

# Protocols for horizontal and vertical bone defects



**Dr. Sascha A. Jovanovic | USA**

Associate Professor, Loma Linda University  
Chairman, gIDE Institute, Los Angeles  
Past-President, European Association for Osseointegration (EAO)  
Private practice in Implant Therapy and Periodontics, Los Angeles

**Dental implant therapy has shown tremendous long-term bone and soft tissue stability when enough bone volume is available at the time of implant insertion. On the other hand, insufficient bone volume around dental implants can be a significant risk factor and negatively affect the long-term prognosis.<sup>1</sup>**

Several techniques for augmenting bone defects have been developed. They include protocols both for bone augmentation before implant placement (two-stage approach) and simultaneously with implant placement (one-stage approach), along with adjunctive materials such as bone blocks, particulate bone substitutes, autologous bone chips, form-stable devices, collagen and dense polytetrafluoroethylene membranes (d-PTFE) membranes, fixation screws and pins and bone harvesting devices.

## **Guided Bone Regeneration: Backed by science**

Among the techniques for horizontal and vertical bone augmentation, GBR is one of the most investigated and evidence-based approaches. It produces predictable re-

sults and high, long-term implant survival rates.<sup>1,2</sup> Studies show that the survival rates of implants placed into augmented bone do not differ from the survival rate of implants placed into pristine bone.<sup>3</sup> The technique is based on sound biological principles with a step-by-step clinical protocol. The surgical complication rate ranges from low to high, categorizing the procedure at times as technique sensitive. The rate of complication largely depends on proper patient selection and diagnosis, detail-oriented surgical steps, careful patient follow-up and optimal choice of biomaterials.

For smaller bone defects a simultaneous GBR approach delivers the same results as a staged GBR approach. With large horizontal ridge atrophy and vertical defects, a staged protocol seems to be more predictable and produce better results.<sup>4</sup>

GBR can be conducted with a 1:1 mixture of autologous particulate bone and anorganic bovine bone substitute (Geistlich Bio-Oss®) in combination with a native collagen membrane (Geistlich Bio-Gide®)

or, for larger horizontal or vertical defects, in combination with a form-stable, titanium-reinforced d-PTFE membrane.

The following sections describe the three main protocols used in our clinical practice and our training programs.

## **GBR Protocol 1: Implant dehiscence and fenestration defects**

In 1992 we published our first study on the GBR protocol around dehiscenced implant surfaces in 12 patients,<sup>5</sup> and one of the patients who was treated for amelogenesis imperfecta is still in follow-up after 29 years with stable crestal bone and successful implants.

In 2018 we published modifications and the results of 45 consecutive cases (63 implants) treated with our layered bone graft and GBR protocol, and followed the patients for 30 months after loading. No patient dropped out of this study, stable bone and soft tissue was noted and no implant or prosthesis failed (see details in **Box 1: GBR Protocol 1: Treatment steps**).<sup>6</sup>

---

**“Periodontal problems have to be solved before the treatment starts and compliance with recall intervals has to be guaranteed with minimal to no plaque deposits.”**

---



## GBR Protocol 1: Treatment steps

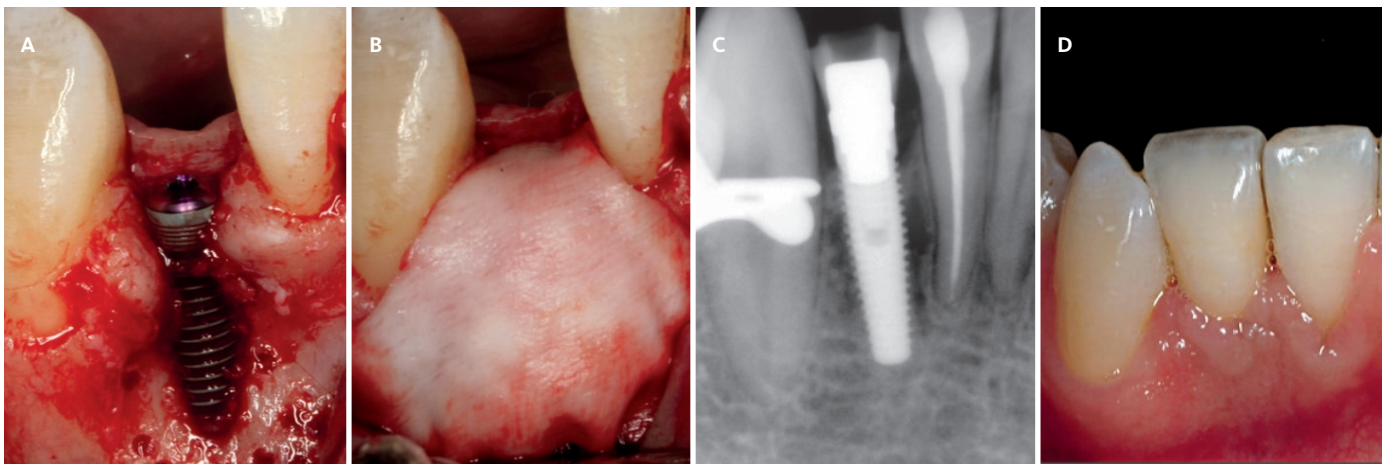
- > Periodontal and soft tissue preparation
- > Mid-crestal incision into the keratinized tissue
- > Elevation of full-thickness flap beyond mucogingival junction and at least 5 mm beyond the bone defect
- > Two vertical incisions at least one tooth away from the defect
- > Recipient site cleared of soft tissue remnants
- > Autologous bone harvested with a minimally invasive cortical bone collector
- > Decortication holes (1 mm bur) at recipient site
- > Implants inserted and guided by a surgical template
- > Exposed threads covered with 2 mm of autologous bone, covered by 2 mm of Geistlich Bio-Oss® and covered by a Geistlich Bio-Gide®
- > Membrane stabilized with sutures or fixed with titanium pins both on the vestibular and on the lingual/palatal site
- > Periosteal releasing incisions for tension free flap advancement
- > Combination of horizontal mattress PTFE suture and single interrupted sutures
- > Temporization of surgical site with no tissue contact
- > Uncovering six-months after implant placement and GBR ,with mucogingival procedure to increase soft tissue thickness and keratinization
- > Preferably simultaneous abutment and CAD/CAM fabricated, screw-retained implant crowns delivered

The key point is to apply this GBR protocol to smaller bone defects, and an accurate CBCT diagnosis is critical for selecting a bone volume between 4 to 6 mm in width. The combination of autologous bone in contact with the implant and anorganic bovine bone on top is the key to success (**Fig. 1**). While the autologous bone has osteoinductive and osteogenic properties, the anorganic bovine bone maintains the volume and contour in the long-term. Collagen membranes are advantageous compared to expanded polytetrafluoroethylene (e-PTFE) membranes in this indication because of the favorable soft tissue healing and because they do not have to be removed. Their lack of form stability can be overcome by the bone mixture and accurate fixation of the membrane that allows immobilization of the graft material.

## GBR Protocol 2: Larger horizontal defects

In 1995 we published the use of space-making titanium-reinforced e-PTFE membranes for large horizontal defects and this was later modified to resorbable

**FIG. 1:** Clinical case pictures of a patient treated in 2007 with a simultaneous resorbable GBR treatment protocol 1 in a thin healed ridge of 4 mm width showing stable crestal bone and soft tissue margin after 12 years of function.<sup>7</sup>



| **A** Esthetic implant placement resulted in labial bone dehiscence. | **B** Simultaneous resorbable GBR procedure with 2-layer bone graft. | **C** Radiograph of implant and abutment after 12 years. | **D** Facial view of restoration on mandibular right lateral incisor following rehydration. Esthetic team work with Dr. Pascal and Michel Magne (Los Angeles, CA).

Photos: Sascha Jovanovic



### GBR Protocol 3: Treatment steps

- > Full thickness mid-crestal incision into the keratinized gingiva
- > Vertical incision at least one tooth away from the surgical site (5 mm away in case of an edentulous area)
- > Reflection of a full thickness flap beyond the mucogingival junction and at least 5 mm beyond the bone defect with a periosteal elevator
- > Recipient site cleared of soft tissue remnants
- > Multiple decortication holes into recipient bed with a 1 mm drill
- > Harvesting of autologous bone and placement of 1:1 mixture of autologous bone and anorganic bovine bone particles, and placement of the graft in the defect area
- > Covering the immobilized graft with a titanium-reinforced PTFE membrane and fixing it with bone tacks or screws
- > Maxillary vertical cases can be combined with a sinus floor elevation to achieve additional apical bone height
- > If the edges of the membrane are not well adapted, a bilayer collagen membrane (Geistlich Bio-Gide®) is put over the non-resorbable membrane to close any open space in the grafted area
- > Periosteal releasing incision
- > Suturing of the flap in two layers (tension-free): horizontal mattress sutures 4 mm from the incision line, single interrupted sutures to close the edges of the flap and leave at least a 4 mm thick connective tissue layer between the membrane and the oral epithelium (to prevent exposure of the membrane)
- > Closure of vertical incisions with single interrupted sutures
- > Implant placement 9 to 12 months later

membranes in one-wall large horizontal defects.<sup>8</sup> For these larger horizontal defects, a staged GBR procedure is safer and more predictable than a simultaneous GBR and implant approach. The bone graft (now a larger volume mixture of autologous bone and anorganic bovine bone) can be covered with a native collagen membrane (Geistlich Bio-Gide®) or with a titanium-reinforced d-PTFE membrane depending on the severity of the bone deficiency. In general, one-wall large buccal defects with a CBCT bone width of 3 to 4 mm can be grafted and covered with a collagen membrane fixed with pins both lingually/palatally and buccally. In cases with severe two-wall horizontal resorption and with a CBCT bone width of less than 3 mm the autograft/bone substitute mixture is cov-

ered with a non-resorbable d-PTFE membrane fixed with screws on the periphery.

Healing periods of six to eight months are used in this GBR protocol, and over 5 mm of new horizontal bone is created, as evidenced in multiple clinical studies.<sup>9,10</sup> This creates enough bone width for predictable implant placement. Soft tissue management before, during and after the GBR technique is essential to ensure healthy, thick soft tissue for tension-free flap closure and to create enough keratinized tissue for implant success.

#### GBR Protocol 3: Vertical bone defects

Vertical ridge augmentation is the most challenging of the GBR protocols, as it

aims to regenerate large amounts of vertical and horizontal bone with little or no bone walls to use as a base for the bone formation. For the blood supply to reach the full distance from native bone into the outer part of the grafted area and for complete mineralization to take effect, a longer healing period of 9 to 12 months is needed. In addition, to protect the bone graft from soft tissue invasion during the healing period, a space making device with long-term cell exclusion and a thick and advanced soft tissue flap is needed to provide a closed healing environment for the GBR-grafted area (**Fig. 2**).

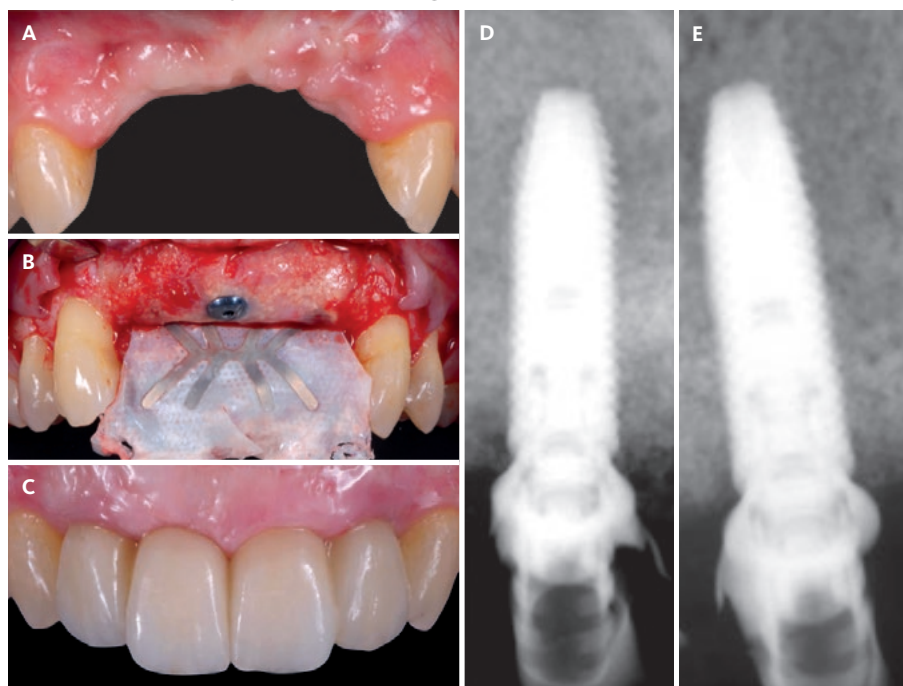
When treating vertical bone defects, a titanium-reinforced e-PTFE membrane was designed, and we tested the first prototype designs in 1993 and published for the first time in 1995 in our animal and human studies.<sup>8-11</sup> The large amount of clinically documented cases has shown that a maximum vertical gain of 12 mm is possible with a mean of more than 5 mm and a horizontal gain of 8 to 10 mm, which is sufficient in most cases to place an implant in the optimal esthetic position. (see details in **Box 2**: GBR Protocol 3: Treatment steps).<sup>12,13</sup>

#### Key to success

Placing an implant into vertically augmented bone is rather challenging, because the bone is still early in its mineralization nine months after augmentation. Therefore, implant placement in this indication should be done by an experienced surgeon, and implant selection has to be performed carefully.

As in all GBR procedures, it is mandatory to select the right kind of patient for this challenging procedure. Periodontal problems have to be resolved before the treatment starts, and compliance with recall intervals has to be guaranteed with

**FIG. 2:** Clinical case pictures of a patient treated with a non-resorbable d-PTFE staged GBR protocol 3 treatment for a severely vertical resorbed ridge in the anterior maxilla.



| **A** Buccal view of a vertical defect in the anterior maxilla. | **B** Vertical augmented ridge result after 9 months at d-PTFE removal time and implant placement. | **C** Final esthetic work with stable gingival margins performed by Dr. Mintrone (Sassuolo, Italy). | **D** Radiograph of the regenerated bone, tooth 12. | **E** Radiograph of the regenerated bone, tooth 22.

minimal to no plaque deposits. Regarding bone graft biomaterial, we always stick with the proven combination of autologous bone plus xenogeneic bone substitute – for the combination of osteoinductive properties and long-lasting volume stability – plus collagen or PTFE membranes depending on the defect (horizontal/vertical/combined). The need for and benefit of adding platelet-rich plasma (PRP) or platelet-rich fibrin (PRF) is still to be fully seen but has possible early wound healing benefits that could help with flap closure. (see details in **Box 3**: GBR Key to success).

#### References

- 1 Lutz R, et al.: Clin Oral Implants Res 2015; 26 Suppl 11:103-22.
- 2 Sanz-Sanchez I, et al.: J Dent Res 2015; 94:1285-142S.
- 3 Donos N, et al.: J Clin Periodontol 2008; 35:173-202.
- 4 Meloni SM, et al.: Clin Implant Dent Rel Res 2017; 19:38-45.
- 5 Jovanovic SA, et al.: Int J Oral Maxillofac Implants 1992; 7(2):233-45.
- 6 Meloni SM, et al.: Eur J Oral Implantol 2018; 11(1): 89-95.
- 7 Magne P, et al.: J Prosthet Dent 2008; 99(1):2-7.
- 8 Jovanovic SA, Nevins M: Int J Periodontics Restorative Dent 1995; 15(1):56-69.
- 9 Urban IA, et al.: Int J Periodontics Restorative Dent 2013; 33(3):299-307.
- 10 Urban IA, et al.: Int J Oral Maxillofac Implants 2011; 26(2):404-14.
- 11 Jovanovic SA, et al.: Int J Oral Maxillofac Implants 1995; 10(1):23-31.
- 12 Urban IA, et al.: Int J Oral Maxillofac Implants 2014; 29:185-93.
- 13 Simion M, et al.: Clin Oral Implants Res 2001; 12(1):35-45.

#### GBR Key to Success: glIDE Institute Protocol

- 1 Establish periodontal health in natural dentition
- 2 Prepare soft tissues in the GBR/implant site before, during and/or after treatment to increase mucogingival thickness and keratinization
- 3 Full-thickness flap elevation (remote or papilla preservation)
- 4 Clean and perforate bone surface
- 5 Release periosteum to advance flap and achieve tension-free closure
- 6 Trim membrane - native collagen (horizontal GBR) or d-PTFE (horizontal/vertical GBR)
- 7 Harvest autologous bone with scraper and place in saline/ blood
- 8 Prepare anorganic bovine bone substitute with saline/ blood
- 9 Mix bone graft in a 1:1 ratio of autograft and anorganic bovine bone substitute
- 10 Apply and fix membrane with suture/tacks/screws
- 11 Place bone graft mixture
- 12 Adapt and fix membrane to cover the complete bone graft
- 13 Advance flap and close using PTFE suture with horizontal mattress and single interrupted suture
- 14 Temporize site with no tissue contact
- 15 Allow healing period of 6+ months for horizontal GBR cases and 9+ months for vertical GBR cases

Photos: Sascha Jovanovic