

## Case Report

# Rigid occlusive titanium barriers for alveolar bone augmentation: two reports with 24-month follow-up

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**Abstract:** Titanium barriers have been used for guided bone regeneration in preclinical and preliminary clinical reports as a possible alternative to bone grafting. In two cases with lateral bone defects, rigid titanium barriers were used to provide a secluded space in conjunction with bone substitutes. Sufficient lateral bone volume was generated for implant placement, and no complications were observed during 2 years of follow up. In conclusion, space-making stiff titanium barriers may be applied successfully for lateral alveolar crest augmentation.

**Keywords:** Barriers, bone augmentation, titanium

### Introduction

Insufficient bone volume for dental implant placement is a constant challenge in oral surgery. Usually, sites with extensive bone defects in the first stage receive bone grafts, with the implants being placed in the augmented alveolar site in the second stage [1]. As an alternative that increases the bone volume, the use of a subperiosteal barrier has been proposed to allow for spontaneous bone growth after the formation of a coagulum below the barrier, permitting guided bone regeneration [2]. However, some researchers have questioned the feasibility of titanium barriers for performing an alveolar ridge reconstruction prior to implant placement [3]. The osteoconductive capability of titanium and the implant stability are reported to play an important role in achieving successful bone augmentation with occlusive barriers [4] or titanium meshes. Essentially, the morphology of the defect is responsible for the clinical outcome and may strongly influence the final results [5, 6].

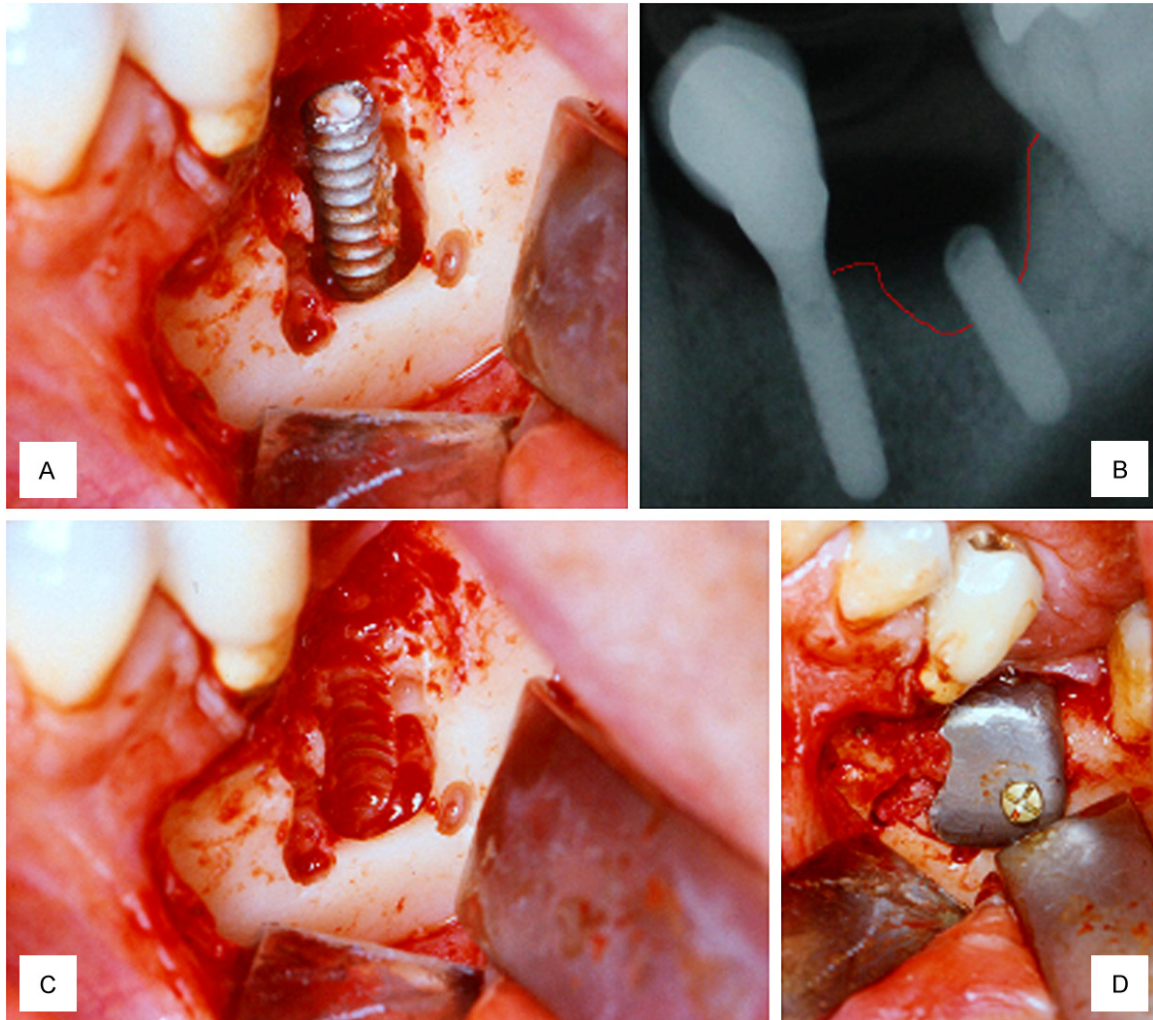
Within the context of contradictory clinical reports [7], the aim of this case study was to demonstrate the use of a rigid titanium occlusive barrier to perform a lateral alveolar bone

augmentation, with and without subperiosteal tunneling.

### Clinical presentation and results

#### Case 1

A 44-year-old healthy man was admitted to our clinic with an implant fracture in the left mandibular first molar region (**Figure 1A**). Radiographically, a vertical bone resorption was observed adjacent to a fractured implant (**Figure 1B**). The implant was removed, identifying a defect in the buccal wall (**Figure 1C**). A rigid titanium occlusive barrier was placed and screwed in the defect region, and a pure  $\beta$ -Tricalcium phosphate (Cerasorb®, Curasan AG, Kleinostheim, Germany) biomaterial was placed underneath the barrier (**Figure 1D**). The wound was closed using a vestibular mucoperiosteal flap. Radiological control was completed at 1 week (**Figure 2A**), and the healing was uneventful. At 3 months, the rigid barrier was removed, and a 7.5 mm crestal width transversal bone was observed 5 mm below the crestal level. At this point, the implant was placed (**Figure 2B**). An implant-supported prosthetic rehabilitation was performed after full osseointegration of the implant was noted at 6 months.



**Figure 1.** A. Peri-implantitis in first molar region; B. Vertical resorption around implant; C. Visualization of buccal defect after implant removal; D. Rigid titanium non-resorbable and screwed barrier placement.

At the 24-month follow up (**Figure 2C**), healthy peri-implant tissues were noted.

#### Case 2

A 66-year-old healthy man was referred for implant placement in the left upper first and second premolar region (**Figure 3A**). The alveolar bone width at the implant site 24 was below 3 mm, and the vertical height was between 6 and 8 mm; these values indicate a need for both vertical and horizontal augmentation. A vertical incision allowed subperiosteal tunneling (**Figure 3B**) for the subantral sinus floor augmentation (SALSA, [8]) with simultaneous implant insertion. Subsequently, a rigid titanium occlusive barrier filled with a pure  $\beta$ -Tricalcium phosphate (Cerasorb<sup>®</sup>, Curasan

AG, Kleinostheim, Germany) biomaterial (**Figure 3C**) was placed to cover the exposed buccal aspect of the implant 2.4 (**Figure 4A**). During the healing period, no exposure of the barrier was observed, and it was removed at the time of implant exposure (**Figure 4B**), showing a transverse dimension of 7 mm 5 mm below the crest. After prosthetic treatment, the patient was controlled clinically and radiographically during a 24-month follow-up period (**Figure 5A** and **5B**).

#### Discussion

Some authors have stated that the best way to allow guided bone augmentation is to use a stiff occlusive titanium barrier [9]. Schmid et al. [10] reported that the degree of mineralization

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**Figure 2.** A. One-week control radiograph; B. 5-months control radiograph; C. 24-months radiograph control; D. 24-months clinical control.

of titanium dome-shaped barriers in rabbits was higher when compared with permeable Teflon barriers, achieving successful results with the model used here. Later, the research of van Steenberghe et al. [2] on humans and rabbits yielded results supporting that a large bone volume augmentation could be accomplished with this technique.

The use of dental implants may be limited by alveolar ridge deficiencies, considering that a minimum of 5 to 6 mm horizontal width is needed [11]. The use of occlusive titanium barriers provides sufficient space maintenance to allow the migration of angiogenic and osteogenic cells into the regenerative space while stabilizing the bone substitute and the coagulum [12].

In both cases, a sufficient gain of bone mass was observed through the placement of implants with at least a 1.5 mm layer of mm

lateral bone at the time of prosthetic loading. Van Steenberghe et al. [2] also reported a vertical and transverse gain of bone height up to 16 mm in severely resorbed maxillary arches, although many of the barriers were exposed early.

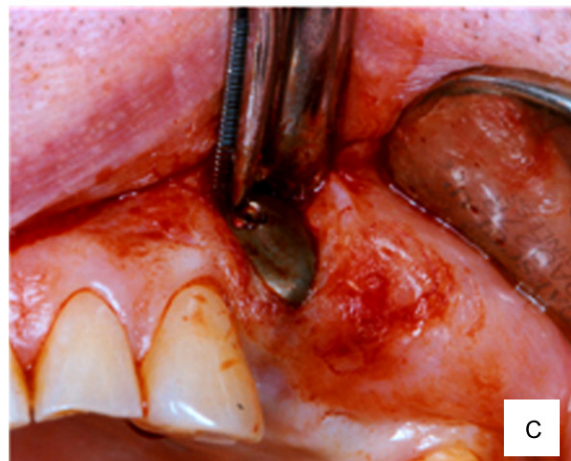
From the cases presented, either using an open approach (case 1) or a subperiosteal tunnel approach, as in case 2, it may be concluded that barrier exposure does not occur if the soft tissue is closed without tension and the barrier volume is not overextended. The latter tunnel technique represents a minimally invasive method that can be considered in alveolar ridge augmentation procedures to have a relatively low morbidity and high level of patient comfort [13].

$\beta$ -Tricalcium phosphate represents an interesting bone graft for craniofacial tissue regenera-

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**Figure 3.** A. Edentulous region of 2.4 and 3.5 teeth; B. Subperiosteal tunneling procedure; C. Rigid titanium non-resorbable and screwed barrier placement.



tion [14, 15], although it remains unclear whether a scaffold providing the material is regularly required underneath an occlusive barrier. However, this may impede the volume contraction of the coagulum, provide calcium and apparently does not have negative effects on the bone regeneration.

Although allografts and xenografts provide less bone quantity and quality when compared with autografts [16], the purpose of bone augmentation was achieved in both cases treated with pure  $\beta$ -tricalcium phosphate. These observations are in accordance with the data of Molly et al [4], who reported that the behavior of allografts and xenografts could be different when these grafts are placed under a stiff occlusive titanium membrane.

It is important to note that some requirements are necessary for a successful barrier out-

come, including stability and blood supply [9]. The stiffness of the barrier used in both cases allows for the maintenance of its shape and the creation of a space for graft placement, thus preventing the collapse of the biomaterial. Another important feature is the occlusivity of this barrier, which prevents fibrous tissue ingrowth [3]. Although the main disadvantage of these barriers are their tendency to become exposed early, as described by van Steenberghe et al. [2], this complication did not occur in any of the cases presented here. A possible explanation could be the favorable relation of the soft tissue coverage compared to the relatively small volume of the barrier.

The main advantage of the technique using a rigid titanium occlusive barrier is that the surgery is less traumatic compared with removing bone grafts and does not require a donor site [2].

## Barriers for alveolar bone augmentation

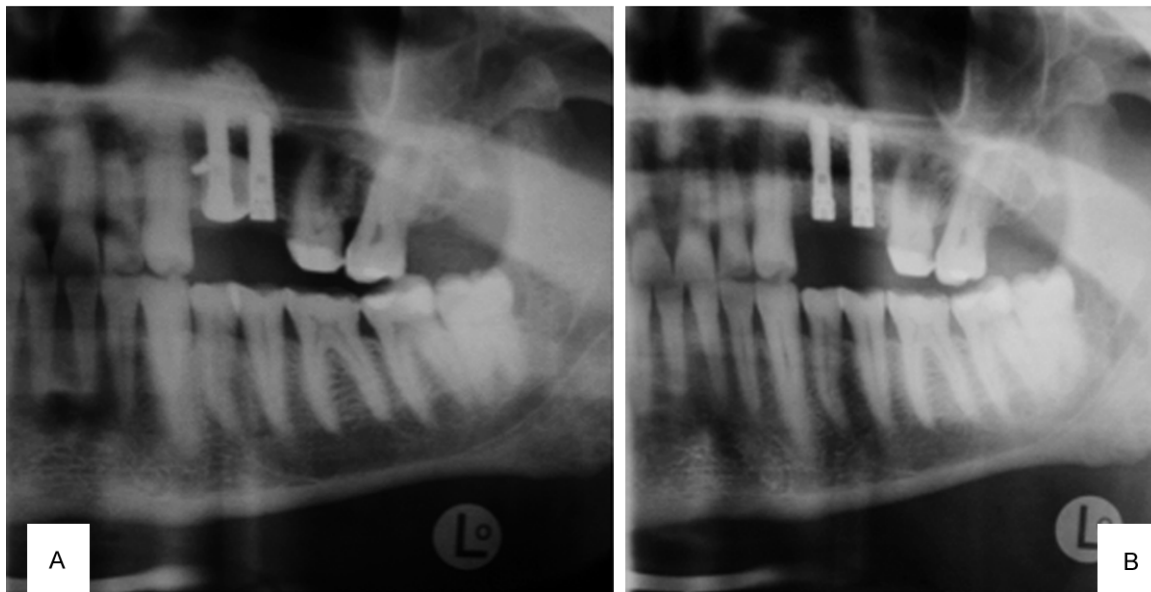


Figure 4. A. Control radiograph after sinus lift and barrier placement; B. 4-months control radiograph.

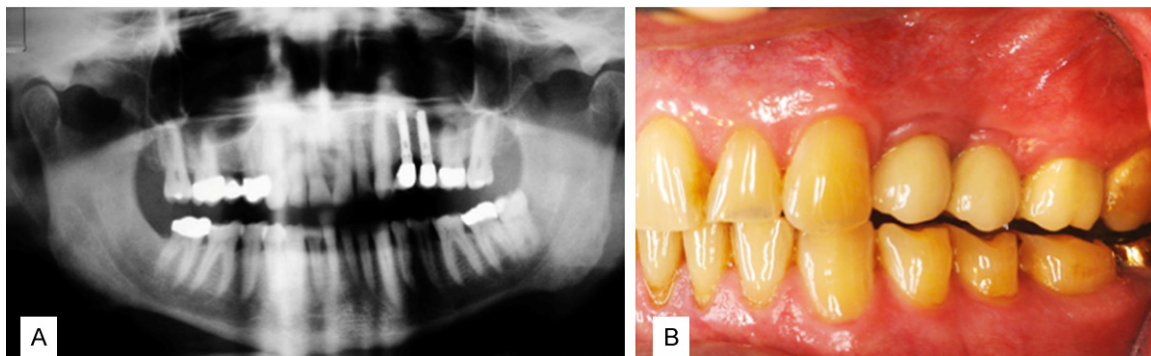


Figure 5. A. 24-months radiograph control; B. 24-months clinical control.

Thus, both clinical cases confirm the previous reports [2, 4] of clinically successful bone augmentations with rigid titanium barriers.

### Conclusion

In conclusion, the use of a rigid titanium occlusive screwed barrier with pure  $\beta$ -tricalcium phosphate might be a reliable technique for lateral alveolar bone augmentation.

### Disclosure of conflict of interest

None.

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