CASE SERIES

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BILAYER TECHNIQUE FOR ALVEOLAR RIDGE AUGMENTATION IN PRE-PROSTHETIC IMPLANT SURGERY: INDICATIONS AND PROBLEMS

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Abstract. Background: *Prosthetic rehabilitation of missing teeth with dental implant-supported restorations has recently become a predictable treatment option in contemporary dentistry with a highly successful rate. Due to different factors, vertical and horizontal bone loss could present, and the available alveolar bone may not be sufficient for optimum implant position. Ridge augmentation procedures could be applied to increase the volume of the deficient sites for accurate prosthetic implant placement, which assures functional and esthetic stability of tissues around the implants, essential for long-term success.* ***Our*** *study aims to evaluate the efficiency of the bilayer technique of guided bone regeneration for alveolar ridge augmentation procedure in cases of bone deficiency for optimum implant placement and long-term success.* ***Materials and methods:*** *We present several cases of alveolar bone deficiency treated with the bilayer technique – the combination of allo- and xenograft, covered by collagen membrane, with long-term follow-up. The defects were filled with allograft, and a layer of xenograft and barrier membrane was placed above it. This technique combines the benefits of all xenografts and barrier membranes.* ***Results:*** *The bilayer technique with allo- and xenograft and collagen membranes is predictable, with a high success rate and lower morbidity. We have a 100% survival rate of the implants placed in a grafted area with long-term follow-up with excellent aesthetic and functional results.* ***Conclusions:*** *The bilayer technique uses the benefits of two bone graft materials, is associated with less morbidity for the patients, and has excellent long-term results if performed accurately according to indications and technique.*

Key words: *guided bone regeneration, bone substitute materials, dental implants, bilayer technique*

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INTRODUCTION

Alveolar ridge atrophy after tooth loss is very common and may compromise the optimal placement of implants. Afunctional atrophy, trauma, oncologic diseases, odontogenic infections, and congenitally missing teeth may cause bone deficiency. A wide range of oral surgical procedures, such as guided bone regeneration (GBR) (through the use of bone graft materials and resorbable and non-resorbable membranes), tent screw (umbrella technique), auto-block grafting, natural bone regeneration (NBR- using PRP and PRF +/- bone graft) and distraction osteogenesis, can be applied for reconstruction of alveolar ridge deficiencies [1-4].

Guided bone regeneration prevents the migration of epithelial and gingival connective tissue cells, provides space, and stabilizes the coagulum in the defect in the postoperative period. The GBR procedure allows entry into the desired site/s of cells capable of new bone formation.

Important for the success of GBR are membrane stability, primary wound healing, absence of infection, and good postoperative care. Tension-free primary closure is a critical factor in preventing wound dehiscence, and a barrier membrane should be fixed without mobility to ensure good and sufficient bone regeneration [3, 4].

This bilayer bone graft procedure combines the benefits of xenografts and allografts. Xenograft gives mechanical support for prolonged space maintenance and has osteoconductive properties. Demineralized freeze-dried bone allograft (DA) contains bone morphogenic proteins and osteoinductive properties, stimulating new bone formation. DA is highly biodegradable and has osteoconductive properties but less structural support than xenografts and mineralized allografts. It could be modified using sticky bone (DA with A-PRF and a layer of xenograft above it covered by collagen or A-PRF membrane) [6, 7].

The bone graft procedure could be performed in two stages (as a delayed approach) or one stage (as a simultaneous approach – GBR combined with at the same time implant placement). In case of minimal bone deficiency and good implant stability can be achieved, the one-stage approach can be applied. This technique is appropriate for horizontal alveolar ridge augmentation, bone dehiscence, or fenestrations and not so efficient for vertical alveolar ridge augmentation.

Intrabony defects are much more amenable and easier for regeneration due to facilely maintaining space and stabilizing the bone graft and membrane. With proper suturing technique easily can be achieved primary soft tissue closure. Other defects can be more challenging in pre-prosthetic surgery cases, such as lateral and vertical bone augmentation procedures [5].

The success of the bone grafting procedure thoroughly depends on the exclusion of epithelial cells during new bone formation from osteoblasts and fibroblasts [8]. Aghaloo et al. assessed the success of different augmentation techniques, such as GBR, block auto grafting, distraction osteogenesis, ridge splitting, etc., based on implant survival [9]. They conclude from their systemic review that GBR is one of the best techniques for successful ridge augmentation according to implant survival [8, 9].

PURPOSE

Our study aims to evaluate the efficiency of the bilayer technique of GBR for alveolar ridge augmentation in cases of bone deficiency for optimum implant placement and long-term success.

MATERIAL AND METHODS

We present several cases of alveolar bone deficiency treated with the bilayer technique, combined with allo- and xenograft, covered by collagen membrane, with long-term follow-up.

The defects were filled with allograft above a layer of xenograft and barrier membrane. This technique combines the benefits of allo- and xenografts and barrier membranes. Xenograft gives mechanical support for prolonged space maintenance. Demineralized freeze-dried allograft (DA) provides a structural framework (osteoconductive capabilities) and contains bone morphogenic proteins that stimulate osteoinduction (osteoinductive capabilities). DA is biodegradable and provides less structural support than xenografts and mineralized allografts. Gamma irradiation and ethylene oxide are used as sterilization techniques. It significantly decreases the risk of transmitting infection but decreases the osteoinductive properties of the graft, mainly morphogenetic proteins.

The GBR technique can be applied in two stages (delayed approach) or one stage (simultaneous approach with implant placement). If the bone deficiency is low and implant stability can be achieved, the one-stage approach can be applied.

Case 1. GBR In Horizontal Bone Loss

We present a case of a 65-year-old female with performed GBR-bilayer technique. Five months after augmentation, the implant placement was made. The implants were with very good initial stability. The two-stage approach is preferable if more bone must be regenerated, and the risk of postoperative complication will be reduced (Fig. 1).

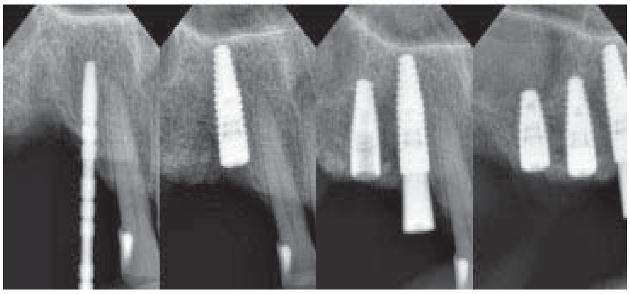


Fig. 1. A Implant placement

Fig. 1. B Intraoperative picture

Case 2. GBR In Immediate Implantation

We present a case of a 32-year-old male patient with a horizontal fracture in the root of 11 teeth after an accident. After several endodontic treatments, the fistula vestibular persists, and the patient was referred for dental implant treatment. After CBCT evaluation, tooth extraction and immediate implant placement were scheduled. The bilayer technique for GBR was performed covered over by collagen membrane. This technique could be used for the treatment of dehiscence-type defects around implants (Fig. 2).

GBR in case of alveolar bone deficiency/preprosthetic surgical procedure

We present three more cases with horizontal and vertical bone deficiency treated with GBR bilayer technique (Fig. 3, 4, 5).

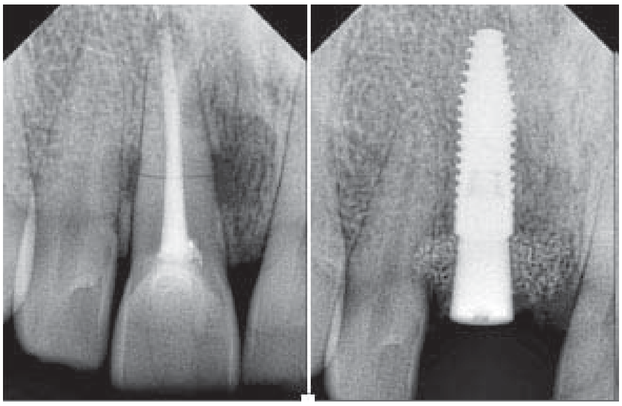


Fig. 2. A Preoperative and postoperative x-ray

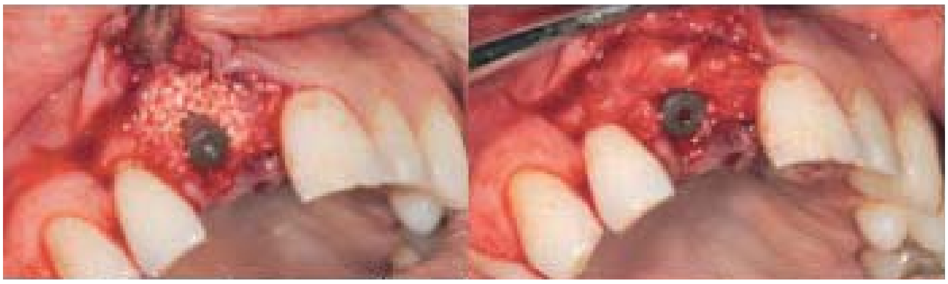


Fig. 2. B Bilayer technique intraoperative

Fig. 2. C Prosthetic restoration with a crown six weeks after implantation.

Fig. 3. A Preoperative alveolar bone deficiency – clinical

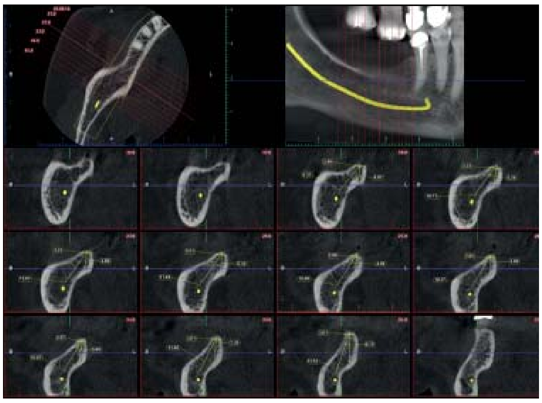
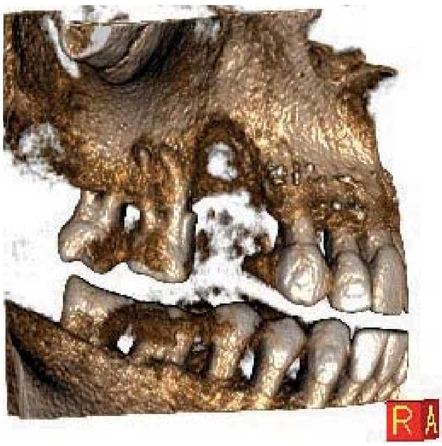


Fig. 3. B Preoperative alveolar bone deficiency – CBCT

Fig. 3 C Five months after the operation – GBR bilayer technique

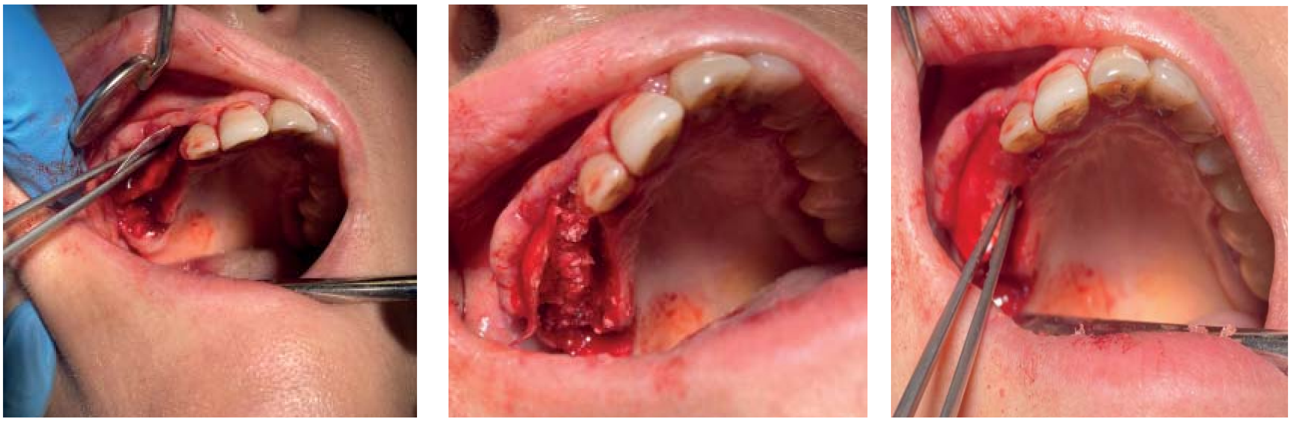


A) before operation

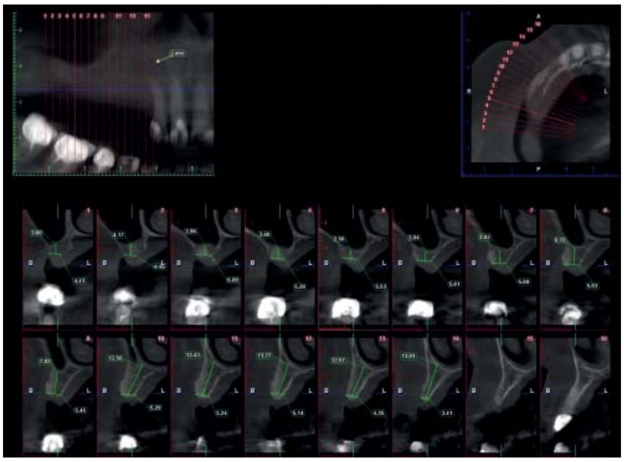
B) 5 months after operation

C) After dental implant procedure

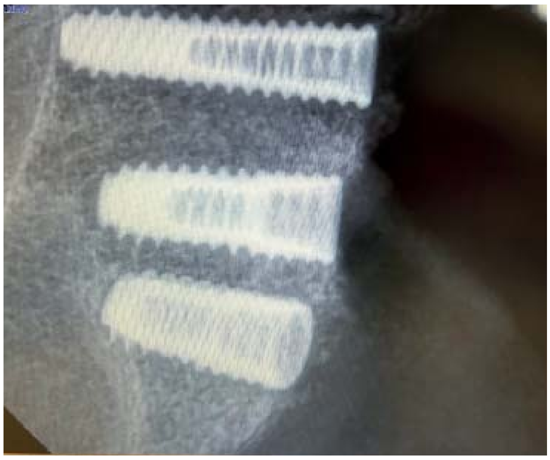
Fig. 4. Management of horizontal and vertical alveolar bone deficiency



A) intaoperative



B) 5 months postoperative



C) after dental implant procedure

Fig. 5. Surgical management of deficient alveolar ridge by GBR- bilayer technique

The post operative period in all cases was uneventful. And all the cases were completed with prosthetic restorations.

RESULTS

The bilayer technique that we described and use with allo-, xenograft, and collagen membranes is predictable clinical protocol, with a high success rate and lower morbidity in mainly horizontal bone deficiency. We have 100% a survival rate and success rate of the implants placed in a grafted area with long-term follow-up.

DISCUSSION

The predictability and success of bone graft procedures are based on several principles and conditions: space maintenance, prevention of local trauma, stability of bone graft and membrane, nutrition, and primary wound closure [5, 10].

Space maintenance

Providing space maintenance is an obligatory condition and can be challenging for clinicians depending on the characteristics of the defect site, which has to be grafted. If significant bone augmentation is required in a severely resorbed alveolar ridge, creating space is critical for the success of GBR.

Different bone substitutes can be used as autogenous, xenografts, allografts, and alloplastic materials [4]. An ideal biomaterial for bone regeneration should be able to form or stimulate new bone formation. The processes and speed of resorption of bone graft and apposition of new bone must be balanced [4, 6].

GBR is very popular among clinicians because of its advantages as the unlimited availability of biomaterial, less morbidity (no donor site), reduced operation time, and less risk of postoperative complications [9, 10, 11].

Xenografts are bone grafts from animals such as cows, horses, or species other than humans [12]. Deproteinized bovine bone (DBB) is the most popular xenograft material frequently used in GBR procedures. DBB has osteoconductive capability that serves as a framework due to the interconnecting pore system favorably for the migration of osteoprogenitor cells. Over time, DBB particles are incorporated within the bone. DBB has low substitution rates because of slow resorption therefore, it can provide space maintenance over the long term [4, 6]. It was shown in the literature that DBB graft particles remain in living bone even after ten years postoperatively [12]. Graft materials with low substitution rates are a good framework for host bone regeneration during the healing period and decrease resorption of the augmented bone [4, 6]. Residual graft particles can affect negatively the healing process of the augmented zone and decrease the regenerating rate, especially in the area of integrated implant surface [12]. In cases that require a greater amount of ridge augmentation – vertical, horizontal, or composite defects, DBB can be mixed with autogenous particulate bone and applied as a mixture which increases possible osteogenic factors and pluripotential cells at defect site [2] or, as we perform the bilayer technique. Most authors recommend allowing 6-9 months to heal augmentation regions before the procedure of implant placement. During the healing process, DBB graft material maintains the space of the augmented site, and autogenous particles encourage the migration of pluripotent cells and the incorporation of this framework with the living bone.

Allografts are bone grafts harvested from the same species but are genetically not similar donor to the recipient [4, 6]. Allograft donors are meticulously screened, specimens are carefully sterilized to reduce the possibility of disease transmission and are freeze-dried. Mineralized allografts (MAs) provide good stability and space maintenance because of their physical properties. [4, 6, 13] Osteoconductive scaffolds of MAs ensure volume preservation and new bone formation [14]. It can be composed of cortical and cancellous particles or both. Mineralized cortical particles with slow resorption rates offer a scaffold and enhance the volume of the augmented site. The cancellous particles have faster resorption rates and cannot ensure a space for a long time but encourage the ingrowth of bone cells and angiogenesis. Less resorption can be expected if the amount of cortical graft particles is increased in the composite graft. [15]. Demineralized allograft (DA) contains bone morphogenic proteins and, therefore has an excellent osteoinduction capability.

In the literature are described different techniques of grafting procedures, often applied DA mixed with other slowly resorbed graft materials to maintain the space for a long period after surgery [16]. The most common indications for the use of demineralized grafts are envelope-type defects and socket preservation. Implants can be placed safely after four months of surgery [16]. Some authors do not recommend using DA in vertical and horizontal augmentation because of expected bone loss after long-term healing [15].

In clinical practice, barrier membranes are routinely used in GBR. There are two barrier membranes: resorbable and non-resorbable [4, 6, 10].

Resorbable membranes, made of native collagen (non-cross-linking) have high biocompatibility, good tissue integration, and ensure rapid vascularization [15].

The most important benefits of resorbable membranes are no need for membrane removal after healing, resulting in decreased morbidity, easy manipulation, and a lower rate of postoperative complications. In achieving space maintenance, resorbable membranes are less successful than non-resorbable membranes. These membranes could be used with bone graft materials and additional tools such as tenting screws (umbrella technique) or titanium plates for space maintenance. Still, they may lose their barrier function early due to rapid biodegradation [16, 17, 18]. The resorption time depends on the membrane's material, thickness, vascularization, cellular activity, and exposure in the oral cavity [19]. One of the advantages of non-cross-linked collagen membranes is the spontaneous closure and epithelization over the membrane if exposure occurs during the healing period [20]. Epithelization of the exposed membrane occurs within a week after suture dehiscence, but the grafting volume may be negatively affected during the new bone formation, and some bone loss may be expected [4, 6]. Some clinicians recommend using a double non-cross-linked membrane over the augmented site to prolong the resorption time [6]. For prolonged degradation time, cross-linking resorbable collagen membranes are indicated [8].

Several essential factors may influence the success of GBR: regeneration time, resorption rate at the augmented site, and space maintenance and it is very important the choice of graft (depends on its properties – type of sterilization, viscoelasticity, hydrophilic), primary closure of the grafted area, membrane choice, surgical technique, absence of dead space, availability of autogenous bone, composition of the graft, vascularization, regeneration potential of the host bone [22].

Stability

The stability of the augmented site in the GBR procedure during healing is an important factor for successful GBR. Stabilization of graft material is obligatory in the prevention of local trauma [5]. Barrier membranes are used to cover the augmented site, which protects epithelial and connective tissue cell migration in the regenerating bone. Sometimes, additional tools are used to ensure stability and prevent local trauma as pressure of lip and mastication force pressure [20].

Membrane fixation can be achieved by pins, sutures which prevent migration of the graft, which is essential for the success of the bone graft procedure [23].

Nutrition

Some clinicians make perforations of the cortical bone before bone grafting for better migrating vessels to the augmented site. Several benefits of decortication of the recipient site have been demonstrated [23]: revascularization is increased after decortication, particularly in the mandible, the release of growth factors can improve healing, and the perforated encourages integration and stability of the graft [23, 24]. There are different studies in the literature suggesting that decortication is not necessary for better regeneration [23, 24].

The goal is to create conditions for restoration of the prosthetic field and for subsequent prosthetic treatment with a decrease of the risk of atrophy and functional disorders [25, 26, 27, 28].

Primary closure

Protection of the grafted site is an important factor. Primary closure is essential, and complications are strongly associated with the grafting volume needed [4, 6].

To achieve successful GBR, the condition of soft tissue should be evaluated meticulously before treatment planning such as the gingival biotype, the amount of keratinized mucosa, the vestibular depth, and previous surgical interventions [6]. For the protection of the augmented site and primary healing, several factors should be considered: flap design is important for tension-free flap closure, primary tension-free flap closure, suturing technique and suturing materials (the clinician should be aware and familiar with different suturing techniques to reduce the pressure on the edges of the flap), accurate post-surgical medications and postoperative care, the bilayer technique with allo- and xenograft and collagen membrane is predictable, with a high success rate and lower morbidity procedure.

CONCLUSION

Many surgical techniques, approaches, and biomaterials have been discussed in the literature that clinicians have the choice to use in reconstructive procedures of alveolar bone deficiencies. The success of these procedures mainly depends on the clinician's experience and skill. The surgeon and patient should carefully evaluate the benefits and risks of the chosen procedure and methods and graft material related to indication in every single case and consider the ideal treatment option. The technique we described is easy, and prosthetic-driven augmentation is recommended for a better outcome.

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