

Ardekian L, et al. The clinical significance of sinus membrane perforation during augmentation of the maxillary sinus. J Oral Maxillofac Surg 64:277-82, 2006. 21refs.

Purpose: To evaluate the significance of the sinus membrane perforations on the incidence, complications, and success rate of this procedure.

Materials and Methods: The study population consisted of 110 patients who received sinus floor augmentation by lateral window technique (Tatum's method) and simultaneous placement of dental implant. For grafting, autogenous bone was grafted by scraping the alveolar crest posteriorly and the zygomatic arch, and was mixed with Bio-Oss. Collagenous membrane was placed to cover the window. In case of perforation of the Schneiderian membrane, a resorbable collagen membrane (Bio-Mend or Bio-Gide) was inserted. Perforations were classified according to Valassis and Fugazzotto criteria.

Findings and Conclusions: Out of 110, 35 patients had sinus membrane perforation that all classified as Class II or III, <10mm in size. 42 patients (60%) were female and 28(40%) were males, and 22 patients (31%) were smokers and 48 (69%) were non-smokers. In residual ridge height of 3mm, perforation of the sinus membrane occurred in 85% of cases, while in residual ridge height of 6m, perforation of the sinus membrane was observed in 25% of cases. Implant success rates after 4 years were 94.4% in perforated group, and 93.9% in non-perforated group, respectively, without statistical difference. A significant statistical correlation was found between membrane perforation and the residual ridge height and between smokers and non-smokers. The minor membrane perforations may not contribute to implant success rate.

Artzi Z, Tal H, Dayan D. Porous bovine bone mineral in healing of human extraction sockets. Part 1: Histomorphometric evaluation at 9 months. J Periodontol 2000; 71:1015-23.

Purpose: The purpose of this study was histologically and histomorphometrically to evaluate the healing of extraction sites in which PBBM was utilized as a filler material in ridge preservation procedures.

Materials and Methods: The study consisted of 15 ASA class I patients. Maxillary single rooted teeth such as incisors, canines, and premolars were treatment planned for extraction with replacement utilizing endosseous implants. Following careful extraction of the teeth, the bony plates were measured in a mesial, distal, buccal, and lingual direction. Each socket was measured from the neighboring crestal ridge level with a periodontal probe. PBBM particles 250-1000 μ in size were grafted into the extraction site with no osteopromotive regenerative barrier being placed. Primary soft tissue closure was obtained via a pediculated split thickness flap to protect the graft site. The PBBM material was monitored radiographically during follow-up exams. According to the radiographs, the particles were radioopaque and filled the socket site. At 9 months, the extraction sites were surgically re-entered for implant placement. The socket bone fill and peripheral level of the alveolar bony walls were remeasured. Cylindrical sample cores 5-7 mm in length were taken from the socket site. Each core was prepared for histological analysis. Each sample was measured histomorphometrically with a projection microscope at x40 magnification. Statistical analysis was performed with an ANOVA test for repeated measures.

Findings: The results of the histomorphometric measurements showed that the overall bone fill was 82.3%. In the dehiscenced walls, mainly the buccal plate, the vertical bone regeneration measured from 2 to 11 mm in height, the average being 4.64 mm. Histological examination revealed an abundant amount of PBBM particles and new bone formation in all the specimens. The coronal sections of the core specimens revealed an abundance of loose connective tissue. Also seen was an amorphous material of PBBM with small amounts of osseous tissue composed of woven bone. At the periphery of the sections, amorphous areas of PBBM were present with most of the osseous tissue being of the lamellar type rather than the woven type of bone. Histomorphometric evaluations revealed the following results. In the crestal region, the bone area fraction was 15.9% compared to the deepest section cuts where it reached 63.9%. The average bone area fraction was 46.3%. The connective tissue (CT) fraction decreased from the superficial cuts (52.4%) to deeper sections (9.5%). The average CT area fraction equaled 22.9%. The PBBM area fraction decreased slightly from 35.1% at the crestal level to 26.4% at the deeper section cuts.

Conclusions: From the statistical analysis performed, in the most coronal aspect a significant increase in CT area was found compared to the bone area. In the middle of the core samples, there was bone area increase with a decrease of the connective tissue area ($p < 0.01$). In the apical region, the lamellar bone area was significantly larger than the connective tissue or the PBBM area ($p < 0.001$). Bone and connective tissue within the socket occupied roughly 70%, where as the PBBM retained a constant relative volume of 30% regardless of the depth of the specimen cores. Based on the histomorphometric data at 9 months, total resorption of the grafted particles was not evident.

Bartee BK. Extraction site reconstruction for alveolar ridge preservation. Part I: Rationale and material selection. J Oral Implantology 2001; 27:187-93.

Purpose: To review the materials used in ridge preservation, and to give rationale for using each material.

Materials and Methods: Literature review

Findings and Conclusions:

Materials for long-term ridge preservation:

1. Particulate, dense hydroxyapatite (Calcitite) is a proven material for long term ridge preservation.
2. Also porous coralline HA (Interpore) is used. This material is a dense HA structure with interconnecting pores that allow bone and soft tissue in growth within the particles.
3. Bioactive glass (Bioglass) is also used.
4. Porous polymethyl methacrylate has also been used.

Materials for transitional ridge preservation:

Transitional ridge grafting provides means to preserve bone mass, allowing future placement of implants.

1. inorganic bovine bone matrix (ABM)
2. resorbable calcium phosphate ceramic
3. macroporous bioactive glass.

Materials for short-term ridge preservation:

The objective of short-term ridge preservation is to maintain bone mass during the initial healing stage in preparation for dental implants- over a 3 to 6 month period.

1. DFDBA
2. Autogenous bone combined with a low density HA or ABM product.

The prevention of ridge resorption using particulate grafting materials is predictable, convenient, and available at a reasonable cost. With the introduction of membrane techniques, results are enhanced by providing containment of the graft particles and preservation of soft tissue contours. Ridge preservation may be long term or transitional depending on the physicochemical properties of the material placed in the sockets.

Boyne PJ, Lilly LC, Marx RE, et al. De novo bone induction by recombinant human bone morphogenetic protein-2 (rhBMP-2) in maxillary sinus floor augmentation. J Oral Maxillofac Surg. 2005; 63: 1693-1707.

Purpose: (1) to evaluate the safety and efficacy of 2 concentrations of rhBMP-2 to induce adequate bone for dental implant placement. (2) To estimate patient and dental implant success rates following 36 months of functional loading of dental implant.

Materials and Methods: 48 patients were enrolled between Oct. 1996 and Jun. 1997 at 6 centers. All patients had the surgery of lateral window sinus opening. They used rhBMP-2 + ACS (highly purified bovine tendon type I collagen) or bone graft. Each group was as follows;

1. Bone graft group: Autogenous bone or a combination of autogenous bone and allogenic bone.
2. 0.75 mg/ml rhBMP-2 group: 0.75 mg/ml rhBMP-2 and ACS.
3. 1.50 mg/ml rhBMP-2 group: 1.50 mg/ml rhBMP-2 and ACS.

Bone induction was quantified by CT scans at baseline and 4 months after material implantation. Histology was obtained by using a trephine. Safety and immune response was monitored by collecting of blood samples.

Findings:

(1) Volume

- The mean total volume of each treatment per sinus: 6.9 cc (bone graft), 11.9 cc (0.75 mg/ml), and 13.8 cc (1.50 mg/ml).

(2) Bone induction at the 4 months postoperative

- The mean bone height changes from baseline: 11.29 mm (bone graft), 9.47 mm (0.75 mg/ml), and 10.16 mm (1.50 mg/ml) → No significant differences between any of the treatment groups
- Bone width changes at the crest of the ridge (1/4 point): Bone graft group (4.66 mm) showed a significant increase compared with 2 rhBMP groups (2.02 mm and 1.98 mm, respectively).
- Other points of bone width changes: No significant differences between the groups.

(3) Bone density

- 4 months after surgery: Bone graft group (350 mg/cc) showed a significant difference compared with 2 rhBMP groups. In addition, the 1.50 mg/ml group (137) showed a significantly greater bone density than 0.75 mg/ml group (84). 6 months after loading: All groups showed similar bone density.

(4) Histology

- Unambiguous bone induction by rhBMP-2 and no difference in the histologic parameters among the groups. No evidence of inflammatory cell infiltration and residual collagen matrix.

(5) Bone quality

- The 0.75 mg/ml group (6) showed twice as many patients with type IV bone as the 1.50 mg/ml group (3).

(6) Implant success rate functionally loaded at 36 months

- % of observed people: All groups – 100% - % of enrolled peoples: Bone graft groups – 62%, 0.75 mg/ml group – 67%, 1.50 mg/ml – 76%.

(7) Implant survival rate (regardless of loading status)

- Bone graft group: 81%, 0.75 mg/ml group: 88%, 1.50 mg/ml group: 79%.

(8) Safety

- Bone graft group showed a significant greater portion of edema (46%) and skin rash (46%). The 1.50 mg/ml group had a significant greater amount of facial edema (82%). The body responses of those materials were transient. No clinical manifestation of an immune response in rhBMP-2 has been identified.

Conclusions: rhBMP-2/ACS safely induced adequate bone for the placement and functional loading of dental implants in patients requiring staged maxillary sinus floor augmentation.

Jensen OT. Alveolar segmental “sandwich” osteotomies for posterior edentulous mandibular sites for dental implants. J Oral Maxillofac Surg. 2006; 64(3):471-5. 21 (Refs)

Purpose: To evaluate crestal stability of alveolar augmentation using an interposition bone graft for dental implants based on 10 retrospective clinical trials.

Materials and Methods: 10 sites in 8 patients with 3 to 7mm of bone above the inferior alveolar nerve were selected. A 3-cm incision was made at the depth of the buccal vestibule posterior to the mental foramen. Anteriorly, the incision remained up to 10mm away from the crest. The osteotomies were performed by using the sagittal saw and were parallel to the crest. The midportion of the segment approached to within 2mm of the inferior alveolar nerve. Anteriorly, a step osteotomy was frequently made vertically to the crest while posteriorly the osteotomy tapered to the crest in a smile-shaped cut terminating near the retromolar pad. The osteotomy proceeded lateromedially until through the lingual plate. An osteotome was used to free the segment. A miniplate was used to position the segment vertically but also allowed medial rotation so that the crest of the ridge could be widened. A cortical wedge of bone harvested locally from the adjacent external oblique ridge was placed between the segment and the basal bone followed by the addition of a particulated autograft. Wounds were closed with 4-0 chromic suture. After 4 months healing, implant placement proceeded in standard fashion. Bone plates were removed at that time. Short implants (8 to 11mm) were still required. Implant diameters were 4 to 4.8mm.

Findings and Conclusions: Each patient was followed from 1 to 4 years. Bone availability above the inferior alveolar nerve was from 3 to 7mm preoperatively in the osteotomy sites. Segments were raised from 4 to 8mm. One patient had an exposed bone plate but the graft was not lost. 22 implants were placed and 20 implants were restored for 90% success rate. All patients had some transient paresthesia postsurgically, the longest lasting 6 weeks. Paresthesia was likely related to flap retraction of the mental nerve. There was indiscernible radiographic regression of vertical dimensions as measured by panograph. Loss of alveolar height was only observed in the area of implant placement. The technique appears to be a viable alternative to block grafting or guided bone regeneration.

Jensen SS, Brogini N, Weibrich G et al. Bone regeneration in standardized bone defects with autografts or bone substitutes in combination with platelet concentrate: A histologic and histomorphometric study in the mandibles of minipigs. Int J Oral Maxillofac Implants 2005; 20:703-12.

Purpose: The purpose of this study was three fold. (1) To evaluate the impact of platelet concentrate (PC) on bone regeneration in standardized bone defects from the time of the initial organization of the blood clot to the point at which complete bone fill was obtained. (2) Evaluate whether the presence of osteoprogenitor cells in the autograft is a prerequisite for PC to have a beneficial effect and (3) Analyze the content of platelets, leukocytes, PDGF-AB and TGF β 3 in the applied PC and correlate the PC content with the observed bone regeneration, qualitatively and quantitatively.

Materials and Methods: Twelve adult Gottingen minipigs were used for this study. Prior to surgery, the animals were given 1 gram of prophylactic amoxicillin. Following administration of general anesthesia, the lateral portion of the body and ramus of the mandibles were exposed and three standardized intraosseous defects were prepared using a trephine under copious irrigation with normal saline. The defects were 9 mm in diameter and 5 mm in depth. The corticocancellous blocks were particulated to 1-2 mm and additional cancellous bone chips which were harvested using a chisel were mixed with this graft to gain an approximate ratio of 1:1 cortical to cancellous bone. Each defect was filled with different graft materials: autogenous bone chips; anorganic bovine bone (Bio-Oss) with particle size of 1-2 mm or synthetic p-TCP with a particle size of 0.7 to 1.4 mm. In the first animal the bone graft was randomly placed into the created osseous defects. In each subsequent animal the bone grafts were placed one defect distal to that of the first animal. The augmented material was mixed with blood and placed into the defect on one side, while on the other side of the mandible; 1ml of PC was added to approximately one gram of bone graft in combination with a few drops of calcium chloride to initiate the coagulation process. All three defects were covered with a GoreTex membrane secured with four fixation screws. The animals received antibiotics for 7 days post operatively. Blood samples and plasma concentrates were measured for platelet and WBC count. Analysis of PDGF-AB and TGF was also carried out. The animals were then divided into four groups and healing was allowed to take place for 1 week, 2 weeks, 4 weeks or 8 weeks. The animals were sacrificed at the end of their respective healing periods and block sections containing the three grafted defects were prepared for histologic evaluation. The three most central sections per defect were analyzed by an examiner who was blinded to the treatment modalities.

Findings and Conclusions: No statistical correlation could be made between the initial platelet concentration in whole blood and the final platelet yield, nor could any correlation be identified between platelet count in PC and concentrations of PDGF-AB. No statistically significant relationships could be found between WBC counts in PC and concentrations of PDGF-AB.

Histology: 1 week: All defects showed the presence of a blood clot irrespective of the type of grafting material used. Granulation tissue could be seen invading the blood clot from the peripheral bony walls. There was no evidence of increased vascular in-growth or soft tissue maturation in defects treated with PC.

2 weeks: The blood clot was replaced by granulation tissue that extended to the barrier

membrane. Woven bone was seen consistently only along the defect walls. In defects grafted with autogenous bone, woven bone formation was seen to the level of the membrane, while in those defects grafted with more compact bone, limited new bone formation was seen. In defects filled with bone substitutes much less bone formation was seen and these differences in all sites seemed to be independent of the addition of platelet concentrate.

4 weeks: Defects grafted with autografts showed graft particles embedded in new bone. Defects grafted with anorganic bovine bone and 3-TCP contained smaller amounts of newly formed bone which was less mature than the bone seen in sites with autografts. The addition of PC did not affect the level of bone maturation or degradation of the graft material.

8 weeks: All defects showed newly formed bone with fully developed bone marrow. Most defects showed new cortical bone formation beneath the barrier membrane. The 3-TCP particles were embedded in new bone and only a few were evident. Anorganic bovine bone particles also showed osseointegration but had a slower substitution rate. PC usage did not influence the level of healing in defects where it was used.

Histomorphometric analysis: When the %volume of bone formation, residual graft material or soft tissue occupying the defect was analyzed, the platelet concentrate exhibited no influence over graft materials or healing at various time intervals.

Therefore it could be concluded that the addition of platelet concentrate did not influence the level of new bone formation nor degradation of the graft material.

L Schropp, A Wenzel, L Kostopoulos, T Karring. Bone Healing and Soft Tissue Contour Changes Following Single-Tooth Extraction: A Clinical and Radiographic 12-Month Prospective Study. Int J Periodontics Restorative Dent 2003;23:313-23.

Purpose: To assess alveolar bone formation and contour changes within a period of 12 months following single tooth extraction.

Materials and Methods: Clinical and radiographic examinations of the extraction site were carried out immediately following extraction and at 3, 6, and 12 months following extraction on 31 women and 15 men referred for extraction of 11 maxillary and 10 mandibular premolars, 9 maxillary and 16 mandibular molars.

Clinical examination was done using study models as well as by measuring probing depths and attachment levels of adjacent teeth. The alveolar height was measured as the distance from the midpoint of the extraction site perpendicular to the line connecting the occlusal surfaces of the adjacent teeth at the most occlusally situated point both buccally and lingually. The width of the alveolar ridge was measured perpendicular to the tangent of the dental arch at the midpoint of the extraction site as the distance between the most prominent points buccally and orally. All measurements were taken twice and reproducibility measured using Spearman's rho and changes over time were calculated and tested by the Wilcoxon matched pairs signed rank test.

Standardized intraoral radiographs were taken and were digitized. Linear measurements of digitized radiographs were performed by means of linear and angular analyses. Bone levels at the mesial aspect of the tooth distal and distal aspect of the tooth mesial to the extraction site were measured. These measurements were carried out at baseline and at 12 months following tooth extraction. At 12 months, the most apically situated point between the mesial and distal aspect of the extraction site was determined. The tooth contour from a pre-extraction radiograph was transferred to both the images. All measurements were performed twice by the same investigator and correlation between the recordings was evaluated by means of Spearman's rho test. The Wilcoxon matched pairs signed rank test was used to evaluate the differences between bone level changes over time, and between bone levels at the extraction site and adjacent teeth. Subtraction radiography was used to measure the areas of bone loss and bone gain 12 months after extraction.

Findings:

- The most occlusal point on the buccal was located on an average 1.3 mm more apically than on the lingual. After 12 months, this difference was reduced to 0.2 mm due to tissue gain buccally and tissue loss lingually. Most of the gain was 3-12 months after extraction and loss was in the first 3 months.
- Immediately following tooth extraction, the mean width of the alveolar ridge was 12mm. Width of the alveolar ridge reduced about 50% and 2/3 during first 3 months - more in the mandible compared to maxilla and more in the molar regions compared to premolars.
- Pocket reduction during first 3 months was 1mm and recession was 0.7mm during 12 month healing. A mean attachment gain of 0.3 mm at the tooth surfaces was observed adjacent to the extraction site.

- The bone levels at the tooth surfaces mesial as well as distal to the extraction site were almost unchanged from extraction to the 12 months visit. At baseline, the mean bone levels at the mesial and distal sites of the extracted tooth were 0.7mm and 0.3mm more apical than the level of the adjacent teeth. After 12 months, the difference in bone levels increased mesially to 0.9mm and distally to 0.5 mm. The bone levels at 12 months were 0.3mm apical than at baseline bone mesially and distally within the extraction site. Most apical point was 1.2 mm apical to mesial and distal measurements. All these differences in measurements were statistically significant.
- Subtraction radiography showed that bone formation took place in the extraction alveoli simultaneously with a loss of height of the alveolar crest. Remodeling of the lamina dura in multi rooted teeth was more pronounced from 6-12 months.

Conclusions: Major changes take place at the extraction site from the time of extraction up to 12 months. These changes vary depending on the site of extraction and in different areas of the mouth.

Wallace SS, Froum SJ, Cho SC et al. Sinus augmentation utilizing anorganic bovine bone (Bio-Oss) with absorbable and nonabsorbable membranes placed over the lateral window: Histomorphometric and clinical analyses. Int J Periodontics Restorative Dent 2005; 25:551-9. 37 (Refs)

Purpose: To compare the results of sinus elevation performed without a membrane (control) to the results of sinus elevation performed with either a short term bioabsorbable membrane (Bio-Gide) or non-absorbable membrane (ePTFE) with regard to both vital bone formation and implant survival.

Materials and Methods: The data were obtained from 64 sinus augmentation procedures performed on 51 patients (13 bilateral and 38 unilateral). The grafting material used was either Bio-Oss alone or a composite graft consisting of Bio-Oss with <20% intraorally harvested autogenous bone. The lateral window was left uncovered, covered with a ePTFE membrane, or covered with a bioabsorbable collagen membrane (Bio-Gide). All sinuses were grafted with either a 100% bone replacement graft (Bio-Oss) or a composite graft consisting of bio-Oss plus a maximum of 20% intraoral autogenous bone harvested from the maxillary tuberosity or the mandibular ramus. Bone core biopsies were carried out at the time of implant placement (6 to 10 month after graft placement). Data on implant survival were included only for those implants that were loaded for a minimum of 1 year.

Findings: Histologic survey from representative samples showed 14% (no-membrane), 30% (ePTFE), 30% (Bio-Gide) in terms of vital bone formation. Also Bio-Oss presented osteoconductive properties contacting with newly formed bone, which was, in turn, covered by a layer of osteoid and numerous osteoblasts.

After the analyses, the vital bone formation in sinus grafts was greater when either a ePTFE membrane or a Bio-Gide was used (16.9% and 17.6%, respectively), in comparison to sinuses grafted without a membrane (12.1%). There was no statistical difference between the membrane groups. Non membrane group was too small to allow for statistical analysis. There was no significant difference in implant survival between ePTFE and Bio-Gide groups (97.8% and 97.6%, respectively).

Conclusions:

- 1: Vital bone formation in sinus grafts is improved when a membrane is placed over the window.
- 2: Vital bone formation is similar with ePTFE and Bio-Gide.
- 3: Implant survival is similar with ePTFE and Bio-Gide.
- 4: Bio-Oss demonstrates excellent osteoconductive properties in the grafted sinus.
- 5: Bio-Oss alone, or as a composite graft with minimal amounts of autogenous bone, results in an excellent implant survival rate in the grafted sinus.

Wang H, Misch C and Neiva R. "Sandwich" bone augmentation technique: Rationale and report of pilot cases. Int J Periodontics Restorative Dent 2004; 24:232-45.

Purpose: To describe the "sandwich" technique approach (SBA) for bone augmentation and evaluate clinical results from five pilot studies.

Methods and Materials:

1. SBA technique: The surgical procedure involves full thickness flap reflection continued by a partial thickness, removal of granulation tissue, intramarrow penetration. The inner bone graft layer is composed of autogenous bone. Autograft collected during osteotomy preparation, this is applied directly against the implant surface covering completely the buccolingual height. The middle layer is composed of DFDBA and the outermost layer is composed of dense particle of HA. After the application of these 3 layers a collagen membrane is placed, the mucoperiosteal flap is positioned coronally to cover the wound without tension.
2. Five- subjects were selected for the study. All subjects were treated at the Graduate Periodontics Clinic, University of Michigan. Patients presented with buccal alveolar dehiscence from 6-10mm. Radiographs and 1:1 magnification color photographs were taken. Implants were placed in combination with the SBA technique. All implants were placed in a two-stage approach.

Findings and Conclusions: Bone augmentation achieved by using the SBA approach was 10.5mm (100% bone fills). Tissue surrounding the implants was resistant to probing and hard in consistency. Histological evaluation would be useful to validate the results obtained via this approach.

Wang HL, Kiyonobu K, Neiva RF. Socket augmentation: Rationale and technique. *Implant Dent* 2004; 13: 286-296. 95 (Refs)

Purpose: The purpose of the article is to describe the rationale behind alveolar ridge augmentation procedures aimed at preserving or minimizing the edentulous ridge volume loss and to describe a technique that has been shown to not only facilitate tooth extraction with minimal damage to the surrounding anatomic structures, but also to improve alveolar bone quality and quantity.

Materials and Methods: Literature Review

Findings and Conclusions: Rationale: Tooth extraction results in alveolar bone loss as a result of resorption of the edentulous ridge. An average of 40-60% of original height and width is expected to be lost after tooth extraction, with the greatest loss happening within the first 2 years. Augmentation is primarily aimed at preserving the current bone level and hopefully regenerating new bone. Lekovic et al. 1997 compared the outcome of alveolar ridge preservation using absorbable barrier membranes and extractions alone. At 6 months, significantly less crestal bone loss (-0.38 mm vs. -1.50 mm), more internal socket fill (-5.81 mm vs. -3.94 mm), and less horizontal ridge resorption (-1.31 mm vs. -4.56 mm) were found in the membrane group than in the control group, suggesting that successful early alveolar ridge augmentation procedures may reduce, or eliminate, the need for future ridge augmentation. Iasella et al. conducted a randomized, controlled, masked clinical trial in 24 patients. Subjects received either extraction alone or socket augmentation using tetracycline hydrated freeze-dried bone allograft (FDBA) and a collagen membrane. Histologic analysis demonstrated greater bone formation in augmented sites after a 6-month healing period. The most predictable maintenance of ridge width, height, and position was achieved when a socket augmentation procedure was used.

Technique: After local anesthesia is achieved, sulcular incisions are performed with a 15-C scalpel to initiate rupture of the supracrestal attachment apparatus. Periostomes are then applied to sever the subcrestal attachment apparatus. Straight periostomes are indicated for use on single-rooted teeth. The instrument is used first to complete rupture of the gingival fibers at the cervical area of the tooth. During this procedure, the long axis of the blade should be angled converging at approximately 20° from the tooth long axis. The blade is inserted into the sulcus to sever the gingival apparatus circumferentially, then the instrument is inserted into the periodontal ligament space and moved repeatedly in a mesiodistal direction, on the whole circumference of the root, severing the periodontal ligament immediately below the alveolar crest. The periostome can reach up to 2/3 of the root length by this procedure, and then the tooth remains attached to the alveolus only by the most apical part of the periodontal ligament. Additional elevation may be required if significant tooth mobility is not achieved. A dental forceps should not be applied until significant tooth mobility is achieved. It is then possible to extract the tooth without having to intrude the dental forceps into the periodontal ligament space, thus avoiding distortion or other damage to the alveolar bone. After tooth removal, the socket is thoroughly curetted of all soft tissue debris. Bleeding, if absent, should be stimulated from the osseous base. The key for maximum bone fill is adequate bleeding from the bone, because blood contains fundamental proteins and growth factors for bone healing. This procedure also triggers the regional acceleratory phenomena (RAP), which is known to stimulate new bone formation and graft incorporation. The graft material should have unlimited supply,

be biologically inert, facilitate revascularization, be osteoconductive, and be completely replaced by new bone. The graft material should be inserted into the socket and tapped down lightly and overfill should be avoided. Adequate space between the graft particles is critical to allow for revascularization to spread throughout the graft. Overfilling the socket will only result in sequestration of the coronal graft particles, possibly leading to development of an infectious source that may negatively influence osseous formation. Only the apical 2/3 of the socket should be filled with bone grafting material. An absorbable collagen dressing material is then placed to seal the coronal portion of the socket. This material provides stabilization for the treatment site. A crossmattress suture is then used to secure the collagen dressing material in the socket for the initial 14 days of the healing process. Ovate fixed or removable pontics may be used to provide support to both interdental papillae and facilitate development of a more esthetically pleasing soft tissue profile.