Case Report

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Localized ridge augmentation in the anterior maxilla using titanium mesh, an alloplast, and a nano-bone graft: a case report

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Abstract

Alveolar ridge deficiency is considered a major limitation for successful implant placement, as well as for the long-term success rate, especially in the anterior maxillary region. Various approaches have been developed to increase bone volume. Among those approaches, inlay and onlay grafts, alveolar ridge distraction, and guided bone regeneration have been suggested. The use of titanium mesh is a reliable method for ridge augmentation. We describe a patient who presented with a localized, combined, horizontal and vertical ridge defect in the anterior maxilla. The patient was treated using titanium mesh and alloplast material mixed with a nano-bone graft to treat the localized ridge deformity for future implant installation. The clinical and radiographic presentation, as well as relevant literature, are presented.

Keywords

Ridge, augmentation, titanium, mesh, alloplast, graft, membrane, maxilla, nanobone

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Introduction

Adequate peri-implant bone support is essential for immediate and long-term implant stability, as well as for future aesthetic outcome.[1] Several reconstruction procedures have been suggested to increase alveolar bone height and width, including autogenous bone block grafts,[2] distraction

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osteogenesis,[3] and particulate autogenous bone grafts.[4] Although these augmentation techniques can increase the ridge dimensions, they have some complications, such as extended time, cost, bone resorption, discomfort to patients, and morbidity.[5]

The main challenge of bone grafting is bone resorption. To limit this disadvantage, the use of bone grafting materials in combination with barrier membranes has been suggested using the guided bone regeneration (GBR) technique.[6,7] The GBR technique entails space using barrier membranes that are subsequently filled with new bone.[8] Several resorbable and non-resorbable membranes have been used clinically for GBR procedures. Enhancing membrane properties can positively affect regenerated tissues during osteogenesis. GBR membranes should provide biocompatibility, occlusiveness (isolation), maintenance of space, and bio-integration with the surrounding tissue.[9–10] Although resorbable membranes do not require a second surgical re-entry, their unpredictable extent of resorption can considerably affect the quantity of regenerated bone. Additionally, if membrane exposure occurs, the accompanied inflammatory reactions lead to rapid degradation of the membrane, thereby affecting the bone regenerative process.[11]

Polytetrafluoroethylene and titanium mesh (Ti-mesh) are the most commonly used non-resorbable membranes. They provide a rigid space-maintaining barrier with a reduced risk of complications, as well as tissue biocompatibility.[12] Ti-mesh was first introduced by Boyne et al.[13] in 1969 for reconstruction of large osseous defects. Thereafter, titanium has been commonly used in various surgical procedures because of its rigidity and high biocompatibility.[14] Von Arx et al.[14] suggested the use of Ti-mesh with autogenous bone for ridge augmentation. The sufficient rigidity of this mesh provides maintenance of space for new bone formation, while preventing graft displacement and mucosal compression. Ti-mesh provides maintenance of space and is less susceptible to bacterial contamination than resorbable membranes.[15] Moreover, the manageability of Ti-mesh allows three-dimensional reconstruction of bony defects.[6,16]

While autogenous bone is believed to be the gold standard in alveolar reconstructive techniques, limited availability and resorption tendency are its main disadvantages.[17] The nano-bone graft is a newly developed alloplast comprising a silica gel matrix with hydroxyapatite nanocrystals in the matrix. The nano-structure pattern together with a rough granular surface create a porous pattern mimicking the structure of normal bone.[18]

In this case report, we evaluated the combined use of Ti-mesh with alloplast and a nano-bone graft for localized ridge defect augmentation.

Case report

A 35-year-old healthy woman was referred to the Department of Periodontology, Alexandria University, Egypt, for implant placement in the maxillary central incisor tooth number 9. Previous extraction was performed 1 year earlier because of a tooth fracture after endodontic treatment. Clinically, a localized vertical and horizontal ridge defect was observed (Figure 1). The horizontal ridge width was less than 4 mm and a 7-mm vertical defect was observed at the future implant site. Before surgery, cone beam computed tomography (CBCT) was performed. The original defect dimensions measured on CBCT were 9 mm vertically and 5 mm horizontally.[6]

A staged approach for implant placement was planned following hard tissue augmentation using Ti-mesh and alloplast. The patient's medical history

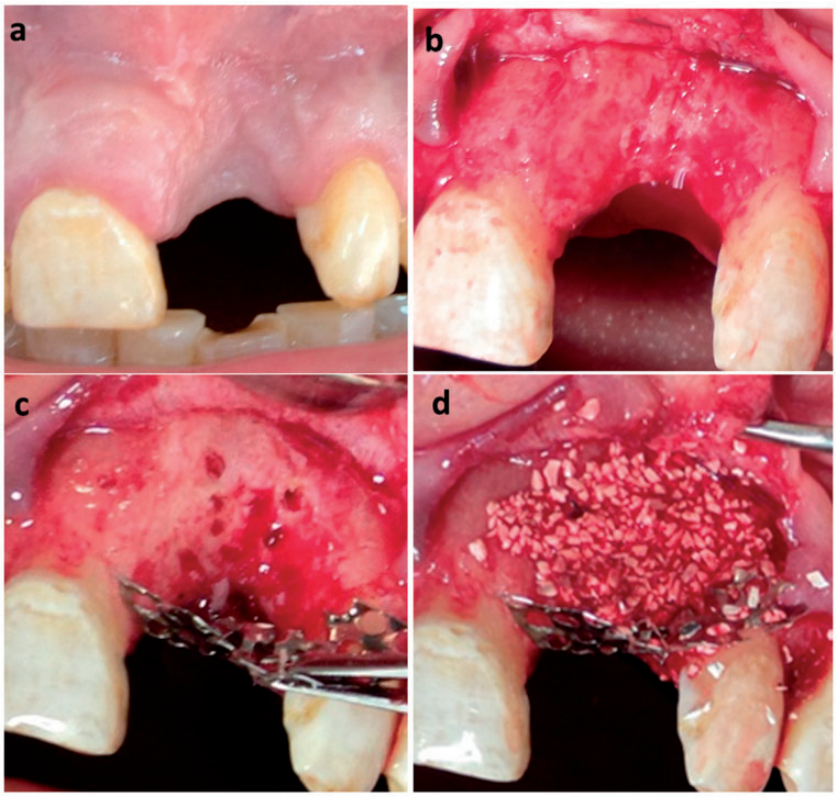

Figure 1. Clinical photographs showing (a) the ridge deficiency preoperatively, (b) the ridge defect after flap reflection, (c) application of the titanium mesh and cortical perforation, and (d) application of nano-bone and alloplast

was reviewed, and her written informed consent was obtained for the treatment procedure.

Intraoperative surgical procedures

Local anaesthesia (Scandonest 2%, Septodent, Saint-Maur-des-Fossés Cedex, France) was administered for haemostasis. A sulcular incision around teeth numbers 7, 8, 10, and 11 was performed. A paracrestal incision between the two teeth that bound the edentulous area was performed followed by full-thickness reflection of a labial and palatal mucoperiosteal flap. The reflection was extended to expose the whole length of the facial cortical plate of the alveolar ridge. The original defect dimension was 9 mm vertically. Bleeding points (decortication) were created using a rounded burr to expose the underlying marrow, followed by Ti-mesh placement. The Ti-mesh was customized to the desired shape of the future alveolar ridge and then secured with fixing screws. The gap between the Ti-mesh and the native bone was then filled with alloplast bone material (Genesis BCP; DIO Implant, Busan, Korea; particle size of 100–500 μm) mixed with nano-bone (NanoBone®, ARTOSS GmbH Company, Rostock, Germany). Periosteal releasing incisions were performed to allow tension

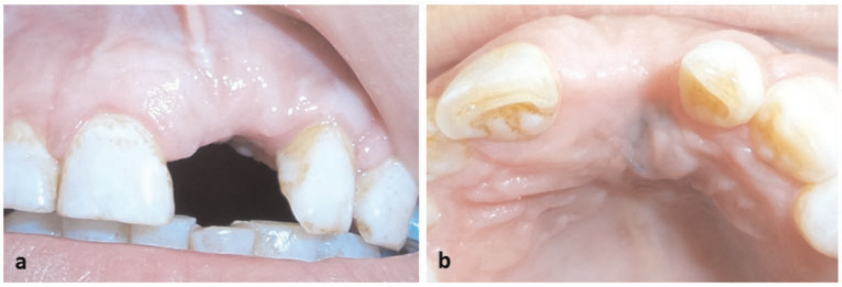

Figure 2. Clinical photographs showing (a) the ridge 5 months postoperatively in the facial view and (b) occlusal view

free closure using resorbable suturing material (vicryl 3-0) (Figure 2).

Amoxicillin (500 mg) and Brufen (600 mg) were prescribed three times daily for 7 days. The patient was advised not to brush the surgical site for 2 weeks, and to use a 0.12% chlorhexidine mouthwash (Peridex; 3M ESPE, St. Paul, MN, USA) twice daily instead. At the 2-week follow-up, the patient was asked to resume oral hygiene procedures with a soft-bristle toothbrush. Wound healing was uneventful without any signs of infection or inflammation (Figure 2).

After 5 months, surgical re-entry was performed with flap reflection. The Ti-mesh was removed, and the space beneath the membrane enclosure was almost completely filled with new hard tissue. The newly formed ridge dimensions were 6 mm horizontally and 10 mm vertically, with complete filling of the defect observed by CBCT. The newly formed bone was 7 mm horizontally. An implant fixture (4×10 mm) was then inserted (Figures 3 and 4). The postoperative follow-ups (6 and 12 months) showed stability of the implant with excellent osseointegration, no buccal depression of the surgical area, and no major biological complications.

Discussion

Previous studies have shown that Ti-mesh maintains space with a high degree of predictably, even extensive ridge defects.[6,14,15] The stiffness of Ti-mesh has an increased incidence of membrane exposure. However, Her et al.[19] reported that although Ti-mesh exposure was observed in their study, the amount of regenerated bone was not affected. This finding could be attributed to a smooth membrane surface that makes it less prone to bacterial infection.[7]

Bone substitute biomaterials are becoming increasingly important for all aspects of surgery. Use of these substitutes may eliminate complications associated with harvesting an autogenous bone graft, such as donor site morbidity, the patient's discomfort, and an extended treatment duration.[20,21]

Previous studies have shown the osteoconductive and osteoinductive regenerative potential of nano-bone, both experimentally and clinically.[22–24] The angiogenic potential of nano-bone is related to hydroxyapatite nanocrystals that stimulate vascular endothelial growth factor. This results in improved angiogenesis and enhanced bone formation.[25] Previous clinical studies have demonstrated that nano-bone has osteoconductive and biomimetic properties and enhanced bone-to-implant contact, even in severely resorbed maxilla.[17,26] Furthermore, when nano-bone is used in sinus augmentation, new bone formation occurs after 3 months.[27,28]

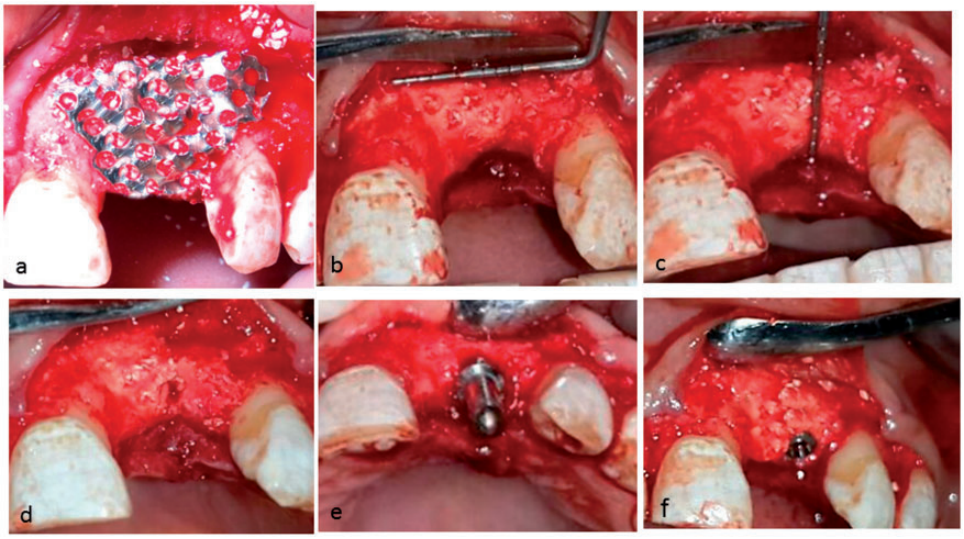

Figure 3. Clinical photographs showing (a) the titanium mesh and graft material in place, (b) surgical re-entry after 5 months showing the newly formed bone, (c) increased horizontal bone width of 7 mm, (d) drilling for implant insertion, (e) implant placement, and (f) final implant position in the newly augmented ridge

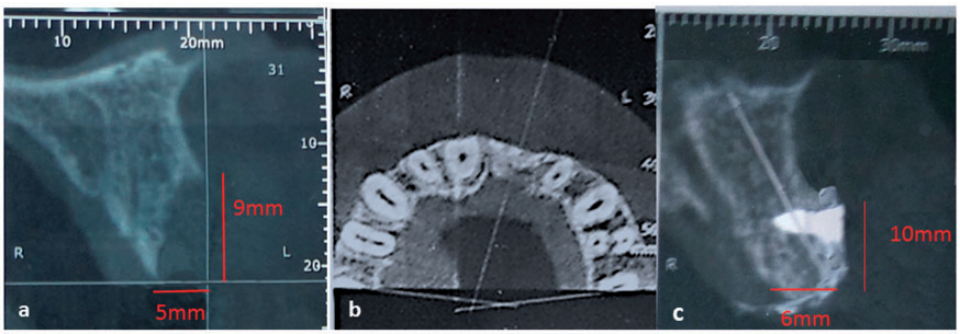

Figure 4. Radiographic images showing cross-sectional cone beam computed tomography images (a, b) at each proposed implant site and (c) 5 months postoperatively showing newly formed bone of width 6 mm

In the current case, the staged approach was used. Although a longer time is required before implant placement in the staged method, its simplicity and satisfactory results, which can be achieved for large or combined osseous defects, make it reasonable for daily practice. In a systematic review, Aghaloo and Moy[20] reported a 95.5% implant survival rate for GBR compared with 75% for autografts. Moreover, implants inserted in an autogenous bone block showed a reduced survival rate compared those inserted after other regenerative techniques.

In our case, we selected a nano-bone graft to enhance the performance of the

alloplast material by incorporating osteoinductive regenerative potential. After 5 months, the formed new bone was clinically hard enough to support placement of an implant with an implant insertion torque of 40 Ncm. Additionally, sufficient horizontal (7 mm) and vertical dimensions (10 mm) were observed after flap reflection, as well as comparable bone density, as shown by CBCT (Figure 4). A previous histological examination showed the stimulatory effect of nano-bone graft osteoblast proliferation inside its porous structure, thus promoting angiogenesis and early bone formation.[18]

To the best of our knowledge, this is the first clinical report on the combined new technique of using a nano-bone graft and alloplast with Ti-mesh for localized ridge augmentation. In this case, the combined technique induced bone regeneration in a localized ridge defect after 5 months. This augmentation technique appears to be a clinically feasible method to restore soft and hard tissue defects for proper implant placement in a relatively shorter time than other graft materials. However, long-term clinical, radiographic, and histological studies focussing on bone quality and final implant treatment outcome comparing nano-bone alone and in combination with alloplast as a graft material are required.

Recommendation

We recommend performing a long-term clinical study with a large sample size to compare the effect of combined alloplast and a nano-bone graft versus alloplast and a nano-bone graft alone. Additionally, the implant survival rate in the new augmented bone should be assessed in the future.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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