

## **Kieferregeneration in der dentoalveolären Chirurgie**

**Römer, Schröger, Sagheb, Kämmerer**

**ZMK 5/2023 (39) 210-218**

1. Tan, W.L., et al.: A systematic review of post-extractional alveolar hard and soft tissue dimensional changes in humans. *Clin Oral Implants Res*, 2012. 23 Suppl 5: p. 1-21.
2. Esposito, M., et al., Interventions for replacing missing teeth: horizontal and vertical bone augmentation techniques for dental implant treatment. *Cochrane Database Syst Rev*, 2009. 2009(4): p. Cd003607.
3. Maticescu, A., et al., Advanced Biomaterials and Techniques for Oral Tissue Engineering and Regeneration-A Review. *Materials (Basel)*, 2020. 13(22).
4. Yang, Z., et al., Advances in Barrier Membranes for Guided Bone Regeneration Techniques. *Front Bioeng Biotechnol*, 2022. 10: p. 921576.
5. Bellini, C.M., et al., Comparison of tilted versus nontilted implant-supported prosthetic designs for the restoration of the edentulous mandible: a biomechanical study. *Int J Oral Maxillofac Implants*, 2009. 24(3): p. 511-7.
6. Durkan, R., P. Oyar, and G. Deste, Maxillary and mandibular all-on-four implant de: A review. *Niger J Clin Pract*, 2019. 22(8): p. 1033-1040.
7. Chiapasco, M., P. Casentini, and M. Zaniboni, Bone augmentation procedures in implant dentistry. *International Journal of Oral & Maxillofacial Implants*, 2009. 24.
8. Chavda, S. and L. Levin, Human Studies of Vertical and Horizontal Alveolar Ridge Augmentation Comparing Different Types of Bone Graft Materials: A Systematic Review. *J Oral Implantol*, 2018. 44(1): p. 74-84.
9. Garg, A.K., Knochen - Biologie, Gewinnung, Transplantation in der zahnärztlichen Implantologie. Vol. 1. 2005, Quintessenz Bibliothek: QUINTESSENZ Verlag. 288.
10. Terheyden, H., Knochenersatzmaterialien- Tissue engineering in der Zahnarztpraxis. Dentale Implantologie und Parodontologie, 2007. 2: p. 90-100.
11. Kyyak, S., et al., Combination of an allogenic and a xenogenic bone substitute material with injectable platelet-rich fibrin - A comparative in vitro study. *J Biomater Appl*, 2020. 35(1): p. 83-96.
12. Marin, E., F. Boschetto, and G. Pezzotti, Biomaterials and biocompatibility: An historical overview. *J Biomed Mater Res A*, 2020. 108(8): p. 1617-1633.
13. Troeltzsch, M., et al., Clinical efficacy of grafting materials in alveolar ridge augmentation: A systematic review. *J Craniomaxillofac Surg*, 2016. 44(10): p. 1618-1629.
14. Dau, M., et al., In vivo comparison of a granular and putty form of a sintered and a non-sintered silica-enhanced hydroxyapatite bone substitute material. *J Biomater Appl*, 2020. 34(6): p. 864-874.
15. Brand-Saberi, B., Essential Current Concepts in Stem Cell Biology. 2020: Springer.
16. Baranova, J., et al., Tooth Formation: Are the Hardest Tissues of Human Body Hard to Regenerate? *Int J Mol Sci*, 2020. 21(11).
17. Kämmerer, P.W., et al., Continuous Electrical Stimulation Affects Initial Growth and Proliferation of Adipose-Derived Stem Cells. *Biomedicines*, 2020. 8(11).

18. Alshihri, A., et al., The effects of shock wave stimulation of mesenchymal stem cells on proliferation, migration, and differentiation in an injectable gelatin matrix for osteogenic regeneration. *J Tissue Eng Regen Med*, 2020. 14(11): p. 1630-1640.
19. Blatt, S., et al., Biofunctionalization of Xenogeneic Collagen Membranes with Autologous Platelet Concentrate-Influence on Rehydration Protocol and Angiogenesis. *Biomedicines*, 2022. 10(3).
20. Dohan, D.M., et al., Platelet-rich fibrin (PRF): a second-generation platelet concentrate. Part I: technological concepts and evolution. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 2006. 101(3): p. e37-44.
21. Miron, R.J., et al., A novel method for evaluating and quantifying cell types in platelet rich fibrin and an introduction to horizontal centrifugation. *J Biomed Mater Res A*, 2019. 107(10): p. 2257-2271.
22. Blatt, S., et al., Biofunctionalization of porcine-derived collagen matrices with platelet rich fibrin: influence on angiogenesis in vitro and in vivo. *Clin Oral Investig*, 2020.
23. Blatt, S., et al., Does Platelet-Rich Fibrin Enhance the Early Angiogenetic Potential of Different Bone Substitute Materials? An In Vitro and In Vivo Analysis. *Biomedicines*, 2021. 9(1).
24. Blatt, S., et al., Possible Implications for Improved Osteogenesis? The Combination of Platelet-Rich Fibrin With Different Bone Substitute Materials. *Front Bioeng Biotechnol*, 2021. 9: p. 640053.
25. Tabassum, S., et al., Effect of platelet rich fibrin on stability of dental implants: A systematic review and meta-analysis. *Int J Health Sci (Qassim)*, 2022. 16(5): p. 58-68.
26. Khurshid, Z., et al., The Impact of Autologous Platelet Concentrates on the Periapical Tissues and Root Development of Replanted Teeth: A Systematic Review. *Materials (Basel)*, 2022. 15(8).
27. Otero, A.I.P., et al., Sinus Lift Associated with Leucocyte-Platelet-Rich Fibrin (Second Generation) for Bone Gain: A Systematic Review. *J Clin Med*, 2022. 11(7).
28. Alrayyes, Y. and R. Al-Jasser, Regenerative Potential of Platelet Rich Fibrin (PRF) in Socket Preservation in Comparison with Conventional Treatment Modalities: A Systematic Review and Meta-Analysis. *Tissue Eng Regen Med*, 2022. 19(3): p. 463-475.
29. Meza-Mauricio, J., et al., Is the use of platelet-rich fibrin effective in the healing, control of pain, and postoperative bleeding in the palatal area after free gingival graft harvesting? A systematic review of randomized clinical studies. *Clin Oral Investig*, 2021. 25(7): p. 4239-4249.
30. Karring, T., et al., Development of the biological concept of guided tissue regeneration--animal and human studies. *Periodontol 2000*, 1993. 1: p. 26-35.
31. Urban, I.A. and A. Monje, Guided Bone Regeneration in Alveolar Bone Reconstruction. *Oral Maxillofac Surg Clin North Am*, 2019. 31(2): p. 331-338.
32. MacBeth, N.D., N. Donos, and N. Mardas, Alveolar ridge preservation with guided bone regeneration or socket seal technique. A randomised, single-blind controlled clinical trial. *Clin Oral Implants Res*, 2022. 33(7): p. 681-699.
33. Deng, Y., Y. Liang, and X. Liu, Biomaterials for Periodontal Regeneration. *Dent Clin North Am*, 2022. 66(4): p. 659-672.
34. Dahlin, C., et al., Bone tissue modelling and remodelling following guided bone regeneration in combination with biphasic calcium phosphate materials presenting different microporosity. *Clinical Oral Implants Research*, 2015. 26(7): p. 814-822.

35. Elgali, I., et al., Guided bone regeneration: materials and biological mechanisms revisited. *Eur J Oral Sci*, 2017. 125(5): p. 315-337.
36. Nowwarote, N., et al., Characterization of a bioactive Jagged1-coated polycaprolactone-based membrane for guided tissue regeneration. *Arch Oral Biol*, 2018. 88: p. 24-33.
37. Schenk, R.K., et al., Healing pattern of bone regeneration in membrane-protected defects: a histologic study in the canine mandible. *Int J Oral Maxillofac Implants*, 1994. 9(1): p. 13-29.
38. Javed, A., H. Chen, and F.Y. Ghori, Genetic and transcriptional control of bone formation. *Oral Maxillofac Surg Clin North Am*, 2010. 22(3): p. 283-93, v.
39. Buser, D., 20 years of guided bone regeneration in implant dentistry. 2nd ed. ed. Twenty years of guided bone regeneration in implant dentistry. 2009, Chicago: Quintessence Pub. Co.
40. Wang, H.L. and L. Boyapati, "PASS" principles for predictable bone regeneration. *Implant Dent*, 2006. 15(1): p. 8-17.
41. Hämerle, C.H. and R.E. Jung, Bone augmentation by means of barrier membranes. *Periodontol 2000*, 2003. 33: p. 36-53.
42. Kammerer, P.W., et al., The allogeneic shell technique for alveolar ridge augmentation: a multicenter case series and experiences of more than 300 cases. *Int J Implant Dent*, 2022. 8(1): p. 48.
43. Liu, J. and D.G. Kerns, Mechanisms of guided bone regeneration: a review. *Open Dent J*, 2014. 8: p. 56-65.
44. Bunyaratavej, P. and H.-L. Wang, Collagen Membranes: A Review. *Journal of Periodontology*, 2001. 72(2): p. 215-229.
45. Pabst, A. and P. Kämmerer, Kollagenmembranen - Möglichkeiten und Perspektiven in der Hart- und Weichgeweberegeneration.
46. Sanz, M., et al., Biomaterials and regenerative technologies used in bone regeneration in the craniomaxillofacial region: Consensus report of group 2 of the 15th European Workshop on Periodontology on Bone Regeneration. *Journal of Clinical Periodontology*, 2019. 46(S21): p. 82-91.
47. Jiménez Garcia, J., et al., Effect of cross-linked vs non-cross-linked collagen membranes on bone: A systematic review. *J Periodontal Res*, 2017. 52(6): p. 955-964.
48. Cucchi, A., et al., Evaluation of complication rates and vertical bone gain after guided bone regeneration with non-resorbable membranes versus titanium meshes and resorbable membranes. A randomized clinical trial. *Clin Implant Dent Relat Res*, 2017. 19(5): p. 821-832.
49. Rothamel, D., et al., Biocompatibility of various collagen membranes in cultures of human PDL fibroblasts and human osteoblast-like cells. *Clin Oral Implants Res*, 2004. 15(4): p. 443-9.
50. Pitaru, S., C.A. McCulloch, and S.A. Narayanan, Cellular origins and differentiation control mechanisms during periodontal development and wound healing. *J Periodontal Res*, 1994. 29(2): p. 81-94.
51. Buser, D., et al., Lateral ridge augmentation using autografts and barrier membranes: a clinical study with 40 partially edentulous patients. *J Oral Maxillofac Surg*, 1996. 54(4): p. 420-32; discussion 432-3.
52. El-Askary, A.S. and D.J. Pipco, Autogenous and allogenous bone grafting techniques to maximize esthetics: a clinical report. *J Prosthet Dent*, 2000. 83(2): p. 153-7.
53. Simion, M., et al., Vertical ridge augmentation around dental implants using a membrane technique and autogenous bone or allografts in humans. *Int J Periodontics Restorative Dent*, 1998. 18(1): p. 8-23.

54. Atieh, M.A., et al., Interventions for replacing missing teeth: alveolar ridge preservation techniques for dental implant site development. *Cochrane Database Syst Rev*, 2015. 2015(5): p. CD010176.
55. Kalsi, A.S., J.S. Kalsi, and S. Bassi, Alveolar ridge preservation: why, when and how. *Br Dent J*, 2019. 227(4): p. 264-274.
56. Hammerle, C.H., et al., Evidence-based knowledge on the biology and treatment of extraction sockets. *Clin Oral Implants Res*, 2012. 23 Suppl 5: p. 80-2.
57. Baroofchi, S., et al., Alveolar ridge preservation: Complications and cost-effectiveness. *Periodontology 2000*. n/a(n/a).
58. Avila-Ortiz, G., et al., Efficacy of Alveolar Ridge Preservation: A Randomized Controlled Trial. *J Dent Res*, 2020. 99(4): p. 402-409.
59. Chappuis, V., M.G. Araújo, and D. Buser, Clinical relevance of dimensional bone and soft tissue alterations post-extraction in esthetic sites. *Periodontology 2000*, 2017. 73(1): p. 73-83.
60. Peer W. Kämmerer, K.M.L., *Socket-Seal-Technik. Ein Literaturüberblick zum Einsatz im Rahmen der Erhaltung von Hart- und Weichgewebskontur nach Zahnektaktion. Ausgabe 3/2022 - ZZI - Zeitschrift für Zahnärztliche Implantologie*, 2022.
61. Landsberg, C.J. and N. Bichacho, A modified surgical/prosthetic approach for optimal single implant supported crown. Part I--The socket seal surgery. *Pract Periodontics Aesthet Dent*, 1994. 6(2): p. 11-7; quiz 19.
62. Stimmelmayr, M., et al., Use of a combination epithelialized-subepithelial connective tissue graft for closure and soft tissue augmentation of an extraction site following ridge preservation or implant placement: description of a technique. *Int J Periodontics Restorative Dent*, 2010. 30(4): p. 375-81.
63. Mirza, T. and A. Majumdar, Re: Stimmelmayr M, Guth J-F, Igihaut G, Beuer F. Preservation of the ridge and sealing of the socket with a combination epithelialised and subepithelial connective tissue graft for management of defects in the buccal bone before insertion of implants: a case series. *Br J Oral Maxillofac Surg*, 2013. 51(4): p. 368.
64. Stein, J.M. and C. Hammacher, Postextraction Socket Seal Surgery with an Epithelialized Connective Tissue Graft Using a Subpapillary Tunneling Procedure. *Int J Periodontics Restorative Dent*, 2015. 35(6): p. 877-84.
65. Thoma, D.S., et al., Impact of a collagen matrix on early healing, aesthetics and patient morbidity in oral mucosal wounds - a randomized study in humans. *J Clin Periodontol*, 2012. 39(2): p. 157-65.
66. Martins, J.R., et al., Comparison of the efficacy of different techniques to seal the alveolus during alveolar ridge preservation: Meta-regression and network meta-analysis. *J Clin Periodontol*, 2022. 49(7): p. 694-705.
67. Fickl, S., et al., Scar Tissue Formation Following Alveolar Ridge Preservation: A Case Control Study. *Int J Periodontics Restorative Dent*, 2018. 38(1): p. e1-e7.
68. Darby, I., S. Chen, and R. De Poi, Ridge preservation: what is it and when should it be considered. *Aust Dent J*, 2008. 53(1): p. 11-21.
69. Sufaru, I.G., et al., 3D Printed and Bioprinted Membranes and Scaffolds for the Periodontal Tissue Regeneration: A Narrative Review. *Membranes (Basel)*, 2022. 12(9).

70. Adel-Khattab, D., et al., Development of a synthetic tissue engineered three-dimensional printed bioceramic-based bone graft with homogenously distributed osteoblasts and mineralizing bone matrix in vitro. *J Tissue Eng Regen Med*, 2018. 12(1): p. 44-58.
71. Obregon, F., et al., Three-Dimensional Bioprinting for Regenerative Dentistry and Craniofacial Tissue Engineering. *J Dent Res*, 2015. 94(9 Suppl): p. 143S-52S.
72. Bauer, T.W. and G.F. Muschler, Bone Graft Materials: An Overview of the Basic Science. *Clinical Orthopaedics and Related Research®*, 2000. 371: p. 10-27.
73. Sittitavornwong, S. and R. Gutta, Bone graft harvesting from regional sites. *Oral Maxillofac Surg Clin North Am*, 2010. 22(3): p. 317-30, v-vi.
74. Zeltner, M., et al., Volumetric analysis of chin and mandibular retromolar region as donor sites for cortico-cancellous bone blocks. *Clin Oral Implants Res*, 2016. 27(8): p. 999-1004.
75. Safi, Y., et al., Bone quality and quantity of the mandibular symphyseal region in autogenous bone grafting using cone-beam computed tomography: a cross-sectional study. *Head Face Med*, 2021. 17(1): p. 26.
76. Hameed, M.H., et al., Vertical Ridge Gain with Various Bone Augmentation Techniques: A Systematic Review and Meta-Analysis. *J Prosthodont*, 2019. 28(4): p. 421-427.
77. Al-Nawas, B. and E. Schiegnitz, Augmentation procedures using bone substitute materials or autogenous bone - a systematic review and meta-analysis. *Eur J Oral Implantol*, 2014. 7 Suppl 2: p. S219-34.
78. Hellem, S., et al., Implant treatment in combination with lateral augmentation of the alveolar process: a 3-year prospective study. *Clin Implant Dent Relat Res*, 2003. 5(4): p. 233-40.
79. Kim, Y.K. and J.K. Ku, Ridge augmentation in implant dentistry. *J Korean Assoc Oral Maxillofac Surg*, 2020. 46(3): p. 211-217.
80. Elnayef, B., et al., Vertical Ridge Augmentation in the Atrophic Mandible: A Systematic Review and Meta-Analysis. *Int J Oral Maxillofac Implants*, 2017. 32(2): p. 291-312.
81. Xie, Y., et al., Titanium mesh for bone augmentation in oral implantology: current application and progress. *Int J Oral Sci*, 2020. 12(1): p. 37.
82. Miron, R.J., et al., Use of platelet-rich fibrin in regenerative dentistry: a systematic review. *Clin Oral Investig*, 2017. 21(6): p. 1913-1927.
83. Isik, G., et al., Guided bone regeneration simultaneous with implant placement using bovine-derived xenograft with and without liquid platelet-rich fibrin: a randomized controlled clinical trial. *Clin Oral Investig*, 2021. 25(9): p. 5563-5575.
84. Amaral Valladao, C.A., Jr., M. Freitas Monteiro, and J.C. Joly, Guided bone regeneration in staged vertical and horizontal bone augmentation using platelet-rich fibrin associated with bone grafts: a retrospective clinical study. *Int J Implant Dent*, 2020. 6(1): p. 72.
85. Clark, D., et al., Advanced platelet-rich fibrin and freeze-dried bone allograft for ridge preservation: A randomized controlled clinical trial. *J Periodontol*, 2018. 89(4): p. 379-387.
86. Urban, I.A., et al., Effectiveness of vertical ridge augmentation interventions: A systematic review and meta-analysis. *J Clin Periodontol*, 2019. 46 Suppl 21: p. 319-339.
87. Zouhary, K.J., Bone Graft Harvesting From Distant Sites: Concepts and Techniques. *Oral and Maxillofacial Surgery Clinics of North America*, 2010. 22(3): p. 301-316.
88. Wortmann, D.E., et al., Harvesting anterior iliac crest or calvarial bone grafts to augment severely resorbed edentulous jaws: a systematic review and meta-analysis of patient-reported outcomes. *Int J Oral Maxillofac Surg*, 2022.

89. Putters, T., et al., Calvarial bone grafts to augment the atrophied maxilla: experience, morbidity and histology. *International Journal of Oral and Maxillofacial Surgery*, 2013. 42(10): p. 1345.
90. Depeyre, A., et al., Retrospective evaluation of 211 patients with maxillofacial reconstruction using parietal bone graft for implants insertion. *Journal of Cranio-Maxillofacial Surgery*, 2016. 44(9): p. 1162-1169.
91. Mertens, C., et al., Reconstruction of the severely atrophic edentulous maxillae with calvarial bone grafts. *Clin Oral Implants Res*, 2017. 28(6): p. 749-756.
92. Mertens, C., et al., Reconstruction of severely atrophied alveolar ridges with calvarial onlay bone grafts and dental implants. *Clin Implant Dent Relat Res*, 2013. 15(5): p. 673-83.
93. Reinert, S., et al., [Follow-up studies of 3-dimensional osteoplastic reconstruction of the extremely atrophied maxilla combined with implants]. *Mund Kiefer Gesichtschir*, 1999. 3 Suppl 1: p. S30-4.
94. Avishai, G., et al., [Bone augmentation of the extremely atrophic anterior mandible, using allogeneic block grafts, via submental approach]. *Refuat Hapeh Vehashinayim (1993)*, 2016. 33(3): p. 49-60, 74.
95. Steller, D., et al., Retrospective analysis of time-related three-dimensional iliac bone graft resorption following sinus lift and vertical augmentation in the maxilla. *International Journal of Oral and Maxillofacial Surgery*, 2022. 51(4): p. 545-551.
96. Kessler, P., et al., Harvesting of bone from the iliac crest--comparison of the anterior and posterior sites. *Br J Oral Maxillofac Surg*, 2005. 43(1): p. 51-6.
97. Nkenke, E., et al., Morbidity of harvesting of bone grafts from the iliac crest for preprosthetic augmentation procedures: a prospective study. *Int J Oral Maxillofac Surg*, 2004. 33(2): p. 157-63.
98. McKenna, G.J., et al., Effect of Autogenous Bone Graft Site on Dental Implant Survival and Donor Site Complications: A Systematic Review and Meta-Analysis. *J Evid Based Dent Pract*, 2022. 22(3): p. 101731.