

Simultaneous Implant Placement and Vertical Ridge Augmentation with a Titanium-Reinforced Membrane: A Case Report

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The present report demonstrates a clinical approach to achieve vertical ridge augmentation around endosseous implants. Two implants were placed, leaving the threads exposed, in the atrophic mandibular right posterior quadrant of a male patient. Both implants were covered with a titanium-reinforced expanded polytetrafluoroethylene (e-PTFE) membrane. Second-stage surgery was performed 12 months after implant placement. Upon membrane removal, growth of mineralized tissue was observed around both implants, covering areas previously not covered by bone. Implants were then progressively loaded and restored. Titanium-reinforced e-PTFE membranes can be satisfactorily used for vertical augmentation of atrophic ridges. (INT J ORAL MAXILLOFAC IMPLANTS 2000;15: 883-888)

Key words: alveolar ridge augmentation, dental implant, guided bone regeneration

Severe alveolar bone loss related to traumatic tooth extractions, long-lasting periodontal disease, periapical infection, or trauma can often limit the use of osseointegrated implants for the restoration of totally or partially edentulous patients. Guided bone regeneration (GBR) procedures have been successfully utilized to treat peri-implant bone defects at the time of implant placement (simultaneous approach) or to correct alveolar ridge defects before the placement of implants (staged approach) in animals and humans.¹⁻⁵ Guided bone regeneration techniques are based on the principle of compartmentalized wound healing. By placing a physi-

cal barrier between epithelial and connective tissues on one side and implants and bone on the other side, GBR procedures aim to create a protected space for the blood clot to form and organize. The presence of a cell-occlusive membrane is required to prevent the migration of epithelial and connective tissue cells into the wound area, thus allowing bone cells coming from marrow spaces to repopulate the defect and to mature into new bone.⁶⁻⁸

A number of different techniques and materials, including both non-resorbable and bioabsorbable membranes used alone or in combination with autografts, allografts, alloplastic grafts, titanium pins, or titanium and gold meshes, have been used in GBR procedures with encouraging results.⁹⁻¹⁴ Recently, the use of an expanded polytetrafluoroethylene (e-PTFE) membrane that incorporated a thin titanium mesh (tr-GTAM) has shown positive results in the treatment of periodontal and peri-implant defects by combining barrier action and space-maintaining capability.¹⁵⁻¹⁷ This case report describes the application of GBR principles using a tr-GTAM membrane to obtain vertical bone augmentation around 2 endosseous implants.

CASE PRESENTATION

A 58-year-old male was referred for implant treatment. The patient presented with an extended right mandibular edentulous area caused by the loss of

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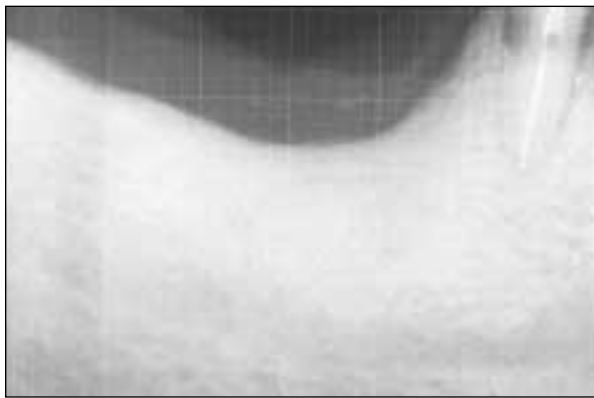


Fig 1a Preoperative intraoral radiograph of the edentulous area showing vertical loss of bone.

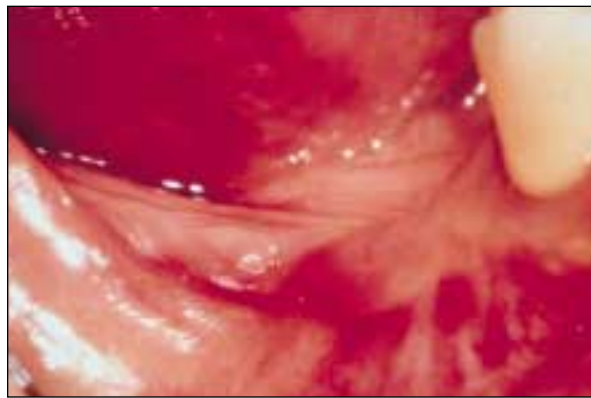


Fig 1b Preoperative intraoral clinical view of the edentulous area.



Fig 2 Two implants were placed in the edentulous area. Notice the threads exposed above the ridge.

mandibular molars related to rampant root caries 20 years previously. The patient was in good health, with no medical contraindications for surgery, with excellent oral hygiene and a strong desire to restore the area with a fixed prosthesis. Because of the absence of posterior teeth as abutments for a conventional fixed partial denture, the treatment plan included the placement of 2 endosseous implants to restore the area with an implant-supported fixed partial denture. Radiographic and clinical examination (Figs 1a and 1b) revealed the presence of sufficient width but insufficient height of the alveolar ridge for the placement of 2 implants. Consequently, it was decided to utilize a non-resorbable titanium-reinforced e-PTFE membrane to coronally augment the height of the alveolar ridge simultaneously with the placement of the 2 implants.

The surgical procedure was performed under conditions that included a sterile surgical field and instruments, preoperative decontamination of the oral cavity with chlorhexidine 0.2% mouthrinse (Corsodyl Collutorio, SmithKline Beecham, Baranzate, Italy)

for 1 minute, and perioral skin disinfection with a 10% povidone-iodine solution (Betadine, The Purdue Frederick Company, Norfolk, CT). Antibiotics were administered (amoxicillin 500 mg, Velamox, Smith-Kline Beecham) 2 hours preoperatively and every 6 hours postoperatively for 7 days. Local anesthesia was produced using lidocaine 2% with epinephrine 1:100,000 (Astra, Westborough, MA). A split- to full-thickness remote flap design was planned, and a shallow incision, perpendicular to bone, was made 4 mm below the buccal mucogingival junction of the mandibular ridge crest. Following supraperiosteal preparation toward the ridge crest, the periosteum was incised at the mid-crest level, and full-thickness flaps were elevated 4 to 6 mm and reflected. Retraction sutures were placed through the lingual flap and tied cross-arch; this established a self-maintaining flap reflection to minimize soft tissue trauma.

After the flaps were reflected, the intrasurgical view confirmed the presence of an alveolar process possessing width sufficient for the placement of 2 endosseous implants, but with an extensive vertical defect that required bone augmentation. Two ITI implants (Institut Straumann AG, Waldenburg, Switzerland) (length 13 mm, diameter 4 mm) were placed following the standardized technique described by Schroeder and associates.¹⁸ An effort was made to place the implants in an appropriate position from a prosthetic standpoint, based upon previously prepared casts. After the implants were placed in the positions of the mesial and distal roots of the first mandibular molar, peri-implant bone vertical defects of 4 mm and 7 mm were present at the mesial and the distal implants, respectively (Fig 2). Perforation of the peri-implant cortical bone was made with a small round bur to open the marrow spaces and facilitate the access of osteogenic and angiogenic cells involved in bone formation. A

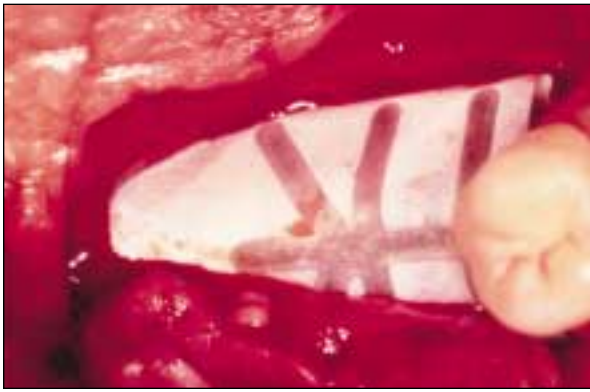


Fig 3a Titanium-reinforced membrane was applied to cover both implants.

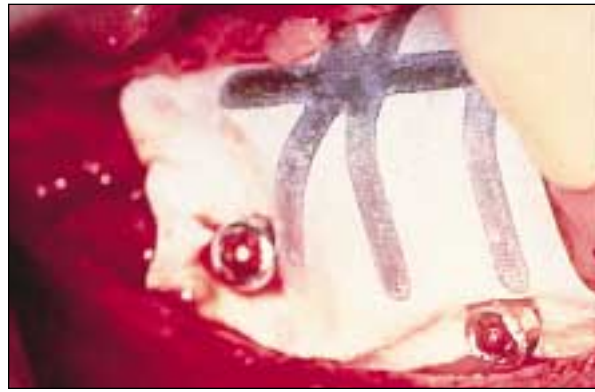


Fig 3b The membrane was secured to the bone via miniscrews.

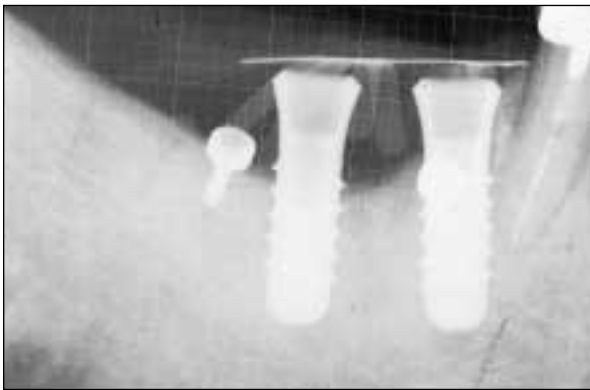


Fig 4a Intraoral radiograph taken immediately after suture placement.

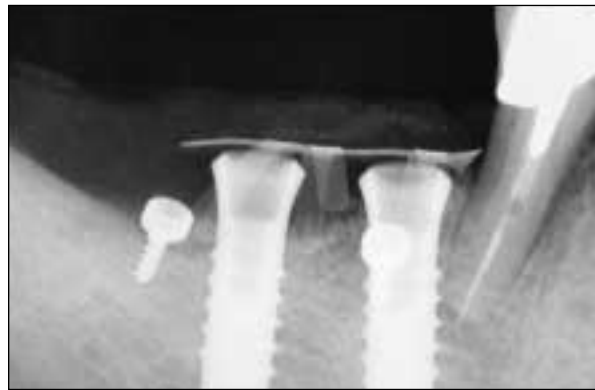


Fig 4b Intraoral radiograph taken after 12 months of healing. Note the presence of mineralized tissue around previously uncovered areas.

titanium-reinforced e-PTFE membrane (Gore-Tex, W. L. Gore, Flagstaff, AZ) was used for its ability to combine space-maintaining and cell-occlusive properties. For these reasons, the authors decided not to use any other space-maintaining graft material.

The membrane was bent and shaped with hemostats so that the stiffer portion completely covered the 2 implants and maintained an appropriate corono-apical space between the implants and bone to be created through the blood clot (Fig 3a). The flexible portion of the membrane was trimmed and shaped to overlap the edges of the bone for 3 to 4 mm and was intimately adapted to the bone margins to prevent the ingrowth of gingival connective tissue. The membrane was stabilized with 2 fixation screws (Memphix System, Institut Straumann AG) on the buccal cortical plate and adapted underneath the lingual mucoperiosteal flap to prevent any micromovement during the healing phase (Fig 3b). A horizontal incision of the periosteum at the base of the lingual flap was created to mobilize the flap and permit

complete coverage of the membrane without tension. Primary wound closure was obtained by horizontal mattress and interrupted sutures.

A radiograph was obtained following implant placement, showing the portion of the implants emerging from the alveolar crest (Fig 4a). The patient was instructed not to chew or brush in the treated area for at least 4 weeks. Chemical plaque control with chlorhexidine 0.2% (1-minute mouthrinses 3 times a day) was instituted for the same period. The patient was given a non-steroidal anti-inflammatory medication (diclofenac 50 mg 3 times a day for 3 days; Diclorem, Alfa Wassermann, Bologna, Italy) and instructed to apply an extraoral ice pack. The patient was examined weekly for the first 4 weeks; since no membrane exposure or other complication was noted during this period, the patient was examined once a month for the rest of the healing period.

Second-stage surgery was performed 12 months after implant placement. Following radiographic monitoring of the area (Fig 4b), the site was re-entered

with a crestal incision and reflection of a full-thickness flap to gain complete access to the membrane. After the membrane was removed, it was noted that the previous vertical defect was filled with hard, bone-like tissue (Fig 5). This newly formed bone-like tissue surrounding the previously exposed implant threads was covered by a thick layer (about 2 mm) of connective tissue. The fibrous connective tissue was removed with a sharp curette. At this time, only the most coronal thread was partially visible, indicating growth of mineralized tissue around the implant surfaces that were previously uncovered. Healing abutments were placed without functional loading and the flaps were sutured. The implants were then progressively loaded with acrylic resin provisional restorations and were restored 6 months later with a fixed metal-ceramic prosthesis (Fig 6a). A radiograph was obtained at the time of final cementation, showing bone levels above the threads of both implants (Fig 6b).



Fig 5 After the membrane was removed, a mineralized mass was visible around the implants, reaching the heads of both placed implants.



Fig 6a Definitive prosthesis.

The patient returned to the office 14 months after final cementation, and a radiograph was taken. At this time, typical incipient bone loss of about 1 mm around both implants was detected. Clinical findings were considered to be non-significant, and the patient reported satisfactory chewing capabilities and an absence of symptoms.

DISCUSSION

Vertical ridge defects represent the most challenging clinical situation for the proper placement of dental implants. Resorption of the alveolar ridge in an apicoronal direction often prevents the placement of implants of sufficient length and results in an unfavorable crown-to-root ratio. In the mandible, alveolar nerve transposition has been advocated to increase ridge height in an apical direction and has been utilized to place implants in atrophic posterior areas.¹⁹ However, this procedure often results in temporary or permanent nerve injuries. A recent study by Nocini and colleagues²⁰ reported partial nerve injury in 9 of 10 subjects who received nerve transpositioning for implant placement. Also, the technique does not recreate a favorable crown-to-root ratio. Only bone grafts provide an increase in the height of the alveolar ridge in a coronal direction, thus allowing the placement of implants of proper length and a more desirable crown-to-root ratio. However, these procedures have demonstrated a high rate of resorption of the regenerated bone during the first 3 years, ranging from 14% to 100% of the graft resorption, as shown by Wang and colleagues,²¹ and are associated with high morbidity.

Recently, GBR techniques utilizing a titanium-reinforced barrier membrane as a space-maintainer have shown promising results.²²⁻²⁴ Simion and



Fig 6b Intraoral radiograph taken at the time of final cementation.

coworkers²² utilized titanium-reinforced membranes without grafting materials to regenerate bone vertically around 15 titanium implants. After 9 months of healing, they were able to obtain up to 4 mm of vertical regeneration. The newly formed hard tissue, confirmed to be bone by histologic examination, was covered by a thick layer (mean 2.1 mm) of dense connective tissue. The authors suggested micromovements of the membrane during the healing phase, incomplete blood clot stabilization, and formation of an empty space beneath the membrane as possible explanations for the incomplete bone regeneration.

Tinti and colleagues²⁴ modified the surgical technique by utilizing autogenous bone grafts and titanium-reinforced membranes to provide mechanical membrane support, blood clot stabilization, and reduction of the space underneath the membrane. After a healing period of 12 months, they were able to obtain vertical ridge augmentation up to 7 mm around 14 implants, with only a very thin layer of connective tissue (less than 1 mm) covering the regenerated bone. Tinti and Parma-Benfenati²⁵ confirmed the predictability of the above-mentioned technique in a recent retrospective study including 48 implants placed in 18 patients. Simion and coworkers²⁶ compared the use of autogenous bone chips and demineralized freeze-dried bone (DFDBA) as grafting material using the reinforced membrane technique. Both graft materials showed benefits for vertical augmentation procedures. The authors reported complete vertical bone regeneration, regardless of the material utilized, with the presence of only a thin layer of connective tissue covering the regenerated bone.

Of particular clinical interest in the present case is the postoperative radiograph showing close proximity of the mesial implant to the residual root. The natural tooth, already treated endodontically, was not symptomatic at any time after implant placement, and the patient was able to function normally. Radiograph angulation, tooth location, or the fact that in reality the implant and the root were distant enough that the periodontal ligament space was not invaded are possible factors. Clinical findings confirmed the initial evaluation 14 months after final cementation. Radiographically, incipient bone loss was detectable around both implants. This initial bone loss is in agreement with long-term studies on the clinical outcome of dental implants.²⁷

The present case report confirms the predictability of a titanium-reinforced membrane technique for vertical ridge augmentation around dental implants. On both implants, a gain of up to 3 mm of healthy, sound, mineralized tissue was seen. With a

titanium-reinforced membrane alone, vertical ridge augmentation with complete coverage of the exposed threads of both implants was obtained.

CONCLUSIONS

A titanium-reinforced membrane technique combined cell-occlusive and space-maintaining properties, which allowed the formation and protection of a blood clot of appropriate dimensions and its maturation into new bone. When used without a grafting material, this technique provided vertical ridge augmentation with hard tissue up to 3 mm. However, a layer of about 2 mm of dense connective tissue covered the newly formed bone. In light of recent reports, when this technique is used for extensive vertical ridge augmentation, it would be advisable to combine titanium-reinforced membranes with autogenous bone chips or DFDBA grafts to optimize the amount of bone regeneration.

REFERENCES

1. Dahlin C, Sennerby L, Lekholm U, Lindhe A, Nyman S. Generation of new bone around titanium implants using a membrane technique: An experimental study in rabbits. *Int J Oral Maxillofac Implants* 1989;4:19–25.
2. Becker W, Becker BE. Guided tissue regeneration for implants placed into extraction sockets and for implant dehiscences: Surgical techniques and case reports. *Int J Periodontics Restorative Dent* 1990;10(5):376–391.
3. Nyman S, Lang NP, Buser D, Brägger U. Bone regeneration adjacent to titanium dental implants using guided tissue regeneration: A report of two cases. *Int J Oral Maxillofac Implants* 1990;5(1):9–14.
4. Lazzara RJ. Immediate implant placement into extraction sites: Surgical and restorative advantages. *Int J Periodontics Restorative Dent* 1989;5:332–343.
5. Buser D, Dula K, Belser U, Hirt HP, Berthold H. Localized ridge augmentation using guided bone regeneration. I. Surgical procedure in the maxilla. *Int J Periodontics Restorative Dent* 1993;13(1):29–45.
6. Melcher AH, Dreyer CJ. Protection of the blood clot in healing circumscribed bone defects. *J Bone Joint Surg [Br]* 1962;44:424–430.
7. Boyne PJ. Regeneration of alveolar bone beneath cellulose acetate filter implants [abstract #196]. *J Dent Res* 1964;43:827.
8. Dahlin C, Gottlow J, Lindhe A, Nyman S. Healing of maxillary and mandibular bone defects using a membrane technique. *Scand J Plast Reconstr Hand Surg* 1990;24:13–19.
9. Mellonig JT, Nevins M. Guided bone regeneration of bone defects associated with implants: An evidence-based outcome assessment. *Int J Periodontics Restorative Dent* 1995; 15(2):168–185.

10. Simion M, Misitano U, Gionso L, Salvato A. Treatment of dehiscences and fenestrations around dental implants using resorbable and non-resorbable membranes associated with bone autografts: A comparative clinical study. *Int J Oral Maxillofac Implants* 1997;12(2):159-167.
11. Mellonig JT, Nevins M, Sanchez R. Evaluation of a bioabsorbable physical barrier for guided bone regeneration. Part I. Material alone. *Int J Periodontics Restorative Dent* 1998;18(2):139-149.
12. Malchiodi L, Scarano A, Quaranta M, Piattelli A. Rigid fixation by means of titanium mesh in edentulous ridge expansion for horizontal ridge augmentation in the maxilla. *Int J Oral Maxillofac Implants* 1998;13(5):701-705.
13. Von Arx T, Kurt B. Implant placement and simultaneous peri-implant bone grafting using a micro titanium mesh for graft stabilization. *Int J Periodontics Restorative Dent* 1998;18(2):117-127.
14. Lorenzoni M, Pertl C, Keil C, Wegscheider WA. Treatment of peri-implant defects with guided bone regeneration: A comparative clinical study with various membranes and bone grafts. *Int J Oral Maxillofac Implants* 1998;13(5):639-646.
15. Cortellini P, Pini Prato G, Tonetti M. Periodontal regeneration of infrabony defects with titanium-reinforced membranes. A controlled clinical trial. *J Periodontol* 1995;66:797-803.
16. Schenk RK, Buser D, Hardwick WR, Dahlin C. Healing pattern of bone regeneration in membrane-protected defects: A histologic study in the canine mandible. *Int J Oral Maxillofac Implants* 1994;9(1):13-29.
17. Jovanovic SA, Nevins M. Bone formation utilizing titanium-reinforced barrier membranes. *Int J Periodontics Restorative Dent* 1995;15(1):56-69.
18. Schroeder A, van der Zypen E, Stich H, Sutter F. The reactions of bone, connective tissue and epithelium to endosteal implants with titanium-sprayed surfaces. *J Maxillofac Surg* 1981;9:15-25.
19. Rosenquist B. Fixture placement posterior to the mental foramen with transpositioning of the inferior alveolar nerve. *Int J Oral Maxillofac Implants* 1992;7(1):45-50.
20. Nocini PF, De Santis D, Fracasso E, Zanette G. Clinical and electrophysiological assessment of inferior alveolar nerve function after lateral nerve transposition. *Clin Oral Implants Res* 1999;10:120-130.
21. Wang JH, Waite DE, Steinhauser E. Ridge augmentation: An evaluation and follow-up report. *J Oral Surg* 1976;34:600-612.
22. Simion M, Trisi P, Piattelli A. Vertical ridge augmentation using a membrane technique associated with osseointegrated implants. *Int J Periodontics Restorative Dent* 1994;14(6):497-511.
23. Jovanovic SA, Schenk RK, Orsini M, Kenney EB. Supracrestal bone formation around dental implants: An experimental dog study. *Int J Oral Maxillofac Implants* 1995;10(1):23-31.
24. Tinti C, Parma-Benfenati S, Polizzi G. Vertical ridge augmentation: What is the limit? *Int J Periodontics Restorative Dent* 1996;16(3):220-229.
25. Tinti C, Parma-Benfenati S. Vertical ridge augmentation: Surgical protocol and retrospective evaluation of 48 consecutively inserted implants. *Int J Periodontics Restorative Dent* 1998;18(5):434-443.
26. Simion M, Jovanovic SA, Trisi P, Scarano A, Piattelli A. Vertical ridge augmentation around dental implants using a membrane technique and autogenous bone or allografts in humans. *Int J Periodontics Restorative Dent* 1998;18(1):8-23.
27. Adell R, Lekholm U, Rockler B, Brånemark P-I. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. *Int J Oral Surg* 1981;10:387-416.