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1. Pre-clinical (*in vitro* & *in vivo*) studies (p. 2 – p. 14)
 2. Clinical studies and case series (p. 25 – p. 33)

Pre-clinical (*in vitro* & *in vivo*) studies

1. In vitro comparison of the osteogenic capability of human pulp stem cells on alloplastic, allogeneic, and xenogeneic bone scaffolds

Heitzer M, Modabber A, Zhang X, Winnand P, Zhao Q, Bläsius FM, Buhl EM, Wolf M, Neuss S, Hölzle F, Hildebrand F, Greven J. *BMC Oral Health*, 23(1), 1-13.

<https://bmcoralhealth.biomedcentral.com/articles/10.1186/s12903-023-02726-4#Abs1>

Background: A rigorous search for alternatives to autogenous bone grafts to avoid invasiveness at the donor site in the treatment of maxillomandibular bone defects. Researchers have used alloplastic, allogeneic, and xenogeneic bone graft substitutes in clinical studies with varying degrees of success, although their *in vitro* effects on stem cells remain unclear. Dental pulp stem cells (DPSCs) can potentially enhance the bone regeneration of bone graft substitutes. *The present in vitro study investigates the osteogenic capability of DPSCs on alloplastic (biphasic calcium phosphate [BCP]), allogeneic (freeze-dried bone allografts [FDBAs]), and xenogeneic (deproteinized bovine bone mineral [DBBM]) bone grafts.*

Methods: Human DPSCs were seeded on 0.5 mg/ml, 1 mg/ml, and 2 mg/ml of BCP, FDBA, and DBBM to evaluate the optimal cell growth and cytotoxicity. Scaffolds and cell morphologies were analyzed by scanning electron microscopy (SEM). Calcein AM and cytoskeleton staining were performed to determine cell attachment and proliferation. Alkaline phosphatase (ALP) and osteogenesis-related genes expressions was used to investigate initial osteogenic differentiation.

Results: Cytotoxicity assays showed that most viable DPSCs were present at a scaffold concentration of 0.5 mg/ml. The DPSCs on the DBBM scaffold demonstrated a significantly higher proliferation rate of 214.25 ± 16.17 ($p < 0.001$) cells, enhancing ALP activity level and upregulating of osteogenesis-related genes compared with other two scaffolds.

Conclusion: DBBP scaffold led to extremely high cell viability, but also promoted proliferation, attachment, and enhanced the osteogenic differentiation capacity of DPSCs, which hold great potential for bone regeneration treatment; however, further studies are necessary.

2. Correlations between radiological and histological findings of bone remodelling and root resorption in a rodent cleft model

Möhlhenrich SC, Kniha K, Heitzer M, Magnuska Z, Hermanns-Sachweh B, Gremse F, Chhatwani S, Hölzle F, Modabber A, Danesh, G. *Head & Face Medicine*, 18(1), 33. DOI 10.1186/s13005-022-00338-x

<https://head-face-med.biomedcentral.com/articles/10.1186/s13005-022-00338-x>

Background: The evaluation of bone remodelling and dental root resorption can be performed by histological techniques or micro-computed tomography (micro-CT). *The present study aimed to evaluate the relationship between these two procedures in the context of cleft repair in a rat model.*

Methods: The reconstructed maxillae and the orthodontically-moved first molar of 12 rats were analysed for correlations between the histological and radiological findings retrospectively. The

alveolar cleft repairs were performed using bone autografts or (human) xenografts. Four weeks after the operation, the intervention of the first molar protraction was initiated and lasted for eight weeks. The newly formed bone and the root resorption lacunae were determined via histology. In the micro-CT analysis, the average change of bone mineral density (BMD), bone volume fraction (BV/TV), trabecular thickness and trabecular separation of the jaw, as well as the volume of the root resorptions were determined. The Pearson correlation coefficient was applied to study the associations between groups. **Results:** Positive correlations were found only between the newly formed bone (histology) and BMD changes (micro-CT) in the autograft group ($r = 0.812$, 95% CI: 0.001 to 0.979, $p = 0.05$). The relationship of newly formed bone and BV/TV was similar but not statistically significant ($r = 0.691$, 95% CI: -0.274 to 0.963, $p = 0.013$). Regarding root resorption, no significant correlations were found. **Conclusions:** Due to the lack of correlation between histological and radiological findings of bone remodelling and the development of root resorptions, both methods should be combined in this cleft model in rats for a comprehensive analysis.

3. Lyophilized Human Bone Allograft as an Antibiotic Carrier: An In Vitro and In Vivo Study

Coraça-Huber DC, Steixner SJM, Najman S, Stojanovic S, Finze R, Rimashevskiy D, Saginova D, Barbeck M, Schnettler R. *Antibiotics*. 2022; 11(7):969. DOI 10.3390/antibiotics11070969

<https://www.mdpi.com/2079-6382/11/7/969>

Background: Antibiotics delivered from implanted bone substitute materials (BSM) can potentially be used to prevent acute infections and biofilm formation, providing high concentrations of antibiotics at the surgical site without systemic toxicity. In addition, BSM should allow osteoconductivity supporting bone healing without further surgery. Promising results have been achieved using lyophilized bone allografts mixed with antibiotics.

Methods: In this study specially prepared human bone allografts were evaluated as an antibiotic carrier *in vitro* and *in vivo*. The efficacy of different antibiotic-impregnated bone allografts was measured by drug release tests *in vitro* and *in vivo* and bacterial susceptibility tests using four bacterial species usually responsible for implant associated infections.

Results: The loading procedures of allograft bone substitutes with antibiotics were successful. Some of the antibiotic concentrations exceeded the MIC90 for up to 7 days *in vitro* and for up to 72 h *in vivo*. The susceptibility tests showed that *S. epidermidis* ATCC 12228 was the most susceptible bacterial species in comparison to the other strains tested for all antibiotic substances. Vancomycin and rifampicin showed the best results against standard and patient-isolated strains *in vitro*. *In vivo*, new bone formation was comparable in all study groups including the control group without antibiotic loading.

Conclusions: Human bone allografts showed the capacity to act as customized loaded antibiotic carriers to prevent acute infections and should be considered in the management of bone infections in combination with systemic antimicrobial therapy.

4. Establishing a new alveolar cleft model in rats to investigate the influence of jaw reconstructions on orthodontic tooth movement

Möhlhenrich SC, Heitzer M, Magnuska Z, Gremse F, Chhatwani S, Danesh G, Hölzle F, Modabber A. *Ann Anat.* 2021 Jul;236:151713. doi: 10.1016/j.aanat.2021.151713

<https://pubmed.ncbi.nlm.nih.gov/33675947/>

Background: The aim of the present investigation was to develop a new cleft model in rats that allows alveolar cleft repair and subsequent tooth movement.

Methods: A complete continuity-interrupting alveolar cleft was performed on the left-side maxillae of 33 rats through ultrasonic surgery. The clefts were filled with bone wax, and microCT scans were done to analyze the cleft size. After four weeks, the cleft repair was completed using autologous, xenogeneic (human), or synthetic bone substitute. After an additional four weeks, the orthodontic tooth movement was initiated.

Results: Fourteen rats died during the research, and the study design was constantly adapted accordingly. The main reasons for death included breathing problems during or immediately after the experimental activities (eight animals), followed by two deaths due to circulatory failures. In the remaining 19 animals, the average cleft size was about $2.70 \pm 0.46 \times 2.01 \pm 0.25 \times 1.18 \pm 0.20$ mm, and the mean velocity of orthodontic tooth movement after seven days was between 0.21 ± 0.08 mm in the autologous group and 0.50 ± 0.54 mm in the xenogeneic group. After 56 days, the mean values ranged between 0.67 ± 0.27 mm in the autologous group and 0.82 ± 0.72 mm in the synthetic group.

Conclusions: Surgical interventions in the oral cavity of rats requires a stronger anesthesia and lead to increased risk of coolant and coagulated blood aspiration. The new alveolar cleft model in rats allows for subsequent orthodontic tooth movement after cleft repair, but only in the mesial root of the first molar.

5. Evaluation of different grafting materials for alveolar cleft repair in the context of orthodontic tooth movement in rats

Möhlhenrich, S.C., Kniha, K., Magnuska, Z. et al. *Sci Rep* 2021 Jun 30;11(1):13586. doi: 10.1038/s41598-021-93033-x.

<https://pubmed.ncbi.nlm.nih.gov/34193933/>

To minimize the postoperative risks posed by grafting autologous transplants for cleft repair, efforts are being made to improve grafting materials for use as potential alternatives. The aim of this study was to compare the bone graft quality of different bone substitutes including the gold standard autografts during the healing processes after cleft repair in the context of orthodontic treatment. In 21 Wistar rats, a complete, continuity-interrupting cleft was created. After 4 weeks, cleft repair was performed using autografts from the hips' ischial tuberosity, human xenografts, or synthetic bone substitutes [beta-tricalcium phosphate (β -TCP)/hydroxyapatite (HA)]. After another 4 weeks, the first molar movement was initiated in the reconstructed jaw for 8 weeks. The bone remodeling was analyzed in vivo using micro-computed tomography (bone mineral density and bone volume fraction) and histology (new bone formation). All the grafting materials were statistically different in bone morphology, which changed during the treatment period. The β -TCP/HA substitute demonstrated less resorption compared to the autologous and xenogeneic/human bone, and the autografts led to a stronger reaction in the surrounding bone. Histologically, the highest level of new bone formation was

found in the human xenografts, and the lowest was found in the β -TCP/HA substitute. The differences between the two bone groups and the synthetic materials were statistically significant. Autografts were confirmed to be the gold standard in cleft repair with regard to graft integration. However, parts of the human xenograft seemed comparable to the autografts. Thus, this substitute could perhaps be used as an alternative after additional tissue-engineered modification.

6. Influence of Different Rehydration Protocols on Biomechanical Properties of Allogeneic Cortical Bone Plates: A Combined in-vitro/in-vivo Study

Andreas Pabst, Maximilian Ackermann, Daniel Thiem & Peer Kämmerer, *Journal of Investigative Surgery*, 2021 Oct;34(10):1158-1164. doi: 10.1080/08941939.2020.1767735. Epub 2020 May 22.

<https://pubmed.ncbi.nlm.nih.gov/32441171/>

Introduction: Allogeneic cortical bone plates (CP) are used for alveolar ridge augmentation. Since CP are freeze-dried and dehydrated during processing, the breaking strength (BS) and the flexibility (FX) are reduced, resulting in a relevant risk for plate fractures during insertion. *The aim of this study was to evaluate the influence of rehydration time on the biomechanical properties (BS & FX) of CP in vitro and in vivo.*

Material and Methods: 40 CP were randomly divided into four experimental groups. (A) untreated control (n=10), rehydration for 10 (B), 30 (C) and 60 (D) minutes in 0.9% saline solution (n=10 each). BS [Newton, N] and FX [mm] (force till fracture and distance of deflection to the breaking point) were analyzed. Besides, architectural features of all CP groups were visualized and examined by scanning electron microscopy (SEM). In addition, the frequency of CP fractures of rehydrated- vs. non-rehydrated CP was retrospectively analyzed in 6 patients.

Results: Compared to the control group, significantly increased BS and FX were demonstrated after 10, 30 and 60 minutes of rehydration (p each ≤ 0.035). After a rehydration time of 10 minutes, no additional increase of BS and FX was seen when compared to 30 and 60 minutes (p each = 1.0). SEM scans demonstrated that the CP fracture characteristics were influenced by the different rehydration protocols. The frequency of CP fractures was reduced in patients by CP rehydration.

Conclusion: The biomechanical properties of CP can be significantly improved by 10 min of rehydration, resulting in an increased BS and FX, that might be clinically relevant.

7. Does Platelet-Rich Fibrin Enhance the Early Angiogenetic Potential of Different Bone Substitute Materials? An In Vitro and In Vivo Analysis.

Blatt, S.; Thiem, D.G.E.; Pabst, A.; Al-Nawas, B.; Kämmerer, P.W. *Biomedicines* 2021 Jan 10;9(1):61

<https://pubmed.ncbi.nlm.nih.gov/33435244/>

The impaired angiogenic potential of bone substitute materials (BSMs) may limit regenerative processes. Therefore, changes in the angiogenetic properties of different BSMs in combination with platelet-rich fibrin (PRF) in comparison to PRF alone, as well as to native BSMs, were analyzed *in vitro* and *in vivo* to evaluate possible clinical application. *In vitro*, four BSMs of different origins (allogeneic,

alloplastic, and xenogeneic) were biofunctionalized with PRF and compared to PRF in terms of platelet interaction and growth factor release (vascular endothelial growth factor (VEGF), tissue growth factor β (TGF β) and platelet-derived growth factor (PDGF)) after 15 min. To visualize initial cell–cell interactions, SEM was performed. *In vivo*, all BSMs (_PRF) were analyzed after 24 h for new-formed vessels using a chorioallantoic membrane (CAM) assay. Especially for alloplastic BSMs, the addition of PRF led to a significant consumption of platelets ($p = 0.05$). PDGF expression significantly decreased in comparison to PRF alone (all BSMs: $p < 0.013$). SEM showed the close spatial relation of each BSM and PRF. *In vivo*, PRF had a significant positive pro-angiogenic influence in combination with alloplastic ($p = 0.007$) and xenogeneic materials ($p = 0.015$) in comparison to the native BSMs. For bio-activated xenogeneic BSMs, the branching points were also significantly increased ($p = 0.005$). Finally, vessel formation was increased for BSMs and PRF in comparison to the native control (allogeneic: $p = 0.046$; alloplastic: $p = 0.046$; and xenogeneic: $p = 0.050$). An early enhancement of angiogenetic properties was demonstrated when combining BSMs with PRF *in vitro* and led to upregulated vessel formation *in vivo*. Thus, the use of BSMs in combination with PRF may trigger bony regeneration in clinical approaches.

8. The effect of gamma and microwave radiation sterilization on periodontological grafts for microbiological evaluation

Bargh S, Silindir-Gunay M, Ozer AY, Ekizoglu M, Kart D, Kutlu B, Nohutcu R. *APMIS*. 2021 Oct;129(10):587-597. doi: 10.1111/apm.13162. Epub 2021 Jul 29.

<https://pubmed.ncbi.nlm.nih.gov/34117658/>

Periodontological grafts are materials used in dentistry to regenerate lost gingival soft tissues or bone parts. In the case of direct contact with blood, the possibility of disease transmission from the source to the patient is high. This source can be an animal or a human. Therefore, the sterilization of grafts before implanting to the patient is of significant importance. [The purpose of this study was to evaluate gamma radiation and microwave sterilization processes from microbiological and sterility perspectives and to compare the effectiveness of these two sterilization methods.](#) Grafts were irradiated with 2, 4, 5, 10, 25 and 50 kGy doses of gamma radiation. Another group of same materials was irradiated by microwave for 1, 2, 3 and 4 min at 24,500 MHz and 900 W. Gamma radiation and microwave sterilization methods were evaluated as successful at minimum doses as 5 kGy and 3 min, respectively. Both gamma and microwave sterilization successfully sterilized periodontological grafts coded as PBG1, HBG1, HL1, PDG1, MBG3, MDG2 and PDG3. Moreover, microwave sterilization can be used as an alternative novel method to gamma radiation sterilization.

9. Physicochemical evaluation of gamma and microwave irradiated dental grafts

Saharnaz Bargh, Mine Silindir-Gunay, A. Yekta Ozer, Erhan Palaska, Damla Karaarslan, Semra Ide, Dilek Solpan, *Radiation Physics and Chemistry*, Volume 170,2020.

<https://doi.org/10.1016/j.radphyschem.2019.108627>

Periodontological bone or dermal grafts are materials which are used in dentistry to regenerate lost tissue which can be obtained from a human or animal source. As a result, the possibility of disease transmission from the source to the patient is high. Therefore, sterilization of grafts before implanting to the patient got a significant importance due to the direct contact with blood. Sterilization process for dental materials can be done by three different methods, chemical gas, heat and radiation sterilization. Sterilization by radiation is an accepted official method due to its reliability and applicability to many materials. Radiation sterilization could have different advantages in comparison to the others. The application of radiation to materials in their final packages makes this method as the first option that comes to mind for sterilization. However, this method can have disadvantages like unwanted effects as crosslinking or chain breaking in the sterilized materials. The possibility of causing adverse effects of gamma irradiation has got consideration among companies and tissue banks. Radiation can have a lethal effect on microorganisms directly or indirectly. It affects microorganisms in a direct way by targeting DNA of microorganisms and affects indirectly by aiming the water in the microorganism cell and causes formation of free radicals. Therefore, radiation sterilization as gamma irradiation can be a reliable and effective sterilization method (Nguyen, H; A. F. Morgan, D 2007; Rooney, et al., 2008; Jeng, D. K. H 1987). Microwave irradiation as a very novel radiation sterilization method also got importance recently. In recent studies, microwave radiation showed a successful performance in killing gram positive and negative bacteria at 2 min of microwave irradiation at 900 W and 2450 MHz, respectively (Jeng, D. K. H 1987). This method can be hopeful, acceptable and promising sterilization method to be a good substitute for gamma radiation due to low cost and much easier application process in comparison to gamma radiation. The purpose of this study was to evaluate the effects of gamma radiation and microwave sterilization processes on the physicochemical features of periodontological grafts by applying different physicochemical analyses as organoleptic analyses, FTIR, SEM, TGA and SAXS. Based on the results, both gamma radiation and microwave sterilization were found potential and successful as sterilization methods with no significant physicochemical changes in the characteristic features of the irradiated grafts. Additionally, HBG1, MBG3, PBG1 coded grafts were found as the most compatible materials to gamma and microwave radiation sterilization.

10. Combination of an allogenic and a xenogenic bone substitute material with injectable platelet-rich fibrin – A comparative in vitro study

Kyyak S, Blatt S, Pabst A, Thiem D, Al-Nawas B, Hölze F, Kämmerer PW. *J Biomater Appl.* 2020 Jul;35(1):83-96.

<https://pubmed.ncbi.nlm.nih.gov/32237950/>

Aim: The aim of this in vitro study was the comparison of allogeneic maxgraft® granules and xenogeneic BioOss® with and without injectable platelet-rich fibrin (i-PRF) on cell characteristics of human osteoblasts (HOB).

Material/ Methods: The bone grafting materials were incubated with HOB for 3, 7 and 10 days. HOB viability, migration, proliferation and differentiation (RT-PCR on alkaline phosphatase (AP), bone morphogenetic protein 2 (BMP-2) and osteonectin (OCN)) were measured and compared between the groups.

Results: An increased viability, migration and proliferation was seen for the combination of maxgraft®

granules and i-PRF at the 3 day's time point. For viability and proliferation (days 7 and 10) and for migration (day 10), the combination of bone grafting materials with i-PRF showed higher values compared to the bone grafting materials alone with maximum values for maxgraft® granules + i-PRF and minimum values for BioOss®. Interestingly even maxgraft® alone induced a significantly faster proliferation and increased cell viability of osteoblasts compared to BioOss alone. **Conclusion:** This *in vitro* study shows that maxgraft® granules with i-PRF demonstrate greater proliferation, differentiation, and cell-migration properties than Bio-Oss with i-PRF. Therefore, addition of i-PRF to allogeneic bone grafting material may influence osteoblast activity *in vivo*. Independently of iPRF, maxgraft® seems to have favorable effects on HOB compared to BioOss.

11. Evaluation of the bactericidal effect of cold atmospheric pressure plasma on contaminated human bone - An *in vitro* study

Kniha K, Möhlhenrich SC, Bock A, Ayoub N, Modabber A, Hölze F, Conrads G, Goloborodka E. *Br J Oral Maxillofac Surg.* 2020 Apr;58(3):329-333.

<https://pubmed.ncbi.nlm.nih.gov/31969253/>

The use of cold atmospheric pressure plasma (CAPP) as a bacterial decontaminant for chronic wounds has shown good results. The purpose of this *in vitro* study was to evaluate the bactericidal effects of CAPP on the cancellous area of the bone. Sterile glass slides and processed sterile human bone allografts 1, 2, 3, and 4 mm thick were used for initial contamination and further CAPP treatment. Each block was contaminated with *Staphylococcus aureus* suspension on one side. Each slide was turned 180° and treated on the reverse side. The bacterial count in colony-forming units (CFU) was then measured and compared with that of a control group, and the bactericidal effects of CAPP in relation to bone density evaluated. A significant reduction in count was measured between treated and untreated groups (groups A-D: $p < 0.01$ and group E: $p = 0.04$). A strong positive linear relation was found between bone density and the *S aureus* count ($r = 0.844$, $p = 0.156$). Treatment with CAPP had a bactericidal effect on bone structures with a penetration depth of up to 4 mm. It might be used for all diseases involving infected bone, and so extends the existing range of treatments.

12. Balancing Purification and Ultrastructure of Naturally Derived Bone Blocks for Bone Regeneration: Report of the Purification Effort of Two Bone Blocks.

Barbeck M, Jung O, Xiong X, Kraslev R, Korzinskas T, Najman S, Radenkovic M, Wegner N, Knyazeva M, Walther F. *Material.* 2019 Oct 2;12(19):3234.

<https://pubmed.ncbi.nlm.nih.gov/31581651/>

The present publication reports the purification effort of two natural bone blocks, that is, an allogeneic bone block (maxgraft®, botiss biomaterials GmbH, Zossen, Germany) and a xenogeneic block (SMARTBONE®, IBI S.A., Mezzovico-Vira, Switzerland) in addition to previously published results based on histology. Furthermore, specialized scanning electron microscopy (SEM) and *in vitro* analyses (XTT, BrdU, LDH) for testing of the cytocompatibility based on ISO 10993-5/-12 have been conducted. The

microscopic analyses showed that both bone blocks possess a trabecular structure with a lamellar subarrangement. In the case of the xenogeneic bone block, only minor remnants of collagenous structures were found, while in contrast high amounts of collagen were found associated with the allogeneic bone matrix. Furthermore, only island-like remnants of the polymer coating in case of the xenogeneic bone substitute seemed to be detectable. Finally, no remaining cells or cellular remnants were found in both bone blocks. The in vitro analyses showed that both bone blocks are biocompatible. Altogether, the purification level of both bone blocks seems to be favorable for bone tissue regeneration without the risk for inflammatory responses or graft rejection. Moreover, the analysis of the maxgraft® bone block showed that the underlying purification process allows for preserving not only the calcified bone matrix but also high amounts of the intertrabecular collagen matrix.

13. Beneficial Effects of Vitamins K and D3 on Redox Balance of Human Osteoblasts Cultured with Hydroxyapatite-Based Biomaterials.

Ambrożewicz E, Muszyńska M, Tokajuk G, Grynkiewicz G, Żarković N, Skrzydlewska E. *Cells*, 2019 Apr 8;8(4):325.

<https://pubmed.ncbi.nlm.nih.gov/30965604/>

Hydroxyapatite-based biomaterials are commonly used in surgery to repair bone damage. However, the introduction of biomaterials into the body can cause metabolic alterations, including redox imbalance. Because vitamins D3 and K (K1, MK-4, MK-7) have pronounced osteoinductive, anti-inflammatory, and antioxidant properties, it is suggested that they may reduce the adverse effects of biomaterials. *The aim of this study was to investigate the effects of vitamins D3 and K, used alone and in combination, on the redox metabolism of human osteoblasts (hFOB 1.19 cell line) cultured in the presence of hydroxyapatite-based biomaterials (maxgraft®, cerabone®, Apatos, and Gen-Os).* Culturing of the osteoblasts in the presence of hydroxyapatite-based biomaterials resulted in oxidative stress manifested by increased production of reactive oxygen species and decrease of glutathione level and glutathione peroxidase activity. Such redox imbalance leads to lipid peroxidation manifested by an increase of 4-hydroxynonenal level, which is known to influence the growth of bone cells. Vitamins D3 and K were shown to help maintain redox balance and prevent lipid peroxidation in osteoblasts cultured with hydroxyapatite-based biomaterials. The strongest effect was observed for the combination of vitamin D3 and MK-7. Moreover, vitamins promoted growth of the osteoblasts, manifested by increased DNA biosynthesis. Therefore, it is suggested that the use of vitamins D3 and K may protect redox balance and support the growth of osteoblasts affected by hydroxyapatite-based biomaterials.

14. Cross talk between redox signaling and metabolic activity of osteoblasts and fibroblasts in the presence of hydroxyapatite-based influences bone regeneration.

Ambrożewicz E, Tokajuk G, Muszyńska M, Zareba I, Skrzydlewska E. *J Appl. Biomed*, 2019, 17, 125-135. DOI: 10.32725/jab.2019.004

<https://jab.zsf.jcu.cz/pdfs/jab/2019/02/05.pdf>

Regeneration of bone tissue defects that result from metabolic disorders, including periodontal diseases, can be supported by biomaterials based on hydroxyapatite. Despite of good biocompatibility of biomaterials they can cause oxidative stress and inflammatory processes as a result of mechanical interaction with surrounding tissues. Because osteoblasts are responsible for bone regeneration process in which gingival fibroblasts may also participate, the aim of the work was to investigate the influence of hydroxyapatite-based biomaterials (allogeneic and xenogeneic) and biomaterials combined with enamel matrix derivative (Emdogain) on osteoblast and fibroblast redox balance in the context of osteoblast proliferation and differentiation. The results showed that examined substitutes were not cytotoxic in vitro, but affected redox balance of osteoblasts and fibroblasts (ROS level increase and GSH level decrease) which led to oxidative stress (MDA and protein carbonyl groups level increase) resulting in an increase of the Nrf2 and NFκB expression. The consequence of these changes was partial inhibition of proliferation and osteoblast differentiation. Emdogain alone and combined with biomaterials decreased ROS generation and increased GSH level in both osteoblasts and fibroblasts leading to reduction of transcription factors expression especially proinflammatory NFκB, which promoted osteoblast differentiation and mineralization process.

15. Osseointegration of Superhydrophilic Implants Placed in Defect Grafted Bones.

El Chaar E, Zhang L, Zhou Y, Sandgren R, Fricain JC, Dard M, Pippenger B, Catros S. *Int. J. Oral Maxillofac. Implants* March/April 2019;34(2):443–450.

<https://pubmed.ncbi.nlm.nih.gov/30703182/>

PURPOSE: Only limited information on the effect of implant surface hydrophilicity in conjunction with simultaneous bone augmentation is available. In this study, new bone growth around implants with a superhydrophilic modSLA (SLActive) and hydrophobic SLA (SLA) surface were compared in circumferential defects when grafted in conjunction with mineralized cancellous bone allograft (MCBA, maxgraft®) or sintered bovine bone mineral (SBBM, cerabone®).

Materials and Methods: The osseointegration and bone formation in circumferential defects in minipig mandibles around Straumann Roxolid, Ø 3.3 mm, length 8 mm; either SLA or SLActive, were evaluated. Following implant placement, the 2-mm circumferential defects around the implants were filled with MCBA or SBBM. Distance from implant shoulder to first bone-to-implant contact (f-BIC), percentage of bone-to-implant contact (BIC), and bone aggregate percentage (amount of new bone and remaining graft) within the defect area were evaluated after 8 weeks of healing.

RESULTS: In the SBBM group, lingual fBIC and buccal BIC were significantly lower for SLA (mean -0.404 ± 0.579 mm for modSLA versus -1.191 ± 0.814 mm for SLA, $P = .021$ and mean $62.61\% \pm 9.49\%$ for modSLA versus $34.67\% \pm 24.41\%$ for SLA, $P = .047$, respectively). Bone aggregate percentage was significantly higher for modSLA versus SLA implants in SBBM ($77.84\% \pm 6.93\%$ versus $64.49\% \pm 13.12\%$; $P = .045$). The differences between implant surfaces in MCBA showed a similar trend but were less pronounced than in the SBBM group and did not reach a statistically significant level.

CONCLUSION: The results suggest that implants with a superhydrophilic modSLA surface are more conducive to faster osseointegration even in conjunction with simultaneous bone grafting procedures.

16. Comparison of autogenous and allograft bone rings in surgically created vertical bone defects around implants in a sheep model.

Benlidayi ME, Tatli U, Salimov F, Tükel HC, Yüksel O. *Clin Oral Implants Res.* 2018 Nov;29(11):1155-1162.

<https://pubmed.ncbi.nlm.nih.gov/30281857/>

OBJECTIVES: The aim of this study was to compare autogenous and allograft bone rings in surgically created vertical bone defects.

MATERIAL AND METHODS: Four male, 1-year-old sheep were used in this study. In each sheep, eight vertical bone defects 7 mm in diameter were created using trephine drill in the iliac wing. Autogenous and allograft bone rings 5 mm in height and 7 mm in diameter were used for vertical augmentation around implants. The study consisted of four groups according to the bone ring type and amount of vertical augmentation, autogenous 2 mm, allograft 2 mm, autogenous 4 mm, and allograft 4 mm. Two of the animals were sacrificed after 4 months, and the remaining two animals were sacrificed after 8 months. Undecalcified sections were prepared from harvested samples. Histological assessment and histomorphometric analysis were performed.

RESULTS: Autogenous 2 mm group showed higher values than allograft 2 mm group, and autogenous 4 mm group showed higher values than allograft 4 mm group in terms of bone area and bone-to-implant contact (BIC) after 4 months. However, allograft 2 mm group showed higher bone area and BIC values than autogenous 2 mm group after 8 months. Also, autogenous 4 mm and allograft 4 mm groups showed comparable results after 8 months. Allograft 2 mm and allograft 4 mm groups showed higher bone area and BIC values at 8 months compared with 4 months.

CONCLUSIONS: Allograft bone ring looks promising in augmentation of surgically created vertical bone defects around implants after 8 months of healing.

17. Hydrophilicity, Viscoelastic, and Physicochemical Properties Variations in Dental Bone Grafting Substitutes.

Trajkovski B, Jaunich M, Müller WD, Beuer F, Zafiropoulos GG, Houshmand A. *Materials (Basel).* 2018;11(2):215. Published 2018 Jan 30. doi:10.3390/ma11020215

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5848912/>

The indication-oriented Dental Bone Graft Substitutes (DBGS) selection, the correct bone defects classification, and appropriate treatment planning are very crucial for obtaining successful clinical results. However, hydrophilic, viscoelastic, and physicochemical properties' influence on the DBGS regenerative potential has poorly been studied. For that reason, we investigated the dimensional changes and molecular mobility by Dynamic Mechanical Analysis (DMA) of xenograft (cerabone®), synthetic (maxresorb®), and allograft (maxgraft®, Puros®) blocks in a wet and dry state. While no

significant differences could be seen in dry state, cerabone® and maxresorb® blocks showed a slight height decrease in wet state, whereas both maxgraft® and Puros® had an almost identical height increase. In addition, cerabone® and maxresorb® blocks remained highly rigid and their damping behaviour was not influenced by the water. On the other hand, both maxgraft® and Puros® had a strong increase in their molecular mobility with different damping behaviour profiles during the wet state. A high-speed microscopical imaging system was used to analyze the hydrophilicity in several naturally derived (cerabone®, Bio-Oss®, NuOss®, SIC® nature graft) and synthetic DBGS granules (maxresorb®, BoneCeramic®, NanoBone®, Ceros®). The highest level of hydrophilicity was detected in cerabone® and maxresorb®, while Bio-Oss® and BoneCeramic® had the lowest level of hydrophilicity among both naturally derived and synthetic DBGS groups. Deviations among the DBGS were also addressed via physicochemical differences recorded by Micro Computed Tomography, Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy, X-ray powder Diffractometry, and Thermogravimetric Analysis. Such DBGS variations could influence the volume stability at the grafting site, handling as well as the speed of vascularization and bone regeneration. Therefore, this study initiates a new insight into the DBGS differences and their importance for successful clinical results.

18. Three-dimensional scanning electron microscopy of maxillofacial biomaterials.

Pabst AM, Müller WEG, Ackermann M. *Br J Oral Maxillofac Surg.* 2017 Sep;55(7):736-739. DOI 10.1016/j.bjoms.2017.05.010. Epub 2017 Jun 16.

<https://pubmed.ncbi.nlm.nih.gov/28624164/>

Report on a method of 3-dimensional scanning electron microscopy (3D-SEM) to visualize maxillo-facial biomaterials. 3D visualization of mucoderm®, Mucograft®, and maxgraft®.

19. Evaluation of implant-materials as cell carriers for dental stem cells under in vitro conditions.

Gosau M, Viale-Bouroncle S, Eickhoff H, Prateeptongkum E, Reck A, Götz W, Klingelhöffer C, Müller S, Morsczech C. *Int J Implant Dent.* 2015, Dec;1(1):2. doi: 10.1186/s40729-014-0002-y. Epub 2015 Feb 12.

<https://pubmed.ncbi.nlm.nih.gov/27747624/>

BACKGROUND: Dental stem cells in combination with implant materials may become an alternative to autologous bone transplants. For tissue engineering different types of soft and rigid implant materials are available, but little is known about the viability and the osteogenic differentiation of dental stem cells on these different types of materials. According to previous studies we proposed that rigid bone substitute materials are superior to soft materials for dental tissue engineering.

METHODS: We evaluated the proliferation, the induction of apoptosis and the osteogenic differentiation of dental stem/progenitor cells on a synthetic bone-like material and on an allograft product. The soft materials silicone and polyacrylamide (PA) were used for comparison. Precursor cells

from the dental follicle (DFCs) and progenitor cells from the dental apical papilla of retained third molar tooth (dNC-PCs) were applied as dental stem cells in our study. **RESULTS:** Both dental cell types attached and grew on rigid bone substitute materials, but they did not grow on soft materials. Moreover, rigid bone substitute materials only sustained the osteogenic differentiation of dental stem cells, although the allograft product induced apoptosis in both dental cell types. Remarkably, PA, silicone and the synthetic bone substitute material did not induce the apoptosis in dental cells. **CONCLUSIONS:** Our work supports the hypothesis that bone substitute materials are suitable for dental stem cell tissue engineering. Furthermore, we also suggest that the induction of apoptosis by bone substitute materials may not impair the proliferation and the differentiation of dental stem cells.

20. Comparison of four different allogeneic bone grafts for alveolar ridge reconstruction: a preliminary histologic and biochemical analysis.

Fretwurst T, Spanou A, Nelson K, Wein M, Steinberg T, Stricker A. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2014 Oct;118(4):424-31.

<https://pubmed.ncbi.nlm.nih.gov/25183228/>

OBJECTIVES: Allograft material for alveolar ridge reconstruction is quite promising and appears to be as equally successful as bone autograft material. The aim of the present study was to compare four different allogeneic bone grafts in terms of their histologic structure and DNA content before grafting.

Material and Methods: Four allograft specimens from different suppliers were analyzed histologically, and the DNA content was analyzed before clinical use of the allografts.

RESULTS: Organic tissue remnants were detected in all of the evaluated samples. In the present samples, adipocytes, fibroblasts, osteocytes, and chondrocytes were identified and DNA isolation and purification were possible.

CONCLUSION: Demineralized freeze-dried allogeneic bone transplants can stimulate new bone formation and are a viable alternative to bone autograft material. However, the well-tolerated use of allograft material in regard to our findings should be further investigated.

21. Translational Research: Palatal-derived Ecto-mesenchymal Stem Cells from Human Palate: A New Hope for Alveolar Bone and Cranio-Facial Bone Reconstruction

Grimm WD, Danna A, Giesenhagen B, Schau I, Varga G, Vukovic MA, Sirak SV. *Int J Stem Cells.* 2014 May;7(1):23-9. doi: 10.15283/ijsc.2014.7.1.23.

<https://pubmed.ncbi.nlm.nih.gov/24921024/>

The management of facial defects has rapidly changed in the last decade. Functional and esthetic requirements have steadily increased along with the refinements of surgery. In the case of advanced atrophy or jaw defects, extensive horizontal and vertical bone augmentation is often unavoidable to

enable patients to be fitted with implants. Loss of vertical alveolar bone height is the most common cause for a non-primary stability of dental implants in adults. At present, there is no ideal therapeutic approach to cure loss of vertical alveolar bone height and achieve optimal pre-implantological bone regeneration before dental implant placement. Recently, it has been found that specific populations of stem cells and/or progenitor cells could be isolated from different dental resources, namely the dental follicle, the dental pulp and the periodontal ligament. Our research group has cultured palatal-derived stem cells (paldSCs) as dentospheres and further differentiated into various cells of the neuronal and osteogenic lineage, thereby demonstrating their stem cell state. In this publication will be shown whether paldSCs could be differentiated into the osteogenic lineage and, if so, whether these cells are able to regenerate alveolar bone tissue *in vivo* in an athymic rat model. Furthermore, using these data we have started a proof of principle clinical- and histological controlled study using stem cell-rich palatal tissues for improving the vertical alveolar bone augmentation in critical size defects. The initial results of the study demonstrate the feasibility of using stem cell-mediated tissue engineering to treat alveolar bone defects in humans.

22. Current trends and future perspectives of bone substitute materials - from space holders to innovative biomaterials.

Kolk A, Handschel J, Drescher W, Rothamel D, Kloss F, Blessmann M, Heiland M, Wolff KD, Smeets R. J *Craniofac Surg*. 2012 Dec;40(8):706-18.

<https://pubmed.ncbi.nlm.nih.gov/22297272/>

An autologous bone graft is still the ideal material for the repair of craniofacial defects, but its availability is limited, and harvesting can be associated with complications. Bone replacement materials as an alternative have a long history of success. With increasing technological advances, the spectrum of grafting materials has broadened to allografts, xenografts, and synthetic materials, providing material specific advantages. A large number of bone-graft substitutes are available including allograft bone preparations such as demineralized bone matrix and calcium-based materials. More and more replacement materials consist of one or more components: an osteoconductive matrix, which supports the ingrowth of new bone; and osteoinductive proteins, which sustain mitogenesis of undifferentiated cells; and osteogenic cells (osteoblasts or osteoblast precursors), which are capable of forming bone in the proper environment. All substitutes can either replace autologous bone or expand an existing amount of autologous bone graft. Because an understanding of the properties of each material enables individual treatment concepts this review presents an overview of the principles of bone replacement, the types of graft materials available, and considers future perspectives. Bone substitutes are undergoing a change from a simple replacement material to an individually created composite biomaterial with osteoinductive properties to enable enhanced defect bridging.

Clinical studies and case series

23. Risk Factors for Complications Following Staged Alveolar Ridge Augmentation and Dental Implantation: A Retrospective Evaluation of 151 Cases with Allogeneic and 70 Cases with Autogenous Bone Blocks

Kloss FR, Kämmerer PW, Kloss-Brandstätter A. *J. Clin. Med.* 2023, 12, 6. DOI 10.3390/jcm12010006

<https://www.mdpi.com/2077-0383/12/1/6>

Purpose: the aim of this study was to identify potential risk factors favoring complications by assessing the number and types of complications associated with allogeneic or autogenous bone blocks applied as onlay grafts for alveolar ridge augmentation prior to implantation.

Methods: A retrospective chart review on the success of 151 allogeneic and 70 autogenous bone blocks in a cohort of 164 consecutive patients, who were treated over a period of 6 years by the same surgeon, was conducted. Statistical conclusions were based on ROC curves and multiple logistic regression models.

Results: Complications were observed more frequently with autogenous bone blocks (14 out of 70 cases; 20%) compared to allogeneic bone blocks (12 out of 151 cases; 7.9%; $p = 0.013$). However, these complications were minor and did not impact the successful dental rehabilitation. In a multiple logistic regression model, the risk of a complication was increased by the use of an autogenous bone block (OR = 3.2; $p = 0.027$), smoking (OR = 4.8; $p = 0.007$), vertical augmentation above a threshold of 2.55 mm (OR = 5.0; $p = 0.002$), and over-contouring (OR = 15.3; $p < 0.001$).

Conclusions: Overall, the complication rate of ridge augmentations carried out with autogenous or allogeneic bone blocks was low. Despite previous recommendations, over-contouring and a vertical augmentation above a threshold of 2.55 mm should be avoided.

24. The allogeneic shell technique for alveolar ridge augmentation: a multicenter case series and experiences of more than 300 cases

Kämmerer PW, Tunkel J, Götz W, Würdinger R, Kloss F, Pabst A. *Int J Implant Dent* 8, 48 (2022). DOI 10.1186/s40729-022-00446-y

<https://journalimplantdent.springeropen.com/articles/10.1186/s40729-022-00446-y#citeas>

Purpose: Allogeneic cortical bone plates (CP) might be used for alveolar ridge augmentation as an alternative to autogenous grafts (AG) and bone substitutes (BS). We report about a multicenter case series and our experiences of more than 300 cases using CP and the shell technique for reconstruction of the alveolar process to illustrate surgical key steps, variations, and complication management.

Methods: Different types of alveolar ridge defects were augmented using the shell technique via CP. The space between the CP and the alveolar bone was filled with either autogenous or allogeneic

granules (AUG, ALG) or a mixture of both. Implants were placed after 4–6 months. Microscopic and histological assessments were performed. In addition, space filling using AUG, ALG and bovine BS was discussed.

Results: Scanning electron microscopy demonstrated the compact cortical structure of CP and the porous structure of ALG allowing micro-vessel ingrowth and bone remodeling. Histological assessment demonstrated sufficient bone remodeling and graft resorption after 4–6 months. In total, 372 CP cases and 656 implants were included to data analysis. The mean follow-up period was about 3.5 years. Four implants failed, while all implant failures were caused by peri-implantitis. Next, 30 CP complications were seen, while in 26 CP complications implant placement was possible. CP rehydration, stable positioning by adjusting screws, smoothing of sharp edges, and a tension-free wound closure were identified as relevant success factors. Space filling using ALG and a mixture of AUG/ALG resulted in sufficient bone remodeling, graft resorption and stability of the augmented bone.

Conclusions: CP and the shell technique is appropriate for alveolar ridge augmentation with adequate bone remodeling and low complication rates. Allografts can prevent donor site morbidity and therefore may decrease discomfort for the patient.

25. Comparison of Allogeneic Bone Plate and Guided Bone Regeneration Efficiency in Horizontally Deficient Maxillary Alveolar Ridges

Cinar IC, Gultekin BA, Saglanmak A, Akay AS, Zboun M, Mijiritsky E. *Applied Sciences*. 2022; 12(20):10518. DOI 10.3390/app122010518

<https://www.mdpi.com/2076-3417/12/20/10518>

Background: Bone Lamina Technique and Guided Bone Regeneration (GBR) are commonly used for horizontally-deficient maxillary ridge reconstruction, although more detailed evaluation to assess the differences between such techniques is necessitated.

Methods: In this retrospective study, patients having a horizontal bone width of 4 mm in the maxilla, who were treated with Cortical Strut (CS), were collected to represent the “test group”, and those treated with GBR with no CS involvement represented the “control group”. A 1:1 mixture of autogenous bone (AB) and anorganic bovine bone (ABB) with resorbable collagen membrane was applied to both groups. Volumetric changes between groups were measured with cone-beam computed tomography (CBCT). The primary outcome represented volumetric graft resorption rate whilst the secondary outcomes represented any probable complications and implant insertion torque.

Results: A total of 36 patients were included in this study (36 grafted sites; 18 for CS group and 18 for GBR group). Mean bone graft volume reduction in the CS and GBR groups was 8.26 ± 1.60% and 14.36 ± 3.55%, respectively. The GBR group showed significantly more bone resorption than the CS group ($p < 0.001$). Complications and insertion torque were similar between the groups ($p > 0.05$).

Conclusions: Both CS and GBR techniques for hard-tissue augmentation provided sufficient bone graft mass volume for implant insertion, whereas CS demonstrated lower resorption rate at maxillary augmented sites, compared to GBR.

26. A 3-year prospective randomized clinical trial of alveolar bone crest response and clinical parameters through 1, 2, and 3 years of clinical function of implants placed 4 months after alveolar ridge preservation using two different allogeneic bone-grafting materials

Solakoglu Ö, Ofluoğlu D, Schwarzenbach H, Heydecke G, Reißmann D, Ergun S, Götz W. *Int J Implant Dent* 8, 5 (2022). DOI: 10.1186/s40729-022-00402-w

<https://journalimplantdent.springeropen.com/articles/10.1186/s40729-022-00402-w>

The aim of this study was to longitudinally evaluate changes in alveolar bone crest (ABC) levels and differences in resorption rates (RR) between the tested grafting materials following alveolar ridge preservation (ARP) after tooth extraction after 1, 2, and 3 years (T1–T8) of clinical function.

Methods: Patients were randomly assigned to two different bone allografts (group 1 maxgraft®, group 2 Puros®) for ARP. Non-restorable teeth were minimally traumatically extracted. Sockets were augmented with the tested materials and covered with a pericardium membrane. After 4 months of healing, 36 implants were placed and sites were clinically and radiographically monitored in the mesial (ABC-M), the distal (ABC-D, T1–T8), the bucco-lingual (ABC-BL), buccal (ABC-B) and oral (ABC-O) aspect (T1–T4).

Results: Changes in (ABC-M), (ABC-D), (ABC-BL), (ABC-B), and (ABC-O) levels showed statistically highly significant differences between T1 and T2 for both bone allografts ($p < 0.001$). Changes at the ABC-M and ABC-BL levels between T2 and T3 of group 1 showed a statistically significant difference ($p < 0.001$). Both groups achieved and maintained increased ABC levels without statistically significant differences throughout the monitoring periods of 1–3 years (T6–T8) of clinical function. No failures or adverse events were observed.

Conclusions: To the best of our knowledge, this study is within its limitations the first study to directly compare ABC-changes and differences in RR of two different allogeneic grafting materials for a period of 3 years after ARP. It was demonstrated to be, despite significant differences in RR, a successful method of preserving increased ABC levels through 1, 2, and 3 years of clinical function.

27. Connective tissue graft vs porcine collagen matrix after immediate implant placement in esthetic area: A randomized clinical trial

Puisys A, Deikuvienė J, Vindasiute-Narbute E, Razukevicius D, Zvirblis T, Linkevicius T. *Clin Implant Dent Relat Res.* 2022 Apr;24(2):141-150. DOI 10.1111/cid.13058. Epub 2022 Mar 24. PMID: 35324053.

<https://pubmed.ncbi.nlm.nih.gov/35324053/>

Background: The use of connective tissue graft (CTG) with immediate implant placement and provisionalisation have shown promising results. It is not clear if the same outcome could be achieved using porcine-derived collagen matrix (PDCM) as grafting material.

Objectives: This study aimed to assess the esthetic and functional outcomes of immediate temporization of immediately placed fully tapered implants combined with bone and soft tissue augmentation, using either a CTG or a PDCM, in fresh extraction sockets of the anterior sites.

Materials and Methods: Patients with a failing anterior tooth were included in this study. After extraction, they received an immediate implant with simultaneous hard and soft tissue augmentation and immediate provisional restoration. Patients were randomly assigned to one of the group. Soft tissue augmentation in the control group (CTG) consisted of a CTG, whereas PDCM was used in the test group. After 4 months, definitive restorations were delivered, and pink esthetic score (PES) was evaluated at T1, prosthetic delivery, and at 12-month follow-up (T2). In addition, crestal bone change, probing depth, bleeding on probing, plaque index, bleeding on provisional removal, and implant stability quotient were also recorded.

Results: A total of 45 patients received the intended treatment (22 controls and 23 tests) 45 implants totally, with no implant failures at T2. PES mean \pm SD after 1 year was noted to be 12.9 ± 1.2 for the CTG group and 12.1 ± 1.3 for the PDCM group ($p = 0.507$).

Conclusion: Within the limits of this trial, both treatment protocols resulted in comparable esthetic outcomes, with results showing PES >12 and stable clinical parameters after 1 year of follow-up.

28. Allogeneic cortical struts and bone granules for challenging alveolar reconstructions: An innovative approach toward an established technique

Würdinger R and Donkiewicz P. *J Esthet Restor Dent.* 2020 Dec;32(8):747-756.

<https://pubmed.ncbi.nlm.nih.gov/32920939/>

Objective: The shell technique is a well-established procedure for GBR with which extensive osseous defects can be predictably restored by using cortical bone struts harvested from various intraoral aspects. Recent publications have demonstrated comparable results for autologous and allogeneic bone grafts, whereas the evidence on allogeneic cortical struts remains limited.

Clinical considerations: In this case series, we demonstrate the regeneration of five complex alveolar bone defects in four patients with subsequent insertion of fixed dental implants. In all cases, cortical struts (maxgraft® cortico) made from human donor bone were applied in combination with allogeneic bone granules (maxgraft®) and collagen membranes (Jason® membrane).

Conclusions: Similar to autologous cortical shells, the allogeneic struts functioned by creating an immobile container with which the osseous defects in all patients could be successfully restored, enabling placement of dental implants in accordance with the treatment plan. Even when the containers were solely filled with allogeneic granules, vascularized healthy tissue was present at re-entry, demonstrating the vast potential of these materials for applications in dentistry.

Clinical significance: Especially when it comes to regeneration of complex alveolar bone defects, autologous bone grafts are often outlined as the only treatment modality. Here we show that innovative biomaterials like allogeneic bone grafts hold the potential to mimic the functions of autologous bone transplants and provide excellent clinical results without the requirement of a second surgical side for bone harvesting and no risk of donor-site morbidity.

29. Alveolar ridge augmentation using the shell technique with allogeneic and autogenous bone plates in a split-mouth design—A retrospective case report from five patients

Tunkel J, de Stavola L, Kloss-Brandstätter A. *Clin Case Rep.* 2020 Dec 29;9(2):947-959.

<https://pubmed.ncbi.nlm.nih.gov/33598278/>

Atrophic alveolar ridges of five patients were augmented with allografts and autografts on opposite sites, followed by dental implantation. Both augmentation materials led to equivalent bone gains. Allografts did not compromise the clinical outcome.

30. Three-dimensional analysis of dimensional changes after alveolar ridge preservation with bone substitutes or plasma rich in growth factors: Randomized and controlled clinical trial

Stumbras A, Galindo-Moreno P, Januzis G, Juodzbalys G. *Clin Implant Dent Relat Res.* 2021 Feb;23(1):96-106. doi: 10.1111/cid.12950. Epub 2020 Oct 20.

<https://pubmed.ncbi.nlm.nih.gov/33084205/>

Objectives: To evaluate alveolar ridge dimensional changes of different alveolar ridge preservation techniques after 3 months of tooth extraction and to compare the efficacy of autologous plasma rich in growth factor (PRGF) to the bone substitutes in alveolar ridge preservation and sites left to heal spontaneously.

Materials and Methods: Forty patients requiring tooth extraction in the anterior maxilla were randomly allocated to the four following treatment modalities: spontaneous healing (control), natural bovine bone mineral covered with resorbable native collagen membrane (BBM/CM), freeze-dried bone allograft covered with resorbable native collagen membrane (FDBA/CM) and PRGF alone. Cone beam computed tomography (CBCT) scans were taken after surgery and 3 months later. The measurements of height and width (at 1, 3, and 5 mm below the crest) were performed after superimposing the 2 consecutive CBCT scans.

Results: The greatest horizontal alveolar bone resorption at 1 mm below bone crest was observed in the control group (-1.61 ± 1.76 mm, $P = .037$), whereas the least reduction in width was found in the BBM/CM group (-0.68 ± 0.67 mm, $P = .037$). The most pronounced alveolar height reduction was observed in the control group (-0.86 ± 0.43 mm), whereas alveolar ridge preservation with BBMC/CM (-0.26 ± 0.91 mm) and PRGF (-0.54 ± 0.86 mm) successfully reduced the alveolar height reduction as compared to the control group.

Conclusions: Alveolar ridge preservation technique in the esthetic zone using BBM/CM or using PRGF is beneficial to reduce horizontal and vertical bone changes.

31. Randomized and Controlled Clinical Trial of Bone Healing After Alveolar Ridge Preservation Using Xenografts and Allografts Versus Plasma Rich in Growth Factors

Stumbras A, Januzis G, Gervickas A, Kubilius R, Juodzbaly G. *J Oral Implantol.* 2020 Oct 1;46(5):515-525. doi: 10.1563/aaid-joi-D-19-00179.

<https://pubmed.ncbi.nlm.nih.gov/32315435/>

The aim of this study was to compare bone regeneration in the anterior maxilla between bone substitutes and autologous platelet concentrate in alveolar ridge preservation. Forty patients requiring tooth extraction in the anterior maxilla were randomly allocated to the following 4 treatment modalities: spontaneous healing (control), natural bovine bone mineral covered with resorbable native collagen membrane (BBM/CM), freeze-dried bone allograft covered with resorbable native collagen membrane (FDBA/CM), and plasma rich in growth factors (PRGF) alone. Bone biopsies and histomorphometrical analysis were performed after 3 months of healing. The following parameters were assessed: newly formed mineralized tissue, newly formed nonmineralized tissue, and residual bone-grafting material (if applicable). Statistical analysis was performed to provide descriptive analysis and to compare the parameters of the bone regeneration between the study groups. Histomorphometrical analysis revealed the highest new mineralized tissue formation in the PRGF group. Statistically significant differences in new mineralized tissue formation were found between control/PRGF (46.4% ± 15.2% vs 75.5% ± 16.3%), control/(BBM/CM) (46.4% ± 15.2% vs 20.3% ± 21.9%), control/(FDBA/CM) (46.4% ± 15.2% vs 7.2% ± 8.6%), PRGF/(BBM/CM) (75.5% ± 16.3% vs 20.3% ± 21.9%), and PRGF/(FDBA/CM) (75.5% ± 16.3% vs 7.2% ± 8.6%) groups. The new mineralized tissue formation was in the following order: PRGF > control > BBM > FDBA. Alveolar ridge preservation in the esthetic zone with PRGF was the most effective for bone regeneration of the alveolar ridge.

32. Characterization of circulating DNA in plasma of patients after allogeneic bone grafting.

Solakoglu Ö, Steinbach B, Götz W, Heydecke G, Pantel K, Schwarzenbach, *Clin Oral Investig.* 2019 Dec;23(12):4243-4253.

<https://pubmed.ncbi.nlm.nih.gov/30826920/>

Cell-free DNA (cfDNA) harboring mutations has been found in patients with diseases. Experimental studies have shown that cfDNA can be transmitted, leading to transformations in the host. In the present study, we evaluated whether bone allograft material contains cfDNA and whether this foreign cfDNA can be released into the patient's blood circulation. **MATERIAL / METHODS:** Plasma samples were collected preoperatively and postoperatively on the same day, at 5 weeks, and 4 months from 25 women who received bone allograft material (test group) from male donors and from 10 women who were treated with autologous graft (control group, only pre- and postoperative samples were collected). DNA was quantified and characterized in bone material and plasma samples by quantitative PCR with primers specific for glyceraldehyde-3-

phosphate dehydrogenase (GAPDH) and Y chromosome and gel electrophoresis. DNA in bone material was digested by different concentrations of DNase I. **RESULTS:** We detected between 1 and 1.8 µg cfDNA fragments at a length around 601 base pairs (bp) and smaller in each 100 mg allograft. Treatment of the allograft with DNase I completely degraded the longer but not the shorter DNA 90-bp fragments. Y-DNA was not detected in the patients' bloodstream at any time during the treatment and follow-up, but elevated levels of circulating cfDNA could be measured immediately postoperatively. **CONCLUSIONS:** Our results suggest that a transmission of DNA from allografts used for alveolar ridge reconstruction in humans is unlikely. The observed increase in circulating cfDNA in allograft and autograft patients immediately postoperatively may be elicited by the surgical procedure. **CLINICAL RELEVANCE:** The results support the safety of allograft materials. The results suggest that human allograft materials seem not to release DNA into the blood since we did not measure Y-DNA with our technique.

33. Histological and immunohistochemical comparison of two different allogeneic bone grafting materials for alveolar ridge reconstruction: A prospective randomized trial in humans

[Solakoglu Ö, Götz W, Heydecke G, Schwarzenbach H. Clin Implant Dent Relat Res. 2019 Oct;21\(5\):1002-1016.](#)

<https://pubmed.ncbi.nlm.nih.gov/31424173/>

Preclinical studies have hypothesized a possible immunological response to allogeneic materials due to detection of remnants of potential immunogenic molecules. However, their impact on integration, bone remodeling and immunological reaction after the augmentation procedure is largely unknown and a direct correlation of analytical data and evaluation of human biopsies is missing.

PURPOSE: The present study aimed to compare two commercially available allogeneic materials regarding their content of cellular remnants as well as the bone remodeling, and integration and potential immunologic reactions on a histological and immunohistochemical level, integrating also in vitro analytical evaluation of the specific batches that were used clinically.

MATERIAL / METHODS: Twenty patients were randomly assigned to treatment with maxgraft® or Puros for lateral ridge augmentation in a two-stage surgery. After a mean healing period of 5 months, implants were placed and biopsies were taken for histological, immunohistochemical, and histomorphometrical evaluation regarding bone remodeling and inflammation, protein concentrations in vitro and the presence of MHC molecules of the same batches used clinically.

RESULTS: No differences in clinical outcome, histological, immunohistochemical, and in vitro protein analysis between the two bone grafting materials were observed. Active bone remodeling, amount of newly formed bone, and residual grafting material was independent of the materials used but varied between subjects. MHC1 residues were not detected in any sample.

CONCLUSIONS: Within the limitations of this study, both tested materials yielded equivalent results in terms of clinical outcome, new bone formation, and lack of immunological potential on a histological and immunohistochemical level.

34. Time analysis of alveolar ridge preservation using a combination of mineralized bone-plug and dense-polytetrafluoroethylene membrane: A histomorphometric study

Wen S-C, Barootchi S, Huang W-X, Wang W-X. *J. Periodont.* 2020 Feb;91(2):215-222. doi: 10.1002/JPER.19-0142. Epub 2019 Aug 19.

<https://pubmed.ncbi.nlm.nih.gov/31378923/>

The objective of this study was to histologically evaluate and compare vital bone formation, residual graft particles, and fraction of connective tissue (CT)/other tissues between three different time points at 2-month intervals after alveolar ridge preservation with a cancellous allograft and dense-polytetrafluoroethylene (d-PTFE) membrane.

Material/ Methods: Ridge preservation with a cancellous allograft and d-PTFE membrane was performed at 49 extraction sockets (one per patient). Volunteers were assigned to implant placement at three different time points of 2, 4, and 6 months, at which time core biopsies were obtained. Histomorphometric analysis was performed to determine the percentages of vital bone, residual graft particles, and connective tissue/other non-bone components, and subjected to statistical analyses.

Results: There was a statistically significant difference in the amount of vital bone at every time point from 28.31% to 40.87% to 64.11% (at 2-, 4-, and 6-month groups, respectively) ($P < 0.05$). The percentage of residual graft particles ranged from 44.57% to 36.16% to 14.86%, showing statistical significance from 4 to 6 months (21.29%, $P < 0.001$), and 2 to 6 months (29.71%, $P < 0.001$), while there were no significant differences for the amount of CT/other tissue among the different time points.

Conclusions: This study provided the first histologic comparison of alveolar ridge preservation using a cancellous allograft and d-PTFE membrane at three different time points. Extraction sockets that healed for 6 months produced the highest amount of vital bone in combination with the least percentage of residual graft particles, while similar results were observed for the fraction of CT/other tissues between the three time points.

35. Lateral bone augmentation in narrow posterior mandibles, description of a novel approach, and analysis of results.

Beitlitum I, Sebaoun A, Nemcovsky CE, Slutzkey S *Clin Implant Dent Relat Res.* 2018 Apr;20(2):96-101.

<https://pubmed.ncbi.nlm.nih.gov/29316182/>

PURPOSE: To evaluate a new simplified method for resorbable collagen membrane fixation in lateral bone augmentation procedures in narrow posterior mandibles.

Material / Methods: This retrospective study analyzed 16 procedures performed in 15 patients who followed lateral ridge augmentation procedures before implant placement in the posterior mandible. A particulate mineralized bone allograft was covered with a cross-linked resorbable collagen barrier membrane, which was fixated with a single, non-resorbable pin. Complications were registered and results analyzed on pre and post op measurements on computerized tomographic scans. Descriptive statistical analysis and ANOVA with repeated measures were performed.

RESULTS: No complications were recorded. Average bone gain was 3.3 mm at implant platform level and 4.29 mm at 3 mm apically, both, statistically significant. All sites had sufficient bone width allowing implant placement. Thirty-three implants placed in the augmented areas, integrated and survived for over a 2-year follow-up.

CONCLUSION: The simplified membrane fixation procedure enables large horizontal bone gain with minimal complications while allowing adequate implant placement.

36. The use of mineralized bone allograft as a single grafting material in maxillary sinus lifting with severely atrophied alveolar ridge (1-3 mm) and immediately inserted dental implants. A 3- up to 8-year retrospective study.

Tilaveridis I, Lazaridou M, Zouloumis L, Dimitrakopoulos I, Tilaveridis V, Tilaveridou S. *Oral Maxillofac Surg.* 2018 Sep;22(3):267-273.

<https://pubmed.ncbi.nlm.nih.gov/29858723/>

The primary aim of our study was to evaluate the efficacy of mineralized bone allograft alone in sinus floor augmentation with simultaneous implant placement in cases with severe atrophy of the residual maxillary bone (bone height < 4 mm).

Material/ Methods: Thirty-five dental implants were placed in 29 patients who underwent sinus augmentation via traditional lateral window technique from 2008 to 2013. Patients with residual alveolar height between 1 and 3 mm at the site of implantation were included in the study. The height of residual bone was initially estimated by plain panoramic X-ray and reevaluated intraoperatively by precise micrometric measurement at the site of implantation. Implants of 13 mm height and 3.5 or 4.3 mm in diameter were inserted simultaneously. Mineralized bone allograft was used alone to augment the sinus floor.

RESULTS: No wound dehiscence was recorded. In one case there was a postoperative site infection which subsided with antibiotics without implant failure. One implant migrated during the postoperative period to the maxillary sinus and was removed. One implant failed. The remaining 33 implants were successfully loaded. Follow-up ranged from 3 to 8 years.

CONCLUSIONS: Maxillary sinus lift in severely absorbed alveolar ridges with simultaneous implant placement could be safely performed using mineralized allograft alone, rendering the procedure less invasive and less time-consuming.

37. One Stage Vertical Ridge Augmentation and Dental Implantation with Allograft Bonerings: Results One Year after Surgery

Nord T, Yüksel O, Grimm WD, Giesenhagen B. *J Oral Implantol.* 2019;45(6):457-463

<https://pubmed.ncbi.nlm.nih.gov/31536460/>

The aim of this study was to analyze the success rate of dental implants and the graft shrinkage rate after vertical ridge augmentation and simultaneous implantation with an allograft bonering.

Materials / Methods: Fifty-one patients (81 augmentations and simultaneous implantations) were included. The bonering technique followed a standardized protocol. The alveolar ridge was prepared using a congruent trephine, and depending on the defect size, an allograft bonering with an outer diameter of 6-7 mm was placed. The height of the bonering was trimmed with a diamond disc to the required length. The average height of vertical augmentation was 5.5 mm. Implants were inserted through the bonering into the native bone of alveolar ridge.

Results: After 6 months, dental implants were exposed, and dental prosthetics were placed. Of 81 implants placed with the bonering technique, two failed during a 12-month follow-up, corresponding to a success rate of 97.5%. One year after surgery, the allograft bonering exhibited an average vertical graft shrinkage rate of 8.6%.

Conclusion: The allograft bonering technique was associated with a favorable outcome, and in cases with large vertical defects, both treatment time and donor site morbidity could be reduced.

38. Comparison of allogeneic and autogenous bone grafts for augmentation of alveolar ridge defects – a 12-month retrospective radiographic evaluation

Kloss FR, Offermanns V, Kloss-Brandstätter A. *Clin Oral Implants Res.* 2018 Nov;29(11):1163-1175.

<https://pubmed.ncbi.nlm.nih.gov/30303581/>

The aim of this study was to compare three-dimensional alterations following the use of autogenous versus allogeneic onlay grafts for augmentation at single tooth defects.

Material / Methods: Alveolar bone width at specific implant sites were assessed using sagittal and cross-sectional CBCT images prior grafting and at three subsequent time points. 21 patients received autogenous bone blocks harvested from the retromolar region and another 21 patients received freeze-dried cancellous allogeneic bone blocks.

Results: The vertical and horizontal dimensions did not significantly differ between autogenous and allogeneic bone grafts at any time point. In addition, there were no statistically significant differences in graft remodeling rates between autogenous (mean shrinkage rate after 12 months: 12.5 ± 7.8 %) and allogeneic onlay grafts (mean shrinkage rate after 12 months: 14.4 ± 9.8 %).

Conclusions: Freeze-dried cancellous allogeneic bone blocks showed equivalent volumetric shrinkage rates as autogenous bone blocks when used for treating circumscribed bone defects classified as Type-II to Type-IV according to the ITI-treatment guide categories. Therefore, it is not necessary to over-contour the alveolar ridge when using allogeneic blocks for treating single tooth defects, but to apply the same procedure as when using autogenous blocks.

39. Four-year post-loading results of full-arch rehabilitation with immediate placement and immediate loading implants: A retrospective controlled study.

Simonpieri A, Gasparro R, Pantaleo G, Mignogna J, Riccitiello F, Sammartino G. *Quintessence Int.* 2017, 48(4):315-324.

<https://pubmed.ncbi.nlm.nih.gov/28294200/>

OBJECTIVES: The aim of this study was to evaluate implant survival rate and to measure peri-implant bone changes in full-arch rehabilitations with immediate placement and immediate loading implants with platform switching and Morse taper connection, in addition to platelet-rich fibrin (PRF) and buccal bone augmentation, after 4 years of follow-up.

Material/ Methods: In this retrospective controlled study, patients who had been fully rehabilitated with immediate placement and immediate loading implants were evaluated 4 years post-loading. Implants with platform switching and Morse taper connections were used (In-Kone Universal System, Global D) and PRF and buccal bone augmentation were applied. The radiographic bone loss was calculated by subtracting the bone level at baseline (BLT0) from that at the 4-year follow-up (BLT4) in immediate and delayed implants. Measurements were made at the distal, mesial, vestibular, and oral sites of the implants and the deepest value was recorded. Implants placed in extraction sites and implants placed in healed sites were considered. A comparison between the groups was performed using the Mann-Whitney test. The implant survival rate was calculated using the Kaplan-Meier analysis.

RESULTS: In total, 42 patients (28 females and 14 males; average age 55.8 years old, age range 45 to 77) were recruited to this study. A total of 334 implants were put in place (226 in the maxilla, 108 in the mandible). The implant survival rate was 97.8% for the maxilla and 98.1% for the mandible, 98.3% for immediate implants and 96.9% for delayed implants. No statistically significant differences in the mean radiographic bone loss (mBL) were observed when comparing the immediate and delayed implants and the anterior and posterior implants. Statistically significant differences were found in the mBL between the mandibular and maxilla implants in the vestibular and mesial sites.

CONCLUSION: Within their limits, the present results suggest that rehabilitation with platform switching and taper connection implants, in addition to buccal bone augmentation and the use of PRF, can lead to predictable results.

40. Management of acute maxillary sinusitis after sinus bone grafting procedures with simultaneous dental implants placement - a retrospective study.

Chirilă L, Rotaru C, Filipov I, Săndulescu M BMC Infect Dis. 2016; 16(Suppl 1): 94.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4896248/>

The sinus lift was first described in 1974 and it has proven to be a predictable procedure ever since. The complications of this surgical procedure are reported in the literature to be low, and can include acute maxillary sinusitis, scattering of the grafting material into the sinus cavity, wound dehiscence and Schneiderian membrane perforations. [We aimed to evaluate the rate of acute maxillary sinusitis after sinus lift procedures and the appropriate management strategies.](#)

Methods: Between 2013 and 2015, 245 dental implants were placed in 116 patients (76 males and 40 females) with concomitant bone augmentation of the maxillary sinus floor. The sinus lifting procedure was bilateral in 35 patients and unilateral in 81 patients (a total of 151 sinuses).

Results: Maxillary sinusitis occurred in 5 patients (4.3%). The clinical signs of infection were: headache, locoregional pain, cacosmia, inflammation of the oral buccal mucosa and rhinorrhea or unilateral nasal discharge. A mucosal fistula was observed during inspection in one patient. The management included only the removal of the grafting material in 3 patients, in 1 patient the grafting material was removed together with all the implants, and in 1 patient only 2 implants and the grafting material were removed, 1 implant being left in place. The sinus cavity was irrigated with metronidazole

solution and antibiotic therapy with clindamycin and metronidazole was prescribed for 10 days. Subsequently, all signs of infection disappeared within 5 to 7 days and normal sinus function and drainage were restored.

Conclusions: Although sinus lift is regarded as a safe and reliable procedure, acute sinusitis is a possible complication which has to be managed immediately in order to reduce the risk of further complications like pansinusitis, osteomyelitis of the maxillary bone, and spreading of the infection in the infratemporal space or orbital cavity. To minimize risk, caution must be taken with all the steps of the procedure, in order not to obliterate the ostium, impairing maxillary sinus clearance.

41. Customized 3D-Printed Titanium Mesh Developed for an Aesthetic Zone to Regenerate a Complex Bone Defect Resulting after a Deficient Odontectomy: A Case Report

Gelețu GL, Burlacu A, Murariu A, Andrian S, Golovcencu L, Baci E-R, Maftai G, Onica N. . *Medicina*. 2022; 58(9):1192. DOI 10.3390/medicina58091192.

<https://www.mdpi.com/1648-9144/58/9/1192>

Background and Objectives: Alveolar ridge augmentation in the complex bone defect is a popular topic in implantology. Guided bone regeneration (GBR) is one of the most commonly applied methods to reconstruct alveolar bone. The application of a membrane is the fundamental principle of GBR. There are many membrane types used in oral surgery, but the advantage of the titanium mesh is the rigidity which provides space maintenance and prevents contour collapse. The smooth surface also reduces bacterial contamination. Using computer-aided design (CAD) and computer-aided manufacturing (CAM) in dentistry allows us to obtain the perfect architecture form of the mesh, which covers and protects the bone reconstruction. **Case presentation:** We present a surgical case of a 27-year-old female patient with severe aesthetic bone atrophy after a deficient odontectomy. Based on the GBR clinical applications, the technique consists of bone reconstruction and a customized titanium mesh application. Using mesh titanium in this case presentation was a reliable alternative to perform a lateral alveolar bone augmentation and reconstruct ridge deformities before reaching an ideal implant placement. **Conclusions:** According to our case report, the customized titanium mesh could be a valuable option for guided bone regeneration in aesthetic maxillary defects.

42. Customized Allogeneic Bone Augmentation Improves Esthetic Outcome in Anteromaxillary Dental Implantation

Nilius M, Nilius MH, Mueller C, Weiland B, Haim D, Krahe A, Lauer G. *Case Reports in Dentistry*, 2022, 2022. Jg. DOI 10.1155/2022/6943930

<https://www.hindawi.com/journals/crid/2022/6943930/>

Purpose. In cases of severe atrophic maxilla or maxillary involution, augmentation is necessary for implant-supported prosthetics. Using bone grafts is a standard procedure, and using customized allogeneic bone blocks may be a predictable alternative before dental implantation. **Clinical Findings.** This case study shows the digital workflow, including a preimplantological augmentation by a customized allogeneic block, followed by soft tissue optimization and template-based dental implantation, after six months of healing. It is part of a three-year follow-up study on the resorption rate of allogeneic bone blocks.

Outcomes. Allogeneic bone augmentation is an alternative treatment option to autologous bone grafts. It allows predictable advanced backward planning (ABP) even in the maxillary esthetic zone. Diameter-reduced implants show long-term stability of a minimum of three years after loading and excellent results of prosthetic fixtures.

Conclusion. Prefabricated customized allogeneic blocks for augmentation may increase the fitting accuracy of the graft, decrease morbidity, and reduce the operation time in esthetic maxillary rehabilitation.

43. Volumetric Changes of a Customized Allogeneic Bone Block Measured by Two Image Matching Tools: Introduction of a Novel Assessment Technique for Graft Resorption.

Blume O, Donkiewicz P, Palkovics D, Götz W, Windisch P. *Acta Stomatol Croat.* 2021 Dec; 55(4): 406–417.

<https://pubmed.ncbi.nlm.nih.gov/35001936/>

Objective: The purpose of this case report was to present a method for the assessment of volumetric changes of bone blocks during healing and demonstrate its practicability by analysing the resorption of a pre-shaped allogeneic bone block used for the reconstruction of a complex maxillary defect.

Materials and methods: CBCT-scans of a 19-year-old male treated with an allogeneic bone block were recorded pre-OP, post-OP, and following six months of healing. Graft shrinkage was assessed via two image matching tools, namely coDiagnostiX® and Slicer. A biopsy specimen was harvested along the implant canal at the time of implantation.

Results: The osseous defect was successfully restored and advanced graft remodelling was found upon re-entry as confirmed by the histomorphometric and histologic analysis. The initial volumes of the graft determined via coDiagnostiX® and Slicer were 0.373 mL and 0.370 mL, respectively, while graft resorption after six months of healing was 0.011 mL (3.00%) and 0.016 mL (4.33%).

Conclusions: The avoidance of bone harvesting and reduction of invasiveness display an important issue in dentoalveolar restorations. However, before grafting materials can be considered a safe alternative, understanding their clinical performance, especially resorption stability, is pivotal. [The present case report demonstrates a limited resorption of the allogeneic bone block and further emphasizes the practicability of determining bone resorption by the here introduced method.](#) As our

investigation comprises solely one subject, the results should be considered with care and substantiated by further studies

44. A customized allogenic bone block for alveolar reconstruction quantitated by a 3D matching technique: A case report

Blume O, Back M, Martin K, Windisch P. Clin Case Rep. 2021 Sep 12;9(9):e04771. doi: 10.1002/ccr3.4771.

<https://pubmed.ncbi.nlm.nih.gov/34532047/>

After initial resorption, the bone volume showed long-term stability following loading of the implant. Furthermore, 3D matching was a suitable quantification method to analyze the volume development of bone augmentation.

45. Decompression technique — A modified approach for lateral alveolar ridge augmentation: A case report

Puisys A, Auzbikaviciute V, Vindasiute-Narbutė E, Zukauskas S, Deikuvienė J, Razukevicius D. Clin Case Rep. 2021 Jan 3;9(3):1253-1260.

<https://pubmed.ncbi.nlm.nih.gov/33768821/>

A particular technique can increase the mucosal and peri-implant bone thickness, prevent compression around implant neck, and obtain proper space for the following prosthetic treatment with an adequate emergence profile.

46. From a CAD/CAM-milled, allogenic bone block to an implant-supported fixed partial denture with angulated screw channel: a case report

Tuna T, Yilmaz B, Hermanns-Sachweh B, Raith S, Wolfart S. Quintessence Int. 2021;52(1):56-63.

<https://pubmed.ncbi.nlm.nih.gov/33118004/>

Augmentation of alveolar ridge defects is a technique-sensitive procedure in dental implantology. Depending on the size of the defect, it may be necessary to use autogenous bone blocks. However, patients may be against these blocks as these procedures are surgically invasive.

Case report: This report describes the restoration of a partially edentulous mandible, which suffered a major bone defect from the right canine to the third molar site after multiple implant losses. The use of a CAD/CAM allogenic cancellous bone block from a living donor bone was planned for the reconstruction of the alveolar ridge at the defected site. A CBCT scan was taken and the virtual planning of the bone augmentation and placement of four implants was performed. The milled bone block was fixed for augmentation and the implants were placed using a CBCT-generated surgical guide.

After osseointegration, a CAD/CAM-fabricated screw-retained metal-ceramic implant fixed partial denture with angulated screw channels was delivered.

Results: The use of CAD/CAM-milled, allogeneic bone block resulted in a time-efficient and simplified reconstruction of the defect because no donor site was used, and the fit of the block on the native bone was uneventful and fast. At the 1-year follow-up, an average peri-implant vertical soft tissue decrease of 1 mm on buccal and 0.3 mm on lingual sites was observed and the peri-implant tissues were healthy: **Conclusions:** The long-term success of this CAD/CAM cancellous bone block needs to be evaluated in well-designed clinical studies.

47. Ridge Augmentation Using Customized Allogeneic Bone Block: A 3-Year Follow-up of Two Case Reports

Landsberg C, Moses O. *Int J Periodontics Restorative Dent.* Nov/Dec 2020;40(6):881-889.

<https://pubmed.ncbi.nlm.nih.gov/33151194/>

A variety of surgical techniques and grafting materials for the purpose of ridge augmentation have been developed during the last three decades. Recently, the use of customized allogeneic bone blocks, prepared by CAD/CAM techniques, has been introduced. This new augmentation technology may significantly reduce surgical time and improve donor-recipient fit and adaptation. However, promising clinical and histologic results have been published in only a few short-term case reports. The 3-year follow-ups of these two case reports may provide more clinical data on the use of the customized bone blocks for horizontal and vertical ridge augmentation in the posterior mandible.

48. Customized allogeneic bone grafts for maxillary horizontal augmentation: A 5-year follow-up radiographic and histologic evaluation

Kloss FR, Offermanns V, Donkiewicz P, Kloss-Brandstätter A. *Clin Case Rep.* 2020 Mar 11;8(5):886-893.

<https://pubmed.ncbi.nlm.nih.gov/32477540/>

We report the histological evaluation of an individualized allogeneic bone block 5 years after alveolar ridge augmentation. The biopsy showed a well-vascularized lamellar bone with fatty incorporations without any avital allograft remnants. The presence of osteocytes, lining cells, macrophages, and blood vessels indicated a healthy and vital bone tissue.

49. Bilateral maxillary augmentation using CAD/CAM manufactured allogeneic bone blocks for restoration of congenitally missing teeth: A case report.

Blume O, Donkiewicz P, Back M, Born T. *J Esthet Restor Dent.* 2019 May;31(3):171-178. doi: 10.1111/jerd.12454. Epub 2019 Feb 12.

<https://pubmed.ncbi.nlm.nih.gov/30756449/>

OBJECTIVE: Various biomaterials have been successfully applied in alveolar bone regeneration, however, the reconstruction of extensive osseous defects remains challenging and is often unfeasible

with granular grafting materials. Several studies have outlined allogenic bone blocks as valid alternative to autologous block grafting.

CLINICAL CONSIDERATIONS: In this report, we demonstrate the regeneration of two large osseous defects in the maxilla with allogenic bone blocks made from human donor bone. The bone blocks were customized using the CAD/CAM technology in order to enable the insertion of four dental implants.

CONCLUSIONS: Both blocks perfectly matched the defect geometry, showed limited resorption, led to the formation of sufficient amounts of mineralized bone in both horizontal and vertical dimensions and enabled the installation of implants according to the treatment plan. The implementation of innovative technologies for individualization of allogenic bone blocks simplifies the restoration of complex and extensive osseous defects and poses great benefits for both practitioners and patients.

CLINICAL SIGNIFICANCE: The here presented procedure demonstrates the successful regeneration of two extensive osseous defects in a patient suffering from hypodontia using two CAD/CAM manufactured allogenic bone blocks, rendering the procedure far less invasive as compared to guided bone regeneration carried out with autologous transplants. Furthermore, to the best of our knowledge, this is the first case report that radiographically demonstrates the new formation of a cortical bone layer following block grafting with solely cancellous bone blocks.

51. Vertical bone augmentation in a single-tooth gap with an allogenic bone ring:

Clinical considerations

Giesenhagen B, Martin N, Donkiewicz P, Perić Kačarević Ž, Smeets R, Jung O, Schnettler R, Barbeck M. *J Esthet Restor Dent.* 2018 Nov;30(6):480-483. doi: 10.1111/jerd.12392. Epub 2018 Aug 2.

<https://pubmed.ncbi.nlm.nih.gov/30070751/>

OBJECTIVE: The main objective of this case report is to introduce a one-stage bone block augmentation with a cylindrical freeze-dried bone allograft (FDBA) and simultaneous implantation for the reconstruction of a single-tooth bone defect. **Clinical Considerations:** The report describes this method on the basis of radiographical and clinical images derived from a single patient. **CONCLUSIONS:** The report demonstrates the time-saving and successful application of this treatment concept, which has the potential to increase patient satisfaction and comfort. **CLINICAL SIGNIFICANCE:** The application of the presented technique enabled a prosthetic rehabilitation of the extracted tooth about 3 months earlier as compared to the conventional procedure, while demonstrating no compromises regarding clinical outcome, functionality and esthetics.

52. Treatment of Severely Resorbed Maxilla Due to Peri-Implantitis by Guided Bone Regeneration Using a Customized Allogenic Bone Block: A Case Report

Blume O, Hoffmann L, Donkiewicz P, Wenisch S, Back, M, Franke J, Schnettler R, Barbeck M. *Materials* 2017 Oct 21;10(10):1213. doi: 10.3390/ma10101213.

<https://pubmed.ncbi.nlm.nih.gov/29065477/>

The objective of this case report is to introduce a customized CAD/CAM freeze-dried bone allograft (FDBA) block for its use in Guided Bone Regeneration (GBR) procedures for severely deficient maxillary

bones. Additionally, a special newly developed remote incision technique is presented to avoid wound dehiscence. The results show optimal integration behavior of the FDBA block after six months and the formation of new vital bone. Thus, the results of the present case report confirm the use of the customized CAD/CAM bone block for augmentation of complex defects in the maxillary aesthetic zone as a successful treatment concept.

53. Bone augmentation and simultaneous soft tissue thickening with collagen tissue matrix derivate membrane in an aesthetic area. A case report
[Puišys A, Žukauskas S, Kubilius R, Vindašiūtė E, Linkevičius T. Stomatologija. 2017;19\(2\):64-68.](#)

<https://pubmed.ncbi.nlm.nih.gov/29243686/>

[This case report describes a technique for aesthetic single implant placement with simultaneous bone grafting and soft tissue thickening.](#) At the time of implant surgery, allogenic (maxgraft®, Botiss Biomaterials, Germany) and xenogenic bone substitute (cerabone®, Botiss Biomaterials, Germany) was used for bone grafting, soft tissues were augmented simultaneously with collagen tissue matrix derivate membrane (mucoderm®, Botiss Biomaterials, Germany). After 4 months during second stage surgery the implant was exposed. Subsequently healing abutment was replaced with provisional crown for gingival contouring. An individual zirconia abutment was made, and a cemented full-ceramic crown was placed for final restoration. The 12-month follow-up check-up revealed a pleasing aesthetic treatment outcome, as well as clinically healthy peri-implant soft tissues. Radiological examination showed a stable bone crest with minor bone remodelling around the implant platform. The use of a collagen tissue matrix derivate, simultaneously with GBR, in the aesthetic area can provide excellent results, by establishing and maintaining facial bone wall and thick soft tissue in aesthetic area.

54. Custom-milled individual allogeneic bone grafts for alveolar cleft osteoplasty—
 A technical note

[Otto S, Kleye C, Burian E, Ehrenfeld M, Cornelius CP. J Craniomaxillofac Surg. 2017 Dec;45\(12\):1955-1961. doi: 10.1016/j.jcms.2017.09.011. Epub 2017 Sep 20.](#)

<https://pubmed.ncbi.nlm.nih.gov/29066039/>

INTRODUCTION: Bone grafts from the iliac crest are most commonly used for osteoplasties of the cleft alveolus. To preclude undue donor site morbidity custom-milled allogeneic bone grafts might be an appropriate choice. **MATERIAL AND METHODS:** This technical note showcases the repair of an alveolar cleft using an individualized allogeneic bone graft in a 36-year old female patient. She was asking for an alternative to the iliac crest bone grafting. Her alveolus was successfully built up by a custom-milled cancellous bone block allograft (maxgraft® bonebuilder). **RESULTS:** Custom-milled cancellous bone block allografts can greatly facilitate alveolar cleft repair and may present an effective treatment option under the premise that resorption resistance corresponds to autografts. **CONCLUSION:** Further clinical studies are needed to explore the potential of bone block allografts for alveolar cleft osteoplasty.

55. Posterior atrophic mandible rehabilitation with onlay allograft created with CAD-CAM procedure: a case report

Jacotti M, Barausse C, Felice P. *Implant Dent.* 2014 Feb;23(1):22-8. doi: 10.1097/ID.0000000000000023.

<https://pubmed.ncbi.nlm.nih.gov/24378654/>

Implant rehabilitation of the atrophic right posterior mandible in a 48-year-old woman using dehydrated homologous bone block, shaped with a computer aided design-computer aided manufacturing (CAD-CAM) system, to avoid harvesting of autologous bone block and to assure a perfect fitting of the block above the alveolar crest.

RESULTS: After 7 months, 6.09, 7.36, and 8.08 mm (mean, 7.18 mm) of total horizontal bone gain was observed at sites 6, 12, and 18 mm posterior to the right mental foramen, respectively. **CONCLUSIONS:** The use of a bone block with CAD-CAM system for alveolar ridge augmentation is a valuable alternative to autograft because it reduces time, cost, and complications for the patients. Data from a computerized tomographic scan can be used to shape a precise 3-dimensional homologous bone block using a CAD-CAM system.