# Nitride-Coated Titanium Mesh and Particulate Allograft for Vertical Ridge Augmentation

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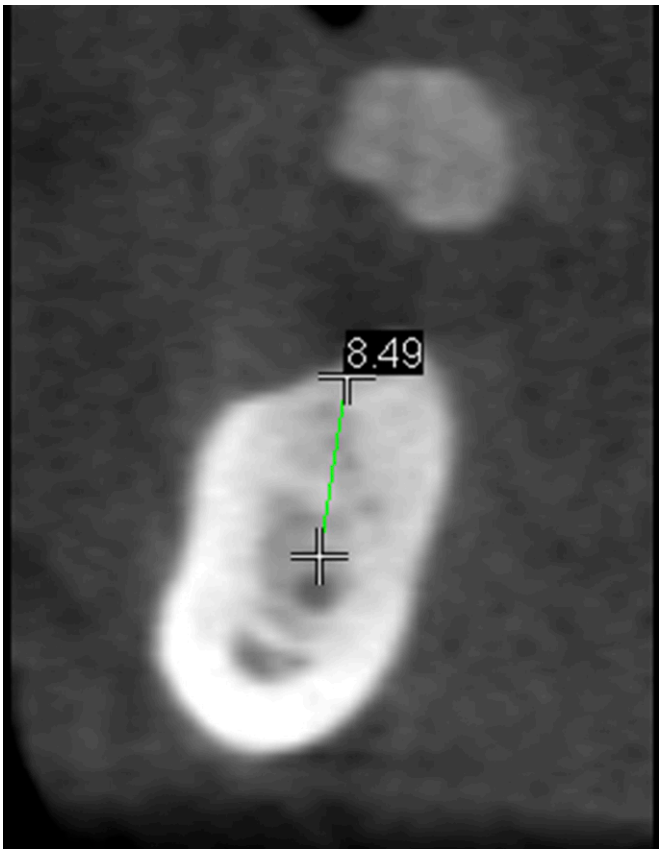


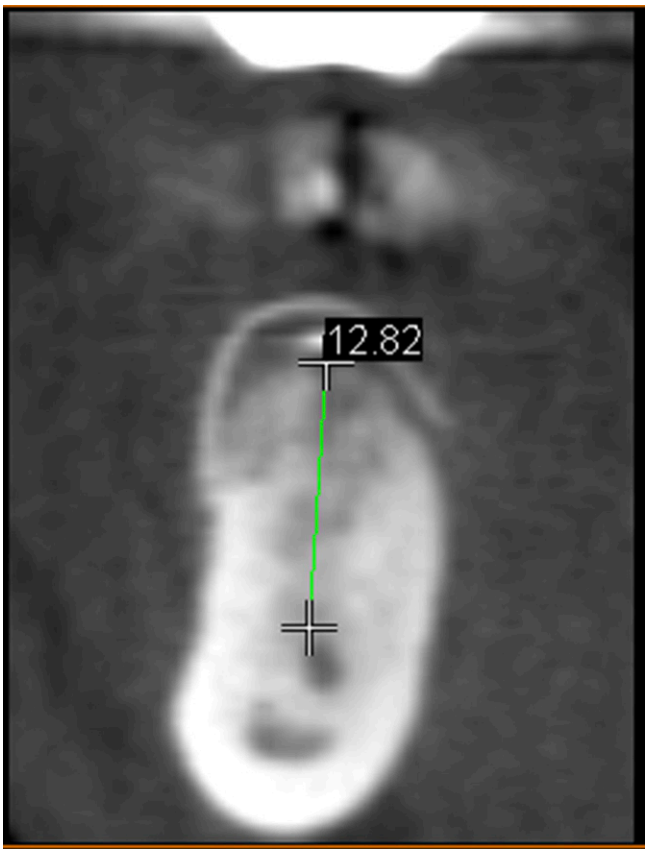


**Introduction:** Titanium mesh (Ti-mesh) has been used as a space-making material in vertical ridge augmentation (VRA). Difficulties in handling this material remain a major obstacle for its routine use. This case report describes the clinical efficacy of Ti-mesh with a modified surface for VRA.

**Case Presentation:** A 65-year-old Asian male presented requiring VRA in the posterior mandible for the placement of standard-sized implants (≥10 mm). The area was treated with Ti-mesh and allograft particulates. The Ti-mesh used has a small pore size (300 μm), which is capable of containing bone grafts, and titanium nitride coating, which allows for easier mesh retrieval. The healing was uneventful. Six months after the surgery, a mean of 4.0-mm ridge height gain was obtained. Three standard-sized implants (3.8 × 10.5 and 4.6 × 10.5 mm) were placed in the augmented region.

**Conclusions:** This case report demonstrates that the newly designed Ti-mesh applied in this case report, in combination with allografts, is effective in increasing ridge height in the posterior mandible. The amount of vertical bone gain is comparable with the published data in the literature using other types of barrier membranes, including titanium-reinforced membrane. *Clin Adv Periodontics* 2014;4:182-186.

**Key Words**: Alveolar bone loss; alveolar ridge augmentation; bone transplantation; mandible; surgical mesh; titanium.

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**Submitted March 26, 2013; accepted for publication May 14, 2013**

**doi: 10.1902/cap.2013.130032**

## Background

In the posterior mandible, placement of standard-sized implants (≥10 mm in length) is often limited by the available bone height attributable to ridge resorption as a result of tooth extraction and the presence of the inferior alveolar nerve. Hence, vertical ridge augmentation (VRA)

is often indicated. VRA can be achieved by using titanium mesh (Ti-mesh) in combination with bone grafts.[1-8] Ti-mesh was first used for the repair of non-united mandibular fractures.[3] Later, it was applied for the reconstruction of atrophic alveolar ridges.[2] With the popularity of implant therapy, it has also been used for implant site preparation.[1,4-8]

Ti-mesh can provide several advantages.[9] The main advantage is that its rigid structure provides space for the bone to grow. The material is porous, which allows for blood supply from the flaps to the surgical site. Another advantage is that it reduces bone resorption during the healing period.[7] However, it is technique sensitive; molding Ti-mesh to accommodate the ridge defect and fixing it to the bone are the main challenges. Additionally, it is difficult to contain bone particles in Ti-mesh with a large pore size. To retrieve it at the reentry surgery presents another obstacle for using it routinely.

The case presented here reports on the use of a newly designed Ti-mesh,† featuring a small pore size (300 μm) and titanium nitride (TiN) coating for easier retrieval, in combination with a particulate allograft‡ for vertically augmenting an atrophic posterior mandible.

## Clinical Presentation

A 65-year-old Asian male with controlled diabetes was seen in the Graduate Periodontics clinic at the School of Dentistry, University of Michigan, Ann Arbor, Michigan, in June 2012 for oral rehabilitation with dental implants. Irregular crestal soft-tissue level and noticeable vertical ridge resorption were noted in his right posterior edentulous mandible (Fig. 1). Cone-beam computed tomography (CBCT) scans§ showed that the residual ridge height was ≈8.5 mm at implant positions #30 and #31 (Fig. 2).

## Case Management

After discussing possible treatment options with the patient and obtaining both written and oral informed consent, a decision was made to augment the ridge with the previously described Ti-mesh and allograft particulates. Under local anesthesia, a crestal incision was made on the edentulous ridge, connecting with an intrasulcular incision at teeth #27 and #28. Full-thickness flaps were elevated on both the buccal and lingual sites (Fig. 3a). The buccal flap was released by periosteal scoring at several millimeters from the mucogingival junction. Intramarrow penetration was performed on the bare bone at the edentulous ridge (Fig. 3b). Two tenting screws were placed with the aid of a driver‖ (Fig. 3c). Ti-mesh was trimmed and stabilized to the lingual plate by fixation screws.¶ Bone grafts described previously were added under the mesh and packed gently (Fig. 3d); subsequently, the mesh was fixed to the buccal ridge (Fig. 3e). Flaps were approximated with non-resorbable sutures# (Fig. 3f). Postoperative instructions and medications, including analgesics and antibiotics, were given to the patient. Most sutures were removed at 3 weeks. The healing was uneventful during the healing period.

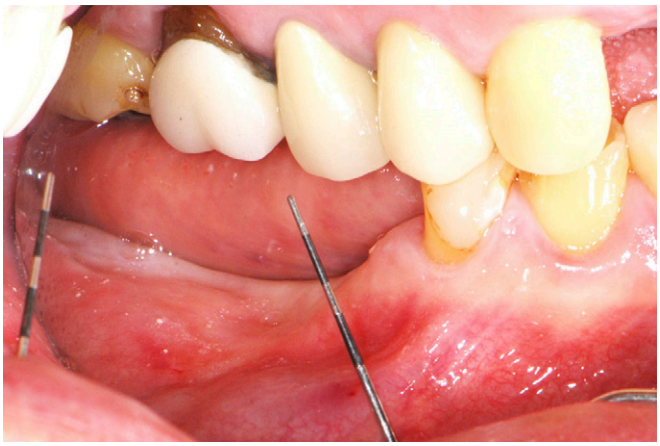

**FIGURE 1** Clinical buccal view of the right posterior edentulous mandible.

## Clinical Outcomes

Six months after the surgery, the soft tissues at the ridge crest had a more even contour (Fig. 3g). The ridge height increased by 4.33 and 3.59 mm, measured at implant sites #30 and #31 from CBCT scans (Fig. 4). The bone grafts were integrated with the host bone (Fig. 5a). Three standard-sized implants** were placed (Fig. 5b) with adequate distances from the inferior alveolar canal (Fig. 5c). Clinical parameters, including soft- and hard-tissue measurements, are summarized in Table 1.

## Discussion

A key to the successful application of Ti-mesh for ridge augmentation relies on manipulation of the material. The small-pore-sized mesh used in this case report favorably contains bone grafts. Its thin layer (0.2 mm), while not losing rigidity, aids in achieving primary closure. It is relatively easy to remove from the bone because of the TiN coating. Conversely, the mesh has a tendency to return to its original shape after being molded, which might increase the risk of wound opening. Therefore, the ability to fix the mesh, especially on the lingual side, is critical. A preformed mesh with three-dimensional architecture might be preferred.[10] Other materials that show good space maintenance property, such as injectable calcium phosphate cement[11] and reinforced expanded polytetrafluoroethylene membranes,[12] can also be used if fixation of Ti-mesh is not attainable.

TiN has been used as a coating material on substrates, such as titanium alloys and other base metals, to improve the resistance of substrates to corrosion, wear, and bacterial colonization.[13,14] The thickness of TiN in most indications is <5 μm, or brittleness and bending cracks can cause

† Osteo-Mesh TM-300, Osteogenics Biomedical, Lubbock, TX.
‡ enCore combination allografts, Osteogenics Biomedical.
§ i-CAT Cone-Beam Computed Tomography machine, Imaging Sciences International, Hatfield, PA.
‖ Pro-fix Precision Fixation System Tenting Kit, Osteogenics Biomedical.
¶ Pro-fix Precision Fixation System Membrane Fixation Kit, Osteogenics Biomedical.
# Non-resorbable PTFE Monofilament Suture, Osteogenics Biomedical.
** Tapered Internal Implants, BioHorizons, Birmingham, AL.

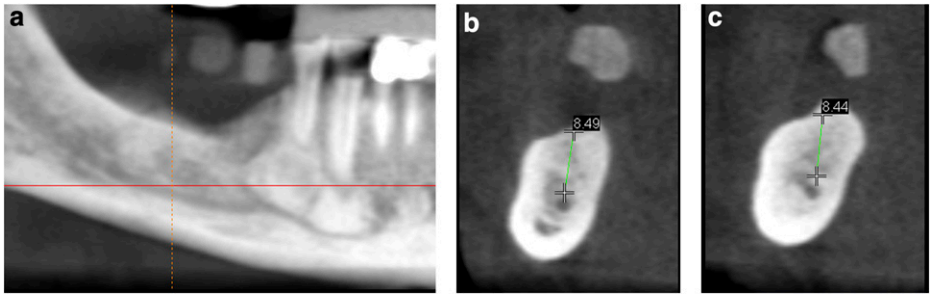


**FIGURE 2a** Reconstructed panoramic view of the atrophic ridge. Cross-sectional views at teeth #30 **(2b)** and #31 **(2c)** with the digital scale showing that the ridge height was ≈8.5 mm.

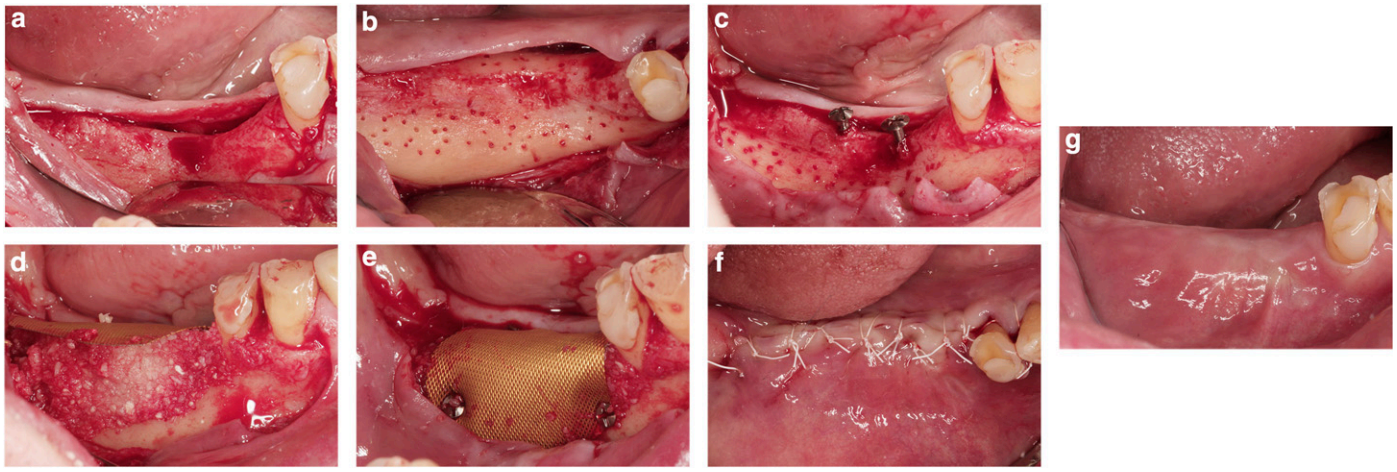


**FIGURE 3a** Full-thickness flaps were elevated to expose the underlying bone. **3b** Intramarrow penetration was performed on the bare bone to accelerate the healing. **3c** Two tenting screws were placed at the ridge. **3d** Allograft particulates were gently packed in the space between the bone and mesh. **3e** The mesh was fixed to the bone. **3f** Sutures were placed to achieve primary closure. **3g** Clinical view of the ridge at 6 months after the surgery.

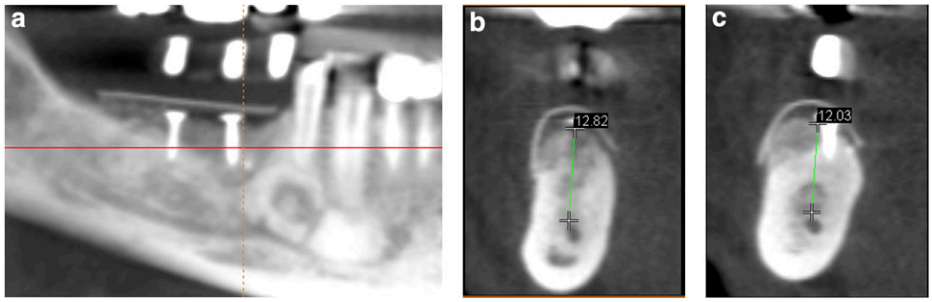


**FIGURE 4a** Reconstructed panoramic view of the augmented ridge. Cross-sectional views at teeth #30 **(4b)** and #31 **(4c)** with the digital scale showing that the ridge height was 12.82 and 12.03 mm, respectively.

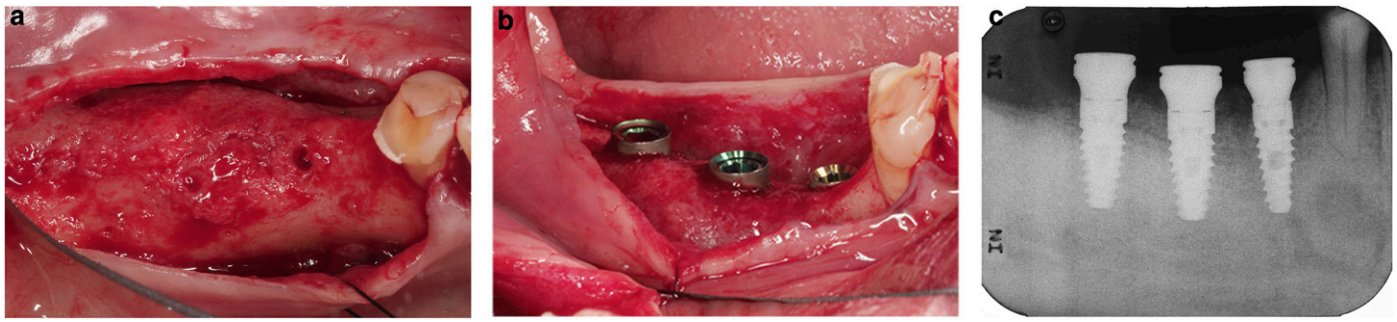


**FIGURE 5a** Clinical occlusal view of the augmented bone. **5b** Three implants were placed in the augmented ridge. **5c** A periapical radiograph showing that the three implants were in optimal locations.

concerns. The biocompatibility of TiN is similar to titanium oxide and pure titanium. The high density of the TiN coating along with the small pore size makes the mesh used in this case report easier to remove.

Most studies[2-8] using Ti-mesh for VRA combined the use of autogenous bone as a sole or part of the grafting material. Although considered the "gold standard," autogenous bone is associated with increased patient

**TABLE 1** Clinical Soft Tissue and Radiographic Bone Tissue Measurements at Tooth Sites #30 and #31

| Tooth Site | Baseline (mm) | | | Reentry (mm) | | | | ΔRH |
|---|---|---|---|---|---|---|---|---|
| | KM Width (B) | KM Width (L) | RH | KM Width (B) | KM Width (L) | RH | Implant Diameter | |
| #30 | 5 | 4 | 8.49 | 3 | 6 | 12.82 | 4.6 × 10.5 | 4.33 |
| #31 | 2 | 5 | 8.44 | 0 | 4 | 12.03 | 4.6 × 10.5 | 3.59 |

KM = keratinized mucosa; B = buccal; L = lingual; RH = ridge height, measured from the crest to the superior border of the inferior alveolar canal; ΔRH = increase in ridge height after the augmentation procedure.

morbidity and extended surgical time from graft harvesting. This case report uses an allograft that provided both osteoinductive and osteoconductive properties, eliminated a second surgical site, and shortened surgical time. Clinical outcomes from this case report are encouraging; a clinical trial with a larger sample size and histologic examinations is underway to further validate this surgical approach.

The literature related to the use of Ti-mesh and autogenous block grafts,[8] a mixture of inorganic bovine bone mineral and autogenous bone grafts[5,6] and bovine bone,[1] reported a mean 3- to 5-mm vertical gain. The amount of vertical bone gain in this study, measured at implant sites #30 and #31, is on average 4.0 mm, which is in agreement with the literature. Therefore, Ti-mesh might be useful for correcting moderately vertical deficient edentulous ridges. ■

## Summary

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|---|---|
| **Why is this case new information?** | ■ This case report supports that Ti-mesh with modified material properties could be as effective as other types of Ti-mesh for VRA. |
| **What are the keys to successful management of this case?** | ■ Prudent case selection (soft tissue and bony defect characters) and ensuring that the flap remains closed during healing are important. |
| **What are the primary limitations to success in this case?** | ■ The use of Ti-mesh is very technique sensitive, and it requires great clinical experience. |

## Acknowledgments

This case report is partially sponsored by the University of Michigan Graduate Periodontics Research Fund. The authors thank Osteogenics Biomedical, Lubbock, Texas, and BioHorizons, Birmingham, Alabama, for their generous sponsorship of the materials used for ridge augmentation and dental implants, respectively. Dr. Wang has received lecture fees from Osteogenics Biomedical and BioHorizons. Dr. Chan reports no conflicts of interest related to this case report.

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