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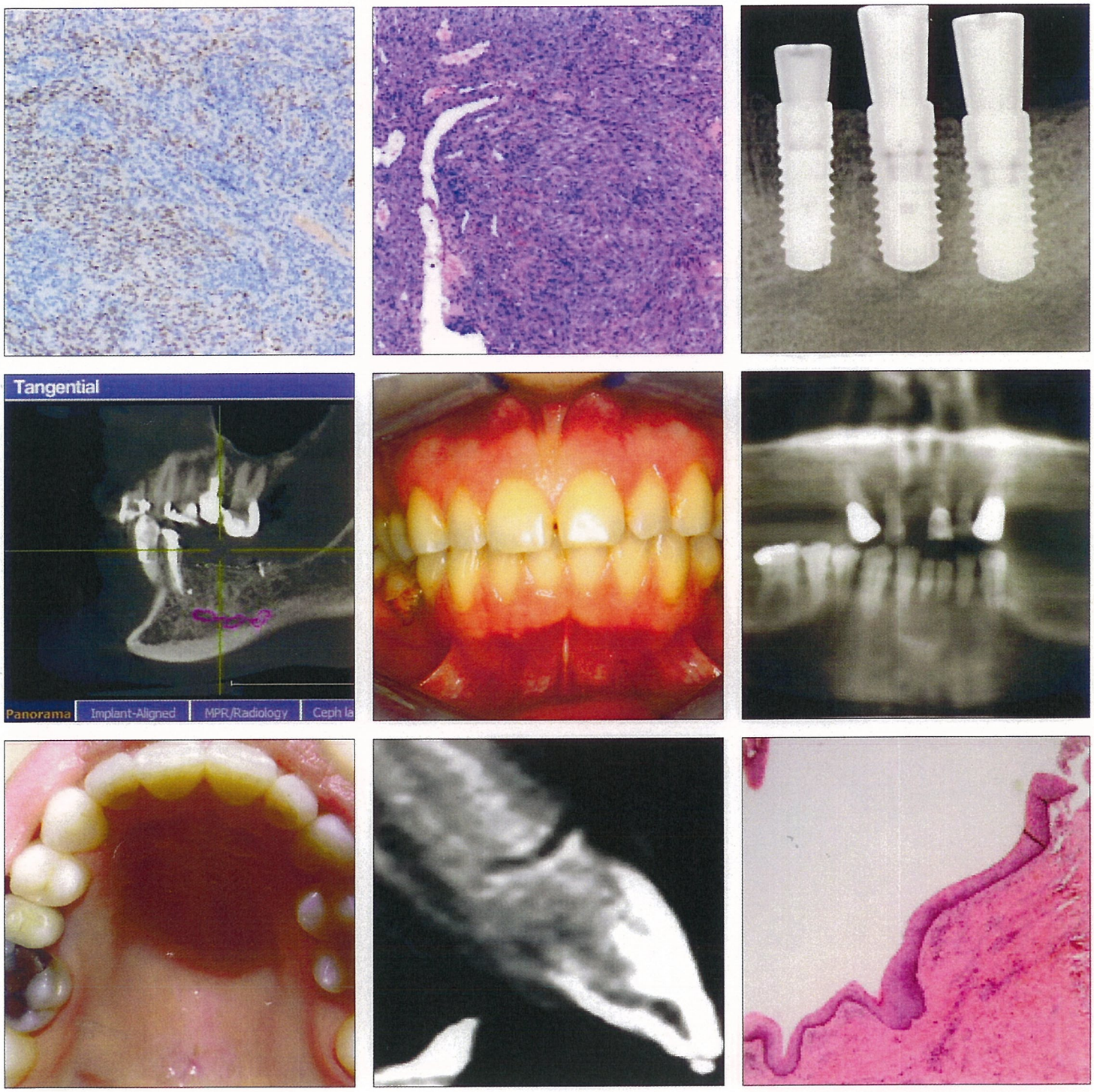

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Atrophic Alveolar Ridge-augmentation with Titanium Mesh and rh-BMP2 for Implant Placement: Case Report

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Abstract
The atrophic posterior mandible has unique challenges when implant placement is planned. The purpose of this case report is to evaluate the use of recombinant human bone morphogenetic protein2/ acellular collagen sponge (rh-BMP2/ACS) and titanium mesh for augmentation of the atrophic posterior mandible prior to implant insertion. The treated patient had a failed dental implant in position #19 that led to a vertical and horizontal bone loss in that site, and a fractured tooth in position #20. The atrophic ridge was augmented using a titanium mesh as a space maintainer and protective barrier. The rh-BMP2/ACS was placed underneath it. In the socket site of tooth #20, DBM putty with mineral chips was placed and a small part of the rh-BMP2/ ACS was laid over it as a barrier. Three dental implants were placed successfully in the area after six months of healing. This approach offered many advantages mainly in eliminating the need for bone harvesting, reducing the morbidity in including another site and reducing surgical time.

Key Words: Ridge augmentation, dental implants, titanium mesh, rh-BMP2, DBM putty

Introduction
The topic of dental implants has become one of the most popular topics discussed in dentistry. Implant dentistry has come a long way since Brånemark placed his first dental implant (Branemark et al, 1975, 1985). With baby boomers starting to age, there has been an increase in number of patients with missing teeth, mostly due to gross caries, periodontal disease and RCT failures (Hull et al, 1997). In the past, mandibular edentulous sites have been considered a hard challenge for implant surgeons and not every patient with mandibular alveolar ridge deficiency was considered as an implant candidate due to the anatomical limitations i.e.: mandibular nerve and lingual concavity.

Implant surgeons have been performing various procedures for atrophic posterior mandible to aid the placement of implants, such as block bone grafting (Cordaro et al, 2002), short implants (Grant et al, 2009), lateral nerve repositioning (Peleg et al, 2002), distraction osteogenesis (Garcia-Garcia et al, 2003), interpositional grafts (Jensen OT, 2006), vertical ridge augmentation with autografts from the iliac crest (Boyne PJ et al, 2005), guided bone regeneration (Simion et al, 1996), and titanium mesh with bone grafting (Misch, 2011). Bone graft is needed to increase the height and width of a deficient posterior mandibular alveolar ridge. In the past, titanium mesh was used in autografts from the iliac crest (Boyne, 1997). However, vertical ridge augmentation with autografts from the iliac crest posed problems including patient morbidity, significant donor site resorption and high costs of the procedure.

Particulate allograft bone replacement grafts have become a popular choice among implant surgeons due to the fact that the material is easy to handle, slowly resorbed and replaced with bone, and has some osteoinductive potential (Michael et al, 2004). Although particulate allografts offer various advantages, they also have a few shortcomings. They do not provide structural integrity. Without a containment system like a membrane or mesh, soft tissue collapse can lead to dislocation or compression of the bone graft, resulting in bone graft failure or implant failure (Louis et al, 2008). Therefore, titanium mesh is commonly used with a particulate bone graft to provide the structural integrity. Preformed titanium mesh has advantage over the traditional membrane approach because it is both rigid and easily manipulated by cutting and shaping. Preformed mesh is contoured to the shape of a ridge and it can be adapted to the anterior and posterior parts of concave shaped residual ridge on the mandible, while leaving possible bone graft space underneath it (Louis et al, 2008).

The recombinant human BMP-2 (rh-BMP2), an inductive growth factor with the ability to attach to specific receptors on mesenchymal stem cells allowing them to differentiate and proliferate into bone forming cells osteoblasts, has been investigated clinically in multiple studies regarding sinus bone grafting (Boyne et al, 2005), mandibular continuity defect (Herford et al, 2008), and extraction socket bone repair (Fiorellini et al, 2005). These studies confirmed that rhBMP-2 resulted in increase in bone volume, allowing implant placement. Bioabsorbable collagen sponge (ACS) is selected because it is one of the optimal rhBMP-2 carriers (Fiorellini et al, 2005) due to the fact that it resorbs in a timely fashion over two months allowing the slow release of the rh-BMP-2. Therefore, in this case rhBMP-2/ACS (Infuse® from Medtronic) was used and placed underneath

the titanium mesh to result in a greater bone augmentation by preserving the needed space and a Demineralized Bone Matrix putty (DBM from Zimmer®) was placed in the adjacent socket to help this particular site preservation.

This case report describes placement of three dental implants in an atrophic mandibular site, which was augmented both vertically and horizontally with rhBMP-2 Infuse® and a synthes® titanium mesh, and placement of a dental implant after extraction socket preservation using a DBM putty.

Case Report

A 51 year old healthy Caucasian female had lost a dental implant in position #19, which led to a vertical defect in that site and a subsequent fracture of tooth #20. A Cone beam computed tomography (CBCT) was taken pre-operatively to investigate the amount of bone loss, revealing bone loss of 5mm in both vertical and 7mm in horizontal directions (Fig1). Tooth #20 showed buccal plate bone loss up to 1/3 apical. Diagnostic cast was made prior to the surgery and a synthes titanium mesh of 0.3mm pore size was trimmed and shaped in the area of defect on the cast. Sharp edges were removed and polished.

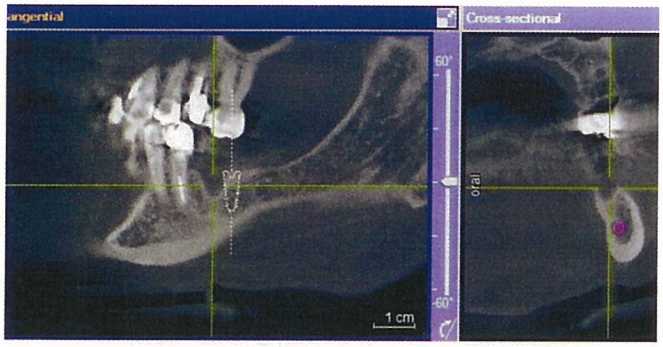

Figure 1 *CBCT showing the vertical and horizontal bone loss on site of #19 failed implant*

Infuse® Bone Graft (0.7cc) from Medtronic was used. The rh-BMP2 was reconstituted with sterile water and it was uniformly distributed on the ½" x 2" Absorbable Collagen Sponge (ACS) 15 minutes prior use to allow optimal protein binding of the growth factor to the carrier.

Local anesthesia was administered by giving of 2% lidocaine with 1:100,000 epinephrine given as a mandibular block and infiltrations on the buccal and lingual of posterior mandibular left quadrant. A full-thickness mucoperiosteal flap was reflected by making a crestal incision from the area distal to position #18 and extended to the distal of tooth #20 and an intrasulcular incision was done buccally and lingually. Tooth #20 was atraumatically extracted using piezoelectric surgery. Afterwards, the atrophic alveolar ridge was clinically examined and the titanium mesh was tried and adjusted to the area of #18 - 20. The deficient ridge was decorticated using a round diamond insert of the piezoelectric surgery. The decortication allows increase in vascularity needed for successful bone regeneration (Fig2).

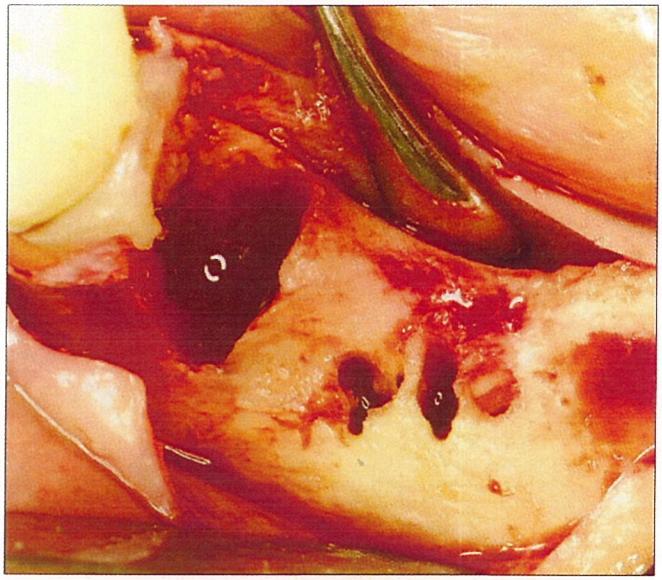

Figure 2 *The atrophic ridge on site of #18 and 19 decorticated and the extraction socket of tooth #20 showing the loss of the buccal plate.*

In the socket of tooth #20, a DBM putty with cancellous bone particles from Zimmer dental was placed. The synthes titanium mesh of 0.3mm pore size was fixated in place using two stainless steel Impladent screws, one on the distal at the bone crest (1.5x3mm) and one on the apical area anteriorly. The mesh covered the mid distal part of the socket and extended mesially on the buccal plate. Under the titanium mesh, the rhBMP-2/ACS was placed. It covered the DBM putty that was placed in the socket at its coronal part and covered the buccal plate (Fig3). Primary closure was achieved over the mesh (Fig4) and the site stayed covered throughout the healing period (Fig5).

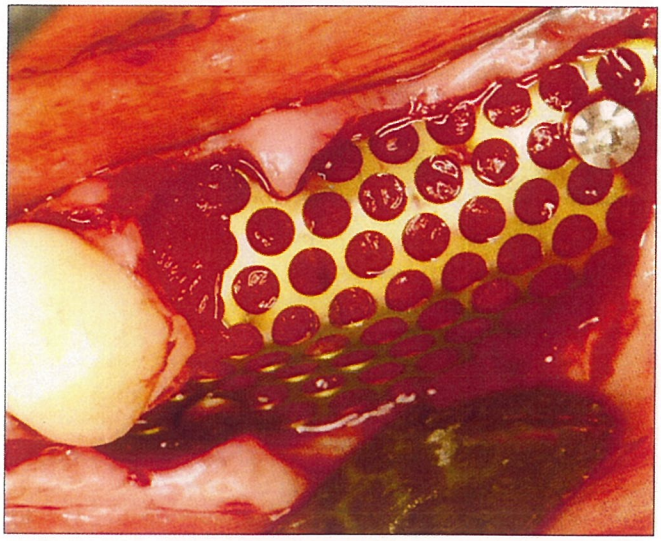

Figure 3 *Titanium mesh in place covering the rh-BMP2/ACS*

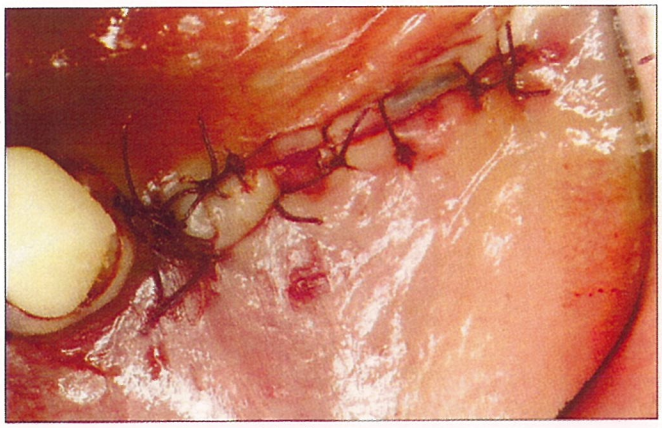

Figure 4 *Primary closure of the flap*

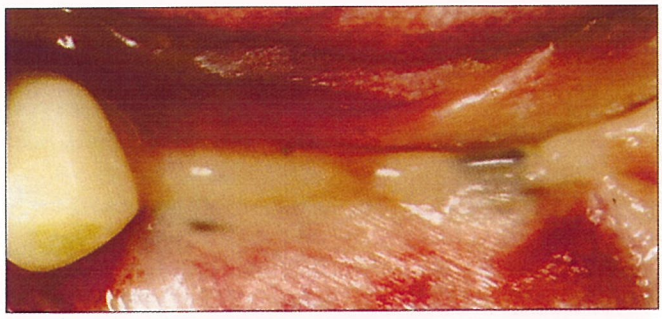

Figure 5 *Six month post-operative picture showing no exposure of the titanium mesh*

A control CBCT was taken six months post operatively and revealed successful bone fill of the defect in area #19 both vertically and horizontally (Fig6). The socket showed adequate fill and three 4.1diameter bone level SLA straumann implants were placed in positions #20, 19 and 18 (Fig7 and Fig8).

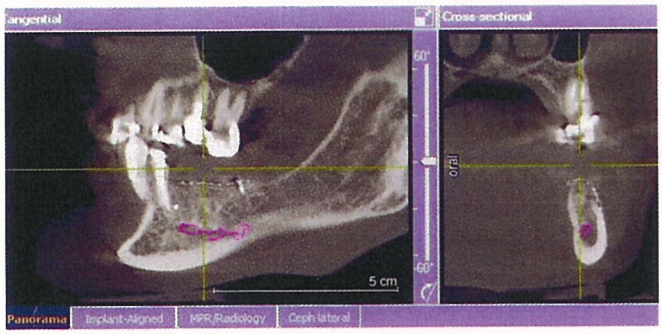

Figure 6 *CBCT of # 19 site showing a complete bone fill in both vertical and horizontal direction.*

Discussion

In order to gain successful long-term prognosis on osseointegrated implants, obtaining sufficient alveolar ridge height and width prior to the implant placement is crucial. If an adequate volume of alveolar ridge bone is not achieved due to resorption, implants are destined for compromised esthetics, function, or even failure. Gaining adequate alveolar bone volume with bone grafting in an atrophic mandibular alveolar ridge has been challenging in the past. In our case,

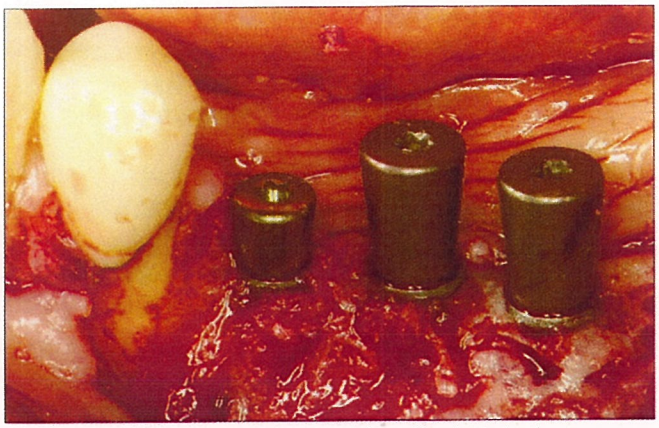

Figure 7 *Three Straumann bone level dental implants in place.*

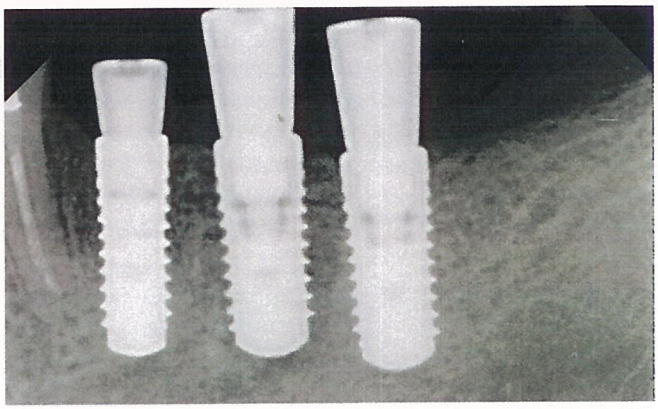

Figure 8 *Control X-ray of the implant in place.*

CBCT on the mandibular left sextant determined that the alveolar bone was insufficient in bone volume for implant placement. Therefore, alveolar bone reconstruction was needed before implant placement.

There are various methods in reconstructing alveolar bone using different bone graft materials and membrane barriers that can block soft tissue ingrowth and maintain stability. Two main bone graft materials in alveolar bone reconstruction in use today are particulate allograft materials and autogenous bone block grafts.

Because particulate bone graft material lacks structural integrity, it requires a membrane barrier that will hold the bone graft material and serve as a structural support. There are two types of membrane barriers: resorbable and non-resorbable membranes. Non-resorbable membranes include e-PTFE (expanded polytetrafluroethylene) and titanium mesh reinforced, which used to be considered the gold standards in horizontal bone augmentation as shown in the comparative histologic study in humans by Simion M. et al (1996) comparing resorbable membranes of polylactic acid and polyglycolic acid (PLA/PGA) to non-resorbable e-PTFE membrane. The study showed that e-PTFE membrane produced more bone regeneration over that of PLA/PGA

membranes. With the advent of technology, the collagen based resorbable membrane barriers have shown a comparable success in horizontal bone augmentation (Antoun et al, 2001) and in vertical augmentation (Merli et al, 2007).

Although vertical augmentation is a predictable technique (Simion et al 2001, Urban et al 2009), this technique is still associated with complications. Clinicians and patients must carefully weigh risks and benefits when considering the use of vertical guided bone regeneration (Merli et al, 2007).

In our case, titanium mesh was chosen as the barrier membrane because our case required both vertical and horizontal bone augmentation. In addition, titanium mesh provides exceptional biocompatibility, enough stability to prevent soft tissue collapse, and allows space underneath for the bone graft (Louis et al, 2008). Both studies by Louis PJ et al, 2008 and Misch CM, 2011 showed successful bone augmentation by using titanium mesh. With titanium mesh there is always a risk of mesh exposure during the healing period. One of the advantages of titanium mesh is that it endures exposure well compared with the e-PTFE membranes with less risk of infection than the latter.

In the study by Louis PJ et al, 2008, 55% of their patients had exposure of the titanium mesh in the mandible during the healing period. 7 out of 23 patients had early mesh removal due to infection and only 1 patient had complete graft failure. Partially dentate patients showed more exposure than edentulous patients. The bone augmentation level of patients with exposure was slightly lower than that of patients without exposure. In our case, there was no exposure of titanium mesh during the healing period. Because we did not have a control to compare with mesh exposure, we could not be sure if there would have been a decrease in bone augmentation level due to the exposure.

In our case, rhBMP-2/ACS might have contributed to having the soft tissue completely covering the titanium mesh since rh-BMP2 has an effect on the mesenchymal cells that enhance the formation of bone cells and endothelial cells. The study by (Fiorellini et al, 2005) showed that local alveolar ridge augmentation of buccal wall defect with recombinant human bone morphogenetic protein-2 (rhBMP-2) delivered in bioabsorbable collagen sponge (ACS) resulted in a greater bone increase than the control without rhBMP-2 due to osteoinductive properties of rhBMP-2 (Fiorellini et al, 2008). In addition, rhMBP-2 is chemotactic for endothelial cells, mesenchymal stem cells, osteoprogenitor cells, and osteoblasts. Perforations on the osseous recipient region were made on our patient with a round bur to allow access to the bone marrow where these cells reside (Misch, 2011). Because we did not have a control to compare to, we could not determine the effect of rhBMP-2 on bone augmentation.

Conclusion

Once challenging atrophic mandibular alveolar bone augmentation for implant placement has now become a routine procedure. In our case, the patient came in for replacement of her failed dental implant at site #19. A CBCT scan revealed that mandibular alveolar ridge on #19 site was atrophic both vertically and horizontally and a fractured tooth #20 was evident with buccal bone loss. A DBM putty with cancellous bone chips was used to augment the deficient socket of tooth #20 and a ridge augmentation of site #18, and #19 was done using the rhBMP-2/ASC with a titanium mesh, a space maintainer necessary for successful bone regeneration. Titanium mesh was chosen over other types of membrane barriers for the reasons described earlier. It acted as a as a space maintainer. There was no titanium mesh exposure. Six months post-op CBCT scan revealed a successful bone graft resulting in alveolar bone height and width augmentation. Three dental implants were placed in the newly augmented alveolar bone.

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