CLINICAL, RADIOGRAPHIC, AND HISTOLOGIC EVALUATION OF MAXILLARY BONE RECONSTRUCTION BY USING A TITANIUM MESH AND AUTOGENOUS ILIAC GRAFT: A CASE REPORT

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KEY WORDS

Titanium mesh
Ridge augmentation
Bone graft

The current clinical report describes the use of titanium mesh for maxillary alveolar ridge augmentation. Autogenous bone graft was harvested from the iliac crest and was loaded on a titanium mesh that was left in the patient's maxilla for 7 months before it was removed. Twelve months after the bone grafting procedure the patient received 10 implants on the maxilla, and a biopsy was taken from the augmented ridge. CT scan examination was performed before and after the maxillary ridge augmentation. Clinical evaluation revealed successful integration of the graft. The radiographic analysis demonstrated that a 10-mm vertical ridge augmentation had been achieved. Histologic evaluation revealed remnants of the autogenous bone graft still present, whereas the grafted area had a reduced remodeling activity. The clinical report demonstrated the potential of the titanium mesh to achieve extensive alveolar ridge augmentation, whereas the augmented ridge may possess an inferior capability for bone remodeling.

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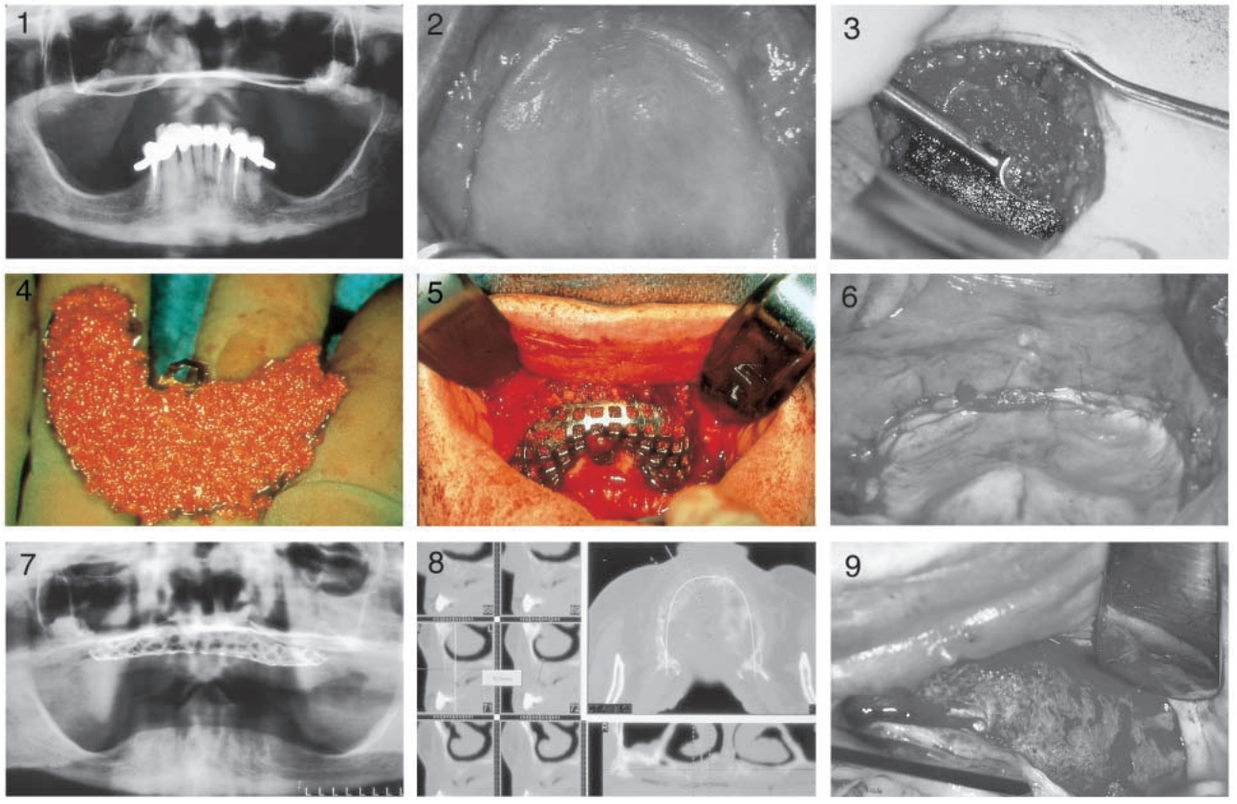
INTRODUCTION

Autogenous bone grafting harvested extraorally has been used alone[1–4] or in combination with alloplastic grafting materials[5,6] for the reconstruction of the alveolar ridge before the placement of a complete denture. However, after the acceptance of dental implants as a valid treatment modality for the totally[7,8] or partially[9,10] edentulous patients, bone grafting has been proposed before[11–20] or simultaneously[15,20–26] with the placement of dental implants in order to fabricate an implant-supported prosthesis for patients with advanced alveolar ridge resorption.

Several methods have been used



FIGURES 1–9. FIGURE 1. Initial radiograph. Notice the severe resorption of the maxillary alveolar ridge. FIGURE 2. Intraoral view, maxillary alveolar ridge. FIGURE 3. Autogenous bone marrow is harvested from the iliac crest. FIGURE 4. The bone graft is loaded on a titanium tray. FIGURE 5. The titanium tray along with the autogenous bone graft is inserted into the patient's mouth. FIGURE 6. Intraoral view after the flaps have been sutured. Primary closure is essential for the success of the grafting procedure. FIGURE 7. Postoperative panoramic radiograph with the titanium mesh in place. FIGURE 8. CT scan after the removal of the titanium mesh. FIGURE 9. After the alveolar ridge augmentation procedure, a full thickness flap is reflected in order to install the implants. Notice the volume of the newly formed maxillary alveolar ridge.

for bone grafting. Extraoral[15,17,21–26] and intraoral[11–13,15,16,18–20,27] donor sites have been proposed, whereas different techniques have been applied to secure the graft in the recipient site. Membranes,[12,14,16,20,27] fixation screws,[18,19,27] dental implants,[21,22,24–26] or titanium mesh[28–40] are the most common securing devices. The current case report provides a clinical description and histologic analysis of the use of titanium mesh in conjunction with autogenous bone graft harvested from the iliac crest.

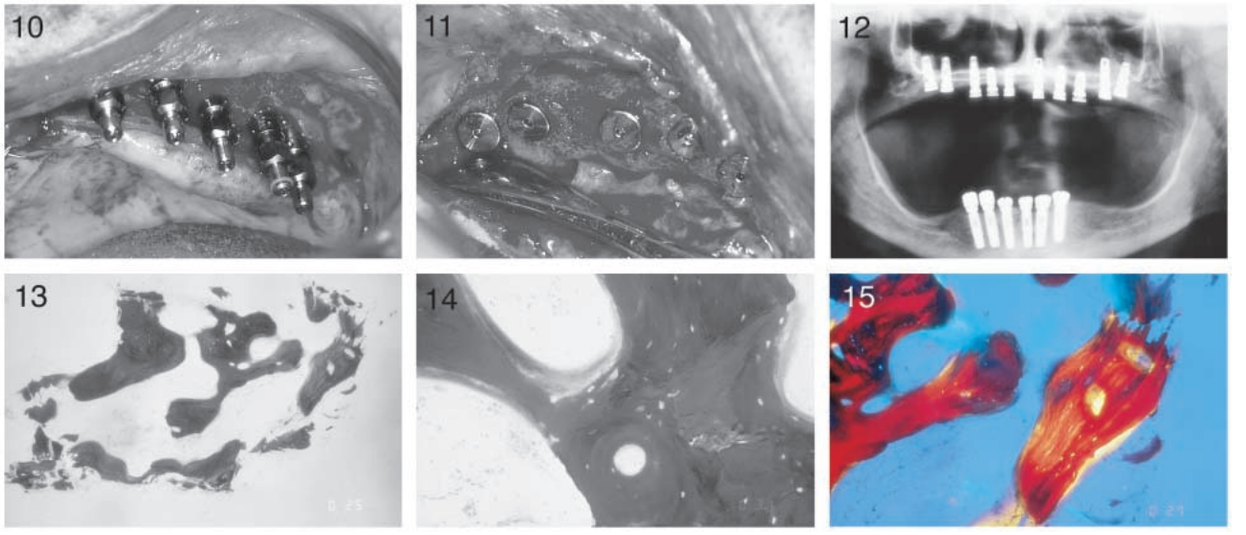
CASE REPORT

Clinical report

A 71-year-old female Caucasian patient presented at the Center for Prosthodontics and Implant Dentistry at Loma Linda University seeking treatment for her total maxillary and partial mandibular edentulism (Figure 1). Clinical (Figure 2) and radiographic (Figure 1) examination revealed extensive resorption of the maxilla. The patient expressed the desire for an implant-retained prosthesis in both arches. A CT scan was taken from the maxillary area with a diagnostic template in place. The clinical and radiographic findings dictated the necessity for a bone grafting procedure before the placement of dental implants on the maxillary area. The final treatment plan for the maxilla included an implant-supported overdenture and a fixed-screw–retained prosthesis for the mandible. For the maxilla, autogenous bone graft would be used in conjunction with a titanium mesh that would provide protection and mechanical support to the particulate autogenous bone graft.

An impression was made from the maxilla with irreversible hydrocolloid (Dentsply International Inc, York, Penn). Baseplate wax (Tri-Wax; Dentsply) was applied on the stone cast to simulate the prospective grafting procedure. The modified cast was duplicated in a form of an autopolymerized acrylic resin model. Titanium mesh was trimmed and adapted on this acrylic resin model as it has been described before.[30,31]

The bone grafting procedure was performed in August 1998 at the Department of Oral and Maxillofacial Surgery at Loma Linda University. The



FIGURES 10–15. FIGURE 10. Five implants are inserted in the left side. FIGURE 11. Implants placed at the right side of the maxilla. FIGURE 12. Postoperative radiograph after the placement of the implants. FIGURE 13. Histologic overview (original magnification ×4). FIGURE 14. The slightly lighter stained bone in the center is most likely a remnant of the autogenous bone that has been incorporated into the new bone formation (original magnification ×20). FIGURE 15. The polarized photomicrograph emphasized the immaturity of the bone and the very slow remodeling process (polarized view; original magnification ×10).

graft was harvested from the right iliac crest area (Figure 3) and loaded on the modified titanium mesh tray (Sofamor Danek USA, Memphis, Tenn; Figure 4). The mesh was inserted on the maxillary area after a full thickness buccal–palatal flap reflection (Figure 6). The maxillary sinuses were simultaneously grafted with the same autogenous graft material. Because of the extensive maxillary resorption, a combination of inlay (subantral augmentation) and onlay (autogenous bone graft supported by a titanium mesh) was indicated. Periosteal fenestration[41,42] was performed to facilitate primary closure (Figure 6).

The healing of the grafted area was uneventful (Figures 6 and 7). The titanium mesh was removed 7 months later. A new CT scan was taken after the removal of the mesh (Figure 8).

Twelve months after the grafting procedure, the patient received dental implant surgery at the Center for Prosthodontics and Implant Dentistry at Loma Linda University. Ten threaded, root-form, HA-coated implants (Steri-Oss; Nobel Biocare, Yorba Linda, Calif) were placed at the maxilla (Figures 9 through 11). Inorganic bovine mineral (Bio-Oss; Osteohealth Co, Shirley, NY) was added in the left maxillary sinus. Six additional implants were placed in the mandible after extracting the remaining natural teeth.

A 2-mm internal diameter trephine bur was used during the implant site preparation in the area of tooth 9 to harvest a specimen for histologic evaluation. The specimen was immediately inserted into 10% buffered formalin. A panoramic radiograph was taken after the implant surgery (Figure 12). The healing process after the implant surgery was uneventful.

Histologic processing

The histologic processing and analysis was performed by the Hard Tissue Research Laboratory at the University of Oklahoma. The specimens were fixed in 10% buffered formalin, dehydrated in alcohol, and embedded in specialized resin (Technovit 7200 VLC, Kulzer, Wehrheim, Germany). Initial midaxial sections of 200 μm were made by means of the cutting-grinding system (Exact Medical Instruments, Oklahoma City, Okla). The sections were then ground to 40 to 50 μm and were used unstained for light fluorescent microscopy.[43,44]

RESULTS

Clinical findings

The healing of both the grafting procedure and implant surgery sites was uncomplicated. It has been reported that exposure of the titanium mesh is a common complication[34,36]; however, no exposure was observed in the current case.

During implant surgery, the grafted maxillary area appeared to have a Type IV bone quality.[45] The bone graft at the left posterior maxilla appeared inadequate, necessitating an additional grafting procedure of the left maxillary sinus simultaneously with the fixture insertion.

Radiographic findings

The initial panoramic and CT scan examination demonstrated extensive maxillary bone loss corresponding to the class VII Cawood classification system.[46] The CT scan taken after the bone grafting procedure revealed a 10-mm vertical ridge augmentation (Figure 8) when compared with the preoperative

CT scan. However, the augmented bone appeared consistent with Type IV quality[45] as defined by measuring the Hounsfield units.[47,48]

Histologic findings

Histologic evaluation suggested that the regenerated bone was vital. The core comprised a fairly immature bone that composed a thick but not well connected trabeculae (Figure 13). The bone appeared to be actively remodeling with new bone being added in osteoid seams. In a higher magnification it was possible to see remnants of the autogenous bone that had been incorporated into the new bone formation (Figure 14). Polarized microscopy emphasized the immaturity of the bone in the specimen (Figure 15).

DISCUSSION

The significance of the current clinical report is that it provides some evidence of the potential of the presented bone grafting technique to achieve extensive maxillary alveolar ridge augmentation. Although a case report cannot be conclusive, the availability of preoperative and postoperative CT scans as well as the histologic evaluation offer an opportunity to evaluate and quantify the results of the use of the titanium mesh in this particular case.

There is a scarcity of histologic evidence in humans within the literature regarding of the results obtained by using titanium mesh in combination with autogenous bone graft. Although animal studies have offered the opportunity to evaluate histologically the results of this method of bone grafting,[29,33,49] only 2 papers have reported histologic evidence of bone formation in humans after performing alveolar ridge augmentation by using a titanium mesh. Shirota et al[35] presented the results of 10 biopsies harvested from humans where new bone trabeculae were observed within the grafted area. The new bone trabeculae contained numerous large lacunae and osteoid tissue lined by developing osteoblasts. The marrow was mature in character and had osteocytes. Marchiodi et al[37] performed a biopsy in 1 of the 25 cases reported on the paper; the grafted area appeared to have signs of active bone remodeling.

During the 1960s and early 1970s, a Vitallium—instead of titanium—mesh[49–52] was used as a device that would secure the bone graft in place. The titanium mesh has been used in a variety of clinical applications besides the alveolar ridge augmentation: trauma and fractures,[51,53–56] orthognathic surgeries,[56] treatment of discontinuity defects,[29,49,52,54,57] and cancer at the dentoalveolar area.[58–61]

Regarding the type of bone grafting that has been used in conjunction with a titanium mesh, the majority of the reported cases involved the used of extraorally harvested autogenous bone graft, typically harvested from the iliac crest.[29,30–33,35,49,51,57] However, hydroxyapatite mixed with an autogenous bone graft[33] also has been proposed as well as the use of intramembraneous autogenous bone graft harvested intraorally from the chin or the ascending ramus area.[34,36–40] Several publications have demonstrated a superiority of the intramembraneous autogenous bone graft in comparison with the extraorally harvested endochondral graft.[62,63] Long-term clinical studies are needed in order to confirm this hypothesis.

Von Arx et al[34] described the 2-stage use of titanium mesh in conjunction with autogenous bone graft harvested from intraoral donor sites as ''the time technique.'' The same author has also proposed the use of titanium mesh in cases of guided bone regeneration where the mesh is used simultaneously with the placement of the implants to treat dehiscences and/or fenestrations.[36,39]

In summary and within the limitations of a case report, it could be hypothesized that the use of titanium mesh in conjunction with extraorally harvested autogenous bone graft can result in extensive augmentation of the alveolar ridge that can potentially reach up to 10 mm in height. However, the histologic picture demonstrated reduced remodeling activity of the augmented ridge. Based on the lack of controlled radiographic evaluation and histologic analysis in the current literature, further research is needed before conclusive observations can be made.

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