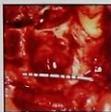


## Localized Ridge Augmentation Using Absorbable Pins and e-PTFE Barrier Membranes: A New Surgical Technique. Case Reports



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*This paper presents a new surgical technique to promote bone formation in localized alveolar ridge defects. The objective was to regenerate sufficient bone volume for implant placement. The technique is dependent on careful defect debridement and the use of absorbable orthopedic pins, which serve as tent poles and prevent the e-PTFE barrier membranes from collapsing into the defects. The three defects treated with this technique were completely resolved with new bone, and implants were successfully placed into the augmented ridges. Biopsies from the treated sites revealed new bone formation. (Int J Periodont Rest Dent 1994;14:49-61.)*

Placement of endosseous implants requires sufficient bone volume to stabilize the implant. After tooth extraction there is remodeling of the alveolar bone. If the tooth is not removed carefully, localized discrepancies in the bone occur; these traumatic injuries compromise future implant placement. Similarly, traumatic accidents in which teeth are avulsed can also lead to alveolar anatomic defects that preclude placement of dental implants. The predictable reconstruction of these types of defects can make it possible to rehabilitate patients with fixed prostheses anchored to endosseous implants.

The application of barrier membrane technology to dental implant surgery is a natural evolution from its accepted application as a recognized periodontal regenerative procedure. The use of barrier membranes to separate healing compartments during the healing process has added a new dimension to periodontal<sup>1-4</sup> and implant therapy.<sup>5-9</sup>

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The application of membrane technology has been expanded to include treatment for implants placed into immediate extraction sockets and to promote bone around implants with bone dehiscences and fenestrations. Furthermore, barrier membranes have been used to augment alveolar ridges with traumatic injuries and bone defects. Seibert and Nyman<sup>10</sup> created extensive ridge defects in dogs. The defects were subsequently augmented with hydroxyapatite and Gore-Tex membranes (WL Gore). Clinical and histologic evaluation demonstrated enlargement of the experimentally created defects with minimal amounts of newly formed bone. Buser and coworkers<sup>11</sup> treated 12 patients with localized ridge defects using a special flap design and e-PTFE membranes. The membranes were displaced from the alveolar ridge by small screws. The screws acted as tent poles and prevented the augmentation material from collapsing against the bone once the flaps were sutured. After 6 months, 9 of the 12 treated patients had sufficient amounts of regenerated bone for implant placement. The gain of bone width varied from 1.5 to 5.5 mm.

Simion et al<sup>12</sup> treated five patients with narrow buccolingual dimensions. The ridges were split, creating green-stick fractures, and implants were inserted. The defects were protected with e-PTFE augmentation material. Biopsies from the treated sites indicated bone regeneration between the split crest.

Shanaman<sup>13</sup> placed implants into ideal prosthetic positions. This frequently resulted in buccal dehiscences and fenestrations. Demineralized freeze-dried bone was implanted over the defects and e-PTFE augmentation material was placed over the implanted sites. At the second stage, the implants appeared to be covered by a bone-like material.

The purpose of this pilot study was to determine if localized ridge augmentation could be achieved using e-PTFE barrier membranes with absorbable pins, which were used to support the barrier membranes and to prevent the material from collapsing into the defects. The goal was to sufficiently increase the existing bone volume to place endosseous implants.

## Method and materials

Three adult patients with evidence of localized mandibular ridge deformities were enrolled in this pilot project. All patients were initially referred to our offices for evaluation for implant placement. The health status of the patients was determined and each patient received a comprehensive periodontal evaluation. Complete-mouth radiographs and panoramic films were taken. When the areas of possible implant placement were determined to be deficient of bone quantity, because of a localized ridge defect, linear tomograms or computer-assisted tomograms were made in addition to the periapical films (Figs 1a, 2a, and 3a). The patients were considered to be in reasonably good health and were given extensive explanations of the procedures that would be performed. They then signed surgical consent forms.

The patients were premedicated with an appropriate antibiotic (amoxicillin, 2 g 2 hours prior to surgery), and were prescribed amoxicillin, 1 g per day for 1 week postoperatively. The patients were anesthetized with an appropriate local anesthetic (Lidocaine 2%, 1:100,000 epinephrine). Incisions were placed either lingual

or buccal to the midalveolar crest and extended one tooth mesial and distal to the defect. To achieve proper visualization of the defects, vertical releasing incisions were placed at the anterior flap extensions. Full-thickness mucoperiosteal flaps were raised, exposing the underlying defects (Figs 1b and 2b). The defects were thoroughly debrided with curettes and files. To promote bleeding, small round burs were used to perforate the bone within the defects (Fig 3b). Carbide 557 burs were used to make 3- to 4-mm-deep pin-retention sites lateral to and within the defect.

Depending upon defect anatomy, three to four support pins were cut from an Ortho-Sorb Absorbable Pin Kit (Johnson & Johnson Orthopedics). The pins are made of polydioxanone and resorb within 6 months. To obtain a snug fit, the pins were slightly reduced in size with either a 557 bur or a surgical blade. Once the pins were trimmed, they were pressed into the recipient sites (Figs 1c, 2c, and 3b). The pins extended approximately 2 to 3 mm coronal to the defect. An appropriately shaped piece of Gore-Tex augmentation material (WL Gore) was draped over the defect, extending a minimum of 3 to 5 mm over the buccolingual defect margins

(Figs 1d, 2d, and 3c). The material was tucked under the flap margins, which were closed with interrupted, horizontal mattress sutures with an attempt to completely cover the augmentation material (Figs 1e, 2e, and 3d). The vertical incisions were sutured with interrupted sutures. The patients were given appropriate analgesics. The sutures were removed in 1 week and the tissues were examined for material exposure. The patients were seen bimonthly for 2 months. In cases where the material became exposed, Peridex (Proctor & Gamble) was applied to the area of exposure with a cotton swab once a day (Fig 2f). Complete photographic documentation was made at the surgical and postoperative visits. In one patient, the material was removed 7 weeks after surgery (Fig 3e).

Prior to implant placement, radiographs were taken to evaluate bone healing within the treated defects (Figs 1f, 2g, and 3f). The radiographs were taken a minimum of 5 months after the initial surgery and all defects exhibited radiographic evidence of almost total bone defect resolution. The time of the second-stage surgery ranged from 5 to 11 months.

At implant placement, the tissues overlying the material

appeared healthy (Figs 1g and 2f). Buccolingual mucoperiosteal flaps were elevated, exposing the retained membranes (Figs 1h and 2h). The removed membranes, with small quantities of underlying bone and a core biopsy from one site, were fixed in 10% neutral buffered formalin and processed for histologic evaluation (Fig 3h). The sections were stained with hematoxylin and eosin. The purpose of the biopsies was to determine the quality of the regenerated bone.

There was bone regeneration in each of the treated defects (Figs 1i, 2i, and 3g). For each of the treated defects, there was sufficient bone volume for placement of endosseous implants (Figs 1j, 2j, and 3i). The implant sites were prepared according to the method of Adell and coworkers,<sup>14</sup> and appropriately sized implants (Nobelpharma) were precisely placed into the prepared sites. Cover screws were fixed to the implants, and the flaps were sutured with interrupted mattress sutures. Six implants were successfully placed in the regenerated alveolar ridges of the three patients.

## Results

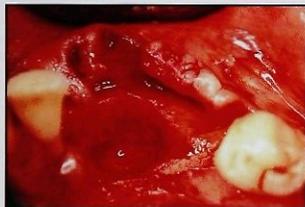
Figures 1a to 1l, 2a to 2m, and 3a to 3j demonstrate the surgical technique and clinical results after treatment of the alveolar ridge defects in this pilot project. The material became exposed in two of the three patients. In one patient the material and pins were removed 6 weeks after placement. In another patient a small piece of material became exposed, but was retained until the time of implant placement. The material remained unexposed in the third patient. The augmentation procedures increased the bone volume sufficiently to allow placement of endosseous implants in each of the treated ridge deformities.

### *Evaluation of biopsies*

The biopsies taken from each of the augmented sites demonstrated vital bone. Figure 1l demonstrates a section through the e-PTFE membrane and underlying bone. The membrane was removed at the time of implant placement. The bone is representative of woven bone. Osteocytes are present and osteoblasts line the bone seams. Figure 2j, a section from the bone core taken at the time of implant placement, demonstrates a clear demarcation between mature and the newly regenerated bone.



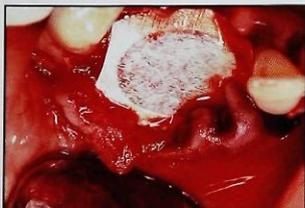
**Fig 1a** Radiographs reveal a deep, wide, crater-like defect between the mandibular left second premolar and lateral incisor.



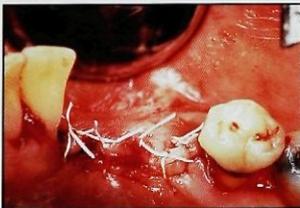
**Fig 1b** (left) After flap reflection, the defect was thoroughly debrided.



**Fig 1c** (right) Two resorbable pins were placed into prepared sites on the buccal aspect of the defect and one pin was inserted in the center of the defect. The pins extended 2 to 3 mm coronal to the defect.



**Fig 1d** (left) An Oval 6 piece of Gore-Tex augmentation material was draped over the pins.

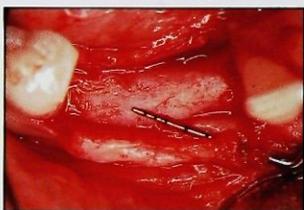
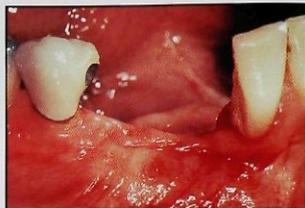


**Fig 1e** (right) Horizontal mattress sutures were used to coapt the flap margins.

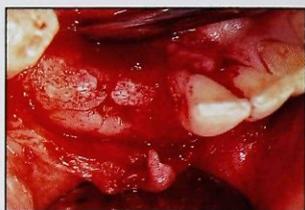
**Fig 1f** (left) Radiograph taken at the time of implant placement. Note complete bone regeneration of previous defect.



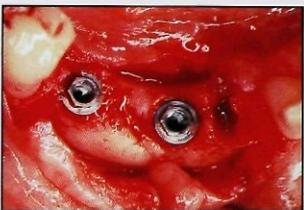
**Fig 1g** (right) The material remained covered for 11 months. The photograph reveals tissue health over the augmented ridge.



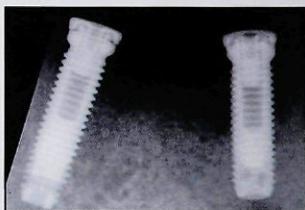
**Fig 1h** Buccolingual flaps have been reflected, revealing the augmentation material totally integrated with the underlying bone. The material was completely dissected from the underlying bone.



**Fig 1i** Complete bone regeneration of the initial defect was achieved. The bone immediately adjacent to the lateral incisor was slightly coronal to the contiguous ridge.



**Fig 1j** The periodontally involved left lateral incisor has been removed and two threaded titanium implants have been placed into the augmented ridge.



**Fig 1k** Radiograph taken immediately after implant placement.

**Fig 11** Histologic section through e-PiTFE barrier membrane and underlying bone. The newly formed bone has osteocytes within the lacunae, and osteoblastic activity is present.

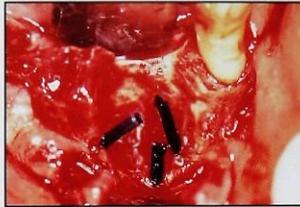


**Fig 2a** Radiograph reveals extensive bone loss in the mandibular left canine and lateral incisor regions.



**Fig 2b** Photograph taken immediately after removal of the periodontally involved right lateral incisor reveals an extensive osseous defect adjacent to the left premolar. There is insufficient bone to support implants.

**Fig 2c** (left) Resorbable pins are placed into the recipient sites, extending 5 mm coronal to the defect base, to provide a tenting effect for the augmentation material and prevent displacement of the material into the defect.

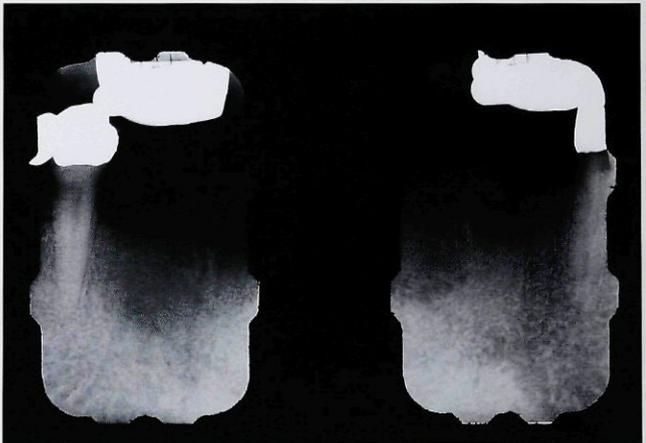


**Fig 2d** (right) A large piece of Gore-Tex augmentation material has been draped over the pins and defect.

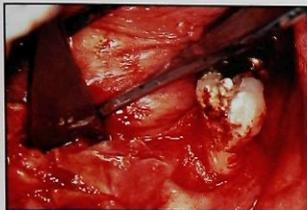
**Fig 2e** (left) One-week postsurgical view.



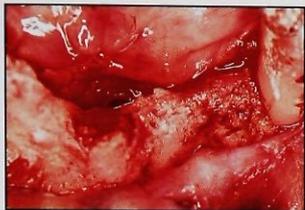
**Fig 2f** (right) Ten-month postsurgical view. There is communication between the oral cavity and the underlying material. The patient has applied Peridex to the area for the preceding 6 months.



**Fig 2g** Radiographs taken at time of membrane removal and implant placement. Note complete bone formation of initial defect.



**Fig 2h** (left) Buccolingual flaps are reflected, exposing the underlying augmentation material.



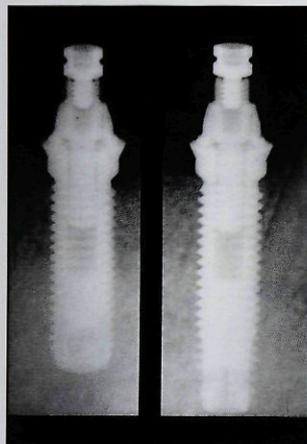
**Fig 2i** (right) There has been complete bone regeneration with sufficient bone dimension for placement of an endosseous implant.



**Fig 2j** (left) Two endosseous implants are placed in the restored ridge.



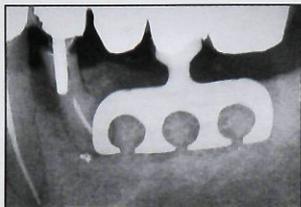
**Fig 2k** (right) Photograph taken at second-stage surgery, 4 months after implant placement. Note bone adjacent to the implant in the left canine region.



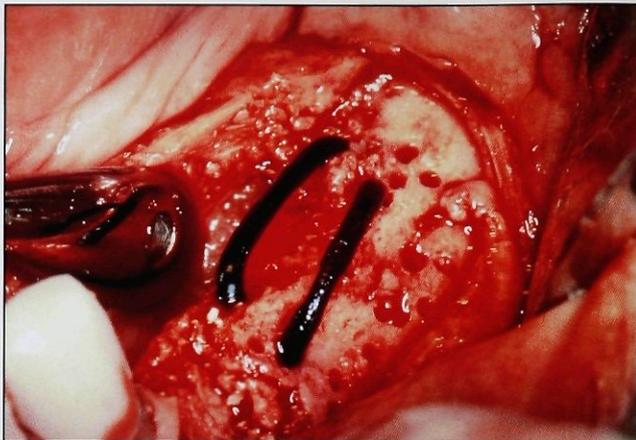
**Fig 2l** Radiograph taken after abutment connection.



**Fig 2m** Implants have been loaded with a provisional restoration.



**Fig 3a** Radiograph of blade implant, which was in place for 9 years. Note extensive bone loss adjacent to implant.



**Fig 3b** The edentulous ridge is narrow with insufficient bone in an apicocoronal dimension. Resorbable pins are shaped to form a staple and are placed into the recipient sites. To stimulate bleeding, the bone is perforated with a small round bur.

**Fig 3c** (left) The augmentation material is draped over the support pins.



**Fig 3d** (right) The flaps are sutured, but complete closure is not achieved.

**Fig 3e** (left) The material became exposed and was removed 7 weeks after placement. At this time the pins were not completely resorbed and were removed.

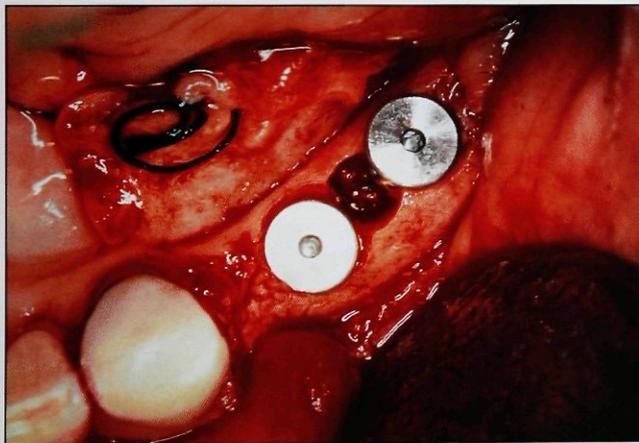


**Fig 3f** (right) Radiograph taken 5 months after the augmentation procedure.



**Fig 3g** (left) Buccolingual flaps have been reflected, exposing the widened alveolar ridge with an apparent increase in bone height.

**Fig 3h** (right) A small trephine is used to remove a sample of bone for histologic evaluation.



**Fig 3i** Two endosseous implants are placed in ideal positions in the regenerated bone.



**Fig 3j** The histologic specimen reveals mature bone in the apical half of the sample and woven-type bone in the coronal half of the section, indicating the presence of new bone formation.

## Discussion

The objective of this pilot study was to attempt a new, effective surgical technique for localized ridge bone augmentation. The patients in this study initially had bone defects that, because of insufficient bone volume, made implant placement unrealistic. The results from treatment indicate that use of absorbable pins to support Gore-Tex augmentation material will create sufficient space to retain a stabilized blood clot. If the membrane remains immobilized, the clot should become organized by bone. The importance of clot stabilization for proper wound healing has been substantiated by Wikesjo and coworkers.<sup>15</sup> The resorbable orthopedic pins are an ideal material to support barrier membranes while creating sufficient space for clot retention. At the time of implant placement, there was no clinical or radiographic signs of residual pin remnants. Unfortunately, because of the variation of defect sizes, it was not possible to accurately measure changes within the defects. However, radiographic and clinical photographic documentation clearly indicate the magnitude of bone formed with this technique.

Clinically, the initial results of this pilot study compare favorably with those reported by Buser and coworkers,<sup>11</sup> who treated edentulous ridges deficient in bone width due to traumatic injuries using stainless steel mini screws, which acted as tent poles to support e-PTFE augmentation material. Collagen Fleece (Pentapharm AG) was used to stabilize the blood clot and to help maintain the space beneath the membranes. In two patients the material became exposed and was removed prematurely. In our study the material became exposed in two out of three patients. The sites in which the material became exposed demonstrated complete healing of the bony defects. Similarly, the one defect in which the material was retained for 11 months also demonstrated complete bone regeneration.

Buser et al<sup>16</sup> recently published the results of treating maxillary anterior ridge deformities with special screws and membrane supporting struts. The clinical results were excellent and implants were placed into the augmented ridges at the time of membrane removal. Collagen Fleece was also used in this documented series of treated patients.

Nevins and Mellonig<sup>17</sup> reported on three patients with traumatized edentulous ridges with insufficient alveolar bone remaining in which to place implants. The defects were debrided and grafted with mineralized freeze-dried bone allografts and augmented with e-PTFE material. After time intervals ranging from 2 to 6 weeks, the membranes became exposed and were removed. At 6 months the ridges were surgically exposed and the previously treated defects had apparently resolved. Endosseous implants were placed in the repaired ridges and ultimately were restored and loaded. The results achieved in our pilot study indicate that maintenance of the space beneath the membrane and a stabilized blood clot are sufficient to promote bone formation without the use of implanted materials.

The principle of guided tissue regeneration has been applied to localized ridge augmentation without the use of grafting materials. The potential of properly placed resorbable pins to maintain the space beneath e-PTFE augmentation materials should be investigated further.

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