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Guided Bone Regeneration [Article type- Technique]

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Abstract

Guided bone regeneration (GBR) is predictable procedure to correct horizontal and vertical alveolar bone defect. The main principle of GBR is using membrane to cover osseous wound space from the ingrowth of the undesirably soft tissue. Combination of autogenous bone and bone substituting material is important part of this technique. GBR can be done together with dental implant insertion if dental implant can be inserted in correct position with primary stability.

GBR has considered one of the most predictable techniques to reconstruct simple to complex alveolar bone defect.

Keywords: Guided bone regeneration, bone defect, bone grafting

Quick Reference/ Description

Treatment of alveolar bone deficiencies is essential for dental implant placement. Various surgical procedures are available for the treatment of osseous deficiencies that eventually result in a functionally and esthetically favorable outcome of dental implant therapy. Guided bone regeneration is a surgical approach that facilitates the success of subsequent implant placement.

Indications

To correct horizontal and vertical bone deficiency:

- The main principle of GBR is using a membrane to cover the osseous wound space from the proliferation of undesirable soft tissue.
- This will exclude cells from the soft tissue and allow osteogenic cells to inhabit the osseous wound without any interference.

Materials/ Instruments

- Autogenous bone graft
- Bone scraper
- Alloplastic bone material
- Xenograft
- Allograft
- Synthetic resorbable membrane
- Bovine, porcine or equine resorbable membranes
- Polytetrafluoroethylene (PTFE) non-resorbable membrane
- Expanded PTFE (ePTFE) non-resorbable membrane
- Titanium reinforced ePTFE non-resorbable membrane
- Titanium non-resorbable membrane
- Monofilament suture material
- PTFE suture material

Procedure

Dental implant placement is difficult without the correction of underlying alveolar bone deficiencies. The osseous deficiencies require surgical management for a successful outcome of planned dental implant placement. Guided bone regeneration is a prevalent surgical procedures for the treatment of bone defects.

Guided Bone Regeneration

Guided bone regeneration (GBR) is a minimally invasive procedure to direct bone growth in regions of osseous deficiency. GBR is based on the concept of utilization of a barrier membrane to protect the bone space from soft tissue invasion. This membrane inhibits the interference of soft tissue progenitor cells and allows cells with osteogenic potential to populate the bony wound. It also stabilizes the bone graft and prevents graft resorption. The use of GBR for the management of horizontal osseous deficiencies is prevalent. Treatment of vertical bone defects with GBR is possible only with the use of a more stable membrane.

The basic requirements of barrier membranes are biocompatibility, space making, stability, cell occlusivity and ease of use with a license (CE certification in Europe). Barrier membranes can be resorbable or non-resorbable (Table I).

Table I Features of Resorbable and Non-resorbable Membranes

Features	Resorbable Membranes	Non-resorbable Membranes
Important properties	- Bone graft and human body biocompatibility - Adequate barrier functions (at least 3 months) to protect bone graft from cellular proliferation - Prolonged sufficient degradation time - No interference in healing process	- Ease of use - Easy removal - Bone graft and human body biocompatibility
Advantages	- No requirement of membrane removal - Easy surgical handling - Enhanced vascularization - Effective in inhibiting epithelial migration - Can be used for horizontal augmentation	- Improved stability - High ductility and strength - Longer barrier function - Can be used in complex horizontal and vertical bone augmentation
Disadvantages	- Collapse of membrane - Shorter duration of barrier function - Cannot be used for complex vertical bone augmentation	- Second surgical procedure required for removal of membrane that means larger wound at second stage surgery - Higher risk of membrane exposure
Examples	- Synthetic - Allogene - Bovine, porcine, equine	- PTFE - Expanded PTFE (ePTFE) - Titanium reinforced ePTFE - Titanium mesh

In GBR, the 'gold standard' graft material is autogenous bone as it has osteogenic, osteoinductive and osteoconductive properties. The mechanical property of autogenous bone when harvested in a block form and the higher regenerative potential of particulate bone graft are important factors in bone regeneration. Harvesting autogenous bone with a bone scraper is usually adequate for GBR. Allografts, xenografts and alloplastic bone materials are commonly used in GBR. One of the aforementioned materials can be combined with autogenous bone. The combination of autogenous bone and osteoconductive materials in a 1:1 ratio is recommended in GBR. According to the authors, using 70% autogenous bone improves the quality of regenerated bone.

Table II Classification of Bone Graft Material

Type of material	**Origin/ source of material**
Autograft	Donor and recipient are the same individual No risk graft rejection
Allograft -Fresh frozen bone allograft -Freeze dried bone allograft -Demineralized freeze dried allograft -Deproteinized bone allograft	Donor and recipient are genetically distinc, but belong to same species Risk of graft rejection
Xenograft -Bone material from animal -From Calcifying corals -From calcifying algae	Donor and recipient have nonidentical genetic composition and belong to different species Risk of graft rejection
Allograft -Carbonat apatite -Calcium Phosphate -Bioactive glasses	Biological materials synthesized in a laboratorium Minimal risk of rejection

Autograft is the only graft material which has osteogenic, osteoconductive and osteoinductive properties. In addition, autograft also has mechanical properties (e.g. from cortical bone) Autograft material are well received by the body without the risk of rejection or spread of infection. It also promotes faster revascularization of the grafted area. Primarily composed of bone matrix and osteocytes, these material are known to release growth factors (including BMPs, PDGF, TGF Beta, VEGF) during healing process

GBR can be performed as a single-step procedure or a two-step procedure. The single-step procedure includes performing bone regeneration and dental implant placement simultaneously (Fig.1). It can be done only if correct 3D position and primary stability of the implant along with tension-free soft tissue closure can be achieved. In the two-step procedure, bone regeneration is performed initially (Fig.2). An implant is placed in the healing bone after 4-9 months of healing. The GBR procedure is commonly performed as follows:

- Local anesthesia is administered.
- A crestal incision is performed across the length of the osseous defect followed by simple straight vertical releasing incisions one or two teeth away from the defect. A single vertical releasing incision on the distal aspect of the defect is adequate to allow tension-free soft tissue closure in simple cases of GBR. For the management of large osseous defects, two vertical releasing incisions should be made two teeth away from the defect on each side. Easy tension-free flap closure is allowed by two vertical releasing incisions.
- To enable easy tension-free flap closure, a vertical incision that is one tooth away from the defect can also be made on the palatal or lingual aspect.
- Dental implants can be placed with sufficient primary stability if the thickness of bone is at least 5mm. This can result in dehiscence on the buccal aspect (Fig.1a). The development of dehiscence on the buccal aspect should be

permitted as GBR is difficult to perform from the palatal aspect. The osseous defect space is filled with only autogenous bone or a combination of autogenous bone and bone substituting material (Fig.1b).

- The dehiscence generated after implant insertion is covered with autogenous bone that is scraped from the adjacent region using a bone scraper. A combination of autogenous bone and bone substituting material can also be used to cover the dehiscence.
- Autogenous bone is covered with a bone substituting material, which is further covered by a barrier membrane.
- In case of usage of more stable forms of membranes like ePTFE or titanium membranes for vertical bone augmentation, membrane fixation with mini master titanium pin or fixation suture is required (Fig.1c). Fixation of resorbable membranes is also required in large horizontal augmentations and in complex cases to provide a stable environment for the bone graft.
- The manufacturer's instructions should be read carefully before application of the barrier membrane.
- To achieve tension-free flap closure, a gentle periosteal releasing incision can be made in the buccal flap. Similarly, a lingual flap can be elevated accompanied by a periosteal releasing incision on the lingual aspect to reduce flap tension. To protect the important structures on the lingual aspect, dissection of the lingual flap should be done meticulously.
- Closure of the surgical site can be achieved by using 3-0 or 4-0 monofilament suture material or PTFE suture material.
- After the surgical procedure, the patient is advised to maintain good oral hygiene.
- Oral antibiotics are prescribed for 1 week postoperatively.

- In 2 steps horizontal GBR procedure, implant placement can be done 4 months after initial surgery

- In 2 steps vertical GBR procedure, implant placement can be done 8-9 months after initial surgery

- Additional soft tissue surgery to increased amount of keratinized gingiva can be done at the time of second stage surgery or before second stage surgery.

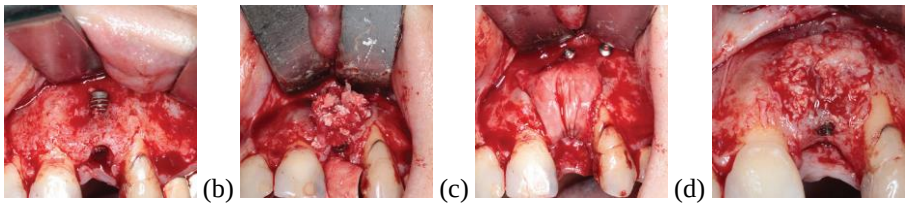

Fig.1 *Single-step GBR procedure. (a) Dental implant was inserted with primary stability in the anterior maxilla. (b) GBR performed using autogenous bone and anorganic bovine bone material (ABBM). (c) Collagen membrane was fixated using small titanium pins. (d) Second-stage surgery performed at 4 months after GBR procedure. Note vital and adequate bone in the regenerated area.*

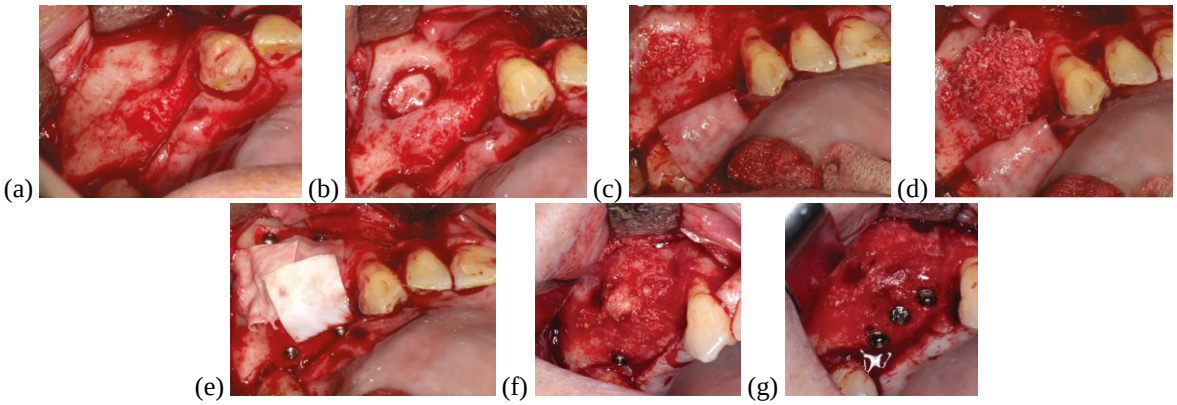

Fig.2 *Two-step GBR procedure. (a) Horizontal and vertical bone defect in the maxillary regions 14–16. (b) Vertical bone deficiency treated with external sinus augmentation. (c) Horizontal bone deficiency treated with two-step GBR procedure. (d) Graft material including autogenous bone and ABBM was placed on the buccal aspect to correct horizontal bone deficiency. (e) Resorbable membrane was used to cover the bone graft. This membrane was fixed with small titanium pins. A second resorbable collagen membrane was used to cover the site not covered by the first membrane. (f, g) Dental implant was inserted 6 months after bone grafting. Note regenerated vital bone in the area.*

Advantages of GBR Technique

- Minimally invasive technique, require less amount of autograft
- Easy to adapt bone graft in irregular bone contours
- Ease of application
- Predictable result

Pitfalls & Complications

- Infection is the most common complication of GBR. Various bacteria including Staphylococcus aureus, Bacteroides forsythus, Porphyromonas gingivalis, Fusobacterium and Propionibacterium acnes can lead to infection, membrane exposure and subsequently, failure of GBR. There is literature to suggest use of antibiotics immediately after GBR is done.
- Membrane exposure and GBR failure can also occur due to:
    - Inadequate surgical procedure
    - Failure to achieve tension-free closure
    - Irritation from prosthesis (especially removable prosthesis)
    - Host factors like uncontrolled diabetes mellitus, immune system-related disease and smoking
- GBR is an expensive procedure with a longer healing time.
- Sometimes it is needed to perform additional small GBR at the time of second stage surgery to reduce bone resorption

Further Reading

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