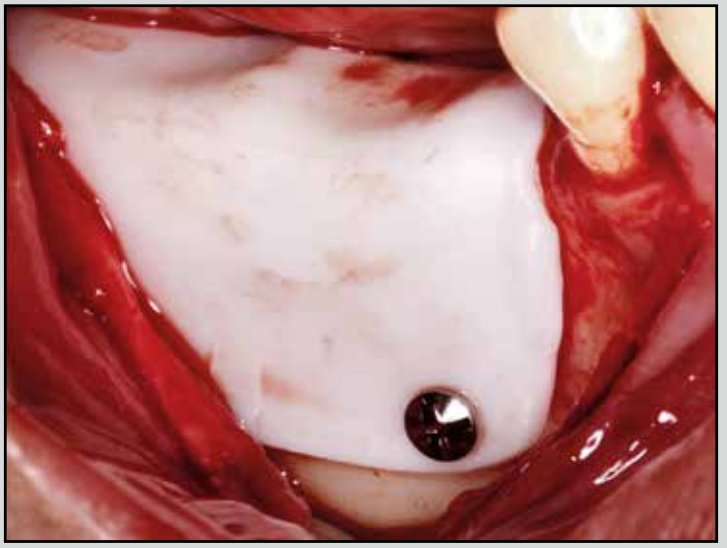
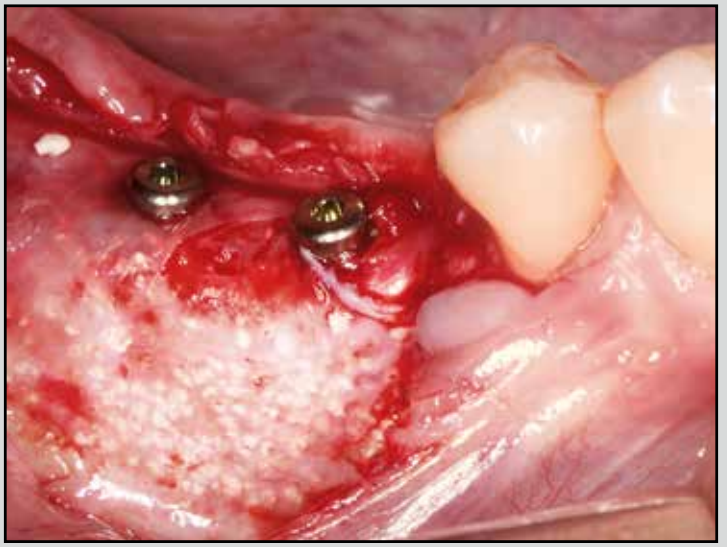
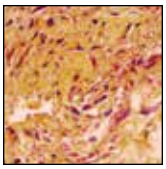




Personalized Bone Regeneration with a Novel Zirconia Membrane: A Case Report



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Varying amounts of bone resorption can occur following tooth loss, and this can lead to implant placement problems due to a lack of an alveolar ridge with suitable osseous dimensions. There are many techniques for bone regeneration and many types of barriers, including polytetrafluoroethylene, collagen, and titanium meshes. The present case report describes the use of a customized CAD/CAM zirconia barrier for vertical ridge augmentation. A bone height gain of 12 mm was observed, as well as 8 mm of width. Subsequent histologic analysis revealed an excellent bone quality, allowing successful implant placement. Int J Periodontics Restorative Dent 2021;41:391–395. doi: 10.11607/prd.4658

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After tooth loss, varying amounts of resorption occur because of the loss of the buccal plate.[1,2] These changes range from a vertical buccal bone loss of 1.99 mm to a 40% to 50% loss of horizontal bone width during the first 6 to 12 months after healing.[3] Most dimensional changes occur during the first months and continue over time, with an additional 11% loss in volumetric mass over the next 5 years.[4] This could lead to implant placement problems due to a lack of an alveolar ridge with suitable osseous dimensions.[3]

Several techniques for regenerating and improving the height and width of the alveolar process have been described to form new bone tissue for implant placement,[5,6] the most complicated and unpredictable of which is vertical ridge regeneration.[7,8] Thus, vast amounts of the literature are regarding bone grafts in block or in particles, osteogenic distraction, and the use of absorbable[9] and nonresorbable barriers.[10]

Different material barriers are currently available, all with varying degrees of complication in their clinical use. These include but are not limited to polytetrafluoroethylene, collagen, and titanium. The latter does not work exclusively as a barrier, but more like a mesh aiding in graft immobilization.

Vertical ridge augmentation can present bone growth from 2 to

Fig 1 *Zirconia membrane in a stereolithographic model.*

14 mm,[7] but treatment failure has been seen, ranging from 0% to 45.5%.[11] The most frequent complications are described during reopening of a healed wound and are due to either poor surgical technique or significant inflammation. Wound dehiscence with or without subsequent infection may also occur.[7,12]

As an alternative technique in regeneration that tailors each treatment to individual patient needs, the present authors created a customized design zirconium barrier using a CAD/CAM and a CBCT scan.[13] There is limited data on the use of zirconium as a barrier for guided bone regeneration. The purpose of this case report is to describe the use of a customized zirconia barrier in vertical ridge augmentation.

Case Report

A 46-year-old woman with diffuse bone resorption was evaluated for implant placement and regenerative treatment at a private practice (G.M.A.) in Lima, Peru. After an extensive clinical history-taking and evaluation along with prosthetic and tomographic viewing, a zirconium membrane was manufactured for better adaptation and to enhance the results of the regenerative processes (Fig 1).

CBCT images were acquired in Digital Imaging and Communications in Medicine (DICOM) format, and digitized in the CAD software (CORiTEC 250i). This file is used for a customized design of the 3D zirconia membrane (Rainbow Block, Dentium) that adapts to the topography of the remaining bone defect. A 0.8-mm zirconia thickness is assigned for a better biocompatibility with soft tissues throughout its surface. Subsequently, the barrier is exported for milling using CAM software, and then sintered at 1,450°C and autoclaved for disinfection (TINHERO-16 Class B, Runyes) at 134°C.

Surgical Phases

First surgical phase

A 60-second clorhexidine oral rinse (Perio-Aid 0.12%, Dentaid) was used prior to surgery. Infiltrative local anesthesia with 20 mg/mL of lidocaine followed by 12.5 mg/mL of epinephrine was delivered at the surgical site (Xylocaine Dental with Epinephrine, Dentsply Sirona). Using a 15c scalpel, a crestal incision was made slightly away from the medial crest. Vertical releasing incisions were made from the buccal site to facilitate adequate flap repositioning. A full-thickness flap was made, removing mylohyoid fibers to release the lingual flap (Fig 2a), followed by remnant bone decortication with a 1.5-mm round drill (Brasseler) to promote and ensure vascularity (Fig 2b). The alloplastic bone graft 60% hydroxyapatite, 40% ß-tricalcium phosphate (Osseoplus, JHS Biomaterials) was mixed with 30% autologous bone (harvested with a bone scraper from the mandible) and placed under the barrier with great ease (Fig 2c). The barrier was fixated with one self-tapping fixation screw (Fig 2d). The membrane adaptation was so precise that a fixation screw was not entirely necessary, as the adaptation would allow membrane placement with no movement. A horizontal mattress suture was performed using polytetrafluoroethylene (PTFE) 4/0 and nylon 4/0 sutures 5-mm from the incision line, followed by simple sutures to ensure primary wound closure.

Postoperative antibiotics (875 mg amoxicillin plus 125 mg clavulanic acid) were prescribed three times a day for 1 week, as well as chlorhexidine 0.12% rinses three times a day.

Second surgical phase

Seven months after the initial surgery, and following tomographic evaluation for dental implant placement, the surgical site was reopened.

The zirconia membrane was removed with great ease, and bone formation was confirmed (Fig 3a). In accordance with the prosthetic plan with splinted crowns, two dental implants (3.5-mm diameter, 14-mm height) with conical Morse connection were placed[14–16] (Neodent Grand Morse, Straumann; Fig 3b). A trephine was used to obtain a biopsy sample of the regenerated bone at the implant placement site. The sample was sent for histologic analysis and inmunohistochemistry.

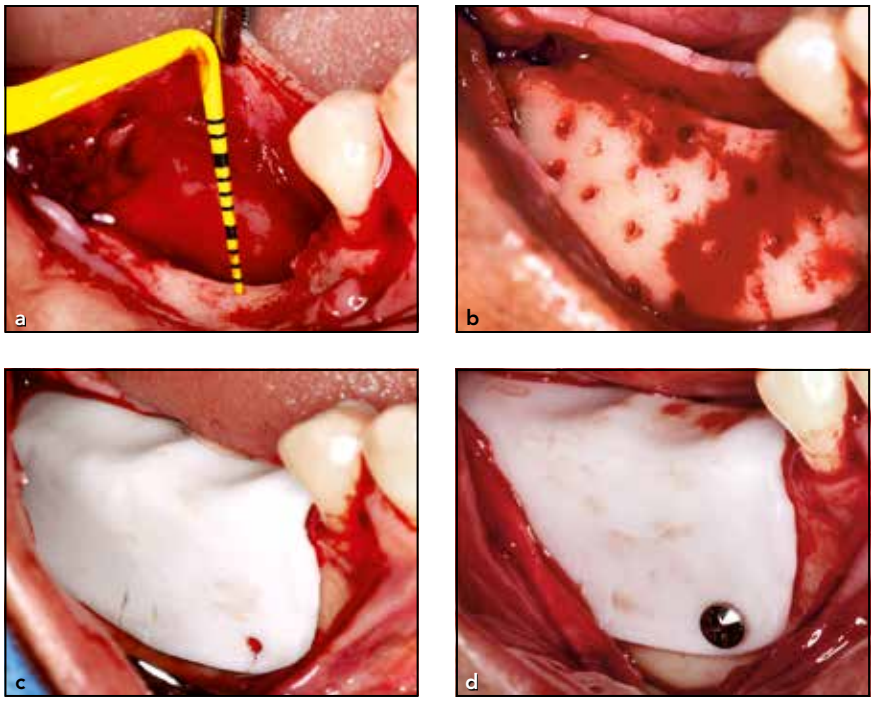

Fig 2 (a) *View of the bone defect. The mylohyoid fibers were debrided.* (b) *Bone decortication was performed for blood supply.* (c) *The zirconia membrane was adapted in the bone defect.* (d) *A fixation screw was positioned to stabilize the membrane.*

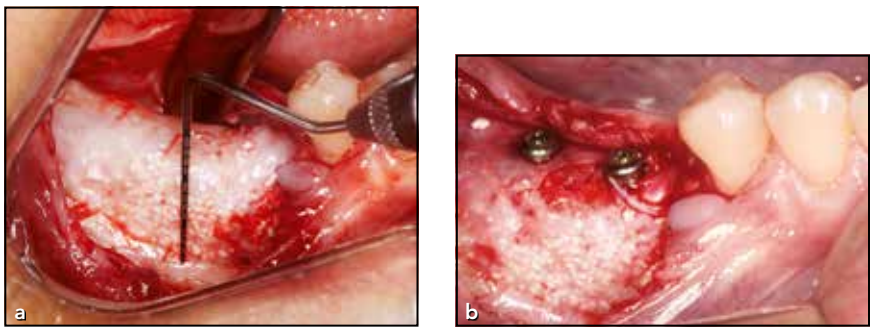

Fig 3 *Second surgical phase.* (a) *The regenerative bone was clinically measured.* (b) *Implants were placed, achieving great stability.*

Histopathologic Analysis

For conventional morphology, the tissue sample was fixed in 10% buffered formalin at room temperature for 48 hours, then decalcified for 24 hours at 37°C (Surgipath Decalcifier I, Leica Biosystems), dehydrated, paraffin-embedded in an automatic tissue processor (Excelsior AS, Thermo Fisher Scientific), and sectioned. Sections were stained with Movat's Pentachrome stain.

For immunohistochemistry, primary polyclonal antibody against Musashi-1 (MSI1) was applied and incubated at a dilution of 1:100 for 1 hour at room temperature. A nonimmunospecific immunoglobin G (IgG) was used as a negative control. The immunostaining was performed in an automatic immunostainer (Autostainer 480S, Thermo Fisher Scientific).

Discussion

This clinical case describes the successful management of a bone defect with a customized manufactured zirconia membrane, resulting in a 12-mm gain in bone height and an 8-mm gain in bone width. Histologic analysis revealed excellent bone quality consisting of 42.6% vital bone, 5.17% residual graft, and 52.2% of nonmineralized fraction (Figs 4a to 4c), allowing implant

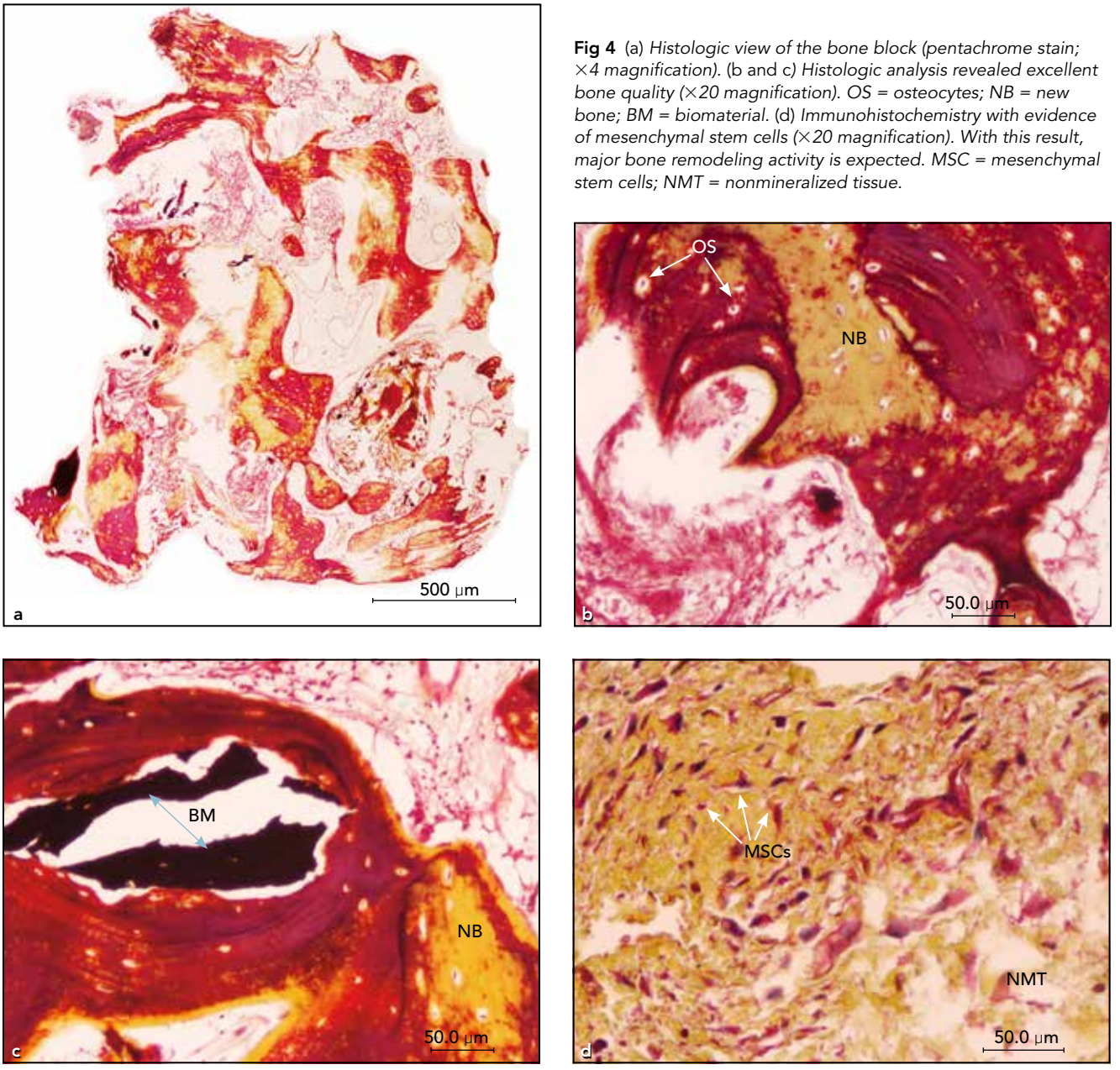

Fig 4 (a) *Histologic view of the bone block (pentachrome stain; ×4 magnification).* (b and c) *Histologic analysis revealed excellent bone quality (×20 magnification). OS = osteocytes; NB = new bone; BM = biomaterial.* (d) *Immunohistochemistry with evidence of mesenchymal stem cells (×20 magnification). With this result, major bone remodeling activity is expected. MSC = mesenchymal stem cells; NMT = nonmineralized tissue.*

placement and osseointegration. In the immunohistochemical analysis, the sample was MSI1-positive and revealed the presence of mesenchymal stem cells. With this result, major bone remodeling activity is expected (Fig 4d).

Although validation of CAD/CAM scanners and the technology to manufacture customized membranes requires vertical regeneration and randomized clinical studies, the present case report successfully demonstrates its use and may pave the way for a relatively unexplored line of research in current implantology.

Vertical osseous regeneration has been achieved using titanium membranes, expanded PTFE (ePTFE), and in some cases, resorb-

able membranes. The use of titanium and ePTFE membranes have been extensively described in the literature and present the greatest predictability.[7]

Conclusions

Zirconia presents great biocompatibility and stability within soft tissues.[17] The use of a customized zirconia barrier allowed better adaptation to the osseous defect and facilitated graft placement within the membrane. Furthermore, the barrier stabilization with fixation screws significantly reduced undesirable movement, favoring a guided osseous regeneration. This study is consistent with previously presented findings[18] describing the use of a customized rigid zirconia barrier to design the required bone shape for predictable regeneration results.[19]

Acknowledgments

The authors declare no conflicts of interest.

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