



# Current trends in hard tissue augmentation in implant dentistry

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**T**he surgical placement of dental implants is often compromised due to a lack of bone. Loss of alveolar bone through infection, trauma or atrophy post tooth extraction can limit implant placement or compromise aesthetics. Fortunately, the use of bone grafts and Guided Bone Regeneration (GBR) can improve our ability to place implants and also improve hard and therefore soft tissue aesthetic around implants. Over the years, a number of bone grafting techniques have been developed that are now well-established as integral parts of implant dentistry. There have also been a number of new innovations in recent years both in relation to surgical techniques and materials used for bone regeneration that assist in the placement of dental implants. This article will provide an overview of GBR techniques and materials in implant dentistry.

## Guided Bone Regeneration

This technique for bone regeneration typically involves the use of some form of bone particulate and a barrier membrane to create and maintain a suitable 'space' into which new bone formation can occur. The basic premise behind GBR is the compartmentalization of the bone and soft tissue by using a barrier membrane to prevent the overlying soft tissues (the connective tissue and epithelium of the overlying flap) from growing or collapsing into the bony defect and thus preventing bone regeneration.<sup>1</sup>

## Barrier membranes used in GBR

Traditionally, Teflon membranes popularized by W.L. Gore & Associates (Gore-Tex) have been the mainstay of this technique. However, its main failing was the need to surgically remove the membrane from the site after an appropriate period of healing (typically 5-6 months). This ultimately led to the development of resorbable barrier membranes which, over the past 20-30 years, have all but superseded non-resorbable membranes in GBR. Today, resorbable membranes are widely used for GBR and have the advantage of not having to be removed from the site post-placement. The type of resorbable membrane used varies but most are composed of cross-linked type II bovine collagen. Examples of such membrane include BioMend® (Zimmer Dental), Bio-Gide® (Geistlich) and OsseoGuard® (Biomet 3i). These materials are all very similar in terms of how they behave biologically, but vary in terms of their clinical handling. Typically, these membranes are draped over the bony defect, which has been grafted with a particulate bone graft. Bone grafting with particulate beneath the membrane helps to provide space maintenance for new bone formation (Figures 1 and 2).

When the size of the underlying bony defect gets larger and has a complex morphology (vertical and horizontal bone loss), the membrane used needs to have some inherent space maintaining ability. In such cases, a non-resorbable Teflon

membrane reinforced with thin titanium struts in the membrane (GTAM, W.L. Gore & associates; Cytoplast™ Ti-250) may be used.<sup>2</sup> However, these materials have the disadvantage of having to be surgically removed at a later date. A recent innovation from Zimmer Dental, Zimmer CurV<sup>†</sup> may offer the means to overcome the need to remove the membrane and may provide an alternative to titanium mesh. It consists of a preformed resorbable membrane (type I collagen) that is rigid and is formed to fit the ridge with the intention that it will perform similarly to the Ti-reinforced membranes that can be bent into shape over a ridge. There are two pre-formed shapes available; anterior and posterior (Figure 3). Like the Ti mesh or Ti-reinforced ePTFE membranes, CurV™ needs to be tacked or screwed into place.

## Particulate bone graft

The use of particulate bone is an essential part of GBR therapy. Traditionally, autogenous bone has been used alone or in combination with another allograft underneath barrier membranes to act as a biological 'scaffold' to assist with the migration of osteogenic cells and the subsequent formation of the bone trough and ridge defect. Today, combining some autogenous bone with allograft would be the most common method used. Autogenous bone may be harvested from around the surgical site by collecting bone chips during osteotomy preparation with inline suction bone traps (e.g. Astra Tech BoneTrap™; Osseous

Coagulum Trap, Salvin®). Alternatively, the use of bone scrapers such as the Safescraper® (Meta®) or Mx-Grafter® (Maxilon Lab, Inc) can also be used to collect cortical shavings from the surgical site or a separate donor site elsewhere in the mouth if a greater volume of autogenous bone is required.

The type of allograft used in GBR varies a great deal and is influenced in part by the clinicians' preference and availability. In the published literature, there is a diverse range of materials that have been recommended. While many of these materials may appear similar in physical appearance, it is important for clinicians to remember that the biological compatibility and osseoconductive properties of these materials can differ considerably. It is therefore incumbent on any clinician using such materials to ensure that there is a sound evidence base (preclinical and clinical) to the use of a particular graft material. Currently, some of the more widely used Allograft materials include bovine derived products (BioOss®, Geistlich; CopiOs†, Zimmer Dental) and donor derived allograft (Puros†, Zimmer Dental; Freeze Dried Bone Allograft - FDBA†, Pacific Coast Tissue Bank). In selecting a particulate material for GBR, smaller particle size (250-1000µm) is recommended. Materials that have a longer resorptive profile are also preferred (e.g. BioOss) when using a combination of autogenous bone grafts. Some clinicians prefer to 'layer' the materials with the autogenous graft being placed first on the surface of the implant and surrounding bone and then being covered with the allograft. Others prefer to combine the two graft materials in a sterile grafting dish before placing the aggregate at the site. There is not conclusive evidence to support one graft placement technique over the other at this time. In addition to these materials, purely synthetic alternatives such as IngeniOs™ hydroxyapatite (Zimmer Dental), Straumann bone ceramic (Straumann) and calcium sulfate (BondBone™, MIS) have also been used as bone graft materials in GBR although the osteogenic activity of this type of graft material is generally limited.

### Block onlay grafting

In cases where the underlying bone defect is large; where implant placement may not be possible due to the lack of residual host bone; and where there are both vertical and horizontal bone loss, onlay block grafting can provide another alternative to GBR using membranes and particulate graft. Block onlay grafting has traditionally involved harvesting autogenous block grafts from either the chin area or the lateral aspect of the ramus using a second surgical site. This carries the disadvantage of having to involve a second surgical site and added surgical morbidity. Recently, an alternative has been suggested in the form of a pre-formed Allograft block.<sup>3</sup>

These Allogenic block grafts (Puros Block Graft†, Zimmer Dental; BioOss block, Geistlich) are modified and shaped and fixed into position using bone screws, just as you would a traditional autogenous block graft (Figures 4-6). Preparation of the recipient site should involve cortical perforations and any space between the edge of the block graft and the surrounding bone should be filled with particulate graft. Some clinicians will also cover the graft site with a resorbable membrane to help contain the particulate graft and reduce or slow the rate of resorption of the block graft, however, the literature is inconclusive as to the need for this at present.<sup>4,5</sup>



Figure 1. Particulate bone graft placed to fill a large dehiscence defect around and implant in the 11 for GBR technique.

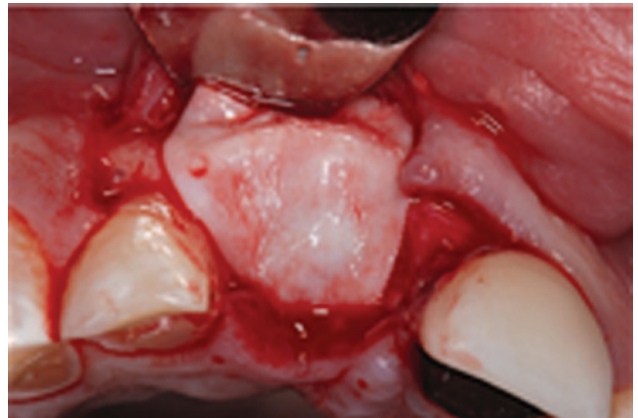


Figure 2. Resorbable collagen GBR membrane is draped over the grafted area before primary soft tissue closure over the top of the surgical site.



Figure 3. The CurV (Zimmer Dental) preformed resorbable collagen membrane (anterior).

### Growth Factors

In recent years, there have been a small number of reports in the literature on the use of both bone morphogenic protein (e.g. rhBMP-2) and platelet derived growth factor<sup>6-8</sup> in conjunction with particulate bone graft and titanium mesh barriers. While these growth factors and their osseoinductive properties hold

promise, the high cost and technique sensitive nature of these materials mean that they are not widely used at this time. Early clinical reports suggest that these growth factors support good regeneration of viable bone, thus facilitating implant placement.

### Summary

The use of bone augmentation is integral to surgical placement of dental implants. While a number of different methods and materials are currently used in clinical practice, GBR with the use of particulate bone graft and resorbable membranes remains the most widely used technique at present. It has a sound evidence base and provides clinical predictability. Bone augmentation assists us in providing adequate bone volume to support dental implant placement and ultimately provide our implant patients with better function and aesthetics in the longer term.

### Availability of products

Certain products mentioned by the author in this article and denoted with the † symbol are only available in New Zealand and are NOT listed on the Australian Register of Therapeutic Goods maintained by the TGA. Use of these products on patients in Australia is illegal. Please contact the manufacturers to determine if these products will be available for use in Australia in the future.

### References

1. Mellonig JT, Nevins M. Guided bone regeneration of bone defects associated with implants: and evidence-based outcome assessments. *Int J Periodontics Restorative Dent* 15:168-85, 1995.
2. Urban IA, Jovanovic SA, Lozada JL. Vertical ridge augmentation using guided bone regeneration in three clinical scenarios prior to implant placement: a retrospective study of 35 patients 12 to 72 months after loading. *IJOMI* 24:502-10, 2009.
3. Lyford R, et al. Clinical evaluation of freeze-dried block allografts for alveolar ridge augmentation: a case series. *Int J Periodontics Restorative Dent*. 23:417-25, 2003.
4. Gielkens P. et al. The influence of barrier membranes on autologous bone grafts. *J Dent Res*. 87:1048-52, 2008.
5. Widmark G, Andersson B, Ivanoff CJ. Mandibular bone graft in the anterior maxilla for single-tooth implants. Presentation of surgical method. *Int J Oral Maxillofac Surg*. 26(2):106-9, 1997.
6. Thoma DS, Jones A, Yamashita M, et al. Ridge augmentation using recombinant bone morphogenetic protein-2 techniques: an experimental study in the canine. *J Periodontol*. 81(12):1829-38, 2010.
7. Misch C, Wang H-L. Clinical applications of recombinant bone morphogenetic Protein-2 for bone augmentation before dental implant placement. *J Perio*. 1;118-31, 2011.
8. Simion M, et al. Three-dimensional ridge augmentation with Xenograft and recombinant human platelet-derived growth factor-BB in humans; report of two cases. *Int J Periodontics Restorative Dent* 27:109-15, 2007.

### About the author

*Dr Michael Danesh-Meyer is a specialist periodontist in private practice in Auckland, New Zealand. He was a Clinical Assistant Professor in Periodontology and Associate Scientist in the Laboratory for Applied Periodontal and Craniofacial Regeneration at Temple University, School of Dentistry in Philadelphia, USA. He has been involved in pre-clinical and clinical research involving Guided Tissue Regeneration/Guided Bone Regeneration and dental implants since 1991, has authored numerous scientific articles and lectures both nationally and internationally on topics related to implant dentistry and tissue regeneration therapy. He established the Institute of Dental Implants & Periodontics and Auckland Clinical Training Centre in 2000 and is Director of Dental Education Continuum and DentalMentor.org.*



Figure 4. This case illustrates the use of 2 block allografts (Puros Block) in the anterior maxilla.

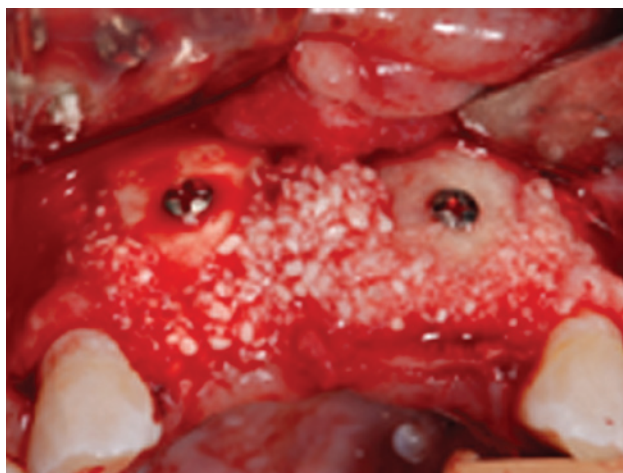


Figure 5. Particulate bone graft is used to 'blend' the edges of the block graft to the surrounding bone.

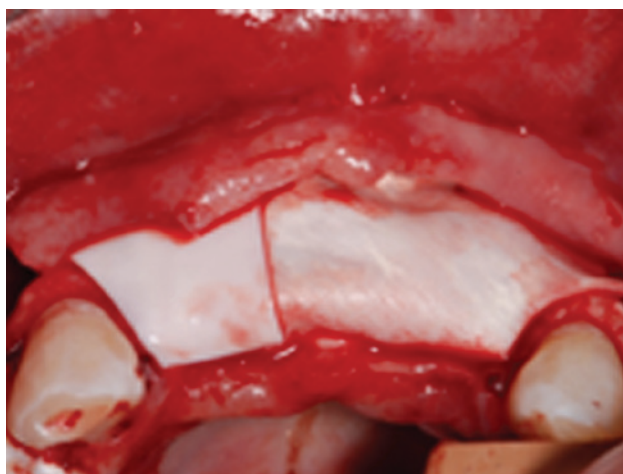


Figure 6. Resorbable Collagen barrier membranes are placed over the graft sites and the overlying soft tissues is then closed over the top and secured with sutures.