

Guided Bone Regeneration - A Review

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ABSTRACT

This paper is a review on Guided Bone Regeneration. Guided Bone Regeneration has emerged as a predictable method to enhance the bone volume in deficient recipient sites prior to implant placement. It provides sufficient bone volume and adequate soft tissue thickness to enable implants to be placed at the most optimal position from a prosthetic point of view. The barrier membrane acts as a physical barrier, excluding competing and non-osteogenic cells from the overlying mucosa into the membrane-protected space.

Key words: Regeneration, placement, implants, non-osteogenic.

INTRODUCTION

During the past decade, the use of osseointegrated implants has become an increasingly important treatment modality for the replacement of missing teeth in fully and partially edentulous patients¹. A sufficient volume of healthy jawbone should be present at potential implant recipient sites to expect a predictable long-term prognosis for such implants.

The most frequent causes of alveolar ridge defects are traumatic extraction of teeth and periodontal disease, which, if left untreated, may cause progressive destruction of the alveolar bone. The other causes include developmental defects, and surgical trauma².

Reconstructive periodontal procedures permit the restoration of the hard and soft tissues of the alveolar ridge to their former dimensions¹ and are aimed to provide sufficient bone volume and

adequate soft tissue thickness to enable implants to be placed at the most optimal position from a prosthetic point of view.

Ridge augmentation procedures may be classified broadly into procedures that augment soft tissue, hard tissue or a combination of both. Vascularized flaps and non-vascularized soft tissue grafts, specifically the sub-epithelial connective tissue graft and the free gingival graft have been used to increase the soft tissue thickness. Several surgical materials and methods to create adequate bone volume have also been developed, such as autogenous block grafts, guided bone regeneration, distraction osteogenesis, interpositional bone grafts and combinations of these procedures.

Guided bone regeneration (GBR)

Guided Bone Regeneration has emerged as a predictable method to enhance the bone volume in deficient recipient sites prior to implant placement³. The barrier membrane acts as a

physical barrier, excluding competing and non-osteogenic cells from the overlying mucosa into the membrane-protected space.

Historical perspective

The principle of using barrier membranes was first evaluated in the late 1950s and early 1960s by the research teams of Bassett *et al.*,⁴ and Boyne *et al.*,⁵ for the healing of cortical defects in long bones and osseous facial reconstruction.

The clinical potential of membrane techniques for bone regeneration was recognized by Nyman and co-workers⁶. It was demonstrated that membranes act as a physical barrier when applied over bone defects, preventing the ingrowth of competing, non-osteogenic cells into the membrane-protected space.

Lazzara *et al.*,⁷ is credited with the first reported use of GBR techniques with implants in immediate extraction sites. Human case reports have shown a benefit from the use of ePTFE membranes in the immediate placement of endosseous implants in extraction sites.

Dahlin *et al.*,⁸ placed implants in less than desirable ridge areas and used GBR techniques to gain bone on the exposed threads. Becker *et al.*,⁹ have demonstrated the successful use of ePTFE with implants placed into extraction sockets in case reports and multicenter studies.

Surgical factors to achieve predictable results with GBR procedures

Buser *et al.* published technique articles for localized ridge augmentation using guided bone regeneration¹⁰. Hermann & Buser¹¹ discussed five factors

1. Achievement of primary soft tissue closure and healing
2. Use of an appropriate barrier membrane
3. Stabilization and close adaptation of the membrane to the surrounding bone
4. Creation and maintenance of a secluded space
5. Sufficiently long healing period for nine months

The first was the achievement of primary

soft tissue closure and healing to avoid membrane exposure. Buser describes making periosteal releasing incisions to obtain primary flap closure when suturing without tension at the flap margins.

The second was selection of the appropriate membrane. Prerequisites for an ideal barrier membrane include biocompatibility, cell occlusivity, tissue integration, space-making effect, and clinical manageability. The e-PTFE membrane, nonabsorbable, appears to fulfill these needs. However, it has been recognized that the use of the nonabsorbable membrane has been limited by the necessity of second surgery for membrane removal and its high membrane exposure rate¹², potentially resulting in patient discomfort, increased cost, post surgical infection, and possibly suboptimal bone regeneration. Thereby, absorbable collagen membranes are preferred because of high biocompatibility with oral tissues, haemostatic properties, chemotactic effects on fibroblasts¹³, ensuring adequate wound closure and lack of need for retrieval. Currently tested and used absorbable membranes are made of collagen or of polyglycolic acid, polylactic acid, or copolymers.

Collagen membranes are mechanically malleable, adaptable, and easy to manipulate, which may be beneficial in clinical application. Other advantageous properties of collagen include hemostatic function, facilitating early wound stabilization, semipermeability, allowing nutrient passage, natural enzymatic degradation, and chemotactic ability to attract fibroblasts¹⁴. The safety and efficacy of collagen membranes have been proven in the field of GTR as well as in GBR¹⁵.

The third was stabilization and close adaptation of the membrane to the surrounding bone. It is important to prevent in-growth of soft tissues under the membrane, which would interfere with regeneration. Micromovements of the flap in the initial phase of repair are enough to modify the differentiation of mesenchymal cells from osteoblasts to fibroblasts¹⁶. Miniscrews or surgical bone tacks have been used successfully to stabilize membranes.

Finally Buser *et al.*¹⁰ said that creation and maintenance of a secluded space was needed.

One of the main downfalls of placing a membrane around an area without some sort of rigid support system is that it may fail to maintain its desired shape due to the forces put upon it. This results in less than desired bone growth. Titanium frameworks or meshworks bone replacement grafts have been used underneath the membranes to create a space.

Extensive studies have been done for augmentation using the GBR technique with different grafting materials including autogenous bone⁹, nonresorbable hydroxyapatite (HA) (17)²⁰, synthetic bone polymer¹⁸,⁴, freeze-dried bone allograft (FDBA) and/or demineralized freeze-dried bone allograft (DFDBA)¹⁷.

Surgical procedure

Preparation of the recipient bed

Patients should be anesthetized with 2% lidocaine with epinephrine 1:80,000.

Incisions

Horizontal incisions should be made slightly lingual to the midcrestal region with care taken to preserve keratinized tissue on both sides of the incision. The interdental papilla should not be included in the incision. Vertical incisions to be made on the buccal surface from the mesial and distal extents of the horizontal incision extending to the mucogingival junction. A full thickness mucoperiosteal flap to be reflected on the buccal side and a pouch created on the lingual side to insert the barrier membrane.

Decortications

Intramarrow cortical perforations should be made at the recipient site with a ½ or 2 round bur at slow speed with copious saline irrigation.

This is done to open the marrow cavity as source of angiogenic and osteogenic cells. It activates bone formation by the release of local and other bone-inducing factors.

Placement of the bone graft

A layer of bone graft should be mixed with patient's blood or saline and placed in the prepared recipient bed covering the decortication sites as well.

Placement of the membrane

The bone graft should be covered with the GBR membrane that should extend at least 3 mm beyond the graft border in all directions. The flap to be coronally repositioned for complete wound coverage without tension. Primary closure should be obtained using a resorbable monofilament (Vicril, Ethicon, 5.0) suture. Periodontal dressing should be done with Coe-Pack.

Patients should be given amoxicillin 500 mg, 1 tab tid, for 1 week; ibuprofen, 1 tab tid, for 1 week; as needed for pain, and Chlorhexidine 0.12% bid rinse for 3 weeks.

CONCLUSION

Guided Bone Regeneration has been successfully applied for increasing the width and height of the alveolar ridge before implant placement¹⁹ and in the treatment of peri-implant bone defects in experimental animals⁸ and in clinical cases⁷. Recently, it has been further applied in preservation of extraction sockets²⁰ in the treatment of fenestration or dehiscence defects of implants at sites compromised by insufficient bone²¹.

REFERENCES

1. Seibert. Treatment of moderate localized alveolar ridge defects. Preventive and reconstructive concepts in therapy. *Dent Clin North Am.* **37**(2): 265-80 (1993).
2. Allen EA, Gainza CS, Farthing GG, et. al. DA. Improved technique for localized ridge augmentation. *J Periodontol* **56**: 195-199 (1985).
3. Buser D, Dula K & Belser U. Localized ridge augmentation using guided bone regeneration. 13. In: Buser D, Dahlin C, Schenk RK. Guided Bone Regeneration in Implant Dentistry. Chicago Quintessence (1994).
4. Bassett CAL, Creighton DK & Stinchfield FE. Contributions of endosteum, cortex and soft tissues to osteogenesis. *Surg Gynecol Obstet* **112**: 145 (1961).

5. Boyne PJ, Mikels TE. Restoration of alveolar ridges by intramandibular transposition osseous grafting. *J Oral Surg.* **26**(9): 569-76 (1968).
6. Nyman S, Lang NP, Buser D, Bragger U. Bone regeneration adjacent to titanium dental implants using guided tissue regeneration: A report of two cases. *Int J Oral Maxillofac Implants* **5**: 9-14 (1990).
7. Lazzara RJ. Immediate implant placement into extraction sites: Surgical and restorative advantages. *Int J Periodontics Restorative Dent* **9**: 333-343 (1989).
8. Dahlin C, Sennerby L, Lekholm U, Linde A, Nyman S. Generation of new bone around titanium implants using a membrane technique: an experimental study in rabbits. *Int J Oral Maxillofac Implants.* **4**(1): 19-25 (1989).
9. Becker, W., Dahlin, C., Becker, B., Lekholm, U., van Steenberghe, D., Higuchi, K. & Kultje, C. The use of e-PTFE membranes for bone promotion around titanium implants placed into extraction sockets: a prospective multicenter study. *Int J Oral Maxillofac Implants* **9**: 31-40 (1994).
10. Buser D, Dula K & Belser U. Localized ridge augmentation using guided bone regeneration. I. Surgical procedure in the maxilla. *Int J Periodont Prost Dent* **13**: 29-45 (1993).
11. Hermann, J.S. & Buser, D. Guided bone regeneration for dental implants. *Current Opinion in Periodontology***3**: 168-177 (1996).
12. Gotfredsen, K., Nimb, L., Buser, D. & Hjørtting-Hansen, E. Evaluation of guided bone regeneration around implants placed into fresh extraction sockets: An experimental study in dogs. *Journal of Oral and Maxillofacial Surgery* **51**: 879-884 (1993).
13. Postlethwaite, A.E., Seyer, J.M. & Kang, A.H. Chemotactic attraction of human fibroblast to type I, II, and III collagens and collagen derived peptides. *Proceedings of the National Academy of Sciences of the United States of America* **75**: 870-875 (1978).
14. Benecke JE Jr. Tympanic membrane grafting with alloderm. *Laryngoscope.* **111**(9): 1525-7 (2001).
15. Sevor, J., Meffert, R. & Cassingham, R. Regeneration of dehisced alveolar bone adjacent to endosseous dental implants utilizing a resorbable collagen membrane: Clinical and histologic results. *International Journal of Periodontics and Restorative Dentistry* **13**: 71-83 (1993).
16. Iglhaut J, Aukhil I, Simpson DM, Johnston MC, Koch G. Progenitor cell kinetics during guided tissue regeneration in experimental periodontal wounds. *J Periodont Res* **23**: 107-117 (1988).
17. Block MS, Kent JN. Placement of endosseous implants into tooth extraction sites. *J Oral Maxillofac Surg* **49**: 1269-1276 (1991).
18. Ashman A. An immediate tooth root replacement: An implant cylinder and synthetic bone combination. *J Oral Implantol* **16**: 28-38 (1990).
19. Feuille F, Knapp Cl, Brunsvold MA, Mellonig JT. Clinical and histologic evaluation of bone-replacement grafts in the treatment of localized alveolar ridge defects. Part 1: Mineralized freeze-dried bone allograft. *Int J Periodontics Restorative Dent.* **23**(1): 29-35 (2003).
20. Lekovic, Camargo. Preservation of Alveolar Bone in Extraction Sockets Using Bioabsorbable Membranes. *J Periodontol* 1044-1049 (1998).
21. Jovanovic SA, Spiekermann H, Richter EJ. Bone regeneration around titanium dental implants in dehisced defect sites: A clinical study. *Int J Oral Maxillofac Implants,* **7**: 233-45 (1992).