Reconstruction of Atrophic Alveolar Process With Xenograft, Fibrin-Rich Plasma, Titanium Mesh, Implant Placement, and Immediate Provisionalization

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Placement of dental implants is often compromised due to alveolar ridge resorption caused by postextraction defects, periodontal disease, traumatic tooth avulsion, or long-term edentulism. During the last 2 decades, various techniques have been proposed for reconstructing atrophic alveolar processes. Different therapeutic modalities have been implemented to achieve bone gain. These techniques require an orderly sequence of maneuvers, which involves handling the soft and hard tissues to minimize the risk of complications. A clinical case of reconstruction of an atrophic alveolar process with xenograft, fibrin-rich plasma (FRP), and titanium mesh; placement of an implant; and immediate provisionalization is reported. The reported case had a significant horizontal and vertical bone deficiency. The combination of different elements, such as the xenograft combined with FRP, the placement of a titanium mesh, and the final coverage of the mesh with an FRP membrane, resulted in a gain not only in the horizontal but also in the vertical direction.

Key Words: alveolar bone, graft, titanium mesh, dental implant, FRP

INTRODUCTION

Dental implant placement is often compromised due to alveolar ridge resorption caused by postextraction defects, periodontal disease, traumatic tooth avulsion, or long-term edentulism. Horizontal alveolar crest bone loss ranging from 29% to 63% has been reported after tooth extraction.[1]

The atrophy of the alveolar processes begins immediately after dental extractions, with a peak of remodeling within 4–6 weeks after extraction, but bone loss continues slowly and progressively over time.[2]

During bone healing, the walls of the socket undergo significant 3-dimensional resorption, resulting in topographic changes in hard and soft tissues and alterations in the contour of the alveolar processes. The magnitude of dimensional changes in bone and soft tissue is influenced by multiple systemic and local or anatomic factors, so the amount of new bone formation within the socket and the extent of volumetric reduction of the alveolar crest are variable and difficult to predict. This decrease in the volume of the alveolar processes can vary from 1 individual to another and between different extraction sockets in the same patient.[3]

After tooth extraction, several inevitable events occur, ending with vertical and horizontal deficiencies.[4,5] It is known that 50% of the loss of horizontal ridge dimension and approximately 0.7 mm of vertical volumetric changes occur within the first 3 months after extraction.[5]

Sufficient vertical and horizontal dimensions of the alveolar ridge are essential to achieving adequate function and esthetics of implant-supported restorations. It has been suggested that a buccal and lingual or palatal alveolar bone width of at least 1 to 1.5 mm around the inserted implant is a prerequisite for achieving adequate osseointegration and a predictable outcome of long-term implant treatment.[1]

Several surgical techniques have been proposed, and different graft materials have been used to reconstruct atrophic alveolar processes.[2]

Different therapeutic modalities have been implemented to achieve vertical bone gain. These techniques require an ordered sequence of maneuvers, which implies the management of soft and hard tissues to minimize the risk of complications.[5]

Guided bone regeneration (GBR) with bone substitute and resorbable collagen membranes is currently a common clinical

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https://doi.org/10.1563/aaid-joi-D-25-00003

Figure 1. Preoperative occlusal view.

Figure 2. Preoperative vestibular view.

technique for bone augmentation.[6,7] However, it has several disadvantages, such as its lack of rigidity and tendency of bone grafting to displace, which may result in alveolar resorption in part due to soft tissue tension and pressure on the graft during incision closure.[5]

Although autogenous bone is considered the gold standard for augmentation of the atrophic alveolar process, there are different bone substitutes available without volume limitation (alloplastics, allografts, and xenograft),[8] which can eliminate additional surgical risks by avoiding a second intervention required when we obtain autogenous bone. However, its use is associated with additional costs and the possibility of producing a foreign body reaction, interfering with or preventing adequate osteogenesis, depending on the material selected. Also, extracted teeth have recently been used as a source of autologous graft.[7]

Alternative treatment strategies and techniques have been proposed for the horizontal reconstruction of alveolar deficiencies, including the split crest technique for ridge expansion and GBR with autogenous particulate bone mixed with bone substitutes.[1]

The combination of fibrin-rich plasma (FRP) with xenografts has shown promising results with a low rate of bone loss.[9,10]

Complications such as wound opening, soft tissue dehiscence during healing, compromised blood supply, and dislocation of the graft and membrane may occur.[11]

This work aims to describe a clinical case of atrophic alveolar process reconstruction with xenograft, FRP, and titanium mesh; placement of an implant; and immediate provisionalization.

Clinical Case

This is a case of a 47-year-old female patient with no systemic diseases who came for a consultation to rehabilitate the esthetics and function of a tooth in the anterior area. Upon inspection, we found an edentulous area at the level of dental organ number 11 (Figures 1 and 2).

Case planning uses a 5X5 FOV cone beam tomography of the abovementioned area. The initial bone measurements were 1.45 mm in ridge width in the cervical area and 13.95 mm in length (Figures 3 and 4).

It was decided to perform GBR using titanium mesh 20 × 25 mm in size and 0.1-mm thick, bovine heterologous mix bone Gen-Os-OsteoBiol (grain size 250–1000 μm), FRP, and in a second surgical stage, the placement of a 3.75 × 13 mm implant with a conical body, internal hexagonal connection with Morse cone, and a pure titanium surface with incorporated calcium phosphate.

Under local anesthesia, a full-thickness flap is performed with 2 tension relief incisions on both sides of the edentulous area (Newman-type flap) with an envelope component and 2 relaxing incisions) (Figures 5 and 6).

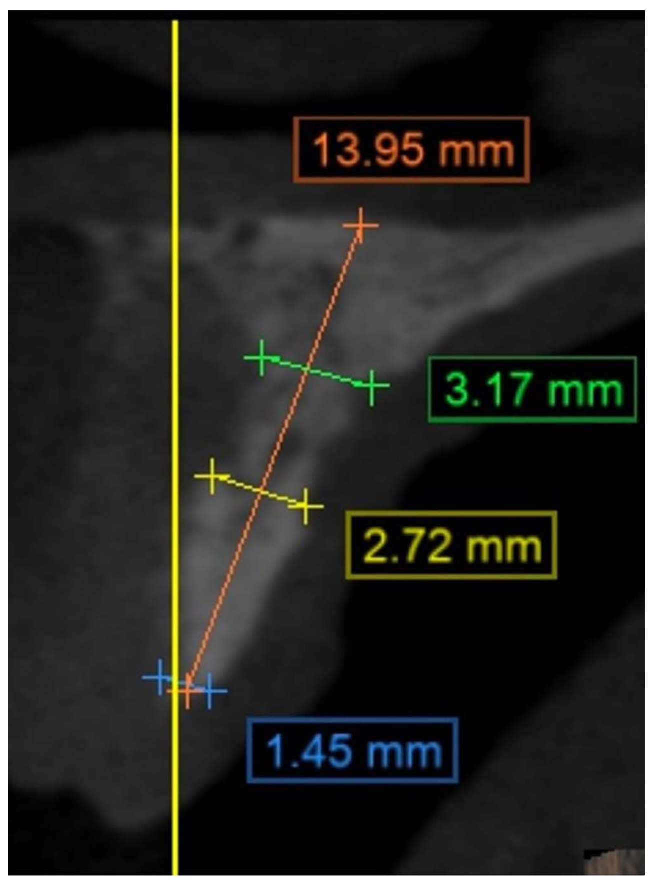

Figure 3. Preoperative tomographic image.

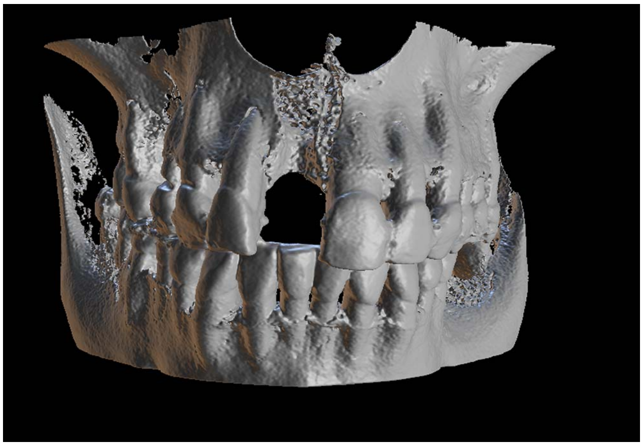

Figure 4. Preoperative three-dimensional reconstruction.

The mesh was fixed on the palatal surface with a 1.5 × 5 mm titanium microscrew, and the bone mixed with FRP was placed, obtaining an agglutinated mixture for easy bone placement (Figures 7 through 9).

Once the bone was placed on the buccal cortex, it was covered with the titanium mesh, and 2 more fixation screws were placed on the buccal surface to fix the mesh (Figure 10).

Subsequently, an FRP membrane was placed over the titanium mesh (Figures 11 and 12). Before suturing, the flap was elongated through incisions on its internal surface in the periosteum to close without tension, and finally, it was sutured with 4-0 Vicryl. After 10 days, an appointment was made to review and remove stitches. No complications were noted at 10 days postop.

To obtain the FRP, a sample of venous blood was obtained, which was put into the centrifuge STI PlasmaPrep for 3 minutes at 2500 rpm to separate the formed elements and plasma, obtaining the portion of fibrin that was mixed with the xenograft bone (Gen-Os-OsteoBiol). Another portion was used as a membrane that covered the titanium mesh (Figures 13 and 14).

After 6 months, it was evaluated with tomography, and adequate bone volume was obtained. The titanium mesh was removed under local anesthesia, again raising a Newman-type flap with an envelope component and 2 relaxing incisions as in

Figure 5. Reflected flap and exposed bone.

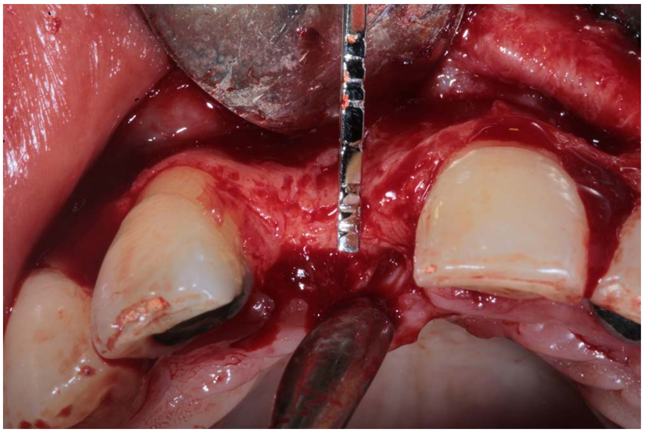

Figure 6. Preoperative transverse bone dimension.

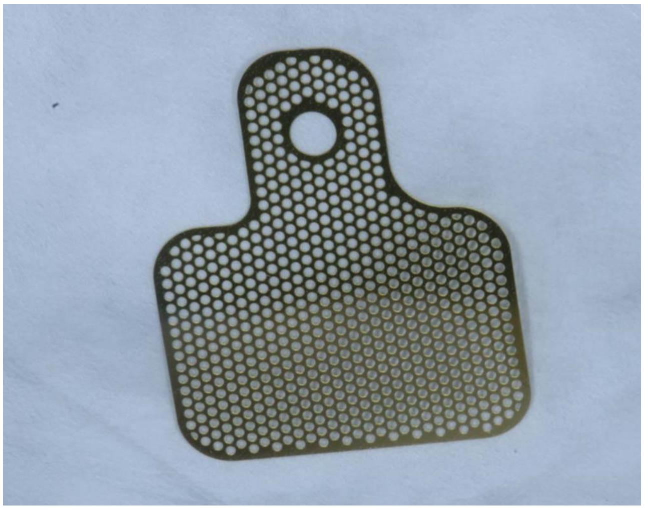

Figure 7. Titanium mesh.

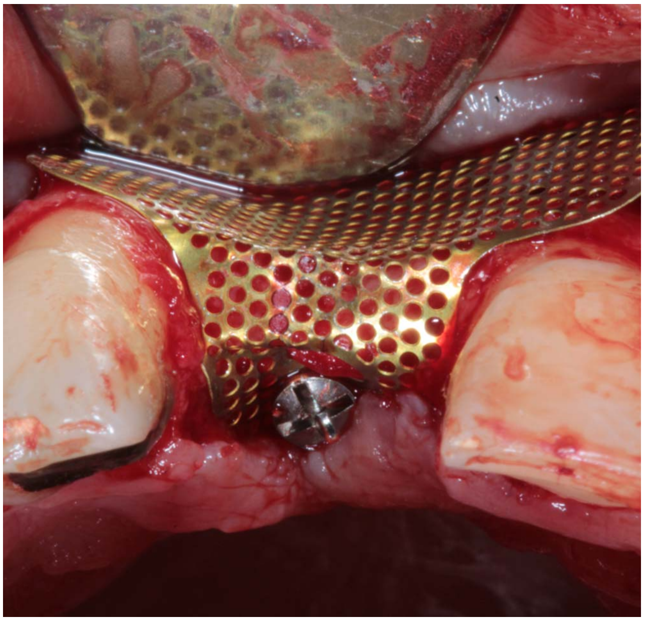

Figure 8. Titanium mesh fixed with microscrews.

Figure 9. Bone graft placed under the titanium mesh.

the first surgical stage, removing the screws and the titanium mesh (Figures 15 through 18). The planned implant was placed into the grafted bone (Figures 19 and 20), and a temporary acrylic tooth was placed (Figure 21).

When the titanium mesh was removed, a thin layer of bone remained attached to it. That bone and the bone derived from drilling when placing the implant were sent to the histopathology service for histological analysis of the obtained material.

Microscopic description: Excisional biopsy product obtained an oval-shaped specimen, light brown, measuring 1.4 $\times$ 0.8 cm. The section showed a crackling consistency; it was processed with hematoxylin and eosin staining. The histopathological study revealed a fragment of irregularly shaped mineralized tissue with an osteoid appearance and abundant osteocytes in the secretory stage toward the periphery of the sample. Moderately dense fibroconnective tissue was identified with a disorganized arrangement of collagen fibers. No associated inflammatory process was identified (Figure 22).

In the tomographic images, bone volume gain is observed vertically and horizontally (Figures 23 and 24). The 3 measurements

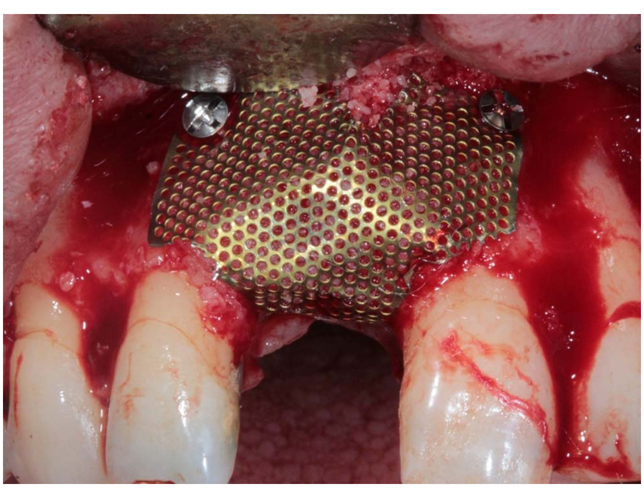

Figure 10. Final fixation of the titanium mesh.

Figure 11. FRP membrane placed over the titanium mesh.

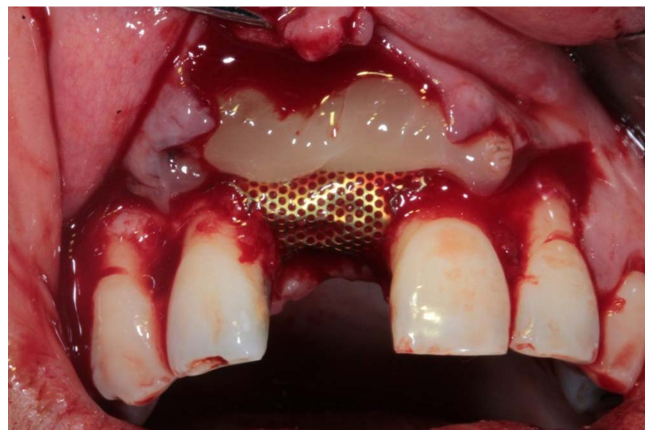

Figure 12. FRP membrane placed over the titanium mesh.

Figure 13. Blood extraction.

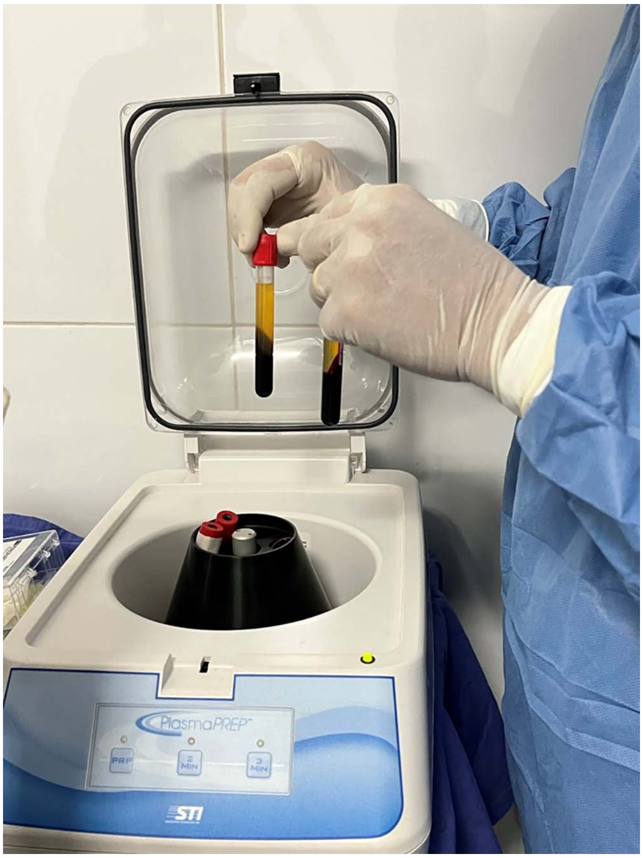

Figure 14. Obtaining the FRP.

derived a mean horizontal bone gain of 5.57 mm. The original dimensions, the dimensions after surgery, and the gain are shown in Table.

Discussion

The reported case had a sizeable deficiency in horizontal and vertical dimensions. The combination of different elements, such as the xenograft combined with FRP, the placement of a

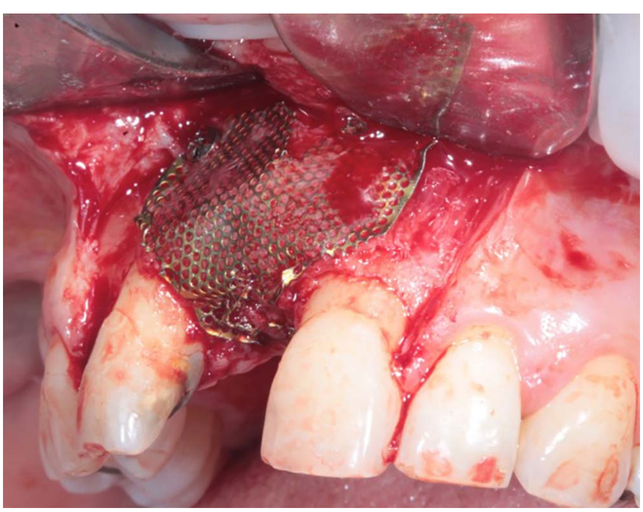

Figure 15. Mesh removal 6 months after placement.

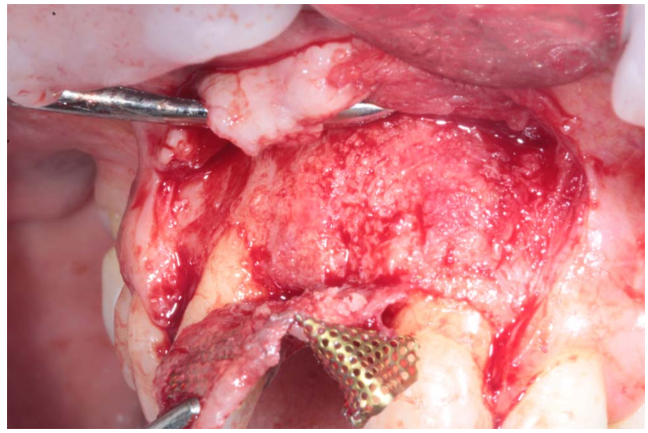

Figure 16. Bone volume obtained after 6 months of placement.

titanium mesh, and the final coverage of the mesh with a platelet-rich fibrin membrane, resulted in a significant gain in these dimensions.

In this case, a mean horizontal bone gain of 5.57 mm was achieved. This is derived from the 3 measurements taken. The original dimensions, the dimensions after surgery, and the gain are shown in Table 1. This gain is more significant than Toledano-Osorio et al report (horizontal gain of 3.95 mm with a range of 3.19 to 4.7 mm) using different guided bone regeneration schemes.[12]

Some authors, such as Starch et al, support the idea that there is no significant difference between autografts and allografts concerning bone gain and long-term stability.[1] In this case, heterologous bone material gave good results with bone gain in horizontal and vertical dimensions. Ucer et al mention that FRP has biological and clinical advantages to improving all wound and tissue healing phases. FRP has growth factors and

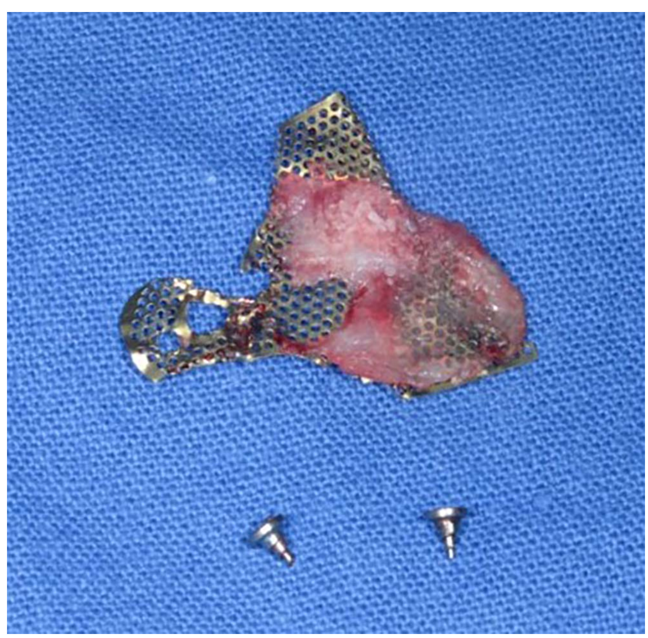

Figure 17. Mesh removed with bone attached to its surface.

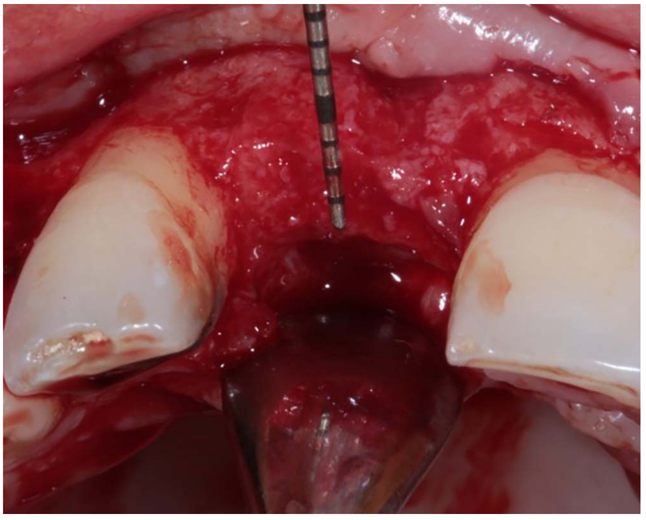

Figure 18. Bone volume obtained.

fibrin that act as a mechanical biomaterial to stabilize the graft and serve as a barrier. In this case, the grafted bone was first mixed with FRP and was subsequently covered with a membrane of the same material.[13]

Although bone has a remarkable ability to spontaneously remodel and regenerate after bone trauma, bone defects of critical size and/or lacking bone wall could not heal spontaneously and would require the use of additional elements such as bone grafts, scaffolds, cells, and/or growth factors to achieve satisfactory regeneration.[14] In this case, osteoinductive elements were combined, such as applying FRP with the graft and the membrane

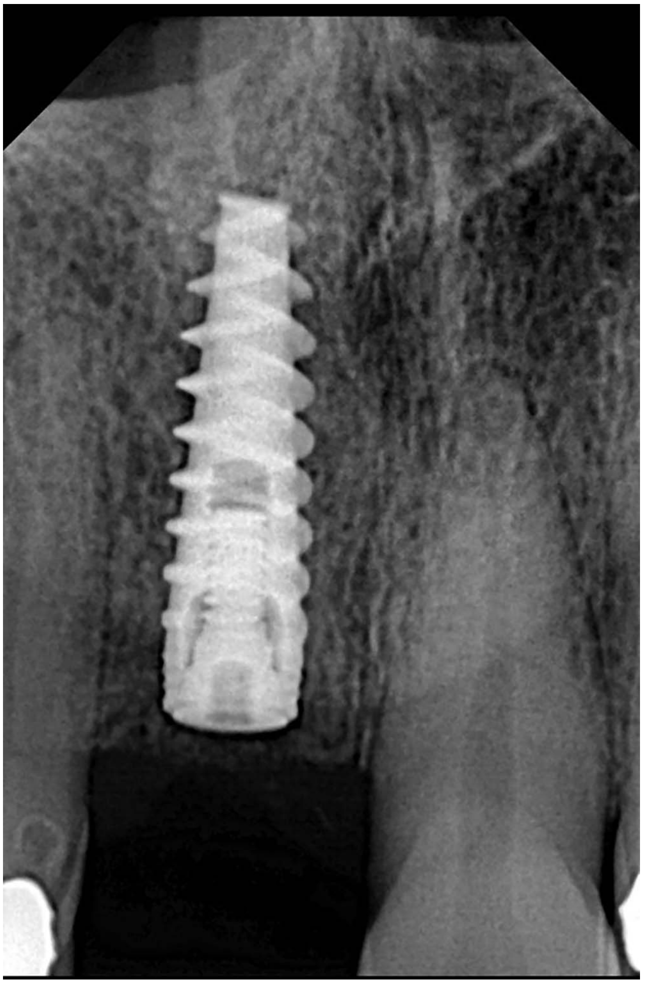

Figure 20. Implant placed in graft site.

of the same material. Osteoconductive elements, such as the graft and titanium mesh, added to the osteoforming capacity of the patient's recipient bone.

In these cases, wound closure is usually complicated because the soft tissue is insufficient to cover without

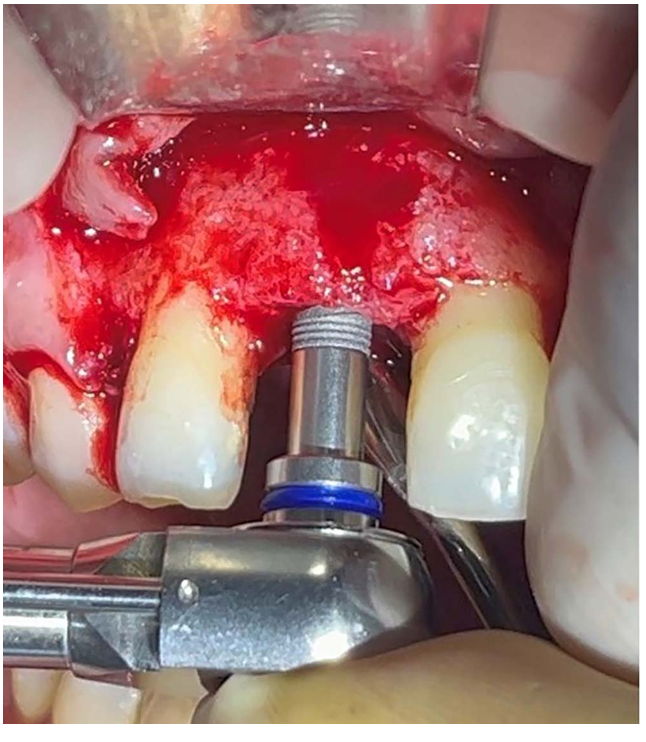

Figure 19. Implant placement at the graft site.

Figure 21. Immediate postoperative period after mesh removal and implant placement.

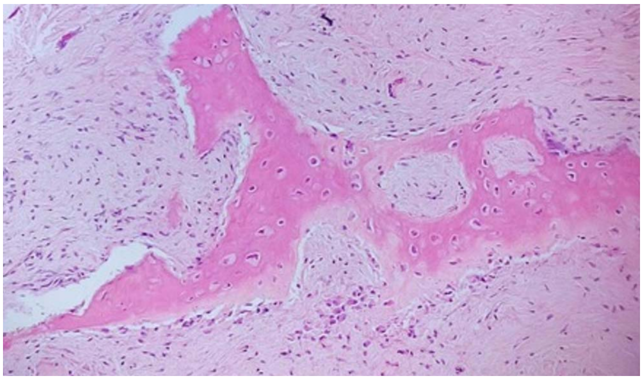

Figure 22. Histopathological image.

tension an area in which there is now more volume occupied by the grafted bone as well as the barrier, in this case, the titanium mesh and the FRP membrane. Unlike what was done to resolve this case, some authors recommend making

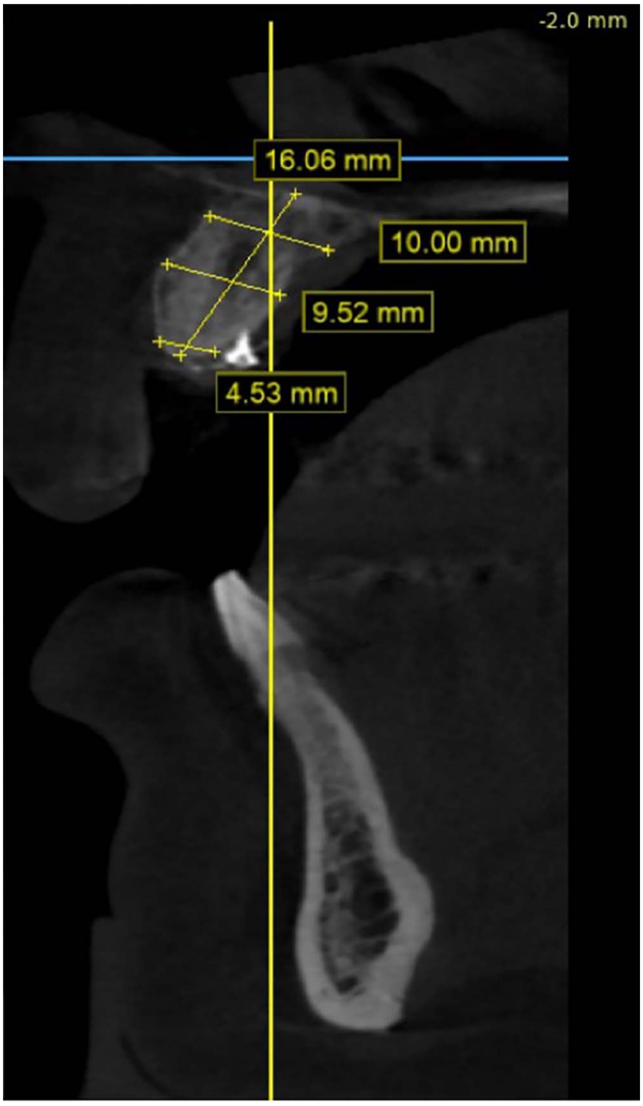

Figure 23. Bone volume gained in both directions on tomographic image.

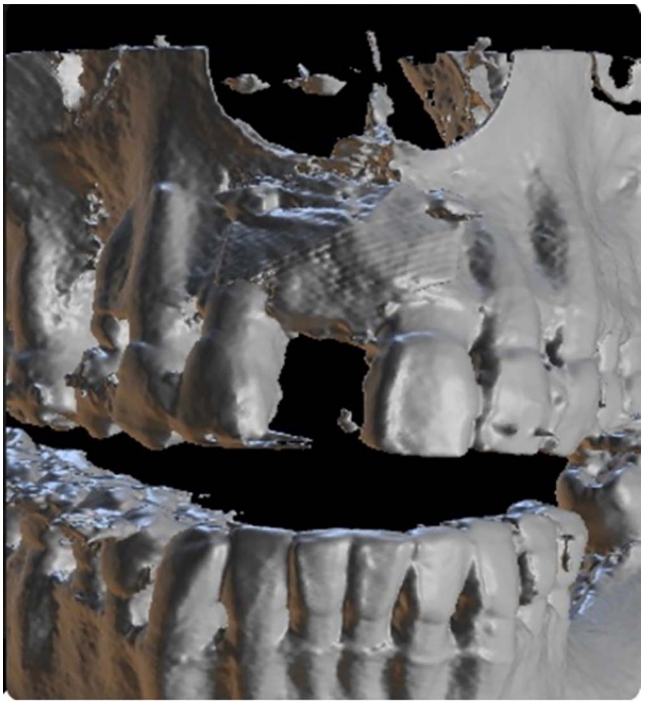

Figure 24. Bone volume gained in both directions on tomographic image with three-dimensional reconstruction.

partial thickness flaps; the flap is only mucosal, leaving the periosteum management in a separate layer.[5] This breaks the tension that the periosteum layer generates, thus reducing the risks of wound dehiscence and subsequent graft exposure. In this case, incisions were made on the inner surface of the flap to allow the periosteum to open and break the tension. Remember that the periosteum is more rigid and less compliant than the oral mucosa.

Immediate loading and provisionalization in native bone, as well as postextraction and simultaneous regeneration, are well described in the literature; however, there is not much scientific evidence of performing implant placement and provisionalization in regenerated bone.[15] In this clinical case, we placed an implant with provisionalization in the anterior sector with a regenerated bone. This suggests that this treatment is predictable and safe, considering primary stability greater than 35 N as a success factor in immediate loading. This allows the patient to leave the office with an esthetic problem resolved, which suggests this treatment be performed by a multidisciplinary team with experience in the area.

Table

Original dimensions, post-surgery dimensions, and gain

Alveolar Process Measurement Area	Preoperative, mm	Postoperative, mm	Gain, mm
Cervical third	1.45	4.53	3.08
Middle third	2.72	9.52	6.8
Apical third	3.17	10	6.833
Height	13.95	16	2.05

The case selection was based on the significant horizontal and vertical bone resorption, the need to place an implant in the area, which would not have been possible in the original bone, and the need to correct the esthetic defect caused by the resorption in the vestibular area.

The treatment was chosen precisely to resolve this severe bone loss in the alveolar process. It was decided to implement osteoinduction (FRP) techniques and osteoconduction (titanium mesh, FRP membrane, grafted bone) combined with the outperforming capacity of the original alveolar process bone.

Things that should be highlighted in the presentation of these cases are the considerable gain of alveolar bone, the quality of bone obtained (confirmed with histopathological study), the primary stability obtained when placing the implant, and the immediate provisionalization. All this was achieved by the combination of different elements as well as the multidisciplinary participation of specialists.

Conclusion

The success of the reconstruction of alveolar processes depends on multiple local and systemic factors. In the reported cases, some of the determining factors for the success of the reconstruction were the combination of therapeutic elements that favored osteoinduction (combination of bone with FRP and placement of FRP membrane) and elements that favored osteoinduction (bone graft and titanium mesh); osteoformation occurred through the recipient's bone.

Incisions were made in the periosteum layer on the internal surface of the flap to eliminate tension during suturing. The periosteum is less flexible than the oral mucosa. This maneuver allows the flap to be more distensible and close with less tension.

The immediate conditionalization after implant placement allowed us to offer the patient a faster esthetic solution.

Note

No external funding was received. The authors declare no conflict of interest. Ethics approval not required. The data supporting this study's findings are available from the corresponding author upon reasonable request.

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