Alveolar Ridge Augmentation Around Exposed Mandibular Dental Implant with Histomorphometric Analysis

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Running title: Exposure of d-PTFE membrane did not impair healing outcomes

Summary and conclusion: d-PTFE membrane exposure does not necessarily lead to adverse healing outcomes for alveolar ridge augmentation if handled properly with close patient follow-up.

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Case Report:

Alveolar Ridge Augmentation Around Exposed Mandibular Dental Implant with Histomorphometric Analysis

Abstract:

Alveolar ridge augmentation either prior to or during implant placement is a predictable procedure under certain conditions. These conditions include creating and maintaining a stable space with adequate blood supply for bone formation to occur in a closed healing environment. A major complication during the healing phase is incision line opening and membrane exposure which may result in reduced bone gain and reduced implant survival. This case report describes alveolar bone regeneration around three dental implants despite membrane exposure that developed during healing post-surgically. Case Report: A 72-year-old female presented requesting dental implants to replace missing #s 18, 19 and 20. A cone-beam computed tomography (CBCT) scan showed loss of horizontal and vertical ridge dimensions. All implants were placed with a variable degree of implant thread exposure on their buccal surfaces, ranging from 3-4.5 mm. Simultaneous bone grafting was done using freeze dried bone allograft and deproteinized bovine bone mineral which was covered by a d-PTFE membrane that was secured with tacking screws. Primary closure was obtained, and flaps were sutured. Three weeks post-surgically, membrane exposure occurred. Exposure was monitored and patient was instructed to follow strict oral hygiene instructions around the exposed membrane. Membrane exposure gradually increased without infection and was removed at 16 weeks. Membrane removal revealed dense fibrous tissues covering all implant surfaces. At the second stage surgery, new bone was seen covering all the implants coronal to the cover screws. A trephine core biopsy specimen revealed significant new bone formation and connective tissue around any residual grafted bone.

Conclusion: d-PTFE membrane exposure does not necessarily lead to adverse healing outcomes for alveolar ridge augmentation if handled properly with close patient follow-up.

Background:

There is increasing demand for dental implants among patients which is estimated to quadruple by the year 2026. The major challenge that faces clinicians placing implants at edentulous sites is vertical and horizontal alveolar ridge deficiencies that follows tooth extraction. [1-4] Bone grafts used in conjunction with a variety of resorbable and non-resorbable membranes are currently being used to augment deficient ridges to allow for implant placement. [5] Ridge augmentation can be performed either as a separate procedure or simultaneously with implant placement and demonstrates high success rates. [5, 6] Success of guided bone regeneration (GBR) depends on several factors such as: primary wound closure, implant and wound stability, space maintenance, and adequate blood supply. [7] Membrane exposure during the healing of a GBR procedure is a common complication and leads to a reduction in bone gain at the regenerated site. [8] The aim of this case report is to describe alveolar bone regeneration around three dental implants that was successful despite membrane exposure that developed during healing post-surgically. CBCT volumetric and histomorphometric analyses as well as healing complications are discussed.

Clinical Presentation:
A 72-year-old white female presented to the Graduate Periodontics Clinic at Indiana University School of Dentistry requesting to replace missing teeth #18, 19 and 20 with dental implants. Clinical and radiographic examination revealed a Seibert class III mandibular ridge deformity. A remaining root tip was also present at site #20 and was not visible clinically. A cone-beam computed tomography (CBCT) scan taken with a radiographic stent showed ridge deficiencies in both horizontal and vertical dimensions.

**Case Management:**

Digital treatment planning was done on the CBCT images for placement of three 4.1 mm diameter\(^1\) implants using implant planning software\(^2\) avoiding vital structures. Implant surgery and guided bone regeneration (GBR) were performed in August 2018 with local anesthetic and moderate intravenous sedation. A mid-crestal incision was made along the edentulous ridge, including sulcular incisions on adjacent teeth for adequate flap reflection. No vertical releasing incisions were used. Full-thickness flap reflection was made and the root tip at site #20 was extracted following bone removal, creating a buccal dehiscence. Implant placement was completed for all three implants using an analogue surgical template. Two 4.1 mm x 10 mm bone level implants were placed at sites #18 and 19 achieving 35 N-cm of torque, while site #20 received 4.1mm x 8 mm bone level implant but primary stability of this implant was only ~20 N-cm. While implant threads were invested in bone on the lingual aspects, there was implant thread exposure varying from 3-4.5 mm on the buccal aspect of all implants. Cover screws were placed, and bone grafting was performed to increase the alveolar width and cover the exposed implant threads. Freeze dried bone allograft\(^3\) (FDBA) was hydrated with sterile saline and placed over the exposed implant threads followed by a layer of hydrated deproteinized bovine bone mineral \(^4\) (DBBM) for contour augmentation of the buccal alveolar ridge. A titanium-reinforced dense polytetrafluoroethylene\(^5\) (d-PTFE) membrane was trimmed to avoid impingement of the mental nerve and was stabilized using titanium membrane fixation screws\(^6\). Periosteal releasing incisions were made to allow for tension free primary wound closure. Horizontal mattress and interrupted d-PTFE sutures were utilized to obtain primary flap closure. The patient received an intramuscular injection of 4mg of dexamethasone to reduce post-surgical swelling and inflammation. The patient was instructed to use ibuprofen for post-surgical discomfort (600mg, every 6-8 hours as needed) and a chlorhexidine mouthwash (0.12%), twice daily for 10 days.

**Clinical Outcomes:**

The postoperative healing was uneventful at one week with no signs of infection or membrane exposure and the patient reported minimal pain or discomfort. Sutures were removed at the 3 weeks when a 3-mm membrane exposure was noted. The patient was instructed to apply povidone-iodine to the exposed membrane twice daily using a cotton swab. Evaluations were scheduled bi-weekly to check on

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\(^{1}\) Institut Straumann AG  
\(^{2}\) Anatomage, Invivo  
\(^{3}\) LifeNet Health, Virginia Beach, VA  
\(^{4}\) Bio-Oss, Geistlich Biomaterials  
\(^{5}\) Cytoplast Ti-250, Osteogenics Biomedical  
\(^{6}\) Pro-Fix Precision Fixation Screw, Osteogenics Biomedical
membrane integrity and exposure. Membrane exposure continued to gradually increase leading to a significant exposure and severe buccal dehiscence by 16 post-surgical weeks. However, the edges of the membrane did not become exposed at any time point nor was there any evidence of infection or graft exposure throughout the follow-up period. The PTFE membrane and the fixation screws were removed utilizing a full-thickness flap surgery after 16 weeks revealing a fibrous tissue completely covering all implants. 10 weeks after membrane removal, a full thickness flap was reflected to uncover the implants and place healing abutments. Regenerated bone was seen covering all three implants occlusal to the cover screws. Measurements obtained from radiographs were used to locate the implants relative to adjacent teeth. A large round bur was used to remove crestal bone and three 6.5 x 4 mm healing abutments were placed. A trephine core specimen was taken from the buccal aspect at a level 4 mm apical to the alveolar crest between #18 and 19 and was placed in formalin. The core bone specimen was decalcified, embedded in paraffin before sectioning for histologic analysis. The specimen was stained using hematoxylin and eosin and assessed for percentages of vital bone, residual graft, and connective tissue.

**Discussion:**

The current case report provides evidence that successful bone augmentation can be achieved despite d-PTFE membrane exposure during the healing following GBR surgery. Unlike the highly porous e-PTFE membranes (5-20µm), the pore size of d-PTFE that is less than 0.3µm does not allow migration of bacteria through the membrane. Therefore, successful bone regeneration is possible even with inadvertent (or deliberate) exposure to the oral cavity [10]. Bartee [11] reported on the efficacy of d-PTFE membrane in achieving favorable results with GBR procedures. These membranes offer advantages over other membranes particularly in cases where primary wound closure cannot be achieved without tension.
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Photos:

**Figure 1:** Preoperative view, (1) Occlusal, (2) Buccal and (3) Lingual
**Figure 2:** Skull 3D reconstruction and inferior alveolar nerve tracing. Implants #18, 19 and 20 planned digitally (note exposure of the coronal third of all three implants)

**Figure 3:** Implants placement
Figure 4: Contour augmentation using FDBA and BioOss after tacking Ti-reinforced d-PTFE membrane

Figure 5: Post-operative views. 1, 3, 9 and 16 weeks postoperative
Figure 6: Membrane removal showing dense fibrous tissue underneath the d-PTFE membrane

Figure 7: Implant uncovering and placement of healing abutments