International Surgery Journal
Uriostegui CBD et al. Int Surg J. 2025 May;12(5):800-804
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20251027

Case Report

Post-extraction vertical guided bone regeneration with a titanium-reinforced polytetrafluoroethylene membrane

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Received: 16 February 2025
Revised: 01 April 2025
Accepted: 02 April 2025

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ABSTRACT

Tooth loss can lead to resorption of the alveolar bone, affecting soft tissue support and altering the facial profile. The long-term success of dental implants depends on adequate bone dimensions, so guided bone regeneration (GBR) is crucial to increase bone volume prior to implant placement. GBR is a technique that promotes new bone formation in bone defects to create adequate support for dental implants. It uses a combination of autologous bone and xenograft to optimize the graft's osteogenic and osteoconductive properties. However, its main limitation is the bone's maturation time, which is usually between 6 and 9 months. A 58-year-old patient with tooth loss due to severe bone destruction required GBR for dental implant placement. The combination of the physical barrier of d-PTFE (polytetrafluoroethylene) and the structural strength of titanium provides a favorable environment for bone regeneration, but it is crucial to consider the potential complications associated with these membranes, such as soft tissue injury and membrane exposure.

Keywords: Guided bone regeneration, Dental implants, Autologous bone, Xenograft, d-PTFE membrane

INTRODUCTION

Tooth loss often leads to alveolar bone resorption, which compromises soft tissue support and can significantly alter the patient's facial profile. The long-term success of dental implants critically depends on adequate bone tissue dimensions, both in the vertical and horizontal planes. Resorption of alveolar ridges following tooth extraction may affect the final aesthetic outcome, increasing the need for guided bone regeneration (GBR) procedures to increase bone volume prior to dental implant placement.[1-3]

GBR is a widely used strategy that has demonstrated predictable outcomes and long-term bone graft stability. A common protocol involves the use of a combination of autologous bone (70%) and xenograft (30%) to optimize the osteogenic and osteoconductive properties of the graft. However, one of the main limitations of this technique is the bone maturation time, which typically ranges from 6 to 9 months.[3-6]

GBR requires physical separation of the bone graft from the surrounding soft tissue using a barrier membrane.[1] This membrane aims to prevent the migration of epithelial cells into the wound, allowing the autologous bone graft and particulate xenograft to stabilize the blood clot and promote new bone formation. By acting as a barrier, the membrane supports a suitable microenvironment for osteogenesis and graft consolidation.[7]

CASE REPORT

A 58-year-old female patient presents for evaluation and treatment. The etiology of tooth loss is attributed to severe attachment loss and bone destruction, classified as Stage IV, Grade B according to the European Federation

of Periodontology (EFP) classification. The history revealed no history of smoking, drug addiction, or allergies. The assessment of general health status according to the American Society of Anesthesiologists (ASA) classifies the patient as ASA I, indicating a normal systemic health status. Clinical and radiographic examination reveals defects located in the mandibular alveolar crest, requiring surgical bone augmentation to facilitate the placement of osseointegrated dental implants and subsequent prosthetic rehabilitation. In the presurgical phase, a cone beam computed tomography (CBCT) was performed to three-dimensionally evaluate the bone anatomy of the recipient site. Based on the data obtained from the CBCT, a stereolithographic model of the lower arch was developed, with the aim of facilitating virtual planning and the design of the surgical guide for the bone augmentation intervention.

Surgical material

Anesthesia-Articaine hydrochloride 4% with epinephrine 0.0001% (1:100,000).

Incision and dissection instruments-Scalpel blades: 15C and 12, molt periosteum, Allen curette, Prichard curette, Minnesota separator, Buser periodontal spatula, Lucas spoon, bone grafting instruments, disposable bone scraper, TKN1 tunneler, Grafting material, porcine bone xenograft, membrane fixation, Gerald straight tissue clamp, 6 self-tapping fixing screws and fixing kit for self-tapping screws.

Membrane-Non-absorbable high-density d-PTFE membrane reinforced with titanium.

Suture-6-0 Teflon suture and 6-0 nylon suture were used.

Suturing instruments-Castroviejo needle holder was used.

Irrigation solution-0.9% sodium chloride (NaCl) solution (physiological saline solution)

Material for exodontia (Tooth 3.6)-Straight elevator, coarse-grained diamond bur (for de-epithelialization of the dental sulcus).

Preoperative care

Seven days prior to surgery, a complete periodontal probing was performed to assess the patient's initial periodontal status, with probing depth values ≤3 mm at all sites assessed. Subsequently, a thorough dental prophylaxis was performed using ultrasound and curettage to remove plaque and dental calculus. Detailed oral hygiene instructions were given to the patient, emphasizing proper brushing technique and flossing.

Before entering the dental office on the day of the operation, the patient was asked to brush her teeth thoroughly. A mouthwash with undiluted 0.2% chlorhexidine gluconate was then prescribed for a period of 60 seconds to reduce the bacterial load in the oral cavity and minimize the risk of postoperative infection.

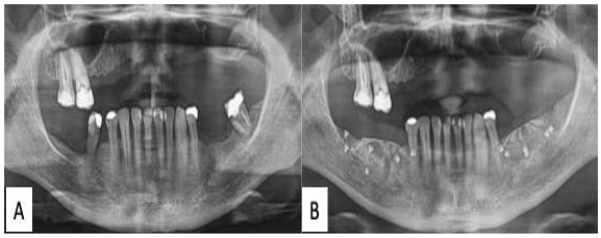

Figure 1: Panoramic x-ray before and after treatment. (A) Initial panoramic radiograph and (B) final panoramic radiograph, taken 30 days after the procedure.

Surgical technique

The procedure was performed under conscious sedation, administered and monitored by a certified anesthesiologist. After confirming the adequate state of sedation, regional anesthetic blockade was performed by infiltrating local anesthetic to block the inferior alveolar and buccal nerves, ensuring analgesia during the intervention.

Tooth 3.7 was extracted a traumatically using a thin straight elevator, minimizing damage to the surrounding tissues. Following extraction, the gingival sulcus was meticulously de-epithelialized with a coarse-grained diamond bur, irrigating abundantly with sterile distilled water at a rotation speed of 100,000 rpm. Subsequently, the socket was thoroughly Curettaged with a Lucas spoon to remove any granulation tissue or inflammatory debris.

A crestal incision was made in the keratinized mucosa, extending intrasulcular on teeth 3.6, 3.5, and 3.4, both on the buccal and lingual surfaces. Two oblique releasing incisions were made mesiobuccal and mesiolingual on tooth 3.4, preserving the interdental papillae to maintain aesthetics and vascular supply. A full-thickness flap was raised, with tunneling at the most distal border of the mandible to expose the external oblique line. Careful release of the buccal flap was performed through a blunt incision in the periosteum. For mobilization of the lingual flap, a molt periosteum was used to elongate the flap without making additional incisions, following the technique described by Istvan Urban to preserve vascular supply and minimize flap tension (Urban et al complete reference to Urban's study).

Using a bone harvester, autologous graft was obtained from the external oblique line of the mandible. The particulate autologous graft was mixed with the xenograft in a 1:1 ratio and hydrated with sterile 0.9% NaCl solution, previously chilled to optimize cell viability. Corticalization of the recipient bone was performed by multiple perforations with a 1.5 mm long and 0.5 mm diameter spear tip to promote vascularization of the recipient bed.

A titanium-reinforced d-PTFE membrane was pre-shaped to fit the anatomy of the defect. After placement, it was fixed to the lingual cortex with three self-tapping screws. The defect was then filled with the mixture of autologous graft and xenograft (1:1 ratio). Finally, the membrane was fixed to the vestibular cortex with three additional self-tapping screws, ensuring stability and maintaining space for bone regeneration.

Primary wound suturing was performed with 6-0 Teflon suture over the rim, using horizontal mattress sutures to coapt the flap edges and join connective tissue to connective tissue. Lingual release incisions were sutured with simple Teflon sutures, and vestibular release incisions were sutured with simple 6-0 nylon sutures. At all times, a tight, tension-free wound closure was sought to promote healing and prevent dehiscence.

The patient was instructed to apply extraoral cold compresses to the surgical area to minimize postoperative swelling and edema.

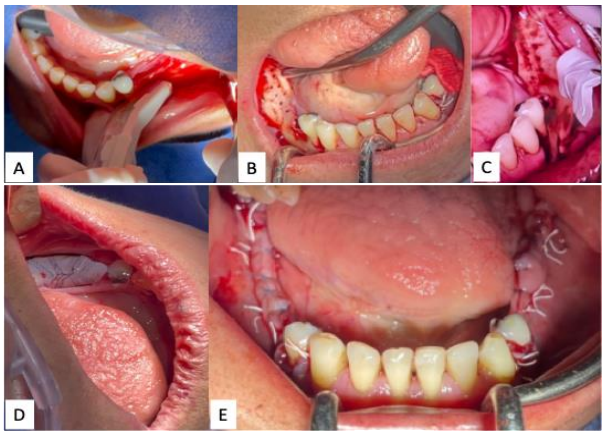

Figure 2: Bone regeneration procedure.
(A) Once the flaps have been released, autologous bone is obtained using a disposable scraper. (B and C) Bone screening and presentation of the titanium-reinforced d-PTFE membrane. (D) Fixation of the d-PTFE membrane with 6 self-tapping screws. (E) 6-0 Teflon suture on the horizontal mattress edge; the ligamentous discharges were sutured with single Teflon stitches and the vestibular discharges with single 6-0 nylon stitches, achieving tension-free wound closure.

Postoperative care

The following postoperative pharmacological regimen was prescribed: Amoxicillin with clavulanic acid (875 mg/125 mg): 1 tablet every 12 hours for 7 days, to prevent bacterial infections. Dexamethasone (8 mg/1 ml injectable suspension): single dose, administered to reduce inflammation and postoperative edema. Nimesulide (100 mg tablets): 1 tablet every 12 hours for 5 days, as an analgesic and nonsteroidal anti-inflammatory drug (NSAID) to control pain. Mouthwash with 0.2% chlorhexidine gluconate (undiluted): perform gentle rinses twice a day, after oral hygiene, to maintain hygiene and prevent the accumulation of bacterial plaque at the surgical site.

The patient was instructed to perform gentle tooth brushing in the surgical areas with a soft-bristled toothbrush (Curaprox 5460) and a toothpaste of her choice, paying special attention to not traumatize the regenerating tissues. The importance of maintaining meticulous oral hygiene to promote healing and prevent complications was emphasized.

Post-surgery

At 30 days postoperatively, the sutures were removed, observing adequate healing of the soft tissues, with no clinical evidence of infection or exposure of the membrane.

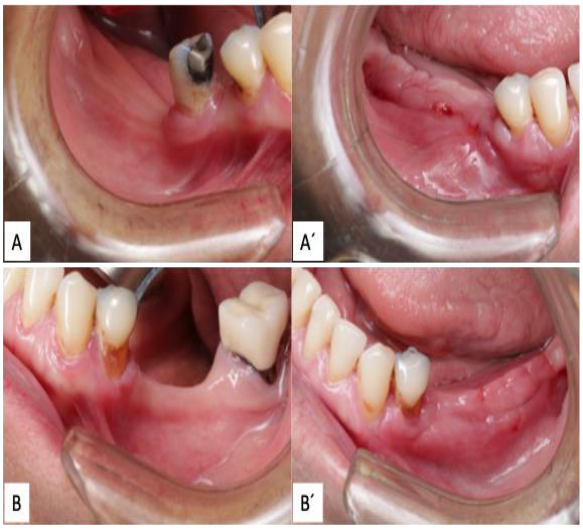

Figure 3: Intraoral photographs.
(A) Pre-surgical intraoral photograph of the right side. (A´) Removal of stitches 30 days after surgery, right side. (B) Pre-surgical intraoral photograph of the left side. (B´) Removal of stitches 30 days after surgery, left side.

DISCUSSION

Three-dimensional bone loss in the field of dental implantology is a problem generally secondary to tooth extractions, jaw surgeries, traumas and age-related changes. It has been shown that adequate bone volume is an indispensable requirement and allows the prognosis of dental implants. In this context, GBR and guided tissue regeneration (GTR) techniques have emerged as possible solutions to promote bone regeneration in the alveolar ridge area.[8] The GBR/GTR technique is based on the use of a barrier membrane that separates the bone defect from the surrounding connective tissue, preventing the invasion of rapidly growing soft tissue and providing space for osteoblasts to repair the periodontal tissue. In 2008, Wang and Boyapati studied the importance of GBR/GTR in periodontal regeneration. These membranes must have characteristics such as biocompatibility, cell

occlusion capacity, tissue integration, ease of clinical management, space maintenance capacity, and adequate physical properties.[9,10] Barrier membranes are classified as resorbable and non-resorbable, initially expanded PTFE (e-PTFE) was used due to its ability to maintain the submembrane space and facilitate the growth of osteoblasts, however e-PTFE can be accompanied by complications such as bacterial infections and membrane exposure, so high-density PTFE (d-PTFE) was studied and developed as a substitute membrane for e-PTFE, so d-PTFE has a low probability of bacterial infection, which can better protect the underlying bone graft material and facilitate its removal.[11-13] Furthermore, metal-based membranes, such as titanium mesh (TM), are used in GBR/GTR due to high stiffness, low density, high temperature and corrosion resistance. Titanium is added to PTFE (d-PTFE) as a stabilizer to form titanium-reinforced d-PTFE. Absorbable membrane-coated TM and titanium-reinforced d-PTFE have been successfully used for vertical and horizontal bone regeneration around implants and are becoming increasingly commercialized. Simion et al demonstrated the successful use of membrane techniques associated with osseointegrated implants for vertical ridge regeneration. Despite the advantages of nonabsorbable membranes, secondary surgical removal is inevitable and the increased risk of membrane exposure and bacterial infection remains. [13] Houses et al performed a clinical and histologic evaluation of a new bioresorbable membrane for GBR composed of polyglactin 910 ester for the treatment of periodontal defects. The study consisted of placement of the membrane over bone defects after surgical access and debridement, followed by clinical follow-up and biopsies for histologic analysis, and observed favorable clinical manifestations with improved probing depth and clinical attachment levels, histologic evidence of new bone formation with good biocompatibility and minimal inflammation, and gradual resorption of the membrane, eliminating the need for a second surgery. The study demonstrated the potential of bioresorbable membranes as an alternative to non-resorbable membranes in GBR procedures.[14] The study by Zhang et al performed a systematic review and meta-analysis to evaluate the effects of different membranes on vertical bone regeneration and clinical complications associated with GBR/GTR. Membranes made of d-PTFE, e-PTFE, cross-linked collagen membrane (CCM), non-cross-linked collagen membrane (CM), TM, TM+CM, TM+CCM, titanium-reinforced d-PTFE, titanium-reinforced e-PTFE, PLA, PEG, and PLA910 were compared. SUCRA (Surface under the cumulative ranking curve) analysis indicated that titanium-reinforced d-PTFE exhibited the greatest vertical bone increment effect, SUCRA is a metric that represents the probability that a treatment is the best among all treatments evaluated. A higher SUCRA value indicates a higher probability that the treatment is more effective. In addition, the incidence of complications was analyzed, finding that soft tissue injury and membrane exposure were the most common complications. The findings of this study suggest that titanium-reinforced d-PTFE might be the best option to achieve optimal vertical bone augmentation in GBR/GTR procedures.[11,12]

CONCLUSION

The combination of the physical barrier of d-PTFE and the structural strength of titanium provides a favorable environment for bone regeneration, but it is important to consider the potential complications associated with these membranes such as soft tissue injury and membrane exposure. Future research should focus on evaluating the long-term outcomes of different membranes in vertical bone regeneration, as well as developing new membranes with improved properties and lower risk of complications. Furthermore, it is essential to conduct clinical studies directly comparing different types of membranes in similar clinical situations to obtain more robust evidence on their efficacy and safety.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Uriostegui CBD, Gallo PL. Post-extraction vertical guided bone regeneration with a titanium-reinforced polytetrafluoroethylene membrane. Int Surg J 2025;12:800-4.