Poster Number

IAO-EAO-SIdP-1017

CLINICAL INNOVATIONS

# Customized 3D Zirconia barriers in multi-center Guided Bone Regeneration: low exposure rates and clinical outcomes

Mandelli F, Pispero A, Colombo F

## ABSTRACT

**Background**
Customized-3D zirconia barriers have elicited interest in guided bone regeneration (GBR) due to their biocompatibility and stability. Previous studies have reported high exposure rates for titanium mesh barriers, often exceeding 20%, which can lead to complications and compromised outcomes.
**Aim**
This study aims to evaluate the clinical outcomes of using customized-3D zirconia barriers for GBR across three clinical centers, focusing on the rate of membrane exposure and overall bone regeneration.
**Material and Methods**
In this multi-center study, 21 patients with severe alveolar bone atrophy underwent GBR using customized-3D zirconia barriers. The barriers were designed using DentalCad software and milled from 1200 MPa zirconia disks. Autogenous bone chips mixed with xenograft (BioOss, Geistlich Biomaterials) were used as graft materials. The barriers were stabilized using screws, were covered using a collagen membrane (Creos Xenoprotect, Nobel Biocare) and allowed to heal for 8 months. Cone beam computed tomography (CBCT) scans were conducted pre- and post-operatively to assess vertical bone gain. The primary outcome measure was the rate of membrane exposure, while secondary outcomes included bone gain and complications.
**Results**
Among the 21 cases, only two instances of membrane exposure were recorded, corresponding to a 9.5% exposure rate. All cases showed significant new bone formation with no signs of infection, demonstrating the effectiveness and reliability of zirconia barriers. The exposure rate of 9.5% observed with zirconia barriers is significantly lower than the exposure rate reported for titanium meshes in previous studies (more than 20%).
**Conclusion and Clinical Implications**
The use of customized-3D zirconia barriers for GBR results in a remarkably low exposure rate and effective bone regeneration. Zirconia proves to be an effective material for creating customized barriers, and the potential to reduce complications represents a significant clinical implication. However, the study is limited by its small sample size. Future research should focus on long-term outcomes and larger patient cohorts to further validate the clinical benefits of zirconia barriers.
**Keywords**
Guided Bone Regeneration, Zirconia, Mesh, Zirconia Mesh, Barrier, Bone Atrophy, Multi-center Study

## BACKGROUND AND AIM

One of the most recent innovations in regenerative surgery is the use of customized titanium meshes, which can be employed for vertical and horizontal ridge augmentation. These meshes allow for precise contouring and adaptation to the defect, facilitating a more predictable bone regeneration process. Although this surgical procedure has demonstrated numerous advantages, such as reduced operative time, the ability to treat severe atrophy, and accurate barrier fitting (1), various preliminary studies have reported a higher exposure rate when compared to conventional titanium-reinforced d-PTFE membranes (2, 3). Mesh exposure is a well-documented complication in guided bone regeneration (GBR) that can lead to compromised healing and increase the risk of infection, often requiring the premature removal of the barrier.

In recent years, alternative materials for GBR have been investigated to mitigate these issues. Among them, customized-3D zirconia barriers have shown promising results due to their biocompatibility, mechanical stability, and minimal soft tissue interaction (4). Zirconia, a polycrystalline ceramic, has been widely used in implant dentistry due to its favorable biological properties, such as lower bacterial adhesion and reduced inflammatory response compared to titanium. This makes zirconia an attractive option for GBR, as it may reduce the risk of membrane exposure while still providing a stable environment for bone regeneration.

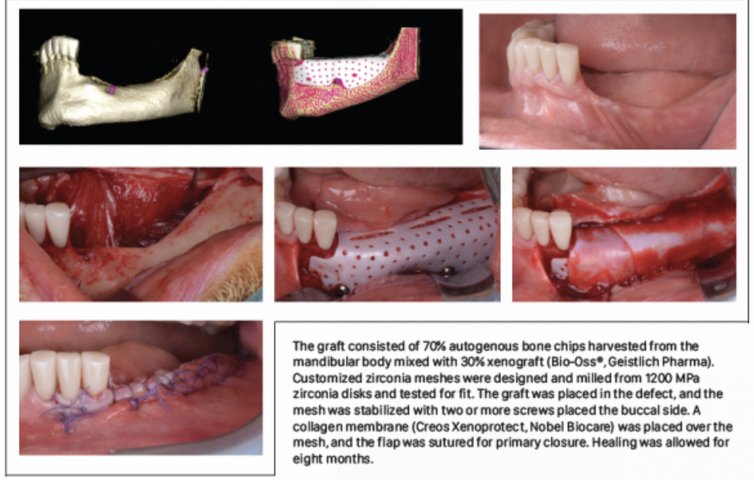
Furthermore, the use of CAD-CAM technology to design and mill customized zirconia barriers allows for a highly accurate fit to the defect site, which can contribute to more consistent and predictable outcomes. These barriers can be manufactured to meet the specific anatomical needs of each patient, providing an individualized approach to GBR. The ability to achieve a precise fit also minimizes the need for intraoperative adjustments, reducing surgical time and the potential for handling errors. Despite these advantages, the clinical application of zirconia barriers in GBR is still in its early stages, and there is limited data on long-term outcomes.

The purpose of this study is to evaluate the clinical outcomes of using customized-3D zirconia barriers for GBR across three clinical centers, with a focus on membrane exposure rates and overall bone regeneration. This study aims to contribute to the growing body of evidence supporting the use of zirconia as an alternative to titanium in regenerative procedures, offering potential benefits in terms of reduced complications and improved clinical outcomes.

## MATERIALS & METHODS

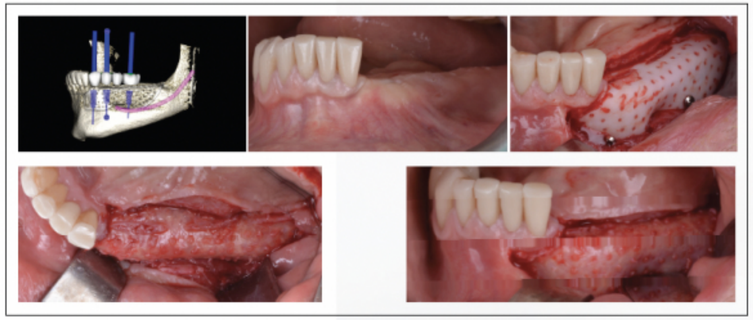
Twenty one patients requiring horizontal and vertical ridge augmentation were included in this multi-center study. Inclusion criteria were an age range of 18 to 80 years, good general health (controlled or absence of serious illnesses), and absence of periodontal disease (FMBS ≤ 25%; FMPI ≤ 25%). Only non-smokers were enrolled.

**Surgical Procedure**
Prior to surgery, patients received professional oral hygiene. On the day of surgery, antibiotic prophylaxis (Amoxicillin/Clavulanic Acid 2.0 g) was administered two hours before intervention. Local anesthesia was provided using 4% articaine with 1:100,000 epinephrine. A full-thickness trapezoidal flap was elevated, buccal and palatal/lingual flaps were mobilized. Periosteal release incisions were performed as needed to ensure flap passivation.



The graft consisted of 70% autogenous bone chips harvested from the mandibular body mixed with 30% xenograft (Bio-Oss®, Geistlich Pharma). Customized zirconia meshes were designed and milled from 1200 MPa zirconia disks and tested for fit. The graft was placed in the defect, and the mesh was stabilized with two or more screws placed the buccal side. A collagen membrane (Creos Xenoprotect, Nobel Biocare) was placed over the mesh, and the flap was sutured for primary closure. Healing was allowed for eight months.

**Reopening and Implant Placement**
After the healing period, a full-thickness flap was elevated and the mesh removed. Dental implants were placed, according to the treatment plan, at the augmented sites, using a trephine bur to collect bone biopsies. Primary closure of the flap was achieved. Three months later, a second-stage surgery was performed to expose the implants, followed by the placement of provisional crowns. After three months of progressive prosthetic, final prosthetic restorations were delivered.



## RESULTS

Among the twenty one patients treated, two instances of mesh exposure were recorded, corresponding to a 9.5% exposure rate. Despite these exposures, no signs of infection were observed, and the exposed barriers were managed without further complications. All cases showed significant new bone formation, allowing a successful implant placement without additional bone augmentation. Exposures happened along the perimeter of the mesh: in this area the graft was partially fibro-encapsulated and removed: it didn't jeopardize the area in which dental implants were planned. The exposure rate of 9.5% observed with zirconia barriers is notably lower compared to the rates reported for titanium meshes in previous studies, which often exceed 20%.

## Conclusions and Clinical Implications

The use of customized-3D zirconia meshes for guided bone regeneration demonstrated a low exposure rate and effective bone regeneration. Zirconia is an effective material for creating customized barriers, with the potential to reduce complications compared to traditional titanium meshes. However, the study's small sample size limits its external validity. Future research should focus on long-term outcomes and larger patient cohorts to further validate the clinical benefits of zirconia barriers.

## References

1.Sumida T, Otawa N, Kamata YU, Kamakura S, Mtsushita T, Kitagaki H, Mori S, Sasaki K, Fujibayashi S, Takemoto M, Yamaguchi A, Sohmura T, Nakamura T, Mori Y. Custom-made titanium devices as membranes for bone augmentation in implant treatment: clinical application and the comparison with conventional titanium mesh. J Craniomaxillofac Surg. 2015;43(10): 2183–8. (Vantaggi della castomizzazione)
2. Ciocca L, Lizio G, Baldissara P, Sambuco A, Scotti R, Corinaldesi G. Prosthetically CAD-CAM-guided bone augmentation of atrophic jaws using
customized titanium mesh: preliminary results of an open prospective study. J Oral Implantol. 2018;44(2):131–7.
3. Cucchi A, Giavatto MA, Giannatiempo J, Lizio G, Corinaldesi G. Custommade titanium mesh for maxillary bone augmentation with immediate
implants and delayed loading. J Oral Implantol. 2019;45(1):59–64.
4.Cucchi A, Vignudelli E, Napolitano A, Marchetti C, Corinaldesi G. Evaluation of complication rates and vertical bone gain after guided bone
regeneration with non-resorbable membranes versus titanium meshes and resorbable membranes. A randomized clinical trial. Clin Implant Dent Relat
Res. 2017;19(5):821–32. (Articolo che dimostra la maggior tendenza all'esposizione delle mesh)
5. Urban IA, Montero E, Monje A, Sanz-Sánchez I. Effectiveness of vertical ridge augmentation interventions: a systematic review and meta-analysis. J Clin Periodontol. 2019;46(Suppl 21):319–39. (Urban dice che ha 6.6% di esposizioni con ptfe e 20 con le mesh)
6. Ronda M, Desantis V, Bruno D, Veneriano L, Elli C, Pispero A. New Generation Customized Titanium Meshes for the Guided Bone Regeneration of Severe Alveolar Ridge Defects: Preliminary Results of a Retrospective Case Series. Int J Periodontics Restorative Dent. 2024 Sep 6:1-25. doi: 10.11607/prd.7246. Epub ahead of print. PMID: 39270312.