Implant-induced expansion of atrophic ridges for the placement of implants

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The applicability of endosseous implants is directly related to the topography and quality of the patient's residual bone. Several techniques have tried to expand the applicability through implant design alterations and surgical techniques for bone augmentation. This article describes an implant-induced bone expansion procedure that facilitates the placement of implants in atrophic alveolar ridges. This procedure expands the cortical plates of the alveolar ridges with or without fracture using wedge-shaped implants and the principles of guided tissue regeneration. The use of implants of larger diameters and the remodeling of the ridge external contour can be achieved with this procedure. (J Prosthet Dent 2001;85:377-81.)

The use of endosseous implants for successful restoration of patients with partial or total tooth loss has been well-established.[1-3] Placement of cylindrical implants requires minimal bone dimensions,[4,5] which vary from 5 mm height and 6 mm width[6,7] to 8 mm height and 6 mm width.[8,9] One criterion used for implant placement is at least 1 mm of bone around the implant when in place.[10] Bone resorption is an inevitable consequence of tooth loss. In edentulous patients, vertical resorption can progress to reach the basal bone.[11,12] Horizontally, the resorption may progress to the extent that, even if there is enough bone height, the lack of bone width may render implant placement impossible.[13,14]

When there is insufficient bone, alveolar ridge augmentation is necessary.[10] Several techniques for bone augmentation, both vertically and horizontally, have been proposed. Bone grafting with the application of synthetic materials or combinations of 2 or more graft types frequently are used.[15-26] An alternative surgical procedure is the osteotome technique.[27] Block et al[28] proposed a procedure for vertical mandibular bone augmentation that uses a bone distraction osteogenesis proven to be effective in animal studies. Anterior maxillary osteoplasty, as proposed by Richardson and Cawood,[29] is yet another technique. Nevins and Fiorellini[30] developed a surgical procedure for horizontal ridge augmentation in the premolar region of the maxilla. Finally, Scipioni et al[31] and Simion et al[32] presented a bone expansion technique associated with guided bone regeneration principles.

This article presents a bone expansion procedure that: (1) uses the elastic and plastic deformation potentials of the remaining bone, (2) uses bone regeneration potential,[33] and (3) can expand implant applicability.

Fig. 1. Bioform implants with vertical and horizontal shapes.

PROCEDURE

For patients to be treated with this procedure, local anesthetic can be used with regional block and/or infiltration according to site. Incisions are made to allow maximum access and visualization to preserve the soft tissue and to avoid subsequent membrane exposure.[34] Soft tissue management must accommodate the enlargement of the bone crest.

Because 2 types of implants are used (vertical and horizontal) (Figs. 1 and 2), there are differences in the expansion procedures. For vertical implants, bone expansion is achieved in depth; for horizontal implants, expansion is achieved longitudinally. In both situations, however, after total cortical bone separation, ridge expansion is obtained with the use of an implant analog with smooth surfaces.

In the mandible, a crestal incision[35] within the attached gingiva is performed. When teeth are present, the incision is extended within the gingival sulcus and anteriorly to the adjacent teeth. Vertical releasing inci-

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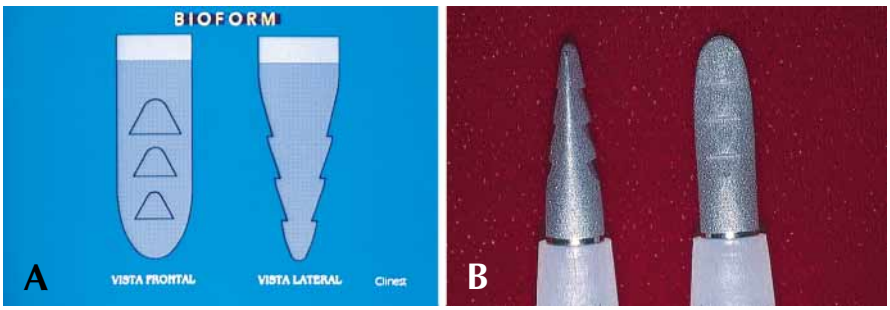

Fig. 2. Frontal and lateral views of Bioform implant. Lateral view shows wedged shape. **A,** Implant schematic design; **B,** 5 × 15-mm implants.

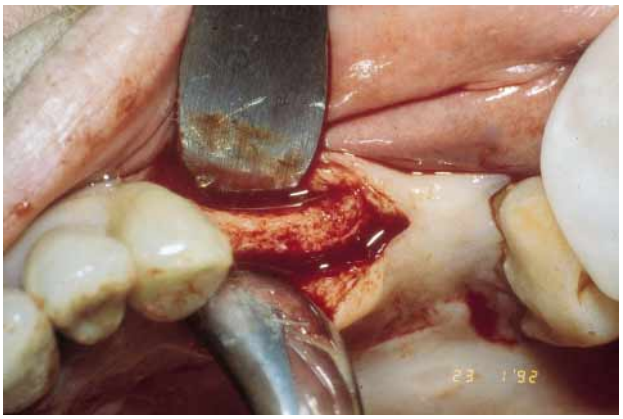

Fig. 3. Mucoperiosteal detachment and bone crest exposure.

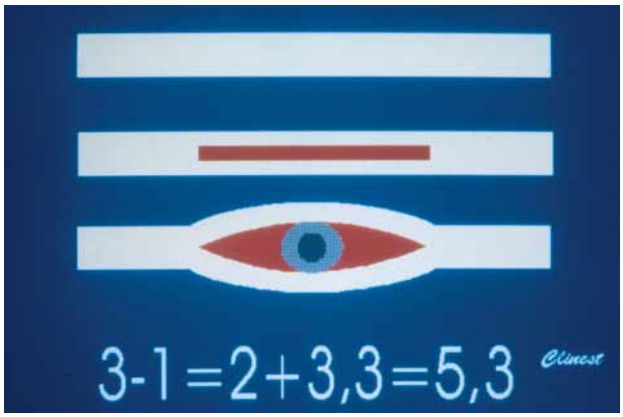

Fig. 4. Diagram of 3.3-mm implant in 3.0-mm crest shows bone expansion.

sions are made at the ends of the crestal incision approximately 7 mm away from the proposed length of the osteotomy. The lingual flap is raised to full thickness and continued mesiodistally and within the gingival sulcus with the same width used in the vestibular side. When necessary, a vertical releasing incision of 3 to 4 mm is used to release the periosteum. In the vestibular side, the periosteum releasing incisions start from the most apical part of the vertical releasing incision and continue 3 to 4 mm to the center of the crestal incision.[36]

In the maxillary arch, a crestal incision and 2 vertical buccal releasing incisions are made following the same principles described for the mandible. In the palatal side, an intrasulcular incision is performed with the same wideness used in the buccal side. The mucoperiosteal flap is carefully detached, maintaining periosteal integrity (Fig. 3) so that the periosteum can be used as a natural barrier for guided bone regeneration (GBR).

After bone crest exposure, selection of implant diameter is made. In situations of advanced resorption that result in a 3.0-mm width crest, it is possible to place a 3.3-mm diameter or larger implant (Fig. 4), depending on the site and type of bone. The diameter of the implants has to be compatible with the expected degree of bone expansion.

The initial osteotomy is made with a 0.60-mm wide disk (ISO 310 204 045 171 060, Komet, Rio de Janeiro, Brazil), and the cortical bone is split to a disk depth of 1.7 mm (Fig. 5). After that, the medullar bone is cut to the depth of the desired implant using a long cylindrical bur (ISO 310 204 682 336 012, Komet) (Fig. 6). The horizontal extension of the bone cuts depends on the presence of teeth, bone flexibility, the desired degree of expansion, and the diameter of the implant. The longer the cut, the greater the flexibility of the buccal and lingual parts of the bone.

Successive insertions of the implant analog are made (Fig. 7); their wedged design leads to the desired expansion. For vertical implants, after the introduction of one third of the implant length, circular movements are made to enlarge the osteotomy. In some situations, fracture of the buccal cortical bone is induced (Fig. 8), either through manual pressure on the implant analog or through percussion. In such situations, the implant analog is inserted 1 or 2 mm short of total length of the implant, allowing the later

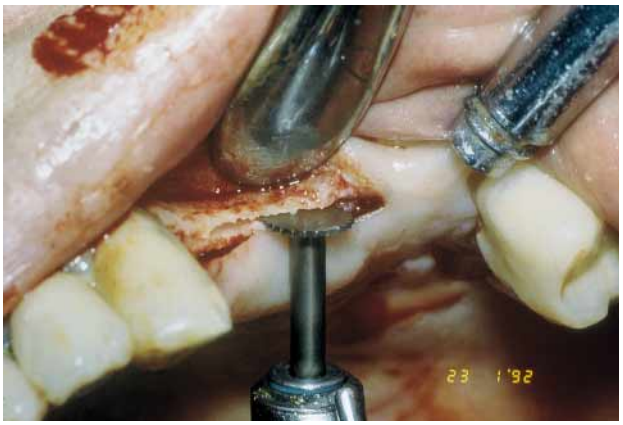

Fig. 5. Bone cortical split with disk.

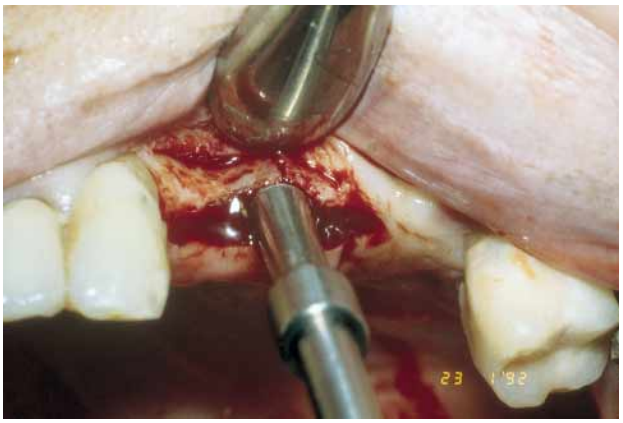

Fig. 7. Partial introduction of implant analog through in-and-out, circular movements. Smooth surface helps introduction.

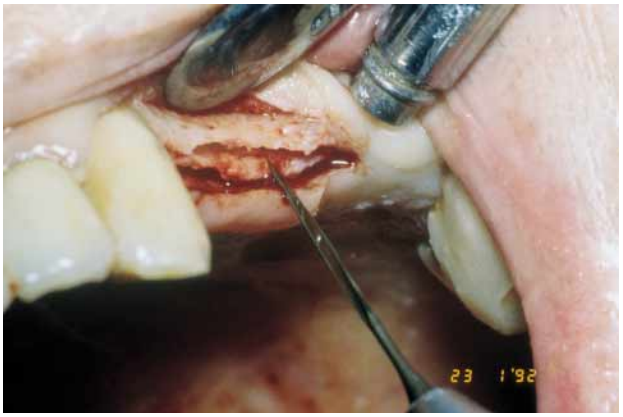

Fig. 6. Medullar bone cut with bur.

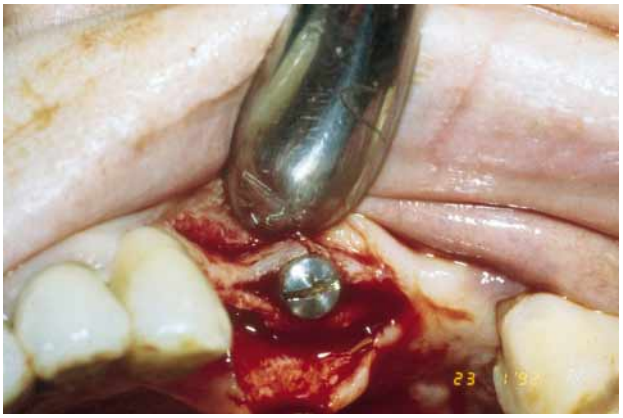

Fig. 8. Total implant introduction through percussion and fracture of buccal cortical bone.

the final movement to guarantee its initial stability. Although fracture of the buccal cortical bone occurs at times, the requirements for GTR are always maintained. For horizontal implants, lateral movements are used and seating (Fig. 9).

With or without fracture, all GTR requirements are followed and a total occlusive membrane[37] (Allumina, Alloplastic membrane for tissue isolation in GTR, Demac) is used. Patients should be seen postoperatively for weekly examinations until 45 days after surgery. The sutures are removed within 5 to 10 days. When the membrane is exposed during the healing process, it is controlled until its removal. For that, Alvogyl (DFL, Spécialités Septodont, Saint-Maur-des-Fossés, Cedex, France) is applied 1 to 2 mm under the surgical borders. The medication is applied every 3 days until the membrane is removed after at least 21 days of healing. The membrane can be removed 30, 40, or 60 days after surgery. In those situations in which exposure does not occur, the membrane should be maintained until reentry surgery (6 months after the initial surgery).

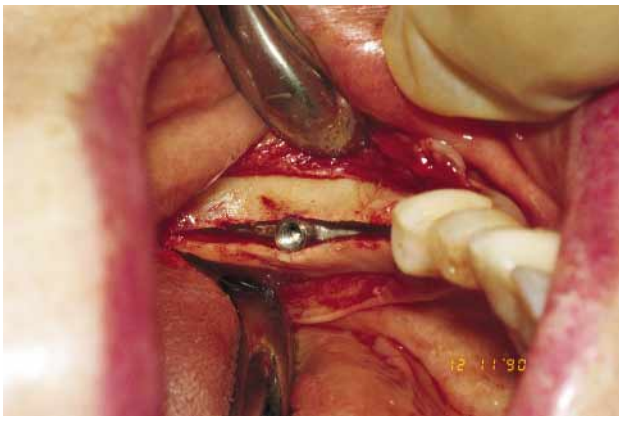

Fig. 9. Introduction of horizontal implant.

Efforts are made to achieve primary closure of the surgical flaps. The eversed crestal flap technique[34] is used, and the horizontal mattress suture alternated

with simple interrupted ones are conducted.[36] All patients receive before and after surgery antibiotics, anti-inflammatories, and analgesics.

During the reentry surgery, soft tissue conditions are evaluated and some reconstructive flaps can be used. The goal is to obtain keratinized gingiva around the implants.[39] Rotational or advanced flaps[40] are used depending on local conditions. Visual confirmation of bone formation should be obtained and tests applied to evaluate the expected osseointegration.[2,38] Implants can receive individual or a multitooth cemented prosthesis. Follow-up of individual patients[1,2,38] should involve several clinical examinations during the first year and, thereafter, at least 1 checkup annually, including a clinical examination and radiographs. Implant stability, peri-implant radiolucency, and the absence of signs and symptoms such as pain, infection, and neuropathies should be observed and controlled.

DISCUSSION

Wedge-shaped implants, whose characteristics change from circular in the cervical area to wedged in the apex, are the main factor that allows the use of bone expansion and enables perfect fit between the implants and the osteotomy. Summers[27] incorporated these characteristics in an osteotome technique. However, the instruments for the technique had the shape of a cylinder to facilitate initial stability within the bone. The cylindrical form of the osteotome requires larger amounts of bone both vertically and horizontally. In this procedure, smaller bone dimensions are required both cervical and apically. Other authors have proposed surgical techniques for ridge expansion, also taking advantage of bone elastic and plastic properties. Scipioni et al[31] achieved alveolar ridge augmentation through buccal displacement of the buccal cortical plate, allowing for implant placement in narrow ridges. In a procedure by Simion et al,[32] the alveolar ridge was split longitudinally with chisels before placing implants. All these techniques are similar to the implant-induced expansion, as they allow for immediate implant placement. However, unlike the implant-induced expansion procedure, they do not take advantage of the similarities between the fracture line of the expanded ridge and the design of the implants. With the procedure described here, deeper bone cuts and fractures can be avoided because of the way that the wedge-shaped implants adapt themselves to the expansion line.

Initial stability in this procedure is created by compression between the bone cortex and the implant itself. It could be argued that the implant-induced expansion procedure reduces the initial stability of the implants, particularly in those situations in which fracture is necessary. However, in such situations, the osteotome technique would not be an alternative because of the reduced dimensions of available bone. Furthermore, even when fracture occurs, the fixation and initial stability of the implants are adequate for the desired bone regeneration and osseointegration.

Different bone types have different elastic and plastic properties.[8,41] Bone crests in young patients likely will allow for immediate expansion. However, in older patients, bone crests are more resistant to expansion and less resistant to fracture.[42,44] There are also differences in bone quality between maxilla and mandible as well as between different areas of the maxilla and mandible.[44-46] Therefore, it may be necessary to deepen the bone cut with a bur before the implant analog is introduced. The initial evaluation of the patient, the tactile sensitivity of the operator, and his/her judgment are essential to decide how much to cut and how much to expand.

As a consequence of bone resorption, the external contour of the alveolar bone often is lost with deleterious consequences for the final esthetic result of the implants. The degree of bone expansion that can be achieved with this procedure allows for the reconstruction of bone contour in both the maxilla and mandible. The implant-induced expansion procedure can be applied in patients whose residual maxillary or mandibular bone would not allow for placement of traditional cylindrical implants without any previous bone augmentation.

SUMMARY

The implant-induced expansion procedure allows the placement of implants in areas in which bone resorption makes the use of traditional cylindrical implants impossible. The procedure uses the elastic, plastic, and regenerative properties of bone associated with an appropriate implant design. The degree of bone expansion obtained can remodel the alveolar bone, an important esthetic achievement.

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