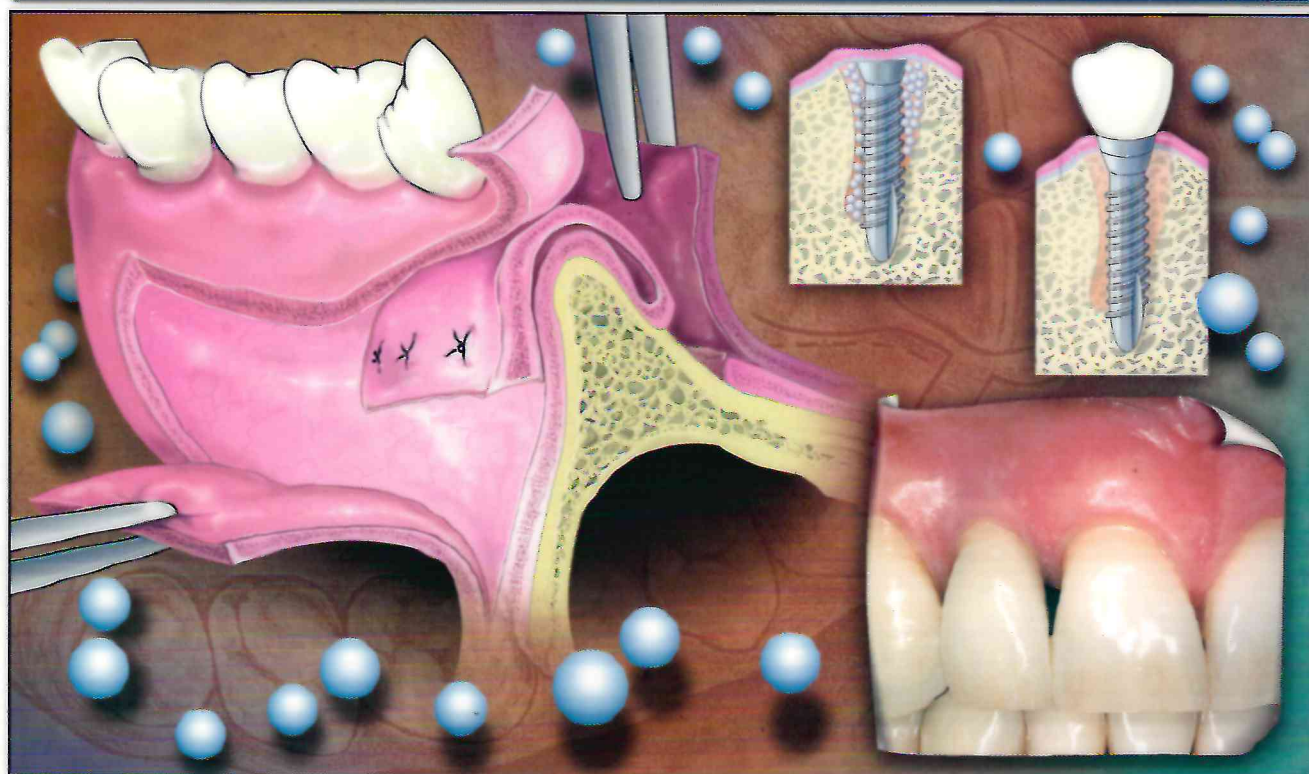


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THE REGENERATION REPORT

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1995

Complete Flap Coverage In Augmentation Procedures Around Dental Implants Using The Everted Crestal Flap

Cobi J. Landsberg, DMD

Guided bone regeneration around exposed parts of dental implants requires the use of membrane barriers that allow only bone forming cells to repopulate the deficient implanted site in the jaw. The membrane should preferably be submerged under the soft tissue during the entire healing process. This provides stabilization of the wound and successful bone regeneration on a predictable basis. The learning objective of this article is to demonstrate the application of the everted crestal flap for guided bone regeneration procedures around dental implants to ensure complete flap coverage over the membrane during the entire healing process.

Animal^{1,3} and human^{4,8} studies have successfully demonstrated that by using the biologic principle of guided tissue regeneration, bone may regenerate around dental implants placed in fresh extraction sockets or in other jawbone defects. To regenerate bone around exposed areas of dental

...using the principle of guided tissue regeneration, bone may regenerate around dental implants placed in fresh extraction sockets...

implants, a membrane barrier is placed over the implant extending 5 mm to 8 mm to the surrounding bone and providing a space between implant and membrane so that only bone-forming cells repopulate this space. Several methods have been proposed to ensure that this space is maintained during the healing period.^{5,9-15}

Dr. Landsberg is a member of the Department of Periodontology, Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, and Diplomate of the American Board of Periodontology. He maintains a private practice limited to Periodontics and Implantology in Tel Aviv, Israel.

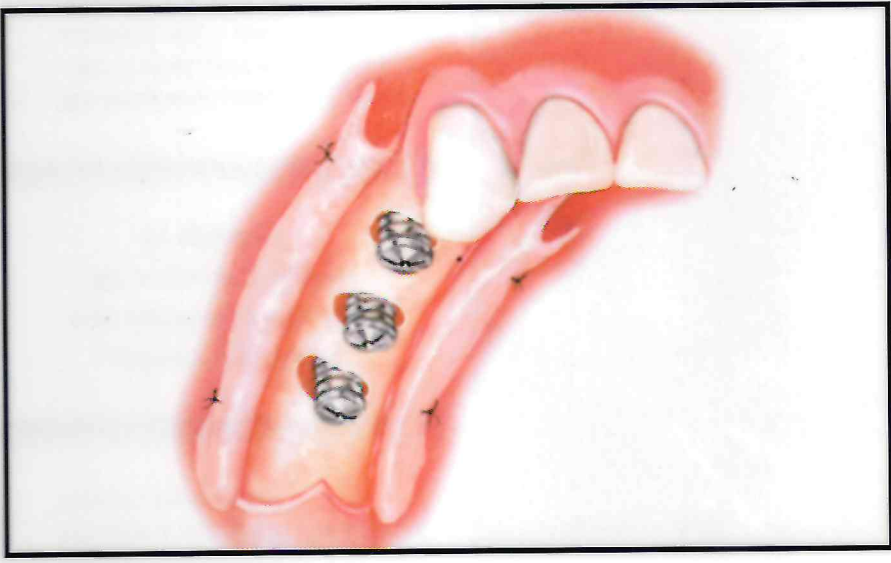


Figure 1. A schematic, demonstrating retraction of buccal and lingual flaps maintained by simple "anchoring" sutures.

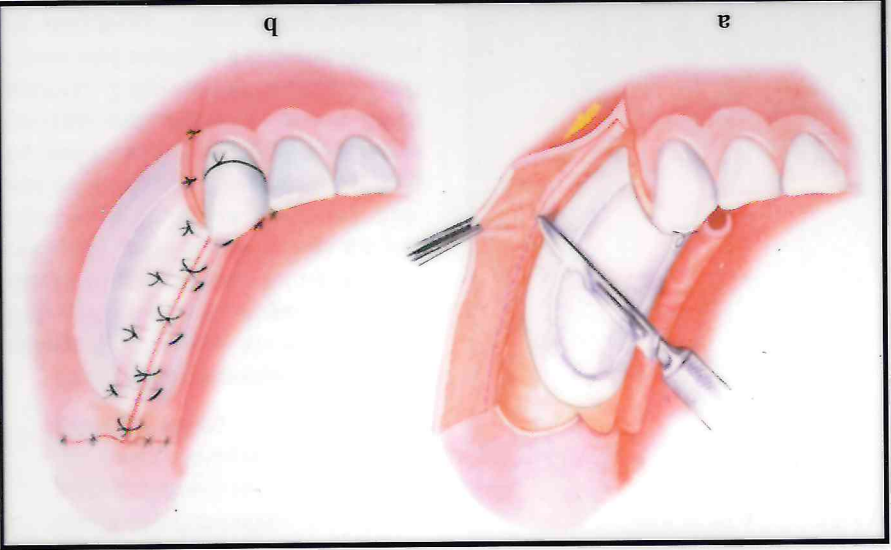


Figure 2. a. Dissecting the inner aspect of the buccal flap. b. Combination of vertical mattress and simple sutures.

It is desirable that the membrane, once accurately placed over the implant and associated bony defect, be completely covered by soft tissue to prevent its contamination and premature removal. This allows optimal biologic conditions for bone regeneration into the space provided by the membrane.^{2,5,9-15} Primary flap closure in such augmentation procedures is usually difficult to achieve for three reasons:

- The flaps may be too short to bridge the gap created between them because of the extra ridge volume. This problem is even more emphasized in cases of immediate post-extraction implant placement, since by removing teeth, a substantial gap is automatically created between the two flaps.

**...primary flap closure
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- The membrane under the flaps provides a relatively wide avascular substrate which compromises flap nourishment during healing, placing flap survival at risk.
- Conventional suturing techniques tend to invert flap edges once approximated, allowing epithelial ingrowth to intervene and prevent unification between the flaps.

In their study on regeneration and enlargement of jawbone using guided tissue regeneration, Buser et al⁹ indicated that primary flap closure may significantly influence the prognosis and must be optimized. A combined split- and full-thickness flap technique should be used to achieve complete membrane coverage and tension-free closure. Of 10 patients, 2 showed dehiscences of soft tissue and another 2 showed abscess development. These complications indicate the necessity for further improvements of the surgical technique.⁹

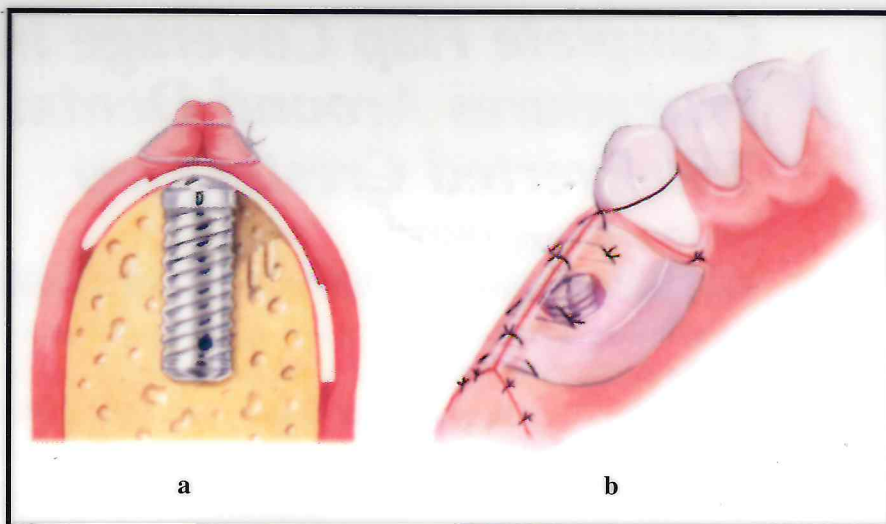


Figure 3. a. Transversed view of vertical mattress suture evertting flap margins for complete coverage. **b.** Lingual view of a typical augmentation procedure.

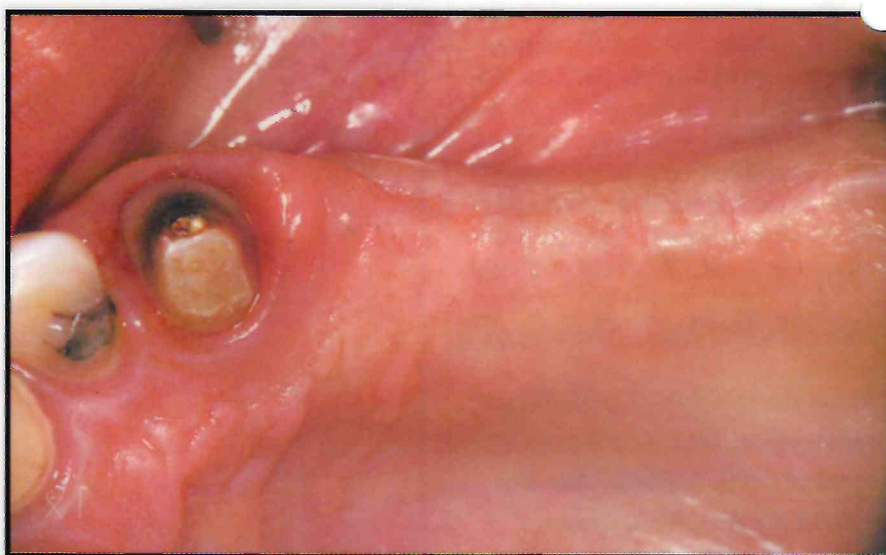


Figure 4. Case 1. Preoperative occlusal view of the narrow edentulous ridge.

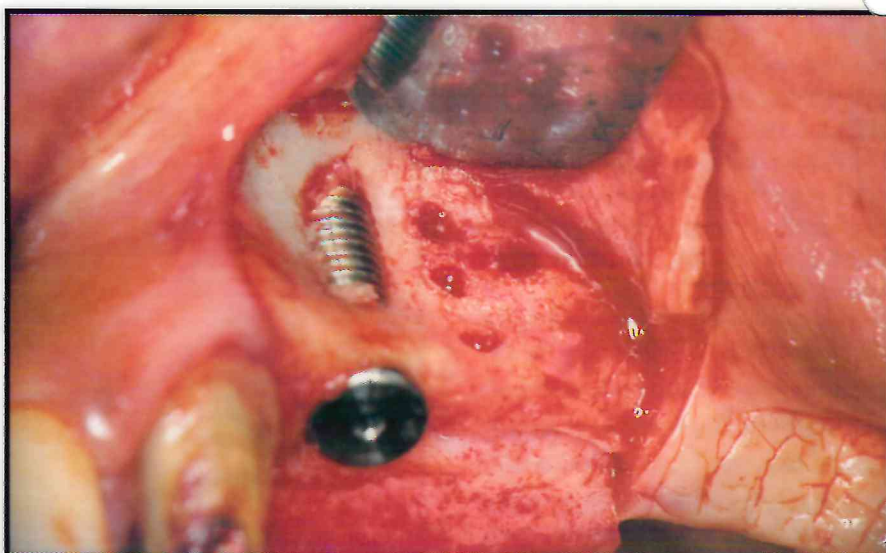


Figure 5. An 18 mm long implant, placed distally of the maxillary left canine. Its middle portion is exposed. Note decortication of the very narrow and concave ridge.

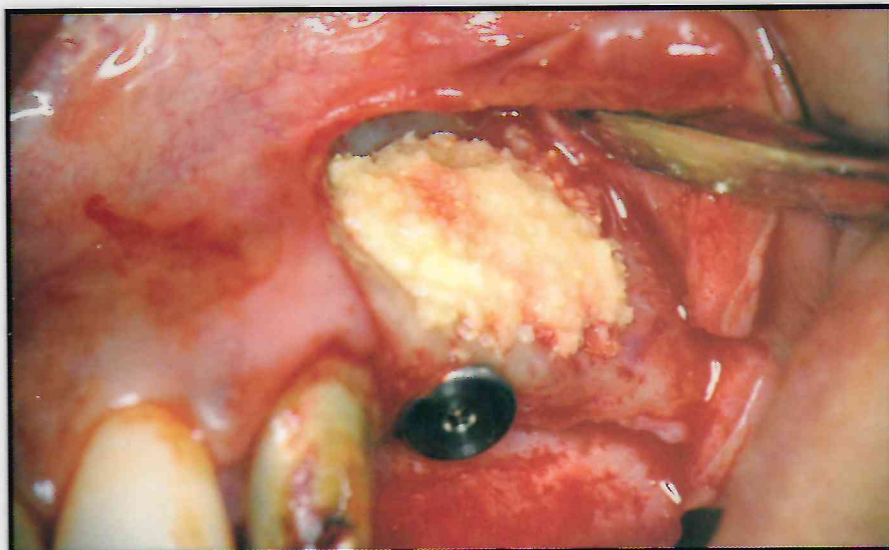


Figure 6. Freeze-dried bone particles mixed with tetracycline powder grafted in the ridge concavity and over the exposed implant.

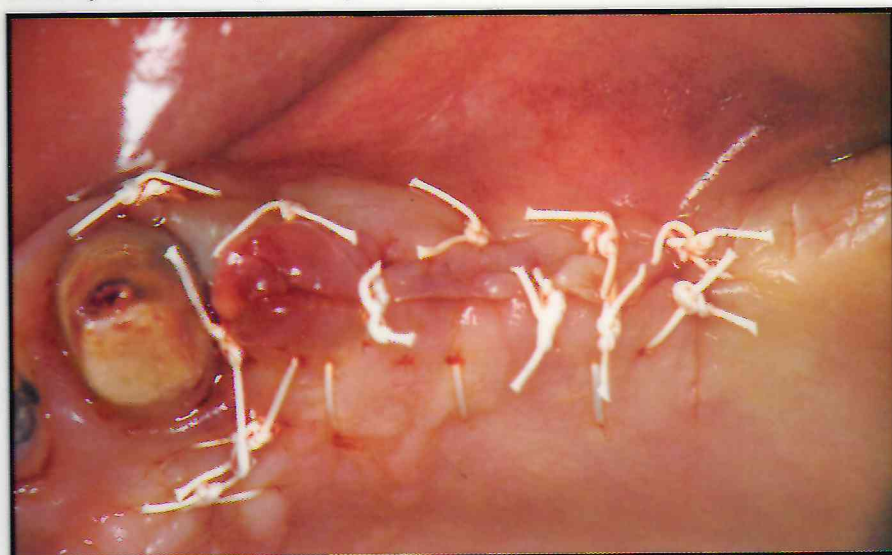


Figure 7. Eversion and full coaptation of flaps is achieved by a combination of vertical mattress and simple sutures.

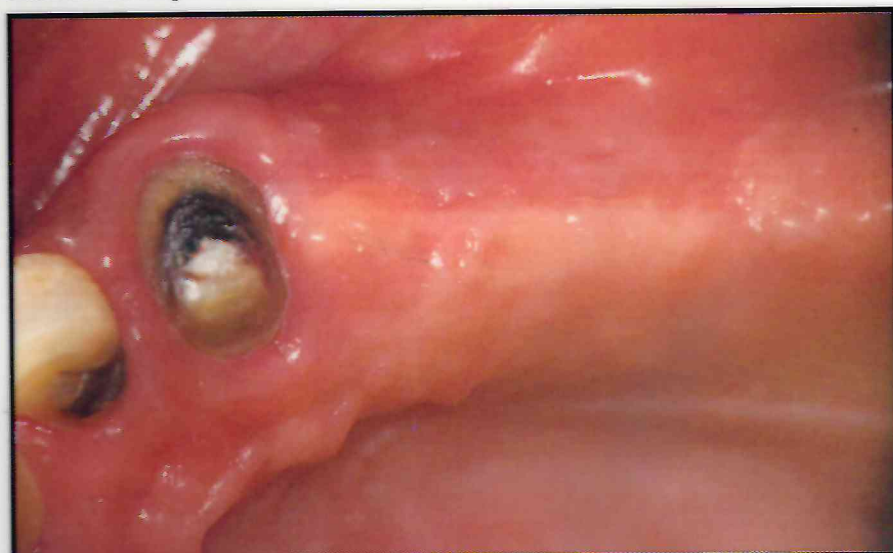


Figure 8. Complete wound closure is still present at 6 months postsurgery.

Recently, a modified flap design for routine endosseous implant procedures was suggested.¹⁶ This design, the everted crestal flap (ECF), enables midcrestal eversion of the flaps by vertical mattress sutures to ensure primary flap closure⁹ over the implant site.

This article presents the application of the ECF design to bone regeneration procedures associated with endosseous implants, in which primary flap coverage during the entire healing process is a major consideration.

SURGICAL TECHNIQUE

Flap Management

Using midcrestal horizontal incision and vertical release incisions, mucoperiosteal buccal and lingual/palatal flaps are elevated to expose the surgical area. If a tooth borders the implant site, the vertical incisions are usually made at the tooth line angle that approximates

In extensive bony defects, in other than simple fresh extraction sites, the availability of bone-forming cells is relatively limited.

the implanted site. This prevents disturbance of the attached gingiva at the buccal aspect of the tooth at manipulation and suturing of the buccal flap. "Anchoring" simple sutures may be added temporarily to maintain flap retraction during implant placement (Figure 1). Once implants have been placed in the bone and after covering the implant and associated bony defect with the membrane, the flaps are pulled over the membrane without tension, and the distance between them is measured. For immediate postextraction implant placement, the papillae are excised to straighten the flap margins. The buccal flap is dissected internally in a mesiodistal direction to a depth approximately half the distance between the flaps as previously measured (Figure 2a). This undermining of the flap in its periosteal aspect enables its coronal positioning to fully approach its counterpart without any tension.

SUTURING TECHNIQUE

Depending on the mesial/distal length of the flaps, several vertical mattress sutures are used to ensure close adaptation between the vascularized flap margins without interference from epithelial tissue (Figures 2b and 3). Simple sutures are placed between the vertical sutures to ensure complete isolation of the membrane from the outer oral environment (Figures 2b and 3b). If the surgical area is bordered by a tooth, it is suggested that the suture closest to the tooth be anchored around the tooth cervix to optimize flap adaptation to the tooth (Figures 2b and 3b). Simple sutures are added where vertical release incisions have been made (Figures 2b and 3b).

Because of their unique tendency not to cause any direct or indirect inflammatory tissue reaction, e-PTFE sutures should preferably be used.

It is desirable that the membrane
...be completely covered by
soft tissue to prevent contamination
and premature removal.

CASE REPORTS

Case 1

A 37-year-old female presented with an edentulous ridge distal to the maxillary left canine (Figure 4). The alveolar ridge appeared to be very narrow and concave buccally. An 18 mm long implant (Branemark, Nobelpharma, Goteborg, Sweden) was placed with the intention of having it fully surrounded by bone in its coronal and apical portions. However, unavoidably, its buccal middle portion was left exposed (Figure 5). The exposed part, together with the narrow and concave ridge distal to it, was grafted with decalcified freeze-dried bone particles (University of Miami Tissue Bank, Miami, FL) mixed with tetracycline powder (Teva, Israel) at ratio 4:1 (Figure 6). The grafted area was then isolated by a membrane barrier (Gore-Tex, W.L. Gore Associates, Flagstaff, Arizona).



Figure 9. The ridge at 6 months postsurgery. Note reformation of the buccal plate over and distal to the implant.

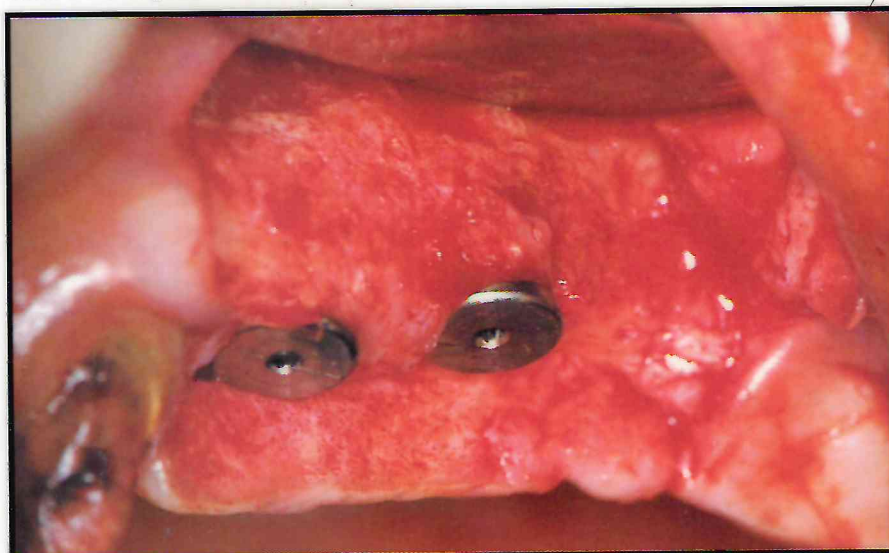


Figure 10. Another implant is placed in the widened ridge.

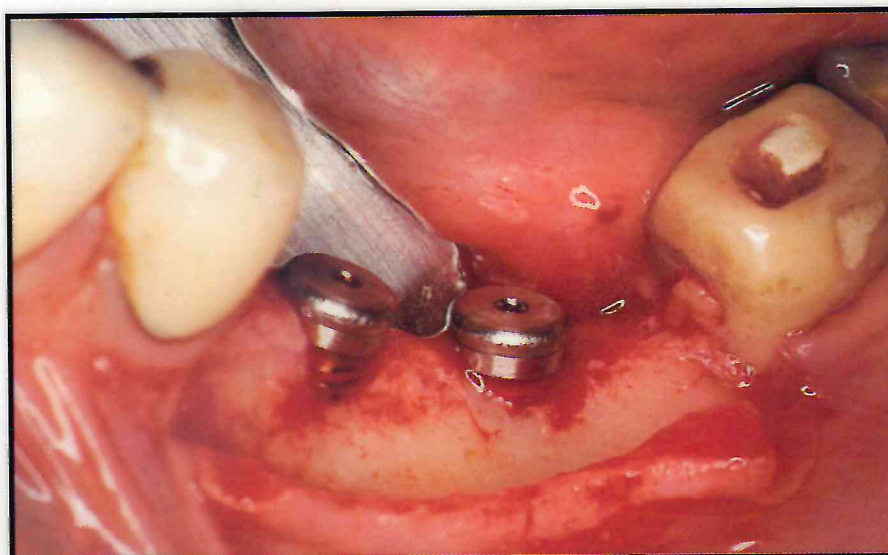


Figure 11. Case 2. Both implants have 2 to 3 mm of their coronal area above the crest.

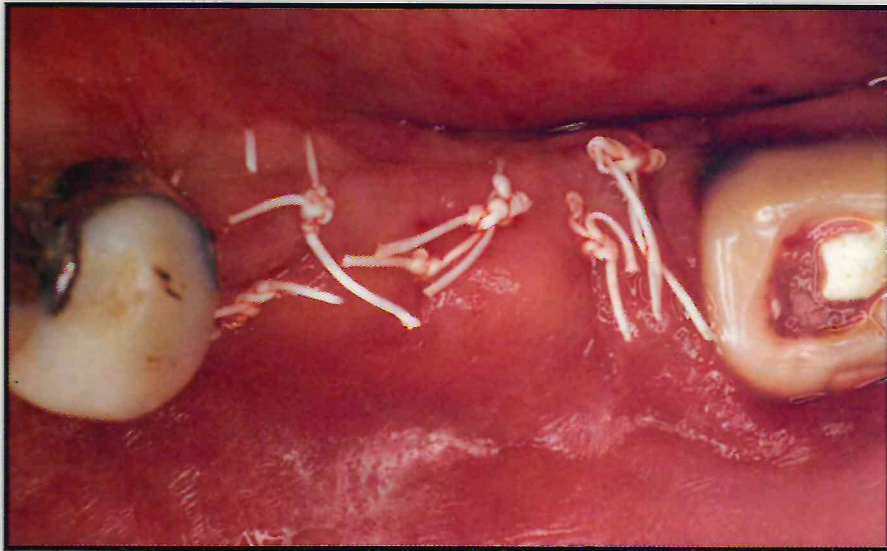


Figure 12. A combination of vertical mattress and simple sutures to maximize flap coaptation.

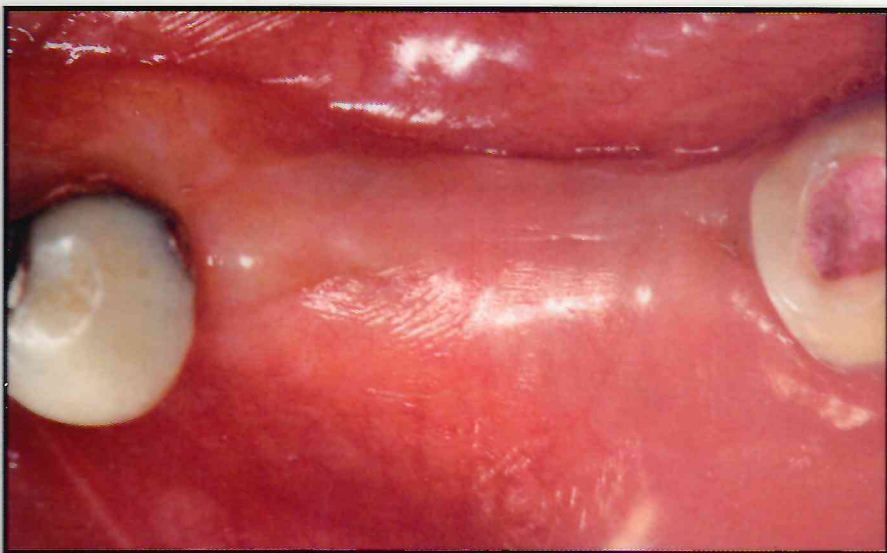


Figure 13. Complete soft tissue coverage of the wound area — at 6 months postsurgery.

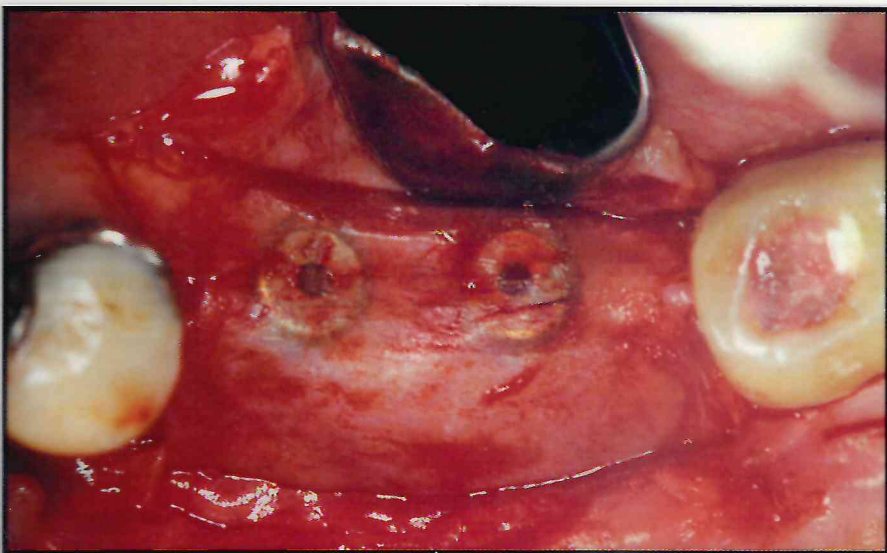


Figure 14. Augmented ridge prior to membrane removal. Note clean, noninfected membrane tightly adapted to the new regenerated tissue underneath.

The buccal flap was released in its inner apical base, positioned coronally, and sutured as described (Figure 7). The sutures were removed after 1 week, and during the next 6 months there was complete soft tissue closure of the wound with no exposure of the membrane (Figure 8). The membrane was then surgically exposed and removed. Reformation of the buccal plate over the exposed implant had occurred, and the widened ridge distal to the implant enabled the placement of another implant (Figures 9 and 10).

Case 2

A 52-year-old female presented with an edentulous ridge between the mandibular left first premolar and the second molar. The patient's dental history revealed that a previous attempt to insert blade implants had failed. The ridge was severely resorbed, with only

The everted crestal flap enables midcrestal eversion of the flaps... to ensure primary flap closure over the implant site.

9 mm to 10 mm remaining between the crest and the mandibular canal. In addition, the lingual concavity in the body of the mandible limited correct aligned implant insertion to a maximal 7 mm depth. Two fixtures (Branemark, Nobelpharma, Goteborg, Sweden), each 8.5 mm long; were inserted, but 2 mm to 3 mm of each implant completely protruded from the ridge (Figure 11). Decortication of the ridge was performed on its buccal aspect, and decalcified freeze-dried bone particles were grafted on the buccal aspect and interproximally between the implants. After placement of the membrane, the buccal flap was dissected in its inner apical portion, taking care not to damage the mental nerve. Vertical mattress and simple sutures were used to coapt the flaps over the membrane (Figure 12). During the next 6 months, there was complete soft tissue coverage with no exposure of the membrane

(Figure 13). The membrane was then surgically exposed and removed (Figure 14). Regeneration of bone occurred buccally, lingually, and interproximally, and the implants were completely embedded in hard tissue (Figures 15 and 16).

Case 3

A 48-year-old male presented to the clinic with a desire to replace the maxillary right second premolar with an implant-anchored crown. Buccal and lingual flaps were elevated, using midcrestal horizontal incision, combined with vertical release incisions on the distal line angle of the first molar and mesial line angle of the first premolar buccally, and on the

For immediate postextraction implant placement, the papillae are excised to straighten the flap margins.

mesial line angle of the first molar and distal line angle of the first premolar palatally. A 13 mm long implant (Branemark, Nobelpharma, Goteborg, Sweden) was placed, leaving a dehiscent surface on its buccal aspect (Figure 17). After placement of decalcified freeze-dried bone allograft and e-PTFE membrane, the buccal flap was coronally positioned and fully coapted to the palatal flap, using three vertical mattress sutures. Additional simple sutures were placed only where vertical incisions were made (Figures 18 and 19). The membrane remained fully submerged for the next 6 months (Figure 20) at which time it was removed, exposing a fully embedded implant in hard tissue (Figure 21).

Case 4

A 34-year-old female presented with a request to replace the missing mandibular right first molar with an implant-anchored crown (Figure 22). Buccal and lingual flaps were elevated using midcrestal horizontal incision combined with vertical release incisions

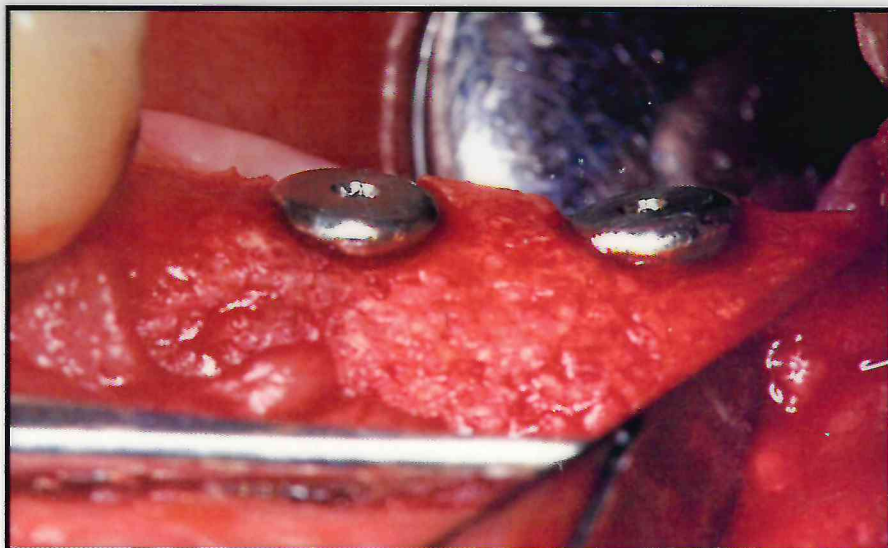


Figure 15. Buccal view at 6 months after surgery, exhibiting "new bone formation" buccally and interproximally.



Figure 16. Six months after implant placement. Note sharp angle created between new crest and new thin lingual plate as a result of only minimal space maintenance.

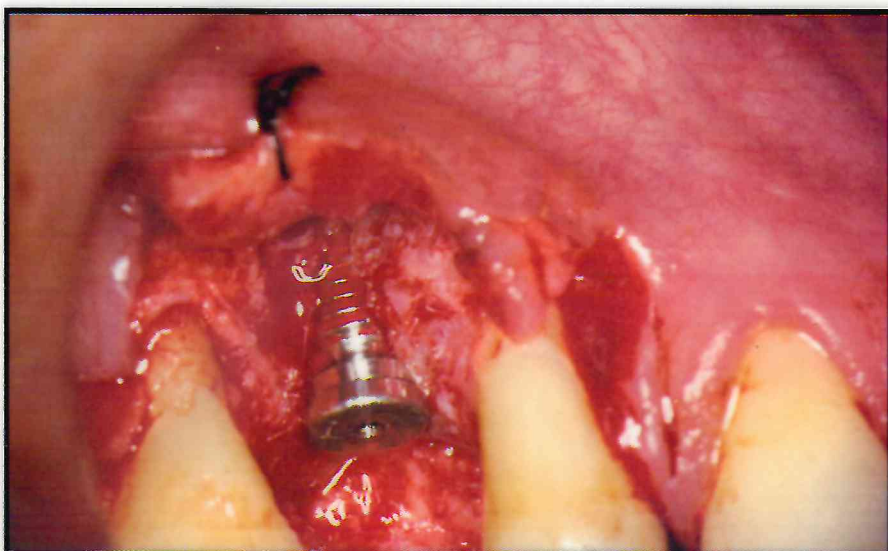


Figure 17. Case 3. Implant in place. Correct alignment necessitated leaving the coronal buccal aspect exposed.

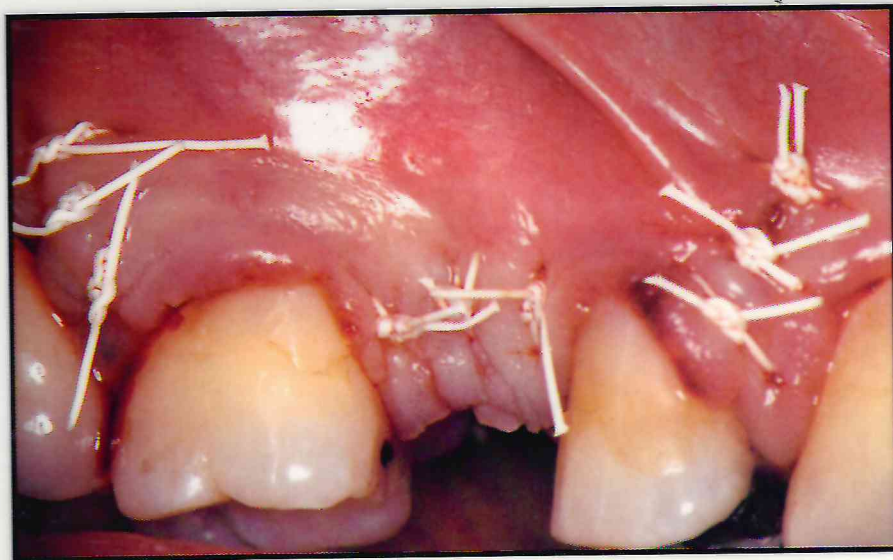


Figure 18. Three vertical mattress sutures ensure immediate primary closure of the wound.

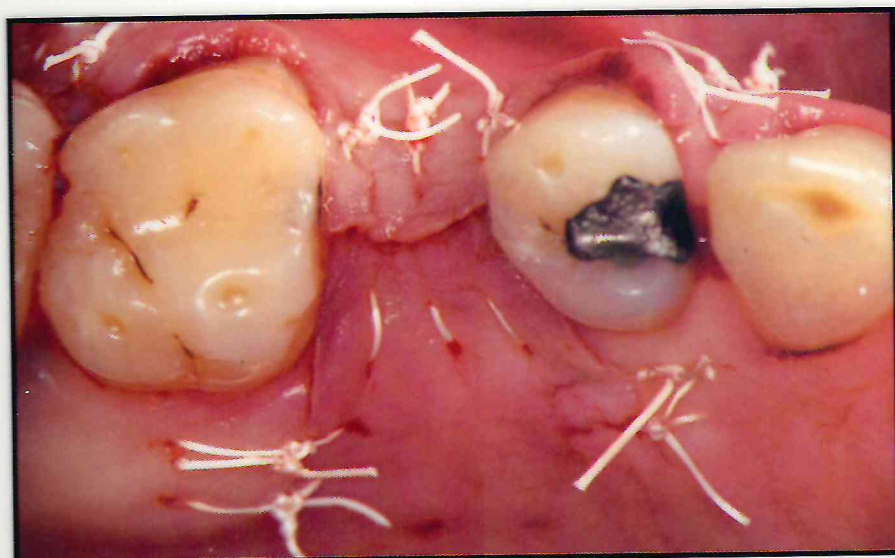


Figure 19. Occlusal view of the primary closure of the wound.



Figure 20. View of the site 6 months after surgery. Note the coverage and tissue health.

in the line angles approximating the surgical site of the neighboring teeth. The alveolar ridge appeared to be narrow, concave, and too short mesiodistally for correct placement of two implants. A 10 mm long (5 mm in diameter) implant (Branemark, Nobelpharma, Goteborg, Sweden) was placed with its coronal buccal aspect unavoidably dehiscd (Figures 23 and 24). After decortication of the ridge and freeze-dried bone engraftment (Figure 25), an e-PTFE membrane was placed to fully cover the implant and bone graft (Figure 26). The buccal flap was coronally positioned and sutured as described (Figure 27). The membrane remained submerged for 6 months, at which time it was removed, revealing a well-embedded implant in newly-regenerated bone (Figures 28 and 29).

...superior quality of newly regenerated bone is achieved if the membrane site remains submerged during the entire healing period.

DISCUSSION

The importance of achieving primary wound closure in most surgical procedures is emphasized in all textbooks on surgery. When foreign material (even though sterile, inert, and nonimmunogenic) is placed in a wound, the complete closure of the wound becomes even more critical.

The use of e-PTFE membrane in conjunction with immediate implant placement into fresh extraction sites in humans was first described by Lazzara.⁴ However, he did not advocate primary flap coverage over the membrane. The material was held in place for approximately 1 month, maintained "clean" by chlorhexidine irrigations, and then surgically removed, allowing the wound to heal for another 6 months. At second-stage surgery, he demonstrated successful bone regeneration around the implants in two cases. However, in extensive bony defects in other than simple fresh extraction sites, the availability of bone-forming

cells is relatively limited, and in such cases the wound may need an extended period of membrane protection. Becker et al⁵ were the first to recognize the importance of complete isolation of the membrane from the oral cavity in such clinical situations. They pointed out the ability to reduce postoperative infection and inflammation and the advantage of minimizing patient trauma, since no additional surgery is necessary before the second-stage implant procedure.

Other studies^{2,3,6-11} have also emphasized that superior quality of newly regenerated bone is achieved if the membrane site remains submerged during the entire healing period. However, in most of these studies, primary flap closure was generally achieved using simple interrupted sutures with no attempt to evert the flap margins.^{2,6,8,11}

Eversion of flaps was first suggested by Branemark¹⁸ in "routine" osseointegration procedures...

Eversion of flap margins is a routine surgical technique, used mainly in plastic surgery procedures where primary closure of the wound is mandatory.¹⁷ Eversion of flaps was first suggested by Branemark¹⁸ in "routine" osseointegration procedures and later by others in bone augmentation procedures associated with dental implants.^{3,5,9} In those procedures, the flap design included vestibular horizontal incisions with the aim of keeping flap margins and sutures away from the implanted site to ensure complete flap coverage of the wound with limited risk of infection. However, this "vestibular" approach may have some undesirable side effects, such as postoperative edema, ecchymosis and pain, difficult suture removal, and significant reduction of vestibular depth.

The everted crestal flap design (ECF) was originally developed to simplify flap management in "routine"

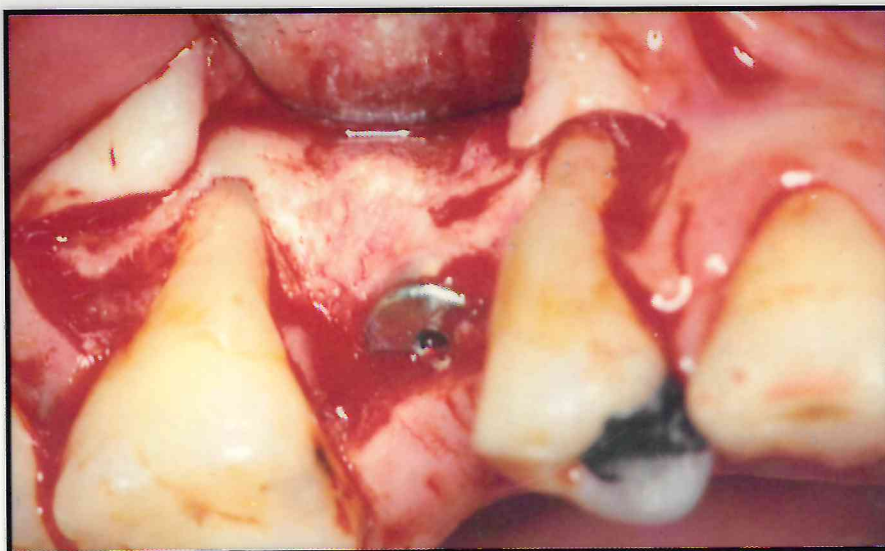


Figure 21. View after membrane removal. Note the well-embedded implant in hard tissue.

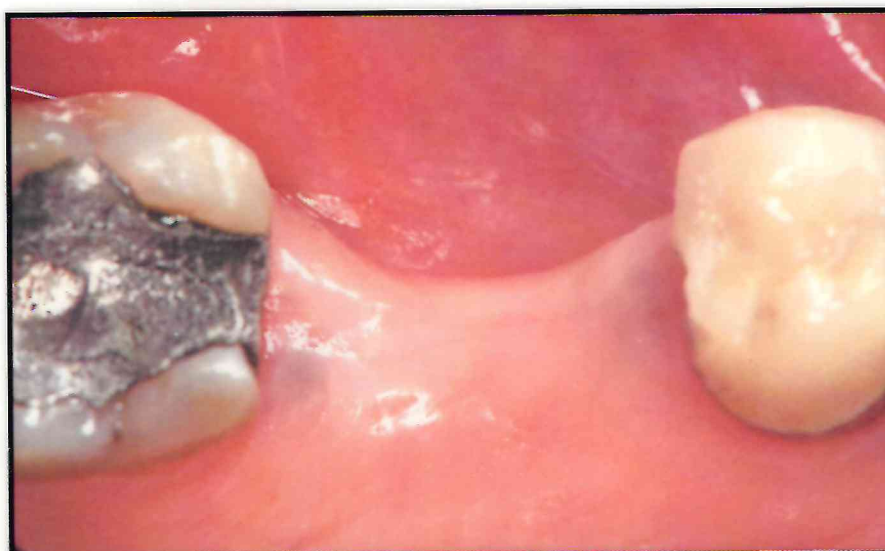


Figure 22. Case 4. Implant site before surgery. Note buccal concavity of the edentulous area.

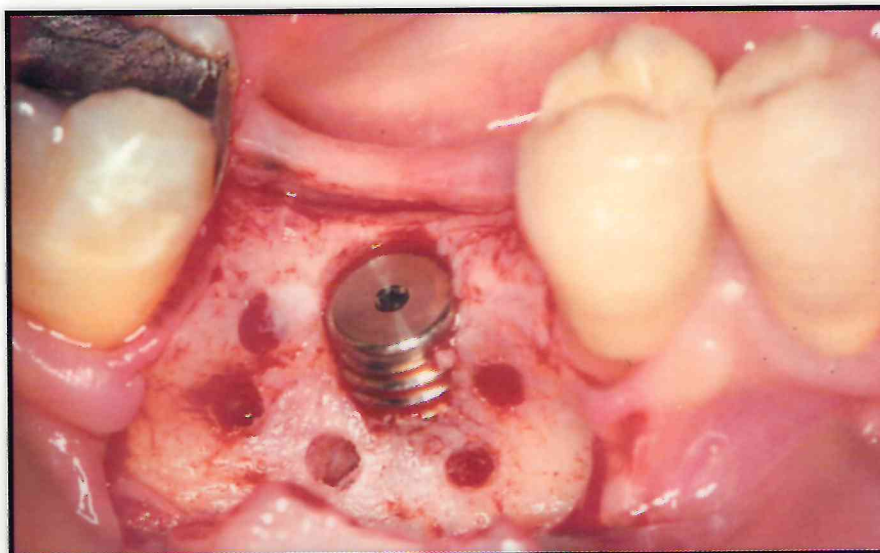


Figure 23. Implant in place, buccal view. Correct implant alignment, left coronal buccal aspect of dehiscent implant.

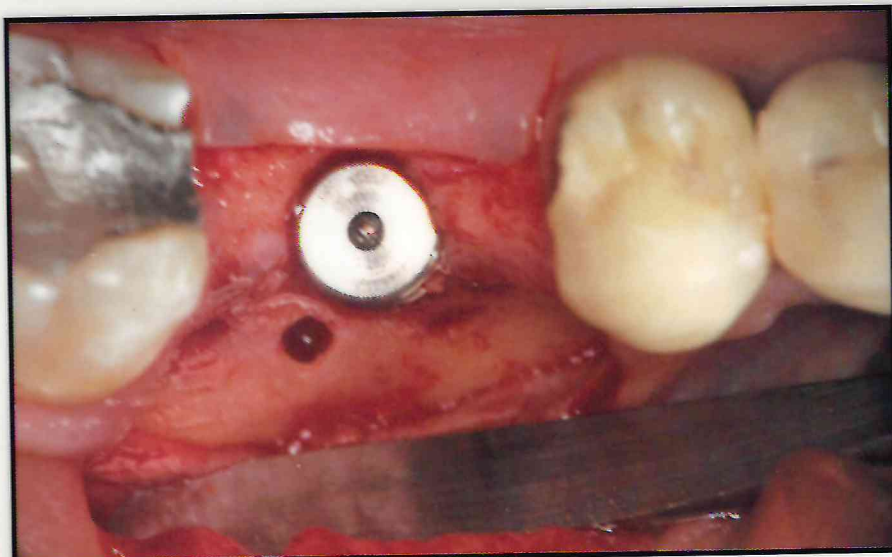


Figure 24. Implant in place, occlusal view. Note significant buccal protrusion of the implant relative to the ridge.

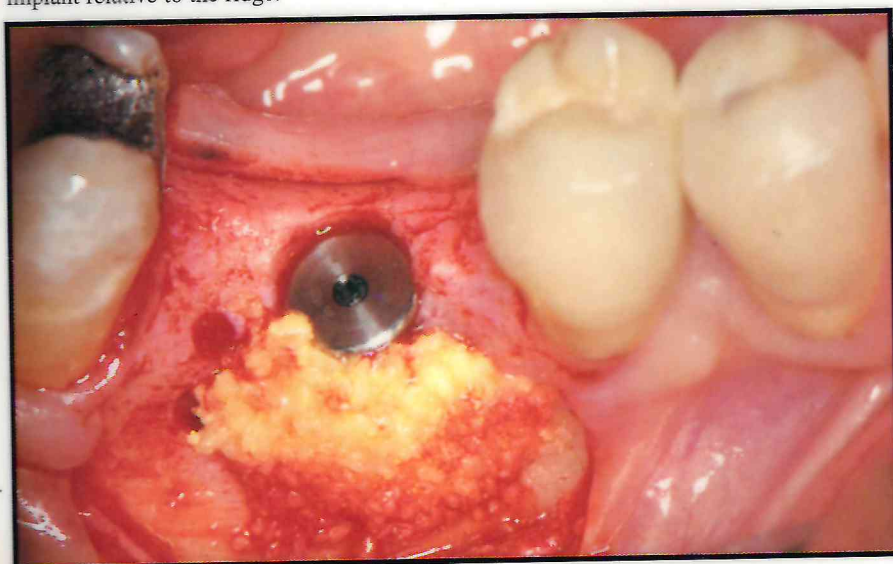


Figure 25. Freeze-dried bone allograft mixed with tetracycline powder placed around the implant which fills the ridge defect.

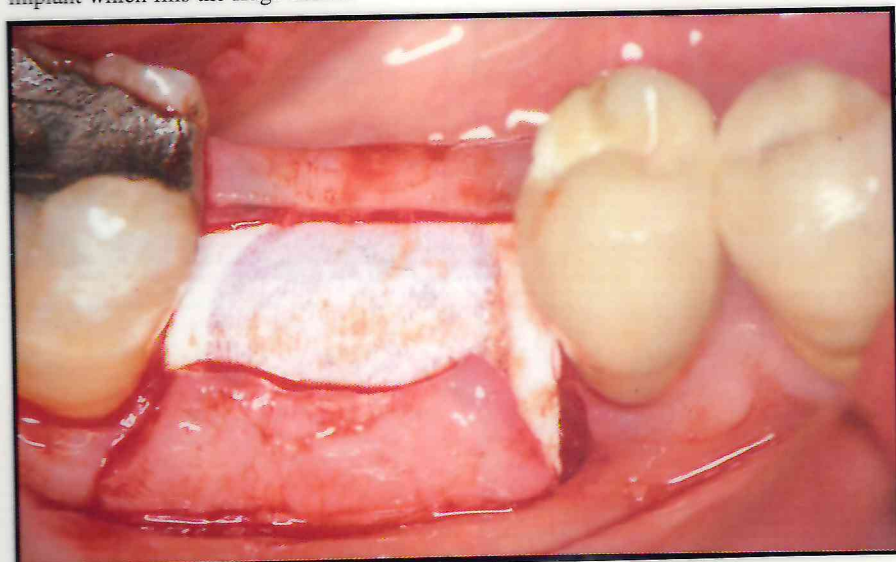


Figure 26. e-PTFE membrane fully covers the implant and bone graft.

endosseous implant procedures.¹⁶ It may be applied to guided bone regeneration procedures with a slight modification, ie, by coronally advancing the buccal flap to fully approach its counterpart without tension. This modified flap design, although relatively technique sensitive, may achieve primary flap closure of the wound with significant predictability. However, the ECF unavoidably sacrifices some amount of keratinized tissue and interdental papillary height, which is one disadvantage. It may cause functional, phonetic, and aesthetic results unacceptable to the patient, especially when the procedure is performed in the maxillary anterior region. Therefore, other immediately postextraction techniques aimed at optimal ridge preservation, such as socket seal surgery,¹⁹ may be indicated in such instances.

CONCLUSION

In summary, the everted crestal flap combines four basic principles, well recognized in flap surgery, which account for safe nourishment of the flap and ensure primary wound closure on a predictable basis:

- The base of a flap should be broad and its margins located a short distance from its base.
- Main circulatory supply to the flap should not be severed.
- A flap should not be forcefully pulled at suturing.
- Eversion of flap margins by vertical and/or horizontal sutures should be performed.

These principles have been partially applied in regular osseointegrated dental implant procedures,^{16,20,21} but, as described, they can be fully applied and are specially advantageous in bone regeneration procedures associated with dental implants where complete flap coverage of the wound during the entire healing process is of utmost importance.

Acknowledgment

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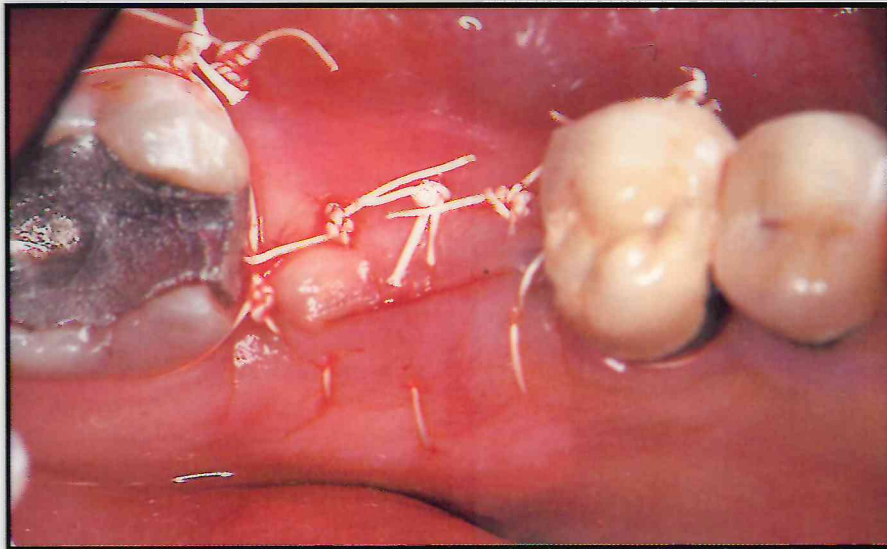


Figure 27. Three vertical mattress sutures ensure primary wound closure.

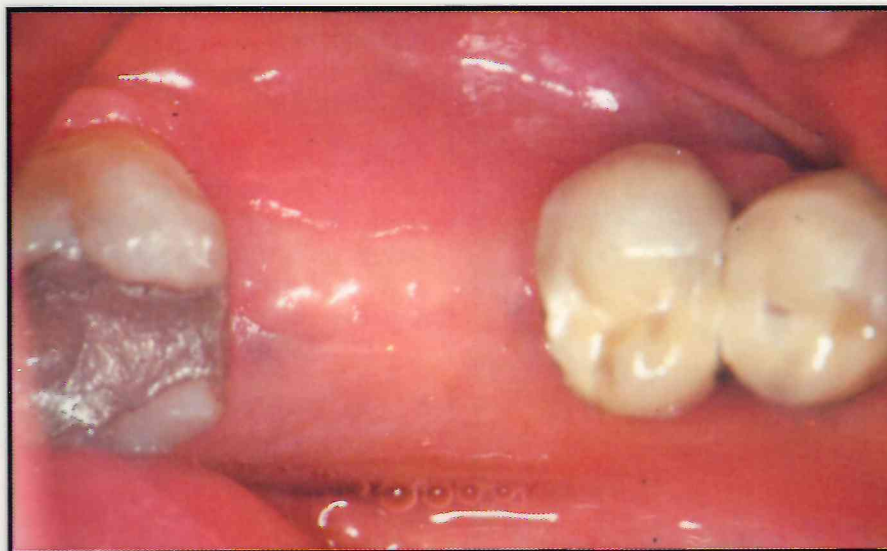


Figure 28. Six months after healing. Note complete flap coverage of the membrane.

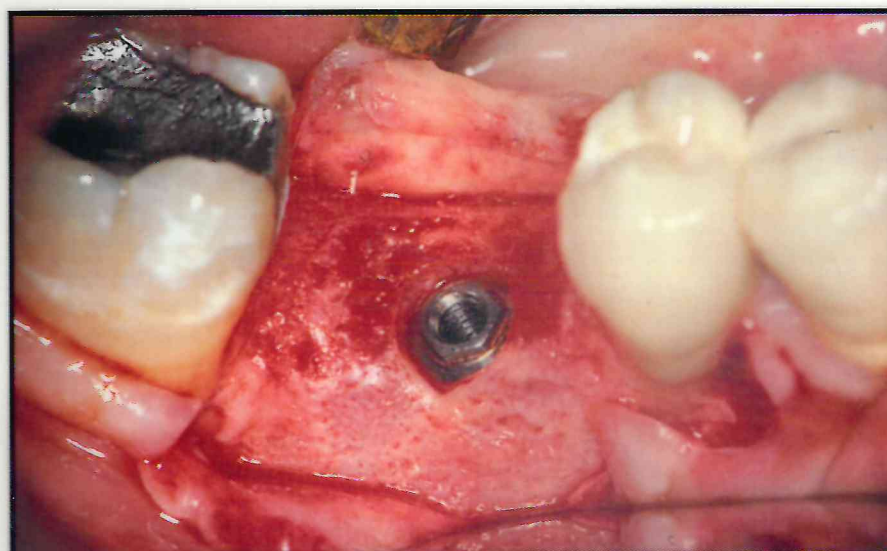


Figure 29. After membrane removal. Note complete bone regeneration around the implant.

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