Case Report

Double Flap Incision Design for Guided Bone Regeneration: A Novel Technique and Clinical Considerations

Yong Hur,* Teppei Tsukiyama,* Tae-Ho Yoon,† and Terrence J. Griffin*

Background: *Premature membrane exposure for guided bone regeneration may result in complications, such as inadequate bone regeneration, inflammatory reactions, and wound infection. This paper presents a clinical case of a novel incision-flap design used to advance the flap to enhance tension-free primary closure for the vertical ridge augmentation.*

Methods: *A 61-year-old white man presented with the chief complaint of wanting to replace his posterior mandibular teeth. A severe alveolar bone deformity vertically and horizontally (Seibert Class III) was noticed, especially over the mental foramen area. A staged guided bone regeneration procedure prior to the implant installation was chosen as the most optimal treatment. A partial-thickness flap, separating the mucosal flap from the periosteum overlying the alveolar bone, was used to advance the flap.*

Results: *During the healing period, neither soft tissue dehiscence nor membrane exposure were noted. Clinical and radiographic evaluation revealed a 4- to 5-mm gain in vertical height and a noticeable increase in horizontal thickness. After the 6 to 8 months of healing for both sites, two implants were placed on each side with good primary stability and without complications.*

Conclusions: *This technique facilitates flap advancement by the tension-free nature of the design and enhances soft tissue maintenance during the course of regeneration. This approach, the separation of the periosteal layer and the mucosal layer, can be used as an alternative to overcome some of the limitations with conventional technique.* J Periodontol 2010;81:945-952.

KEY WORDS

Alveolar ridge augmentation; bone transplantation; case report; dental implants; surgical flaps.

The past two decades of clinical and scientific investigation have established the use of guided bone regeneration (GBR) as a proven method to regain a diminished alveolar ridge.[1-5] The success of GBR has increased the use of dental implants and has pushed the boundaries of science, with many clinicians experimenting with a variety of membranes, such as bioabsorbable and non-absorbable types.[6-8] The continuous advancement of GBR has raised clinician and patient expectations of outcomes that recreate normal occlusal function, healthy soft and hard tissue anatomy, and esthetics that resemble the ideal.

Attention must be paid to the case-specific nature of GBR to achieve the best clinical results. The outcome can be affected by various factors including patient habits,[9,10] defect morphology,[11] cortical bone preparation,[12] materials used,[13-15] and membrane stability.[16] Membrane exposure is one of the most significant factors because it inhibits the amount of regenerated bone possible.[17] In 40% to 60% of cases reported with exposure, there is up to 50% to 80% less bone regenerated compared to non-exposure.[17-19] Therefore, it is clearly beneficial for the clinician to prevent premature exposure of the surgical site when using GBR.

Because it has been shown to play a critical role in successful primary closure, the anatomy of surgical sites requiring GBR has been the subject of much research. This type of investigation has yielded information about incision location and blood supply. Due to an avascular zone located over the edentulous ridge about 1 to 2 mm wide, as demonstrated by a recent human cadaver study,[20] it may be inferred that midline incisions and vertical-releasing incisions at the anterior border of the alveolar ridge are the most promising. A recent human clinical trial that also discusses blood supply and incision location[21] favors mid-crestal incisions. Based on the mentioned studies, mid-crestal incisions on the edentulous ridge with a possible vertical incision on the mesial aspect of the flap seem to yield the most anatomic potential for success.

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Along with anatomically guided placement of incisions, various clinical protocols and techniques have been introduced to enhance primary closure as a means of preventing premature exposure. Langer and Langer,[22] Buser et al.,[23] Tinti and Parma-Benfenati,[24] and Fugazzotto[25,26] propose using an overlapped flap design, a coronally positioned flap, or a pedicle flap technique as effective means to obtain primary closure during the regenerative period. Integral to flap design is the inclusion of a releasing incision to ensure a tensionless closure. The application of a releasing incision for flap advancement in the mandibular posterior is often complicated by the precarious proximity of the mental foramen. Despite the fact that a releasing incision in the posterior mandible is hazardous and should certainly be avoided, it is frequently necessary especially when using vertical augmentation.

Vertical ridge augmentation in preparation for dental implants is one of the most unpredictable procedures in dentistry, but is commonly sought in the posterior, mandible. Few modalities exist to augment this area; they include autogenous block bone augmentation, distraction osteogenesis, and GBR with a titanium-reinforced barrier membrane for protection from mechanical forces. All of these approaches have benefits, but GBR with titanium-reinforced barrier membrane is the least invasive, has one surgical site, and has the least jaw bone–related complications. As mentioned previously, however, any GBR procedure's outcome may be compromised by delayed healing or premature exposure.

The purpose of this paper is to present a simple incision-flap design that provides tension-free primary closure when creating space for guided bone regeneration. The authors present a clinical case using one subject to demonstrate the double flap incision approach for extensive vertical and horizontal ridge augmentation in the posterior of the mandible near the mental foramen. Clinical considerations, such as anatomic difficulty of the region, blood supply, and the basic concept of an ideal incision flap, are discussed.

CASE DESCRIPTION AND RESULTS

In August 2007, a 61-year-old white man presented to Tufts University School of Dental Medicine, Boston, Massachusetts, with the chief complaint of wanting to replace his posterior mandibular teeth. He described that he had been edentulous in the area for >30 years without function. The patient's medical history was non-significant for major conditions or allergies and free of contributory factors (e.g., systemic disease and smoking), making him an ideal surgical candidate.

Upon interdisciplinary consultation, implant-supported fixed partial prostheses were deemed the appropriate treatment for the sites. However, the patient's comprehensive oral evaluation revealed severe alveolar bone deformity vertically and horizontally (Seibert Class III).[27] A radiographic evaluation using CT scanning with a computerized program[‡] confirmed the insufficient vertical and horizontal bone volume to accept ideal implant placement. The defects were noticed especially over the mental foramen area. A staged approach including a GBR procedure before the implant installation was decided as the most optimal treatment.

Surgical Procedure

The surgical procedure adopted to release tension for flap advancement includes a partial-thickness flap elevation leaving the periosteal layer on the edentulous ridge and separation of the mucosal layer of the flap (Figs. 1A through 1I). The periosteal layer of the flap is used to stabilize the regenerative site using periosteal sutures.

Mandibular Left Quadrant

After appropriate written informed consent, local anesthesia was attained using three carpules of lidocaine[§] with 1:100,000 epinephrine. A crestal incision with a vertical-releasing incision 2 mm away from the most distal existing tooth was performed with a #15 blade. The crestal incision was then extended toward the distal side of the flap to avoid tension. Then a partial-thickness flap separating the mucosal flap from the periosteum overlying the alveolar bone was made on the buccal side. After enough separation between the external (mucosal) and internal (periosteal) flap was achieved, the periosteal flap was reflected from the bony surface (Figs. 2A and 2B). A lingual full-thickness mucoperiosteal flap was then elevated. Decortication was performed using a #2 round carbide bur on the buccal side of the alveolar bone to enhance osteogenesis. Subsequently, a titanium reinforced expanded polytetrafluoroethylene (e-PTFE) membrane[‖] was used to create a space free from soft tissue. The membrane was trimmed with surgical scissors to match the defect size and the buccal portion of the membrane was stabilized with one bone tack.[¶] The membrane was appropriately shaped to extend 3 to 4 mm beyond the defect margins and to allow a close adaptation of the membrane to bone. The defect was filled with 1.5 cc of mineralized freeze-dried bone allograft.[#] The lingual side of the membrane was tucked under the reflected lingual flap. The periosteal flap was positioned and stabilized with 5-0 e-PTFE sutures[**] using two horizontal

‡ iCATVision, Imaging Sciences International, Hatfield, PA.
§ 2% Xylocaine HCL, DENTSPLY, York, PA.
‖ Gore-Tex Regenerative Membrane, W. L. Gore and Associates, Flagstaff, AZ.
¶ ACE Surgical, Brockton, MA.
# MinerOss, Osteotech, Eatontown, NJ.
** Gore-Tex Suture, W. L. Gore and Associates.

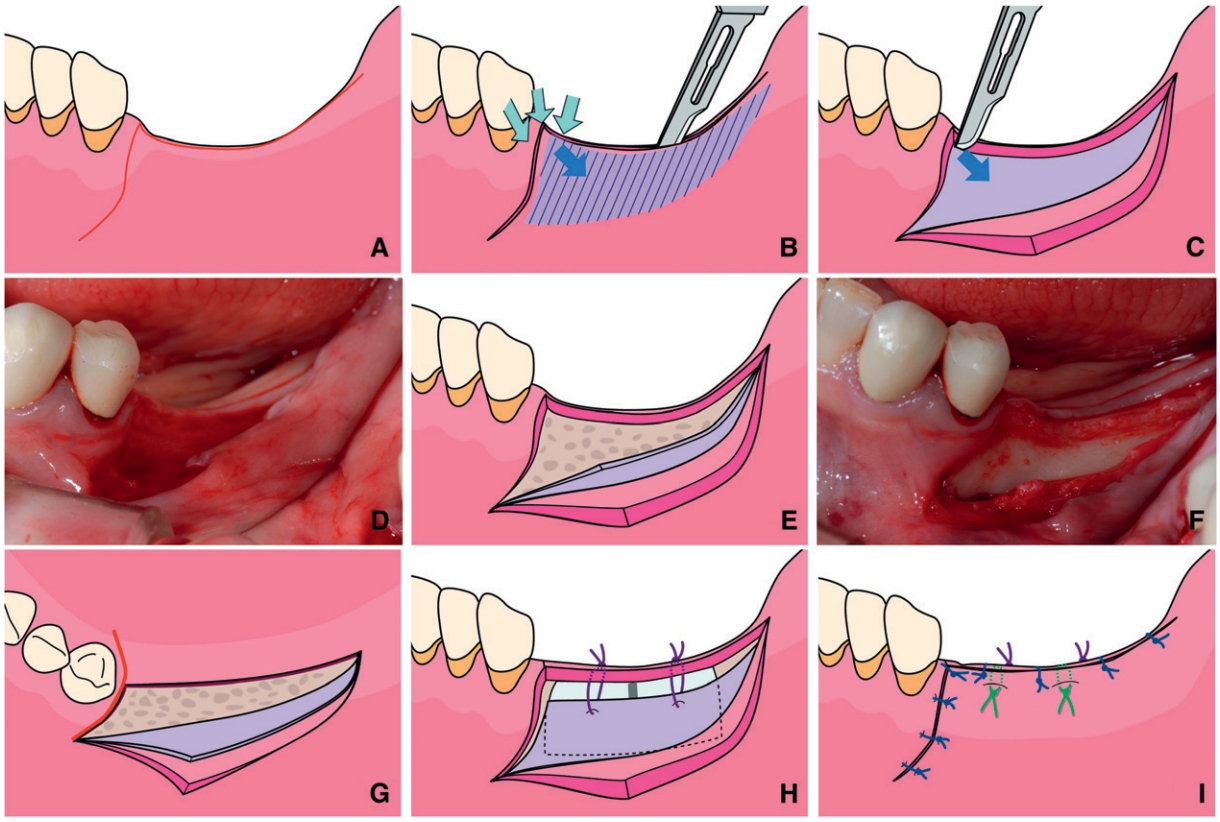

Figure 1.
A) *Crestal incision on the edentulous ridge and one vertical releasing incision are outlined. Note that the vertical incision is separated from attachment apparatus of the tooth.* ***B)*** *The double flap incision design is made leaving the periosteum on the edentulous ridge.* ***C*** *and* ***D)*** *The mucosal layer of the double flap is elevated leaving the periosteal layer.* ***E*** *and* ***F)*** *The periosteal layer of the double flap is elevated exposing the alveolar bone.* ***G)*** *Occlusal view of the double flap. Note that the vertical incision has reached the mucogingival junction on the lingual side to release the tension.* ***H)*** *The periosteal layer of the double flap is sutured to stabilize the grafted site.* ***I)*** *Buccal view after final suturing.*

mattress sutures (Figs. 2C and 2D). A tension-free adaptation of the wound margins was confirmed before final closure. Then the mucosal flap was closed using multiple simple interrupted sutures with 5-0 polyglactin 910†† (Fig. 2E).

The patient was instructed not to wear any prostheses to avoid pressure over the surgical site. The patient was also told not to chew or brush in the treated area for approximately 3 weeks. The home use of chlorhexidine was suggested for chemical plaque control (0.12%, 1-minute rinse, two times a day for 3 weeks). The patient was instructed to apply an extraoral cold pack to the surgical area frequently during the first 3 days after surgery to reduce postoperative swelling. The sutures were removed at the 2-week postoperative visit. The patient was recalled at 1-week intervals until soft tissue healing was completed. Subsequently, the patient was seen every 4 weeks. During the healing period, no soft tissue dehiscence or membrane exposure was noted. The membrane was left in place for a healing period of 8 months. Clinical and radiographic evaluation, which included CT, revealed a 3- to 4-mm gain of vertical height along with noticeable horizontal thickness (Fig. 2F).

Mandibular Right Quadrant

The surgical site was the contralateral edentulous area within the same patient. Even though the overall procedure was the same on both sides, the need for height was greater on the right side because of the proximity of the mental foramen in the right quadrant (Figs. 3A and 3B). A narrow platform implant or regular platform implant with vertical augmentation was suggested. After interdisciplinary consultation, bone augmentation prior to the implant installation was determined as the best approach. Autogenous cortical bone was harvested with a bone scraper‡‡ and mixed with 1 cc of freeze-dried bone allograft. The e-PTFE membrane was trimmed to avoid the mental foramen location. A bone tack was used to stabilize the regenerative site (Figs. 4A

†† Vicryl, Ethicon, Somerville, NJ.
‡‡ Safescraper, META, Reggio Emilia, Italy.

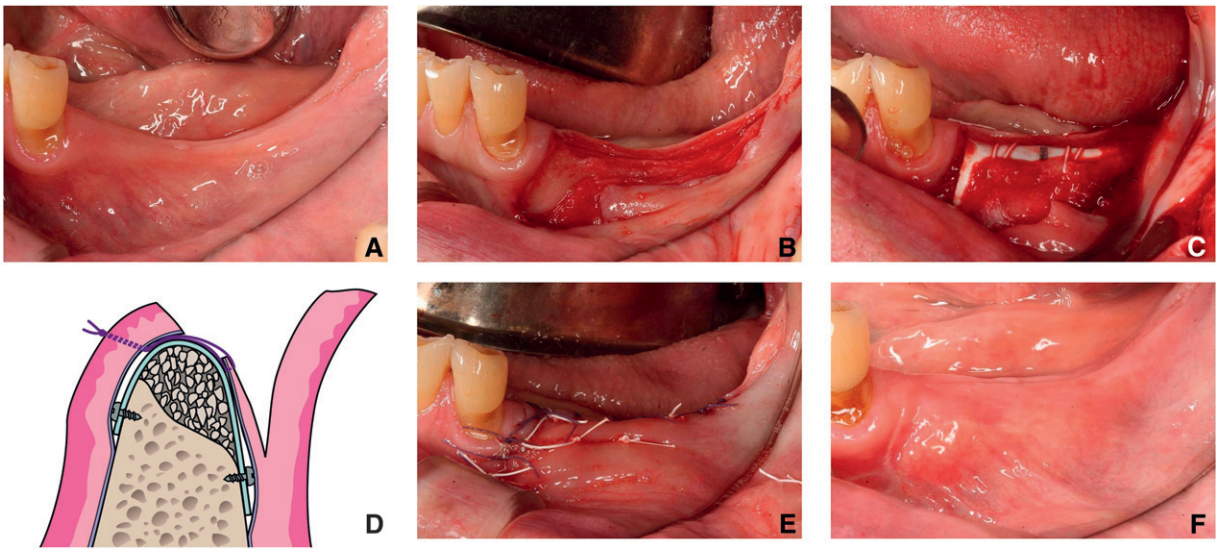

Figure 2.
Mandibular left quadrant. ***A*** *and* ***B)*** *After the mucosal flap was elevated, the periosteal flap was reflected from the alveolar bone.* ***C)*** *The periosteal flap was held with two horizontal mattresses using 5-0 e-PTFE sutures to position and stabilize the membrane.* ***D)*** *Sagittal section of the surgical site. Note, the periosteal layer of the double flap was separated and used for membrane stability. The mucosal layer helped to release flap tension through its separation from the periosteal layer.* ***E)*** *The incision was closed with multiple, simple interrupted sutures using 5-0 polyglactin 910.* ***F)*** *Clinical evaluation revealed vertical and horizontal gain of alveolar ridge in the left posterior mandible after 8 months of healing.*

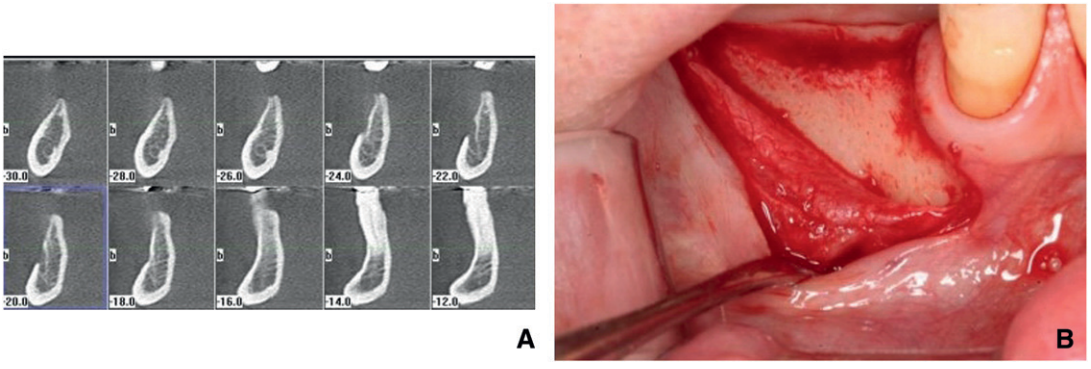

Figure 3.
A) *Presurgical CT image of the right posterior mandible revealed a need for 4 to 5 mm in vertical height because of the location of the mental foramen.* ***B)*** *Clinical picture of the mental foramen on the right posterior mandible after flap elevation. Note that the location of the mental foramen would interfere with ideal implant placement to avoid a mesial cantilever of implant-supported crown and bridges. The splitting between the periosteal layer and the mucosal layer is over the mental foramen, which could easily be visualized using this technique.*

through 4C). After completion of the procedure, the patient was seen with the same recall schedule as the other site. During the healing period, neither soft tissue dehiscence nor membrane exposure were noted. The membrane was left in place for a 6-month healing period. Clinical and radiographic evaluation revealed a 4- to 5-mm gain in vertical height and a noticeable increase in horizontal thickness (Fig. 4D).

After 6 to 8 months of healing for both sites, two implants were placed on each side with good primary stability and without complications (Figs. 4E and 4F).

DISCUSSION

Periosteal fenestration is a commonly used technique for flap advancement in conjunction with vertical-releasing incisions. However, there are limitations and complications, such as swelling, bleeding, and patient discomfort when periosteal fenestration is used for major flap advancement (>7 mm) that requires a deep incision into the submucosa.[28] A greater depth of incision may lessen the blood supply from the vestibule and compromise the vascularity of the flap because a major source of blood to the flap comes from the mucosa toward the coronal aspect.[29] This also could be

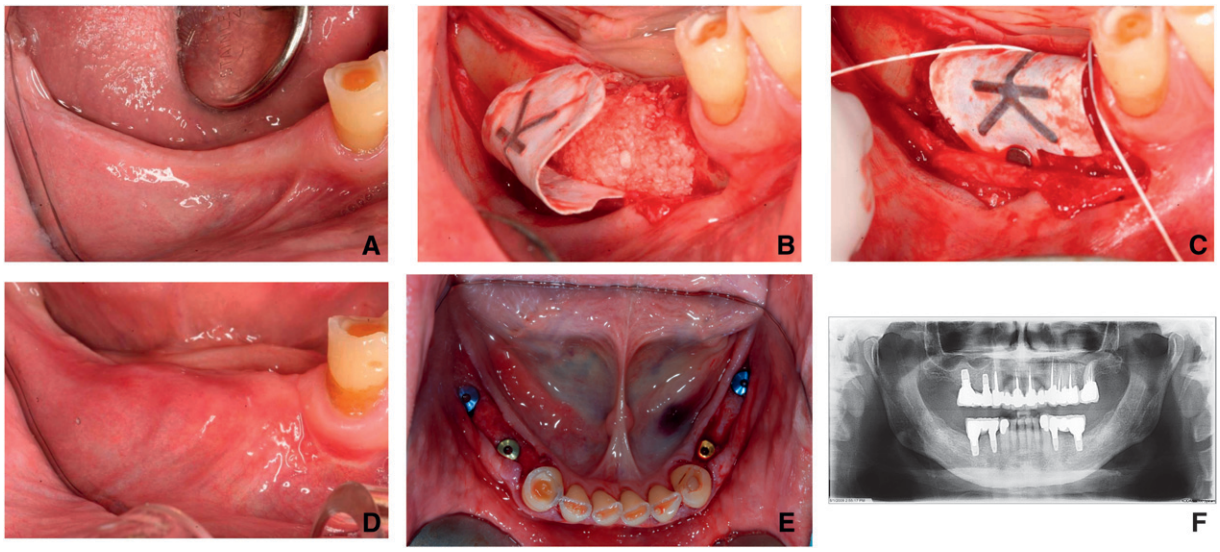

Figure 4.
Mandibular right quadrant. ***A)*** *Buccal view of the right posterior mandible.* ***B)*** *The freeze-dried bone allograft mixed with autogenous cortical bone was placed. The e-PTFE membrane was trimmed around the mental foramen location.* ***C)*** *The double flap technique was used for periosteal sutures.* ***D)*** *Clinical evaluation revealed vertical and horizontal gain of alveolar ridge after 6 months of healing in the right posterior mandible.* ***E)*** *Clinical picture of bilateral implant placement after 6 to 8 months of healing. All implants were placed with good primary stability and without complications.* ***F)*** *Radiographic image of final restorations 1-year after loading.*

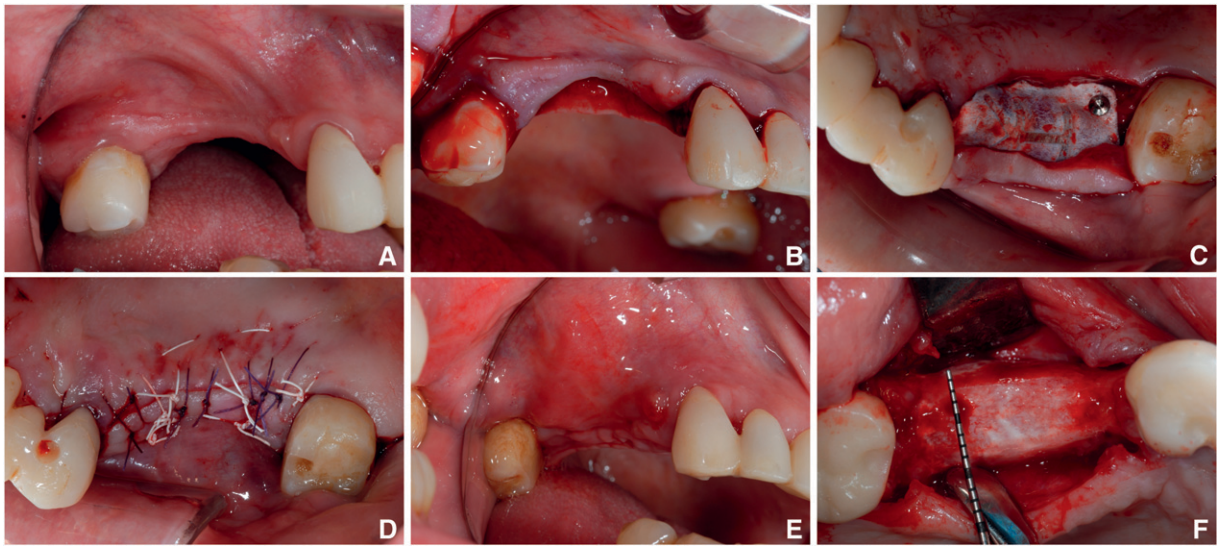

Figure 5.
Maxillary right quadrant with the periosteal fenestration. ***A)*** *Buccal view with ridge deformity.* ***B)*** *The periosteal fenestration was used in the right side.* ***C)*** *The e-PTFE membrane was stabilized with titanium tacks.* ***D)*** *Occlusal view after final suturing.* ***E)*** *Two-week follow-up after the procedure.* ***F)*** *Clinical evaluation at 6 months revealed gain of alveolar ridge in the right posterior maxilla.*

a negative factor for maintaining primary closure that increases possible premature exposure on the surgical sites because this often creates more bleeding and swelling of the tissues, which causes tension on the incision line.

Flap advancement around the mental foramen is often compromised and must be managed carefully to avoid possible damage due to the complexity of mental nerve branches.[30] When conventional techniques are used, the surgeon encounters limitations on the area. The difficulties could be explained because the area may have insufficient flap advancement when a shallow periosteal fenestration is used. It may have more of a chance of paresthesia and

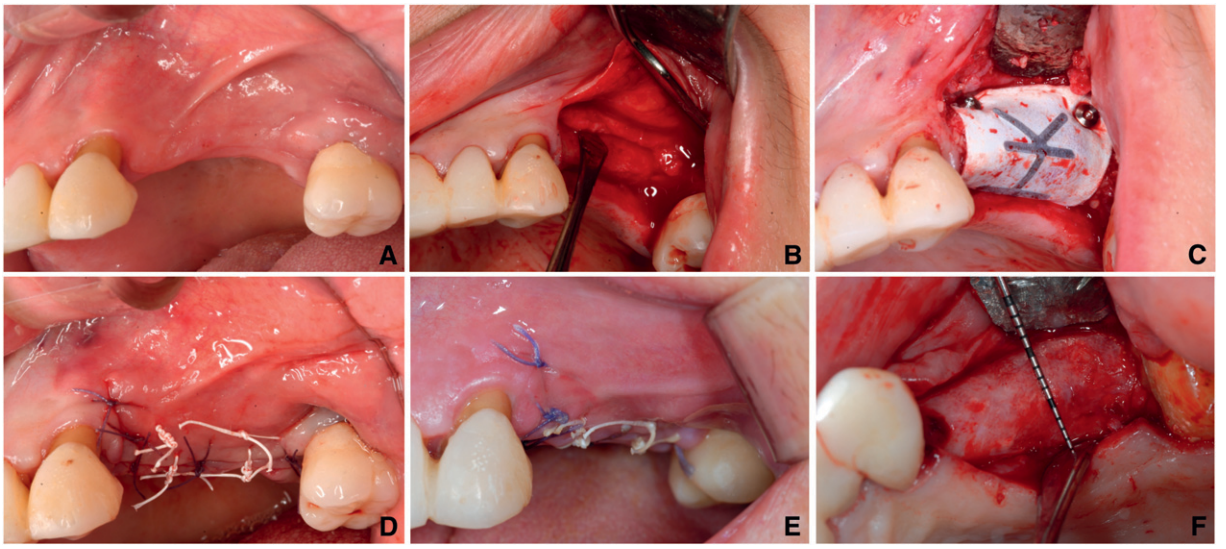

Figure 6.
Maxillary left quadrant with the double flap. ***A)*** *Buccal view with ridge deformity.* ***B)*** *The double flap was used in the left side.* ***C)*** *The e-PTFE membrane was stabilized with titanium tacks.* ***D)*** *Buccal view after final suturing.* ***E)*** *Uneventful healing after a 2-week follow-up. Note that the double flap side showed limited swelling, less redness, with more advanced healing compared to the periosteal fenestration side. The patient also reported better postoperative comfort and less swelling for this site.* ***F)*** *Clinical evaluation at 6 months revealed gain of alveolar ridge in the left posterior maxilla.*

Figure 7.
A) *The mucosal layer of the double flap is elevated leaving the periosteal layer.* ***B)*** *Uneventful healing after a 2-week follow-up.* ***C)*** *Clinical view after 6 months healing.*

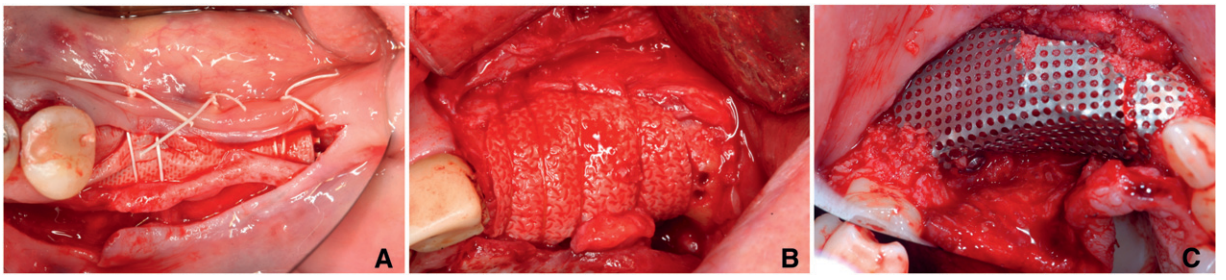

Figure 8.
Diverse double flap applications. ***A)*** *A collagen membrane[§§] was covered and stabilized with sutures over the periosteal layer.* ***B)*** *The double flap was initiated at a lower position because of the thin gingival tissue <2 mm. A collagen membrane was used.* ***C)*** *A titanium mesh[||||] was used for the regenerative site with the double flap.*

§§ OSSIXPLUS, Orapharma, Warminster, PA.
|||| ACE Surgical.

complications when a deep periosteal fenestration is placed. Recently, a dome-shaped incision was introduced as a possible solution for the area.[28]

The new incision-flap design described in this paper for GBR is a practical technique with no significant side effects. Since its development 2 years ago in the Department of Periodontology at Tufts University School of Dental Medicine, a reduced amount of soft tissue complications including dehiscence, edema, necrosis, and exposure were observed by the residents and faculty compared to the periosteal fenestration (Figs. 5A through 5F and 6A through 6F). The main advantage of the double flap incision design is a significant amount of reduction of tension resulting from the separation of the periosteal layer and the mucosal layer. This technique facilitates flap advancement by the tension-free nature of the design because the tension is mainly from the dense periosteum under the flap. Diverse regenerative materials, such as non-resorbable and resorbable membrane and titanium mesh with different size and locations, can be used with this incision design (Figs. 7A through 7C and 8A through 8C). There has not been any instance of paresthesia of the mental nerve when using this technique. The authors postulate that the periosteal layer of the double flap could possess some nerve branches compared to being severed by a deep periosteal fenestration technique, each flap layer could get a separate blood supply from the vestibule, and the wide surfaces between the two flaps could enhance the healing.

A mesial vertical-releasing incision was placed that was separated from the tissue surrounding the adjacent teeth in the cases described previously. When the vertical-releasing incision is located without touching the attachment apparatus of teeth, the following benefits were observed: 1) ease of the double flap incision, 2) fast healing without contamination from the tooth, and 3) no recession on the adjacent tooth. However, its application could be limited because membrane location should be distalized to avoid contamination from the incision line. This incision-flap design is ideally used from the alveolar bone crest when there is enough soft tissue thickness >2 mm. Surgeons could initiate the double flap at a lower position when it comes to a thin tissue <2 mm because the apical mucosal part is thicker than the coronal area (Fig. 8B).

CONCLUSIONS

The results of this paper are based on clinical observation of the technique by the residents and faculty of the Department of Periodontology at Tufts University School of Dental Medicine. Further studies including randomized controlled clinical trials are required to investigate this technique.

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