2014:814578. PMID: 25535616**

- This review covered fifteen studies evaluating the feasibility of using allogeneic bone blocks for atrophic maxillary augmentation. Across the studies, 361 bone block grafts, including grafts provided by LifeNet Health, could be followed 4 to 9 months post-operatively. Only 2.4% failed within 1 to 2 months after the surgery. There was a high implant survival rate (96.9%; 95% CI: 92.8%-98.7%) observed as well as minimal resorption. This review concludes allogeneic bone blocks are a viable option for atrophic maxillary augmentation.

## Safety and Efficacy

**Kim SM, Fan H, Cho YJ, Eo MY, Park JH, Kim BN, Lee BC, Lee SK. Electron beam effect on biomaterials I: Focusing on bone graft materials. Biomater Res. 2015 Apr; 19:10. PMID: 26331080**

- Research by Kim et al. investigated the effects of electron beam irradiation on the bone regeneration capacity of 4 allogeneic bone grafts (included LifeNet Health material), 6 xenogeneic bone grafts, and 6 synthetic bone grafts. After irradiation with varying linear accelerators and irradiation doses, Kim et al. analyzed bone regeneration using multiple microscopy methods and an *in vivo* rat calvarial defect model. The authors found that electron beam irradiation “has thermal, mechanical, and chemical effects on the cross-linking of biphasic calcium phosphate apatites.”

**Andreescu CF. Commentary on “Are Bone Allografts Safe and Effective for Today’s Dental Practitioner?” Dentistry 2015; 5:299. [Click Here For Article](#)**

- Commentary by Andreescu provided a positive review of the article “Are Bone Allografts Safe and Effective for Today’s Dental Practitioner?” Andreescu praised the authors’ thoroughness in evaluating the safety of allografts for dentistry and their in-depth discussion of factors that dental practitioners should consider when selecting bone allografts. Andreescu also commented on allograft processing methods, including irradiation to kill viruses while maintaining material strength, and the efficacy of some bone allografts in dental applications.

**Samsell B, Moore M, Bertasi G, Spinato S, Bernardello F, Rebaudi A, Sfasciotti GL, Powers R. Are Bone Allografts Safe and Effective for Today's Dental Practitioner? Dentistry. 2014; 4:260. [Click Here For Article](#)**

- Samsell and associates reviewed currently available bone allografts used in dental applications. Disinfected and terminally sterilized grafts reviewed in this article included alloplasts, xenografts, autografts, and allografts. In particular, the authors focused on processing, sterilization, and clinical performance of bone allografts in dental applications. "One allograft option, referred to here as "OG bone allograft" or OraGraft®, is provided sterile to a SAL of 10<sup>-6</sup> and with an extensive history of published studies to support clinical efficacy, makes this type of graft a valid option for the dental practitioner to consider."

**Holtzclaw D, Toscano N, Eisenlohr L, Callan D. The safety of bone allografts used in dentistry: A review. J Am Dent Assoc. 2008 Sep; 139(9):1192-1199. [PMID: 18762629](#)**

- Holtzclaw et al. reviewed US government regulations, industry standards, scientific articles, and other guidelines for the use of human bone allografts in dentistry. To highlight the safety considerations when selecting a human bone allograft for dentistry, this review included an extensive discussion of procurement, processing, use, and tracking of human bone allografts. LifeNet Health and Tutogen experience in tissue processing was discussed and used to illustrate concepts important to the clinician. Based on "rigorous donor screening and aseptic proprietary processing programs" the authors concluded that human bone allografts are a safe and viable treatment option.

**Samsell B, Softic D, Qin X, McLean J, Sohoni P, Gonzales K, Moore MA. Preservation of allograft bone using a glycerol solution: a compilation of original preclinical research. Biomater Res. 2019 Feb 13; 23:5. doi: 10.1186/s40824-019-0154-1. [PMID: 30805200](#)**

- This report describes the effects of glycerol-based preservation as an alternative to freeze-drying bone allografts for storage. Bone grafts preserved with a glycerol solution were found to be biomechanically equivalent to freeze-dried grafts while significantly less brittle, greater compressive strength, and having similar osteoconductivity. These results highlight glycerol-based preservation as a better storage method than traditional freeze-drying.

**Curtis DM, VanderWeele RA, Ray JJ, Wealleans JA. Clinician-centered Outcomes Assessment of Retreatment and Endodontic Microsurgery Using Cone-beam Computed Tomographic Volumetric Analysis. J Endod. 2018 Aug; 44(8):1251-1256. [PMID: 29970237](#)**

- In this retrospective study of retreatment and endodontic microsurgery, authors aimed to determine if cone-beam computed tomographic (CBCT)-based analysis could be useful in assessing periapical radiolucencies (PARL). This study found endodontic microsurgery resulted in significantly higher complete healing and combined complete and reductive healing. When compared to traditional methods based on clinical findings and radiographs, CBCT was more sensitive for assessing PARL. Postoperative CBCT-based analysis can be more useful for clinicians when evaluating outcomes.

## Comparative Data

**Miron RJ, Zhang Q, Sculean A, Buser D, Pippenger BE, Dard M, Shirakata Y, Chandad F, Zhang Y. Osteoinductive potential of 4 commonly employed bone grafts. Clin Oral Investig. 2016 Nov; 20(8):2259-2265. [PMID: 26814714](#)**

- Miron and associates studied autograft, DFDBA, bovine xenograft and novel biphasic calcium phosphate (BCP) to investigate and compare their osteoinductive potentials as bone grafts. Of note, DFDBA from LifeNet Health was chosen from the multiple suppliers of DFDBA "due to previous handling and its ability to form ectopic bone formation *in vivo*". In a rat intramuscular pouch model, both DFDBA and BCP demonstrated ectopic bone formation, xenograft demonstrated no ectopic bone formation and autograft resorbed rapidly. These results demonstrated that novel scaffolds composed of biphasic calcium phosphate are successfully able to induce new bone growth, similar to currently used DFDBA and scaffolds containing bone morphogenetic proteins.



**Wei L, Miron RJ, Shi B, Zhang Y. Osteoinductive and osteopromotive variability among different demineralized bone allografts. Clin Implant Dent Relat Res. 2015 Jun; 17(3):533-542. PMID: 23879664**

- A study by Wei and others compared the osteoinductive and osteopromotive abilities of two commercially available DFDBAs (from Osteotech and LifeNet Health) using a rat model of femoral and intramuscular defects. Both allografts demonstrated osteoinductive potential at intramuscular defects early in the study, but LifeNet particles displayed increased new bone formation and osteopontin gene expression later in the study than Osteotech particles. Of note, Osteotech particles were fully resorbed by 4 weeks post-implantation. Femoral defects filled with LifeNet particles also demonstrated significantly more mineralized new bone formation than Osteotech particles or control ( $p < 0.05$ ).

**Srouji S, Ben-David D, Funari A, Riminucci M, Bianco P. Evaluation of the osteoconductive potential of bone substitutes embedded with schneiderian membrane- or maxillary bone marrow-derived osteoprogenitor cells. Clin Oral Implants Res. 2013 Dec; 24(12):1288-1294. PMID: 22882738**

- In a study by Srouji et al. four commercially available osteoconductive scaffolds (Bio-Oss<sup>®</sup>, Bi-Ostetic<sup>®</sup>, OraGraft<sup>®</sup>, and ProOsteon<sup>®</sup>) for sinus lifting and sinus augmentation procedures were analyzed for *in vitro* cell adherence and proliferation, and *in vivo* bone formation. Experiments included *in vitro* seeding of scaffolds with osteoprogenitor cells and *in vivo* implantation in an athymic mouse model. Osteoprogenitor cells adhered significantly better to OraGraft<sup>®</sup> and ProOsteon<sup>®</sup> particles, with OraGraft<sup>®</sup> demonstrating more cell adherence than ProOsteon<sup>®</sup>. Cell proliferation at day 13 post-seeding was significantly higher for cells on OraGraft particles ( $p < 0.01$ ). OraGraft<sup>®</sup> and ProOsteon<sup>®</sup> implantation also resulted in significantly increased *in vivo* ectopic bone formation, with OraGraft<sup>®</sup> (mineralized cortical) demonstrating more than ProOsteon<sup>®</sup> (hydroxyapatite + CaCO<sub>3</sub>). The authors concluded that this testing method was simple and effective to assess biomaterials for sinus lifting and augmentation.

**Deatherage J. Bone materials available for alveolar grafting. Oral Maxillofac Surg Clin North Am. 2010 Aug; 22(3):347-352. PMID: 20713267**

- Deatherage reviewed the evolution of bone grafting materials for alveolar grafting beginning with animal materials and up to bone grown in the laboratory more recently. The author suggested that novel solutions for new bone allografts are necessary to address difficulties with restoring bone in alveolar reconstruction. OraGraft<sup>®</sup> was listed as a grafting solution in Oral and Maxillofacial surgery.

**Capito AE, Tholpady SS, Agrawal H, Drake DB, Katz AJ. Evaluation of host tissue integration, revascularization, and cellular infiltration within various dermal substrates. Ann Plast Surg. 2012 May; 68(5):495-500. PMID: 22531405**

- Capito and others studied host tissue integration, revascularization and recellularization of four commercially available acellular dermal matrices (AlloDerm<sup>®</sup>, Dermacell<sup>®</sup>, DermaMatrix<sup>®</sup>, and Integra<sup>®</sup>) in an *in vivo* rat model. Dermacell<sup>®</sup> (LifeNet Health Acellular Dermal Matrix) and Integra demonstrated significantly increased cellular infiltration while AlloDerm<sup>®</sup> demonstrated the lowest. Dermacell<sup>®</sup> showed no bimodal cellular response while all other matrices showed a bimodal cellular response. A greater number of new vessels were found in Dermacell<sup>®</sup> at Day 7 ( $P < 0.001$ ) though Days 14 and 21 showed no significant difference between matrices. Minimal vessel formation was associated with Integra until Day 14. It is unknown if these differences significantly affect clinical outcomes.

**Agrawal H, Tholpady SS, Capito AE, Drake DB, Katz AJ. Macrophage phenotypes correspond with remodeling outcomes of various acellular dermal matrices. Open Journal of Regenerative Medicine. 2012 Dec; 1(3):51-59. [Click Here For Article](#)**

- A study “compared the macrophage phenotype and tissue remodeling elicited by four different [acellular dermal matrices] ADMs (DermaMatrix<sup>®</sup>, AlloDerm<sup>®</sup>, Integra<sup>®</sup> and Dermacell<sup>®</sup>)”. Agrawal et al. used a rat model and immunohistologic identification of macrophage surface markers. DermaMatrix<sup>®</sup> and Dermacell<sup>®</sup> demonstrated peak pan-macrophage expression at day 14, while AlloDerm<sup>®</sup> showed peak pan-macrophage expression at day 21. The highest influx of macrophages was found in Dermacell<sup>®</sup> and the lowest in Integra. AlloDerm<sup>®</sup> was associated with more “inflammatory type tissue remodeling” while the other ADMs displayed “more constructive tissue remodeling.”

**Nishimoto M, Kan JK, Rungcharassaeng K, Roe P, Prasad H, Lozada JL. Histomorphometric Analysis of Maxillary Sinus Grafts: A Pilot Study. Int J Oral Maxillofac Implants. 2019 May/June; 34(3):759–767. PMID: 30807623**

- Nishimoto et. al. evaluated the results of two-stage sinus augmentation procedures using one of three graft materials: anorganic bovine bone mineral (ABBM), anorganic equine bone mineral (AEBM), or mineralized cancellous bone allograft (MCBA). Procedures performed with MCBA had significantly higher new bone formation and significantly less residual bone particulate than the other two graft materials. There were no significant differences found between the AEBM and ABBM groups. MCBA from LifeNet Health performed better than nonautologeneous grafts most commonly used in sinus augmentation procedures.

**Zhang Q, Jing D, Zhang Y, Miron RJ. Histomorphometric Study of New Bone Formation Comparing Defect Healing with Three Bone Grafting Materials: The Effect of Osteoporosis on Graft Consolidation. Int J Oral Maxillofac Implants. 2018 May/June; 33(3):645–652. PMID: 29420674**

- This *in vivo* study with Wistar rats proposed to compare new bone formation in normal and osteoporotic animals using three types of bone grafts. 2.5 mm femur defects were filled with either: natural bone mineral (NBM, BioOss) of bovine origin, demineralized freeze-dried bone allograft (DFDBA, LifeNet), or biphasic calcium phosphate (BCP, Vivoss). All grafts demonstrated osteoconductive potential in osteoporotic animals. NBM and DFDBA showed similar levels of new bone formation. BCP demonstrated greater new bone formation than NBM and DFDBA, but was associated with higher osteoclast activity and particle degradation.

**Vreeburg SK, Griffiths GR, Rossmann JA. A comparative study of root coverage using Oracell® versus subepithelial connective tissue graft: A randomized controlled trial. The Open Dentistry Journal. 2018; 12:977-86. [Click here for article.](#)**

- This study included twenty-four non-smoking, healthy patients, with 2 mm, or greater, facial gingival recession at a minimum of one site that is classified as Miller Class I, II, or III. The aim was to compare root coverage results between autograft and decellularized human dermis (Oracell provided by LifeNet Health). Vertical recession and clinical attachment level improved significantly in both groups with no significant difference between them indicating Oracell is a potential alternative to autograft in the treatment of gingival recession.

## Other Non-Clinical

**Falah M, Rayan A, Srouji S. Storage effect on viability and biofunctionality of human adipose tissue-derived stromal cells. Cytotherapy. 2015 Sep; 17(9):1220-1229. PMID: 26276005**

- Falah et al. investigated the impact of a mixture of PlasmaLyte A, heparin, glucose, human serum albumin, hyaluronic acid and LifeNet Health DFDBA particles on the cell viability and biofunctionality of adipose tissue-derived stromal cells (ASCs) for bone formation. Prior to mixing, ASCs were treated with rhBMP-2 for 14 days. *In vitro* assays revealed that ASCs maintained >80% viability early after incubation in the mixture, but ASC viability was negatively impacted (50%) after 24 hours incubation. Using an athymic mouse subcutaneous implant model, no difference was found for *in vivo* bone formation between cells incubated in the transplantation mixture and non-incubated control cells.

**Miron RJ, Bosshardt DD, Laugisch O, Dard M, Gemperli AC, Buser D, Gruber R, Sculean A. *In vitro* evaluation of demineralized freeze-dried bone allograft in combination with enamel matrix derivative. J Periodontol. 2013 Nov; 84(11):1646–1654. PMID: 23347347**

- Miron and associates examined the effects of an enamel matrix derivative (EMD) coating on the ability of DFDBA (LifeNet Health) to promote new bone formation and on gene expression associated with osteogenic differentiation. EMD coating did not negatively impact new bone formation, or differentiation and proliferation of osteoblasts and PDL cells. EMD coating significantly increased cell proliferation of both PDL cells and osteoblasts, and also significantly increased gene expression of Runx2 associated with PDL cells, but not osteoblasts. Finally, EMD coating also increased osteocalcin gene expression associated with PDL cells and osteoblasts.

**Kuroshima S, Al-Salihi Z, Yamashita J. Parathyroid hormone related to bone regeneration in grafted and nongrafted tooth extraction sockets in rats. *Implant Dent.* 2013 Feb; 22(1):71-76. PMID: 23296032**

- Kuroshima et al. studied the effects of parathyroid hormone (PTH) therapy on bone formation during ridge preservation in a rat model. After 2-3 weeks of PTH therapy, grafted and non-grafted tooth extraction sockets demonstrated significantly greater bone fill compared to control. Additionally, PTH therapy for two weeks after extractions proved sufficient to increase bone fill of extraction sockets. However, one week of PTH therapy prior to extractions did not result in sufficient bone fill. Collagen, a xenograft, and LifeNet Health DFDBA were used as bone void fillers in the experiment.

**Sato EY, Svec T, Whitten B, Sedgley CM. Effects of bone graft materials on the microhardness of mineral trioxide aggregate. *J Endod.* 2012 May; 38(5):700-703. PMID: 22515907**

- Sato and others tested the effect of four bone graft materials on the microhardness of white mineral trioxide aggregate (WMTA). Acrylic cylinders packed with WMTA were exposed to simulated body fluid and one of four graft materials (xenograft, freeze-dried bone allograft, demineralized freeze-dried bone allograft, or allograft). The authors found that DFDBA (from LifeNet Health) and the control group demonstrated significantly higher WMTA Knoop microhardness values than other graft materials at 2 weeks and 4 weeks. WMTA associated with FDBA, DFDBA, and control had significantly higher microhardness values at 4 weeks compared to 2 weeks ( $P<0.05$ ,  $P<0.01$ ,  $P<0.001$ , respectively). Authors concluded, “demineralized and mineralized graft materials appear to have a differential effect on the microhardness of WMTA.”

**Schwartz Z, Hyzy SL, Moore MA, Hunter SA, Ronholdt CJ, Sunwoo M, Boyan BD. Osteoinductivity of demineralized bone matrix is independent of donor bisphosphonate use. *J Bone Joint Surg Am.* 2011 Dec; 93(24):2278-2286. PMID: 22258774**

- A study by Schwartz et al. investigated the effects of oral bisphosphonate usage on the osteoinductivity of demineralized bone matrix (DBM provided by LifeNet Health and other tissue processors) by using a 35-day muscle pouch nude mouse model. DBM donors who had taken oral bisphosphonates were age- and sex-matched with donors who had not. New bone formation and ossicle size evaluated by histomorphometric measurements were similar regardless of bisphosphonate usage.

**Rodriguez RU, Kemper N, Breathwaite E, Dutta SM, Hsu EL, Hsu WK, Francis MP. Demineralized bone matrix fibers formable as general and custom 3D printed mold-based implants for promoting bone regeneration. *Biofabrication.* 2016 Jul; 8(3):035007. PMID: 27458901**

- Rodriguez et. al. used micro-fibrous surface patterned demineralized bone matrix (DBM) fibers to construct defect-matched and general 3D implants. *In vitro*, implants were found to be mechanically stable, and abundant with osteogenic growth factors and extracellular matrix proteins. *In vivo*, implants demonstrated osteoinductive potential in a mouse muscle pouch and promoted spine fusion in a rat arthrodesis model. DBM fibers can be molded into custom-shaped implants without compromising osteoinductive, or osteoconductive potential, and thus their use may improve patient outcomes.

**Culpepper BK, Bonvallet PP, Reddy MS, Ponnazhagan S, Bellis SL. Polyglutamate directed coupling of bioactive peptides for the delivery of osteoinductive signals on allograft bone. *Biomaterials.* 2013 Feb;34(5):1506-13. doi: 10.1016/j.biomaterials.2012.10.046. PMID: 23182349**

- This study examined how to provide osteoinductive factors to allografts which are not osteoinductive. The peptide known as E7DGEA, is derived from collagen I and modified to express a heptaglutamate domain. Allografts coated with this peptide implanted in rats could be retained for at least three months. E7DGEA delivered intravenously accumulated in the bone tissue. The E7 domain enhanced binding of BMP2-derived peptide on the allograft as well. These results suggest using this peptide can reintroduce osteoinductive signals and potentially improve functionality of allografts.

## Additional References

### Clinical

**Schwartz SA, Koch MA, Deas DE, Powell CA. Combined endodontic-periodontic treatment of a palatal groove: A case report. Journal Endod. 2006 Jun; 32(6):573-578. PMID: 16728255**

- This case report describes the successful collaborative management of a maxillary lateral incisor with an extensive palatal groove using a combination of nonsurgical endodontic therapy, odontoplasty, and periodontal regenerative techniques.

**Aichelmann-Reidy ME, Heath CD, Reynolds MA. Clinical evaluation of calcium sulfate in combination with demineralized freeze-dried bone allograft for the treatment of human intraosseous defects. J Periodontol. 2004 Mar; 75(3):340-347. PMID: 15088870**

- The results of this study indicate that calcium sulfate, when used as a binder and barrier in combination with DFDBA, supports significant clinical improvement in intrabony defects, as evidenced by reductions in probing depth, gains in clinical attachment level, and defect fill and resolution

**Callan DP. Guided tissue regeneration without a stage 2 surgical procedure. Int J Periodontics Restorative Dent. 1993; 13(2):172-179. PMID: 8360007**

- In the two cases described, the problems of insufficient bone and insufficient soft tissue in the edentulous ridge were addressed concurrently. Freeze-dried demineralized bone was used to fill the osseous defect. Freeze-dried fascia lata was used to prevent epithelial migration into the defect, act as a barrier, and eliminate a second surgery for membrane removal. This regeneration procedure can provide increased alveolar bone for better implant placement and esthetics.

**Quattlebaum JB, Mellonig JT, Hensel NF. Antigenicity of freeze-dried cortical bone allograft in human periodontal osseous defects. J Periodontol. 1988 June; 59(6):394-397. PMID: 2455783**

- The purpose of this investigation was to determine whether donor-specific anti-HLA antibodies could be detected against freeze-dried cortical bone allograft (FDBA) placed in human periodontal osseous defects. All allografts were judged clinically successful, with no adverse tissue reactions to the donor material. FDBA may be regarded as a graft material lacking clinically significant antigenicity.

**Landi L, Sabatucci D. Plastic surgery at the time of membrane removal around mandibular endosseous implants: A modified technique for implant uncovering. Int J Periodontics Restorative Dent. 2001 Jun; 21(3):280-287. PMID: 11490405**

- Removal of barrier membranes may complicate second-stage implant surgery, particularly in mandibular areas characterized by a shallow vestibule and minimal amount of keratinized tissue. A new surgical technique that permits implant exposure and membrane removal combined with a plastic procedure to improve soft tissue quality both buccally and lingually is presented.

**Huang PY, Driscoll CF. From childhood to adulthood: oral rehabilitation of a patient with ectodermal dysplasia. J Prosthet Dent. 2014 Sep;112(3):439-43. PMID: 24831743**

- Ectodermal dysplasia, in all its varieties, occurs in approximately 1 in every 100,000 live births. Depending on the variety, hypohidrosis, hypotrichosis, hypodontia, oligodontia, and/or anodontia may be exhibited. Few long-term clinical reports exist. This report follows the development, growth, and initial treatment of a 10-year-old patient with ectodermal dysplasia and his subsequent oral rehabilitation 20 years later.

## Pre-Clinical

**Turonis JW, McPherson JC 3rd, Cuenin MF, Hokett SD, Peacock ME, Sharawy M. The effect of residual calcium in decalcified freeze-dried bone allograft in a critical-sized defect in the *Rattus norvegicus* calvarium. J Oral Implantol. 2006; 32(2):55-62. PMID: 16704106**

- The authors conclude that a 2% residual calcium level I human DFDBA appears to significantly ( $P < \text{ or } = .05$ ) enhance osseous wound healing in the rat calvarium.

**Honsawek S, Powers RM, Wolfinbarger L. Extractable bone morphogenetic protein and correlation with induced new bone formation in an *in vivo* assay in the athymic mouse model. Cell Tissue Bank. 2005; 6(1):13-23. PMID: 15735897**

- Extractable BMP-4 level averaged  $3.7 \pm 0.21$  ng/g of DBM and correlated with osteoinductivity of the DBM in an *in vivo* assessment of induced new bone formation.

**Herold RW, Pashley DH, Cuenin MF, Niagro F, Hokett SD, Peacock ME, Mailhot J, Borke J. The effects of varying degrees of allograft decalcification on cultured porcine osteoclast cells. J Periodontol. 2002 Feb; 73(2):213-219. PMID: 11895288**

- In this *in vitro* model, porcine osteoclasts show significantly more resorptive activity as measured on calcium phosphate-coated disks in the presence of 2.41% residual calcium in DFDBA than in other DFDBA residual calcium levels.

**Mott DA, Mailhot J, Cuenin MF, Sharawy M, Borke J. Enhancement of osteoblast proliferation *in vitro* by selective enrichment of demineralized freeze-dried bone allograft with specific growth factors. J Oral Implantol. 2002; 28(2):57-66. PMID: 12498447**

- Osteoblast proliferation rates indicate that the *in vitro* supplementation of 2% residual calcium-DFDBA with the combination of IGF and TGF-beta, IGF and PDGF, and PDGF and TGF-beta significantly ( $P < \text{ or } = .05$ ) enhance murine osteoblast activity and proliferation at 7 days compared with the control containing no exogenous growth factors.

**Zhang M, Powers RM Jr, Wolfinbarger L Jr. Effect(s) of the demineralization process on the osteoinductivity of demineralized bone matrix. J Periodontol. 1997 Nov; 68(11):1085-1092. PMID: 9407401**

- This study indicated that DBM from female donors in the 31 to 40 years old age group and male donors in the 41 to 50 year age group possess the highest osteoinductive potential, whereas DBM derived from donor bone from both female and male donors in the 51 to 60 year age group presented the lowest osteoinductive potential. DBM derived from male and female donors did not in general show significant differences in osteoinductive potential.

**Zhang M, Powers RM Jr, Wolfinbarger L Jr. A quantitative assessment of osteoinductivity of human demineralized bone matrix. J Periodontol. 1997 Nov; 68(11):1076-1084. PMID: 9407400**

- A linear correlation ( $R^2 = 0.7397$ ) was demonstrated between the *in vivo* calcium remineralization assay and the *in vitro* ALP assay of osteoinductivity of DBM, suggesting that the *in vitro* assay can be used to quantitatively assess the osteoinductive potential of DBM where production and distribution of clinically usable DBM dictates rapid analysis

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LifeNet Health helps to save lives, restore health and give hope to thousands of patients each year. We are the world's most trusted provider of transplant solutions, from organ procurement to new innovations in bio-implant technologies and cellular therapies—a leader in the field of regenerative medicine, while always honoring the donors and healthcare professionals that allow the healing process.

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