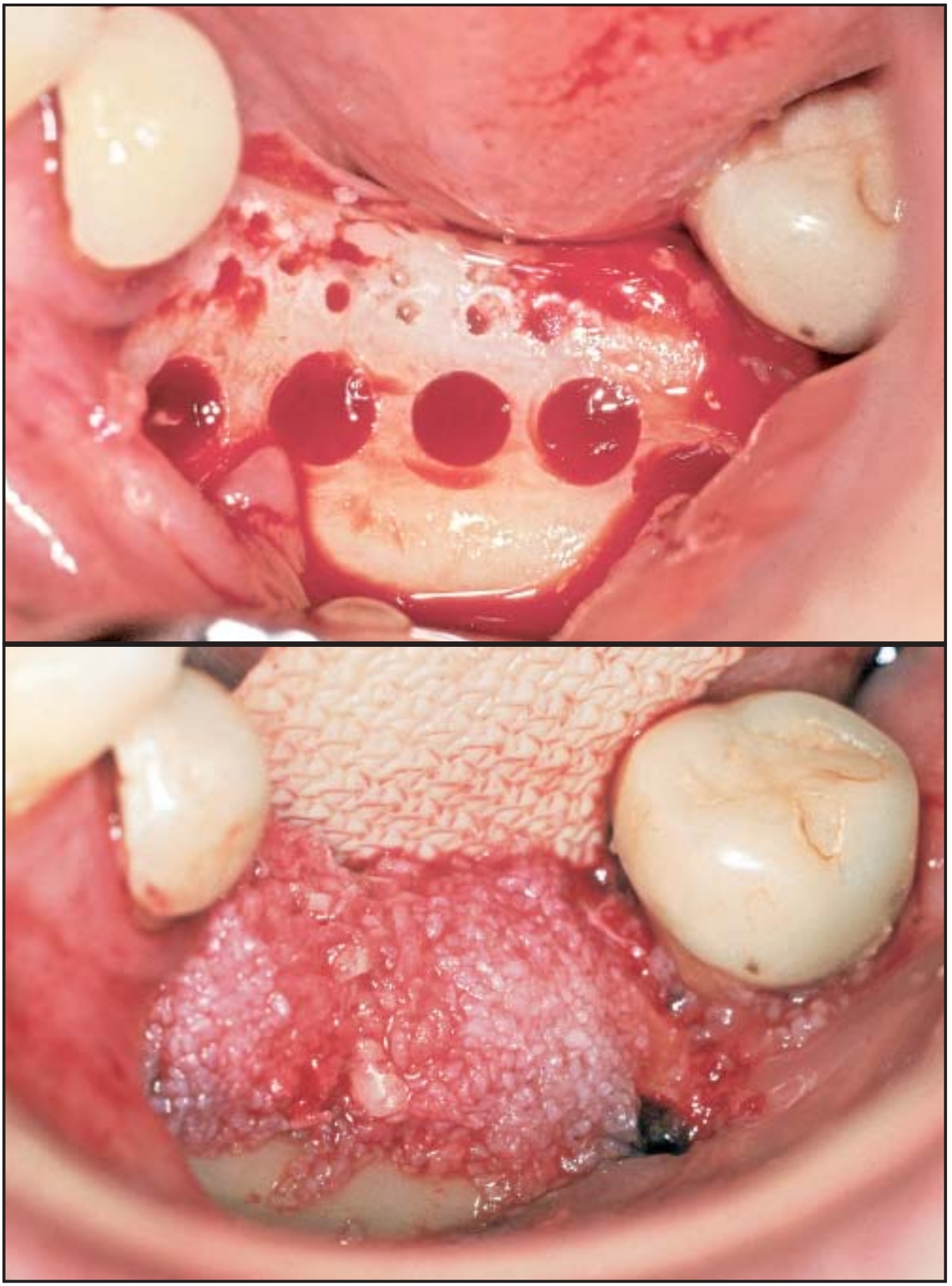
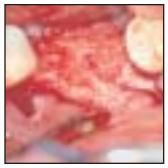


Harvesting Bone in the Recipient Sites for Ridge Augmentation



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A modified ridge augmentation technique is introduced for augmenting deficient alveolar ridges in preparation for endosseous implant placement. The technique is based on the principles for guided bone regeneration, in which a created space is kept isolated from the surrounding soft tissues by a resorbable membrane with an excellent extended resorption profile, thus permitting the accrual of bone-formative elements into the graft site. The absorbable membrane is propped up by an autogenous mixture of native corticocancellous bone cores taken in the graft site and reduced to smaller particle sizes and osseous coagulum collected in bone traps and with a special bone scraper. The major advantage of this technique is that all the autogenous bone graft material is obtained from the actual graft site, avoiding second remote intra- or extraoral surgical sites and attendant morbidities. Ridges augmented with this technique permit optimal endosseous implant placement. (Int J Periodontics Restorative Dent 2008;28:411–419.)

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Patients presenting for dental implant therapy frequently exhibit some alveolar ridge deficiency in the proposed implant sites.[1–3] When the bone volume and morphology of these ridges are significantly altered, they may not permit appropriate implant positioning, which is necessary for the fabrication of functionally and esthetically acceptable implant-supported restorations.[4,5] To achieve optimal implant placement, it is often essential to improve the ridge form. To this end, various methods of ridge augmentation or modification have been developed to enhance the morphology of inadequate ridges for implant placement.[6–14]

When the bone deformities are minor, ridge augmentation can be performed simultaneously with implant placement[15,16] ; however, when the deformities are more extensive, it is necessary to develop an appropriate ridge form prior to implant placement.[5,17] Autogenous bone grafting using blocks of bone obtained intra- or extraorally is widely considered the best approach to augment deficient alveolar ridges.[18–20] Unfortunately, ridge augmentations of this type can

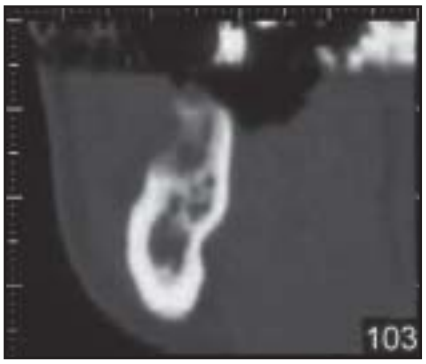
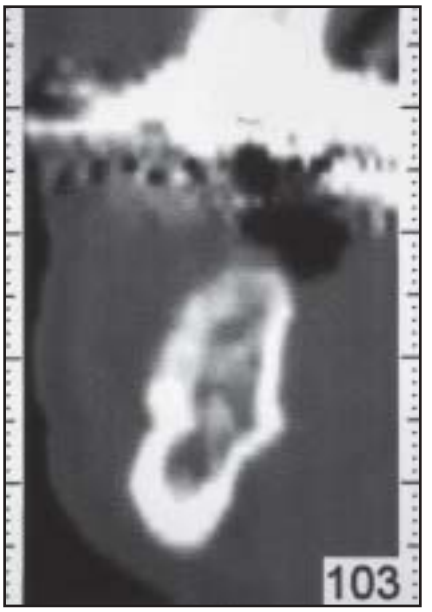


Fig 1a (left) *Pretreatment cross-sectional computerized tomograph.*

Fig 1b (right) *Seven months after augmentation, a thick cortical plate is evident.*



be associated with a variety of patient morbidity problems.[21] With the advent of guided bone regeneration (GBR),[22,23] it became possible to safely and predictably modify inadequate ridges, both horizontally and vertically, with minor untoward sequelae.[24]

GBR is based on the principles of guided tissue regeneration, in which a barrier membrane is used to create a space in which osteogenesis can occur while preventing access of nonosteogenic soft tissues.[22,23] Different barrier membranes have been proposed and used in the GBR approach to ridge augmentation. These include the nonresorbable expanded polytetrafluoroethylene (e-PTFE) barriers[7–10] and the newer resorbable materials such as polylactic acid or porcine[25] and bovine collagen.[26,27] Different graft materials, such as autogenous bone,[7,8,28] allogeneic osseous fragments,[28–31] xenografts,[26,27] and synthetic additives,[32,33] have been proposed as fillers to prop up the membranes and maintain space for and assist in GBR.

Autogenous bone still represents the gold standard bone graft or filler material for alveolar ridge regeneration.[7,28] Therefore, it would be ideal if sufficient quantities of membranous osseous graft could be procured during GBR procedures without having to invade a second site and incur morbidity problems often associated with such approaches.

The purpose of this report is to present a novel approach to GBR that uses autogenous membranous bone obtained in the graft site as a graft material that will also support the barrier membrane. This eliminates the need for a remote second surgical donor site and any attendant morbidities. In addition, the use of a resorbable barrier membrane with an advantageous resorption profile and tissue compatibility is also illustrated.

Description of the technique

Site selection

Patients requiring ridge augmentation were given a full explanation of the technique and signed an informed consent document. The ideal sites for this new technique are edentulous ridges with sufficient height but inadequate width to permit proper implant placement (Figs 1 and 2). The anatomy of the area should permit the harvesting of cores of corticocancellous bone

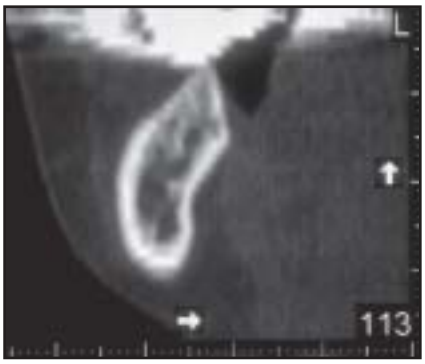
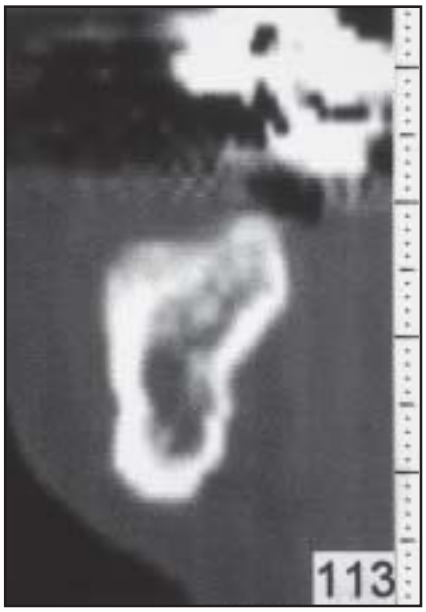


Fig 2a (left) *Cross-sectional tomograph showing the first molar region of the patient from Fig 1. Sufficient corticocancellous bone is available for procuring bone cores.*

Fig 2b (right) *Seven months posttreatment, considerable lateral augmentation has been achieved, with some vertical change almost up to the crest. Note the thick cortical plate.*



in the graft site without jeopardizing vital anatomic structures such as the mandibular and mental nerves and the maxillary sinuses or nasal cavities. The use of appropriate imaging, such as panoramic radiographs and computerized tomographs, is essential to proactively identify potential problem areas. Although proper bone height is important, small insufficiencies in height are acceptable and may even be corrected with this new approach.

Local anesthesia and flap management

Anesthesia is obtained through standard local infiltration and nerve block methods. However, during infiltration, special care is taken not to unduly expand the facial vestibular soft tissues by using excessive pressure or amounts of anesthetic solution, because this unnecessarily complicates the periosteal separation incision.

Access to the surgical site is obtained by a crestal incision and by mesial and distal vertical releasing incisions both facially and lingually (Fig 3). Facial and lingual mucoperiosteal flaps are elevated and further mobilized by means of careful periosteal separation facially as well as lingually when mandibular augmentation is being performed. The mobility of the flaps is then tested to ensure that primary closure of the wound can be attained through tension-free suturing. It is important that the crestal incision extends far enough mesiodistally so that the membrane is not exposed in the areas of the vertical releasing incisions.

Procurement of autogenous bone

The autogenous corticocancellous bone graft material is obtained in two ways: corticocancellous osseous cores and osseous coagulum.

Corticocancellous osseous cores

During GBR surgeries it is considered beneficial to trephine the cortical plates abutting the graft site with a small round bur to speed up the ingress of endogenous osteoprogenitor material. With this technique, a 2-mm bone trephine is used to retrieve corticocancellous bone cores (Fig 4), up to 7 mm in length in ideal circumstances, from the remaining alveolar process. This simultaneously provides decortication of the alveolar cortical plate and corticocancellous bone (Fig

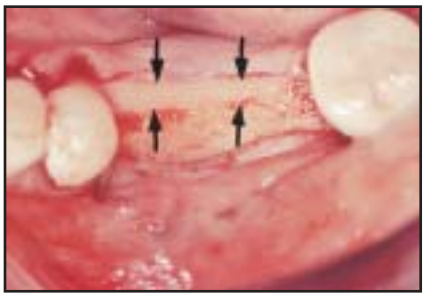


Fig 3 (left) *Lateral view of ridge prior to augmentation showing the flap design. Note the midridge horizontal and vertical releasing incisions at line angles of teeth adjacent to the edentulous area vertical releases. The thin crestal ridge* (arrows) *is also evident.*

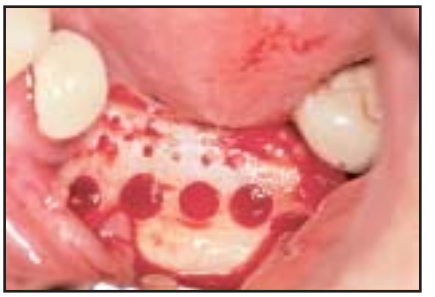


Fig 4 (right) *Lateral view of the trephined holes and intramarrow penetration. Vertical and lateral augmentation is planned.*

Fig 5 (left) *Bone cores prior to further fragmentation.*

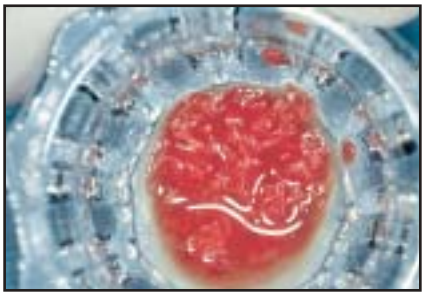


Fig 6 (right) *Osseous coagulum scrapings obtained from the lingual surface of the alveolar ridge.*

5) for grafting. Further finer trephining is performed around the larger holes using a small round bur. The trephine bur should be run at a slow speed under copious irrigation, first drilling counterclockwise to create a purchase for the instrument that can then be run clockwise without slippage. In this way, multiple cores (Fig 5) are obtained and immediately placed in a small dish filled with saline solution. The cores are then crushed into smaller particle sizes using either a rongeur forceps or dedicated bone mills. Throughout the drilling process, a bone trap in the surgical suction line is used to collect as much osseous coagulum as possible.

Osseous coagulum

The bone cores collected with the trephine and the osseous coagulum fragments captured in the bone trap are amply supplemented by osseous coagulum (Fig 6) obtained from the lingual/palatal surfaces of the recipient areas using specially designed Osseous Coagulum Bone Collectors or Scrapers (G. Hartzell & Son). In this manner, it is possible to harvest a significant amount of bone, often up to 2 mL of autogenous bone composite. In most cases, this autogenous corticocancellous bone composite is sufficient to augment localized areas of ridge deficiency for placement of two to three implants.

Membrane preparation and graft placement

The membrane used with this technique is the Ossix (3i/Implant Innovations) regenerative barrier. The type 1 collagen employed for this regenerative material has a patented cross-linkage, which offers extended resorption time together with superior handling qualities and improved biocompatibility. If not exposed to the oral environment, the Ossix barrier degrades in 6 months to 1 year, but when it is exposed by dehiscence of the flap or lack of primary closure, it may be resorbed in 2 to 4 months. In either event, results indicate that successful augmentation can be anticipated.[34]

A square paper template provided in the Ossix sterile package is trimmed with scissors to fit to the recipient site and used as a guide to contour and trim the membrane, which has in the interim been reconstituted in sterile saline in a dedicated container provided in the sterile pack. The trimmed membrane is tucked under the lingual

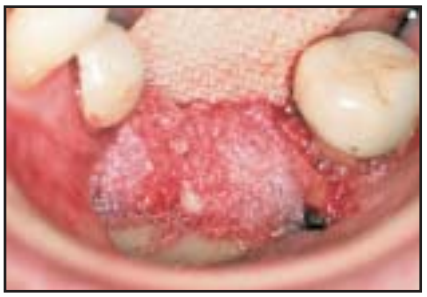


Fig 7 *Ossix membrane placed between the lingual flap and alveolar bone. The lateral and superior surfaces of the prepared ridge are slightly overfilled laterally and superiorly by the core and coagulum composite.*

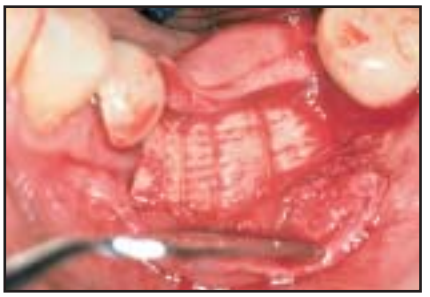


Fig 8 *The membrane is bent over the graft and tucked under the facial periosteum. Note how well the chromic gut horizontal sutures immobilize the membrane and maintain the graft in position.*

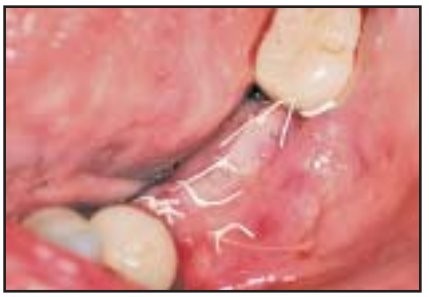


Fig 9 *Tension-free final wound closure with horizontal mattress and interrupted sutures.*

or palatal flap (Fig 7) and held in position while the particulate xenograft or allograft is packed into the trephine holes prior to autogenous graft placement. This will prevent the harvested autogenous bone from being forced back into the areas from which it was procured during the graft placement process.

The autogenous bone composite is then carried to the area in a 2-mL syringe, and the ridge is slightly overbuilt (Fig 7). Telfa (Tyco Healthcare Group) pads, which are cut into 1- × 1-cm squares, are used to compress the bone graft and absorb excess fluids. When the particulate material is in place, the membrane is carefully bent over the graft toward the facial side and tucked under the periosteum, in anticipation of placing the membrane-immobilizing suture.

Suturing

The immobilizing suture is essentially a horizontal mattress using 4/0 chromic gut. It is created by passing the needle through the facial flap deep in the vestibule facially and over the membrane toward and through the lingual flap into the lingual vestibule at a position deeper than the margin of the membrane. It is then passed back through the lingual flap over the membrane once again and through the facial flap into the buccal vestibule. Here, the knot is tied without exerting excessive tension to avoid displacing the graft. The barrier membrane under the suture will adapt nicely over the graft, maintaining the built-up volume (Fig 8). In single-tooth areas, the mattress suture extends from mesial to distal for the same width of the augmentation site, so that the membrane is held down at its mesial and distal extremities. In larger areas, two mattress sutures can be placed, one at the mesial and one at the distal end of the barrier. Additional 5-0 Gore-Tex (W.L. Gore & Associates) horizontal mattress sutures alternated with single interrupted sutures are then used to completely close the wound. Primary closure is usually easily accomplished without the use of excessive tension (Fig 9).

If a portion of the membrane is left exposed, ridge augmentation can still be successful. This is related to the fact that the membrane has sufficient resistance to the action of human and bacterial collagenase, which allows it to remain in situ for an adequate period of time to complete the osteogenesis process.

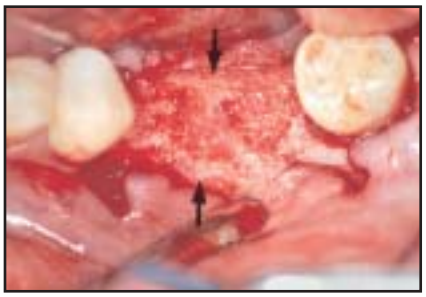
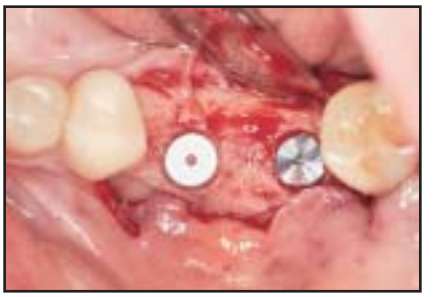


Fig 10 (left) *View of the augmented ridge* (arrows) *at the lingual crest level after 9 months, just prior to implant placement.*

Fig 11 (right) *Implants are placed in a more facial position than would have been possible prior to ridge augmentation.*



Results

Nine sites over a 2-year period have been successfully treated with this approach. Horizontally, 4 to 6 mm of augmentation has been achieved (Fig 10), while up to 3 mm of vertical increase was obtained in some of the sites treated. This amount of ridge augmentation permits advantageous implant placement (Fig 11).

Discussion

During GBR procedures, it is crucial to create a space that is properly isolated from the surrounding soft tissues and can be maintained for an appropriate period of time to ensure osteogenesis.[35,36] In addition, speedy and adequate blood supply to the area is necessary to ensure rapid blood clot formation[37] and the accumulation of a reservoir of endogenous bone-formative elements. This process is expedited by decortication of the cortical bone in the graft site. This is achieved via the core-taking procedure and the finer intramarrow penetration holes drilled in the bone adjacent to the core holes.

The necessary space is created and preserved with the aid of a specialized and immobilized biologic barrier membrane interposed between the graft site and the surrounding soft tissues. Traditionally, the nonresorbable e-PTFE membrane has been used as the barrier to the penetration of nonosteogenic soft tissues and to help preserve the space for new bone growth. The disadvantages are that a second surgery is required to remove this membrane, and there is a high risk of membrane exposure during the healing period.[38,39] It was reported in a meta-analysis by Machtei[40] that exposure of the membrane hampers the GBR process. In GBR studies, resorbable membranes have been

shown to be as effective as nonresorbable membranes.[25,26] Additionally, resorbable collagen membranes seem to be able to overcome exposure problems and possible infection by promoting rapid soft tissue healing once exposed to the oral cavity, as opposed to e-PTFE or noncollagenous resorbable membranes.[41] The resorbable collagen membrane (Ossix) used in this report, by virtue of its superior resistance to bacterial and human collagenase activity, appears to remain in situ for a sufficient length of time (up to 8 months), permitting osteogenesis to occur whether it is completely covered or partially exposed. Its excellent tissue compatibility also appears to encourage rapid soft tissue healing in either event. It has been well documented that stability of the membrane is essential for successful GBR.[25–42] Since tacking or screwing of this membrane into place is not advisable, the use of the modified horizontal mattress suture method, as recommended in this report, will adequately stabilize the membrane. In addition to space maintenance, the membrane plays a role in clot stabilization while simultaneously preventing migration of nonosteogenic tissues into the area. The created space can then be occupied by proliferating vascular, osteogenic cellular, cytokinal, and hormonal components fundamental to successful GBR.[22,43]

When the space created for GBR cannot be maintained because the membrane collapses into it, screw devices or graft/filler materials must be introduced into the space to prop up the membrane.[44,45] According to the literature, the filler material of choice for GBR procedures is still membranous autogenous bone.[7,28] It has also been shown that autogenous bone used as a filler will enhance osteogenesis by inductive and conductive processes.[46] When autogenous bone is collected from intra- or extraoral sites, the main drawbacks reported are the need for a second surgical site, and in some cases, undesirable morbidities.[13,47–49] The innovative technique for bone harvesting described in this article provides sufficient native membranous bone without the negative aspects associated with procurement from a second surgical site.

Based on time-tested principles of GBR, the new approach described in this report has proven to be a safe and predictable method of augmenting deficient alveolar ridges in preparation for endosseous implant placement. The successes attained with this method have prompted the initiation of a clinical research study designed to more definitively quantify the amount of horizontal and vertical augmentation that can be predictably achieved in this way. The quality of the new bone will be assessed by a histomorphometric comparison of regenerated bone cores with cores taken from untreated sites.

Acknowledgment

The primary author designed the Osseous Coagulum Bone Collector and receives royalties on its sale.

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