Rigid Fixation by Means of Titanium Mesh in Edentulous Ridge Expansion for Horizontal Ridge Augmentation in the Maxilla

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The edentulous ridge expansion has been introduced in recent years to reestablish an appropriate alveolar ridge width. This technique consists of the placement of implants in the space formed after the dislocation of the buccal plate in a labial direction. In guided bone regeneration, the quantity of bone regenerated under the membranes has been demonstrated to be directly related to the amount of the space under the membranes. This space can diminish as a result of membrane collapse. To avoid this problem, a new technique of edentulous ridge expansion, which involved the use of a titanium mesh barrier to protect the regenerating tissues and to achieve a rigid fixation of the bone segments, was used in association with autologous bone in 25 patients. At second-stage surgery in all patients, it was possible to see tissue, under the mesh, that had the macroscopic characteristics of mature bone and was superficially covered by a thin soft tissue layer. The microscopic examination showed that all autologous bone particles were embedded in newly formed bone. The use of a rigid mesh can assist bone regeneration in non-space-making defects, since it probably does not interfere with the blood flow to the underlying tissues because of the presence of microholes within the mesh.
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Key words: autologous bone grafting, blocking microscrews, bone expansion, titanium mesh

Guided bone regeneration (GBR) has been used to increase bone volume in highly resorbed alveolar crests before or in conjunction with implant placement.[1–3] An adequate bone volume (4 to 6 mm of buccolingual width) for total coverage of the implants appears to be extremely important for the long-term prognosis of oral implants.[4] A lack of bone, especially in the maxilla, can produce functional and esthetic problems, and the bone resorption that follows tooth extraction frequently necessitates the use of a surgical technique to reestablish an appropriate ridge width.

One of these techniques, which in recent years has provided satisfactory results in a predictable and consistent way, is edentulous ridge expansion (ERE). This technique consists of the placement of dental implants in the confines of the space formed after the dislocation of the buccal plate in a labial direction.[5] In the last few years, this technique has been used with immediate implant placement in 25 patients. It has been demonstrated that in using the GBR technique, the amount of bone regenerated is dependent on the amount of space created and maintained under the membrane[6]; this space is the most important factor in determining the amount of newly formed bone.[7]

In localized ridge augmentation, excessive soft tissue pressure has been shown to cause membrane collapse toward the defect.[7] To avoid membrane col-

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lapse, the use of reinforced expanded polytetrafluoroethylene (e-PTFE) membranes,[7,8] as well as miniscrews and pins to block the titanium membranes, has been proposed. The use of different types of grafts has also been proposed as a means of maintaining the space between implant and surrounding defect.[2]

The aim of this investigation was to provide a clinical and histologic evaluation of a technique of modified ERE using titanium mesh to obtain rigid fixation of the bone segments resulting from the labial dislocation of the buccal portion of the ridge. The choice of this type of mesh over titanium membranes was preferred because it blocked the bone fracture fragments and yet allowed an unimpeded blood flow through the periosteal vessels to the regenerating bone tissue.

Materials and Methods

Twenty-five patients (mean age 56 years; range 40 to 65 years) participated in this study; all gave their written informed consent. All of the patients presented with buccolingual atrophy of edentulous alveolar ridges (Fig 1). Bone proportions were measured by means of panoramic radiography, computed tomography, and a caliper. Radial projections have been used as a control parameter and were repeated after 18 months. In 15 of the patients 78 implants (Pitt-Easy, Oraltronics, Bremen, Germany) were used and in the other 10 patients, 42 implants (Implant Innovations, West Palm Beach, FL) were used; all implants were placed in the maxilla. In all patients, antibiotic, nonsteroid, anti-inflammatory, and antiseptic treatment was instituted 3 days before surgery and was continued for an additional 7 days following surgery. Patients received Augmentin (SmithKline Beecham, Philadelphia, PA) 2 g/day and Aulin (Boehringer, Ridgefield, CT) 200 mg/day. Patients also rinsed three times a day with a mouthwash containing a 0.12% chlorhexidine solution.

In all patients, ERE was accomplished according to the following technique.[9] A soft tissue incision was made over the crest to create a total-thickness flap (Fig 2) and extended 8 mm anterior and posterior to the area where fracture of the bone crest was planned. A releasing incision was made on the vestibular side at the mucogingival line; on the palatal side, a sliding flap was used in a coronal position. The flap was then reflected from the labial plate.

The bone incision was made over the crest and deepened by means of a 64 beaver blade, so as to create a deep intrabone furrow without making incisions in the buccal bone plate. When the margins of the bone crest were separated, the bone site for the implants was prepared in such a way as to obtain good primary stability. This was obtained with correct preparation of the apical part of the implant site, where the bone fracture was not present. The implants were then positioned (Fig 3). Autologous bone chips were placed inside the newly created space in the ridge. These chips were taken from two different areas, the mandibular symphysis and the retromolar areas. The bone chips were composed of 50% cortical bone and 50% medullary bone. An 80-µm microhole titanium mesh (Tocksystem, Rome, Italy) was used to block the fracture fragments and cover the ridge expansion and was fixed by implant cover screws and additional titanium microscrews (Saven, Chicago, IL) (Fig 4). The sutures were removed 10 days after implant placement.

The second-stage surgery was carried out after 8 months, and a small specimen of the regenerated tissue from beneath the mesh was obtained with a small trephine (Fig 5). The specimens were immediately fixed in 10% buffered formalin and processed with the Precise 1 Automated System (Assing, Rome, Italy) to obtain thin ground sections.[10] The specimens were dehydrated in an ascending series of alcohols and embedded in a glycolmethacrylate resin (Technovit 7200 VLC, Kulzer, Wehrheim, Germany). After polymerization, the specimens were sectioned with a high-precision diamond disc at a thickness of about 150 µm and ground to about 30 µm. After polishing, the slides were stained with basic fuchsin–toluidine blue and observed under normal transmitted light in a Leitz Laborlux microscope (Leitz, Wetzlar, Germany). The histochemical staining for acid and alkaline phosphatases was handled according to a previously described protocol.[11]

Results

The postoperative healing was uneventful in all patients but one. No dehiscence of the covering soft tissues was observed. The titanium meshes appeared to adhere tightly to the underlying regenerated tissues, and after their removal it was possible to observe that the space under them was completely filled by tissue possessing the macroscopic features of mature bone covered by a thin soft tissue. A small specimen of this bone-like tissue was retrieved and examined in the manner previously described. Clinically, a significant increase in the width of the alveolar ridge in a labiopalatal direction was found (mean 5.65 mm; range 5.20 to 6.10 mm). In only one patient dehiscences were found around the three placed implants. The histologic analysis showed that in every specimen all of the autologous bone particles were completely embedded in newly formed bone (Fig 6) and that in some areas they were lined by a rim of

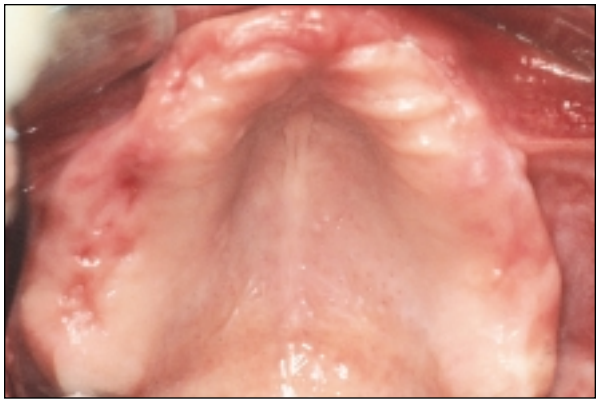

Fig 1 Edentulous maxillary ridge.

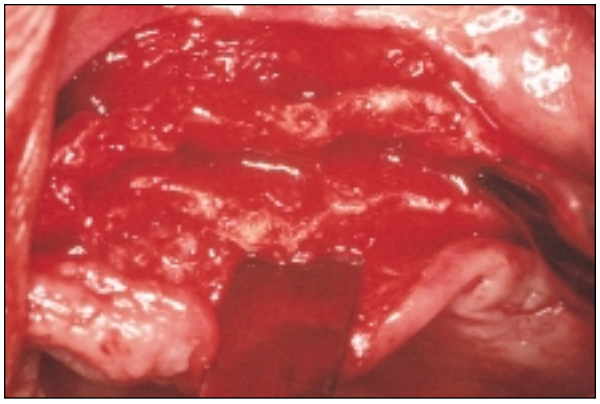

Fig 2 Elevation of the flap.

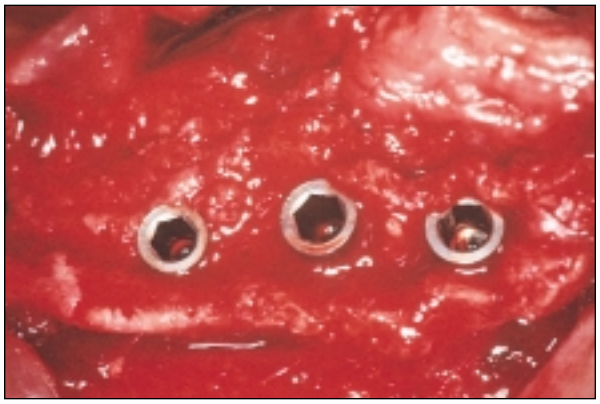

Fig 3 The titanium implants have been positioned.

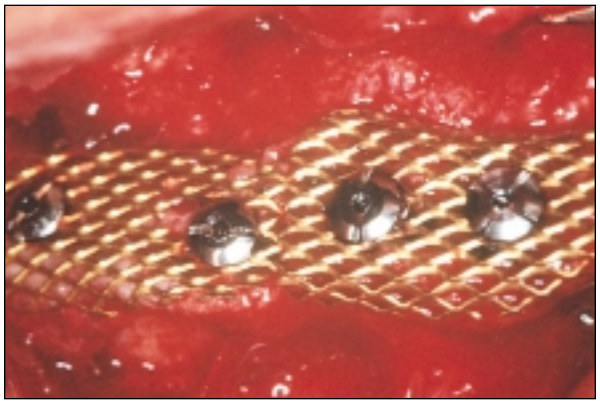

Fig 4 Titanium mesh and fixation microscrews are secured.

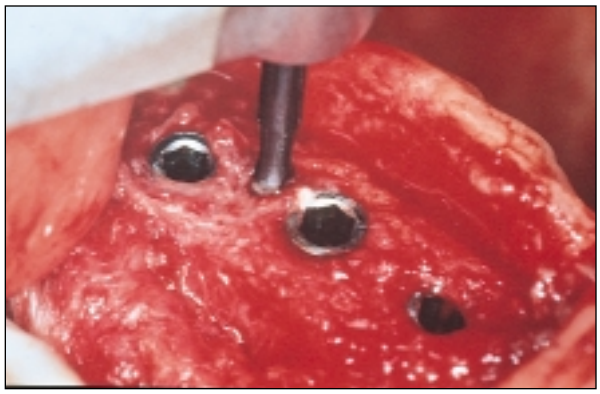

Fig 5 At second-stage surgery, a significant increase in alveolar ridge width can be observed. A biopsy specimen is taken with a trephine.

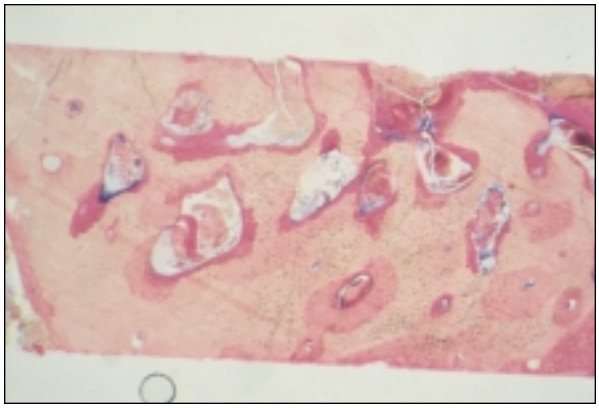

Fig 6 All autologous bone particles are surrounded by newly formed bone (basic fuchsin–toluidine blue, original magnification × 50).

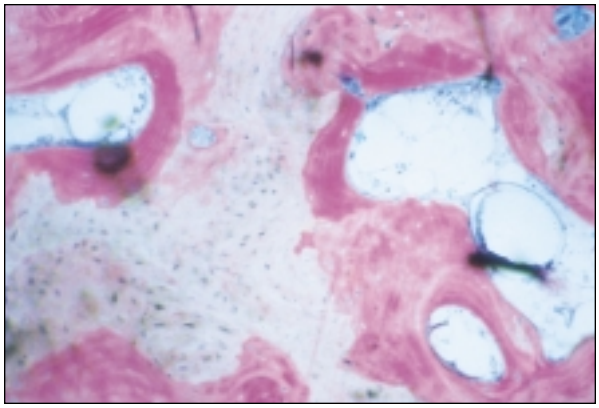

Fig 7 At higher magnification, the different staining characteristics of autologous and newly formed bone can be seen. Only a few osteoblasts can be observed (basic fuchsin–toluidine blue, original magnification × 200).

alkaline phosphatase–positive osteoblasts. No cells positive for acid phosphatase were found. Neither the autologous bone particles nor the newly formed bone presented resorption phenomena. The autologous bone was easily distinguishable from the regenerated bone because it had a lesser staining affinity for dyes and a basic fuchsin–positive, highly stained line, similar to the cementing lines that divided these two types of bone. These lines presented a higher staining affinity than that seen in the cementing lines of normal bone. No gaps were visible at the interface between preexisting and newly formed bone. At higher magnification, it was possible to observe the presence of a few osteoblasts (Fig 7).

Discussion

All but three of the placed implants survived. In one patient at second-stage surgery, dehiscences were visible around the three implants. These implants were considered failures because of substantial peri-implant bone loss. These dehiscences were probably the result of loss of integrity of the periosteum during surgery and subsequent bone necrosis of the buccal plate.

The ERE technique allows the clinician to place implants in anatomic situations involving insufficient bone thickness. Moreover, dislocation of the vestibular cortical bone modifies the buccal profile so that it is possible to obtain a natural emergence profile of the teeth. One of the most important differences between the conventional ERE technique and the modified ERE technique as presented here concerns the type of flap incision used. In the present study a total-thickness flap incision was used in combination with the titanium mesh and microscrews to hold the bone fragments in place. The periosteum was situated above the mesh and continuously covered the bone. The microholes in the mesh allowed for very good blood flow to the underlying tissues, thus preventing the labial plate from becoming a free bone graft.

One problem with occlusive barriers is their tendency, because of lack of stiffness, to collapse toward the defect, thus reducing the space for bone regeneration. Grafts placed under the barrier can partially overcome this problem, but they cannot overcome the negative influence of the overlying soft tissues. For this reason a titanium mesh was chosen as a possible means of eliminating this negative influence. This barrier functioned in two ways: first, it helped to maintain and protect the space needed for bone regeneration; and second, with the help of fixation miniscrews, it aided in maintaining the fractured alveolar crest bone segments in a fixed position. Thus it has been possible to create a complex system of utmost stability. Clinical and histologic results showed that in all but one patient, bone regeneration occurred under the titanium mesh. In all patients, the barrier was easy to handle and had excellent space-making capabilities. No complications (dehiscences, infections) were observed in the healing of the soft tissues. The barrier used was fully biocompatible and caused no untoward effects. In all patients, the use of autologous bone grafts appeared to have had a beneficial effect on the degree of bone regeneration.

Conclusion

In this patient series, clinical and histologic results confirmed that the space for bone regeneration is one of the most critical factors in the success of regenerative techniques. The use of grafting material, particularly autologous bone, beneath the barrier has an important influence. This technique can be particularly useful in the treatment of totally edentulous maxillae, while its use in the mandible is not recommended because of the compact structure of mandibular bone.

Acknowledgments

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