SOCKET GRAFTING: A PREDICTABLE TECHNIQUE FOR SITE PRESERVATION

Brian J. Jackson, DDS; Iyad Morcos, DDS

The demand for dental implants continues to rise worldwide, requiring clinicians to consider the incorporation of bone preservation procedures into their dental practice. Socket grafting offers a predictable, simple way to conserve the buccolingual and mesiodistal dimensions of the future implant site. Careful bone management and the use of various bone-grafting materials must be part of the practice of every implantologist. In this case report, the authors present a fundamental technique for socket grafting and 3 cases of site preservation with subsequent implant placement and restoration. Emphasis is placed on the evidence-based rationale for this procedure, the clinical technique, and the various grafting materials that can be employed by the clinician.

Key Words: atraumatic extraction; bone allograph; socket preservation; osteoinduction

INTRODUCTION

The number of dental implants inserted in the United States has increased more than 10-fold from 1983 to 2002, and more than $150 million in dental implant products have been sold to North American dentists in that same time interval.[1] Single-tooth implants are the most predictable way of replacing missing teeth by eliminating the need for preparing adjacent teeth, decreasing the risk of caries, and increasing the efficacy of oral hygiene procedures. These factors make the single-tooth implant the most common implant procedure, with a survival rate of 95% over a 5-year period.[2] Moreover, the emphasis in implant dentistry has evolved from the fundamental concept of osseointegration to the highly critical discipline of esthetics. As a result, the patient's demands for ideal esthetic outcomes can be achieved only if ideal bone volume is present prior to implant placement.

After tooth removal, the dental team faces the formidable challenge of creating a prosthetic restoration that is indistinguishable from the adjacent natural dentition. The concept of site preservation after tooth extraction is essential because of the normal resorptive process of the healed ridge. Research has demonstrated that the width and height of the alveolus postextraction resorbs, creating a deficiency in bone volume.[3,4] It is critical that ideal bone quantity is present prior to implant placement to maximize the final prosthetic outcome. Site preservation through socket grafting is a predictable procedure to enhance the surgical site prior to implant fixture placement.[5–8]

There are various natural and synthetic bone graft materials available for the clinician to use for socket preservation.[9–11] Although the materials have many differences including harvesting, processing, and cost, the most important is in how they affect surrounding bone. For example, does the graft material foster an environment for bone growth via osteogenesis, osteoinduction, or osteoconduction? The most common type of grafting materials used in implant dentistry are the autografts,[12,13] allographs,[14–16] xenografts,[17–20] and alloplasts.[21–23] The responsibility of the clinician is to select a bone graft material for socket preservation that will foster a positive environment of bone development for future implant treatment.

SURGICAL PROCEDURE

The initiation of the extraction and grafting procedure should begin after a complete patient medical history is taken and reviewed.[24] An informed consent form

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should be explained and signed by the patient, including an explanation about the source and preparation of the bone graft material. The grafting material is reconstituted in a sterile way prior to the administration of local anesthesia. The grafting material can be hydrated with sterile saline or platelet-rich plasma according to the manufacturer's instructions, usually 15 to 20 minutes prior to its use.

A local anesthetic is administered in an infiltration or block technique depending on the arch involved. A local anesthetic containing epinephrine is preferred to obtain adequate analgesia and extended working time and to minimize bleeding (vasoconstriction) (Figure 1). After the patient is anesthetized, periotome tip No. 1 is used to widen the periodontal ligament, and tip No. 3 is used to access the interproximal space (Figure 2). A wiggling or cutting movement is used with these fine instruments as opposed to the tooth luxation/ elevation movement traditionally used with elevators. All attempts should be made not to raise a muccoperiostal flap, thereby protecting the fragile buccal plate of bone. In the case of long rooted teeth (ie, canines), a mead mallet may be employed with a slight, gentle tapping movement. The patient must be informed prior to the onset of this technique to avoid apprehension or anxiety. In the removal of multi-rooted teeth, sectioning of the tooth into individual roots with a 701 long shank carbide bur followed by periotomes or elevators should be employed. Careful manipulation is designed to preserve the height of the alveolar bone in all dimensions.

When sufficient tooth movement is visually evident, the tooth is removed with a forcep in a minimal amount of buccal-palatal luxation (Figure 3). The use of a forcep with extreme force for tooth removal is a contraindication because of the risk of fracturing the vulnerable buccal plate of the bone. The forcep is used only to lift gently the tooth after it is completely loosened from its bony crypt. The preferable technique is to support the buccal plate of bone and dentition with a finger, or sterile gauze, and to lift the tooth out of its socket with a steady, controlled force. The choice of the forceps depends on the size of the collar area of the tooth to be extracted.

After the tooth is removed, the socket should be inspected for residual granulation tissue or signs of purulence. Second, the buccal plate needs to be inspected with the tactile sense of a large blunt instrument (ie, large amalgam burnishing tool). This should be performed from an intrasocket approach. If a buccal bone defect is present, it can be managed with a long-term resorbable membrane placed within the socket adjacent to the buccal wall of bone. Also, the floor of the socket should be inspected by gently using a wide-ended probe to rule out a communication with vital anatomic structures. Finally, bleeding points can be established with a No. 4 round bur on the palatal, distal, and mesial walls of the residual socket. Care should be taken not to perforate the buccal plate of bone to establish bleeding points.

Once the socket has been prepared, the grafting material is placed in its hydrated form (Figure 4). The grafting material can be delivered to the socket with a disposable syringe in a gentle manner (Figure 5). It is condensed with a blunt amalgam plugger with very slight pressure to ensure that the material placed is free of voids (Figure 6). A collagen wound dressing is placed and secured with multiple vicryl sutures (Figure 7). Vicryl sutures are used because of their ease of handling and type of resorption rate (ie, hydrolysis) (Figure 8). A transitional appliance can be placed with an ovate pontic design setting 2 mm into the residual socket.

Postoperative instructions are given verbally and in written form. Emphasis is placed on cold pack application, no smoking, soft diet, and taking medications as prescribed. The patient is encouraged to contact the office if any questions or problems occur. The case is documented in the patient chart, and a tracking sticker provided by the manufacturer is to be placed clearly, indicating the number and characteristic of the material that was used. The patient is discharged and scheduled in 3 weeks for suture removal and a postoperative evaluation.

CASE REPORTS

Case 1

A 15-year-old female patient was referred to the office with a diagnosis of a horizontal root fracture associated with tooth No. 10, the maxillary left lateral

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FIGURES 1–8. FIGURE 1. A nonrestorable premolar with an MOD amalgam restoration. FIGURE 2. Periotomes No. 1, 2, and 3. FIGURE 3. A biradicular upper first premolar removed atraumatically. FIGURE 4. The grafting material is hydrated with sterile saline. FIGURE 5. The grafting material is introduced into the socket with a disposable, sterile syringe. FIGURE 6. The socket is filled with a grafting material to the level of the crestal bone. FIGURE 7. A collagen wound dressing is placed over the bone graft material. FIGURE 8. A 4.0 vicryl suture is used to secure the collagen dressing in place.

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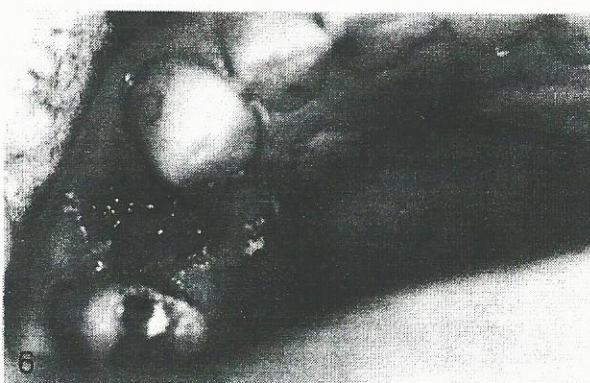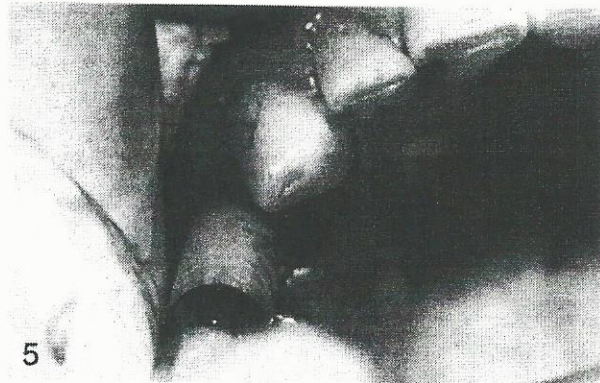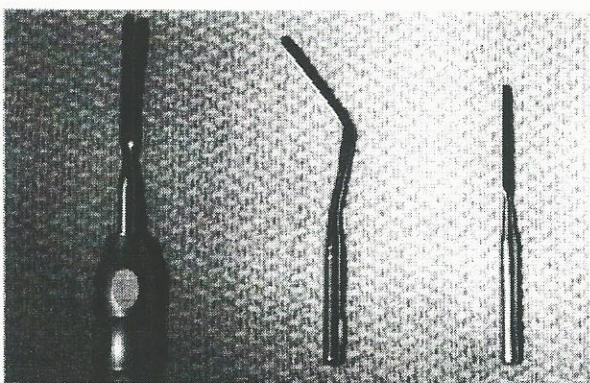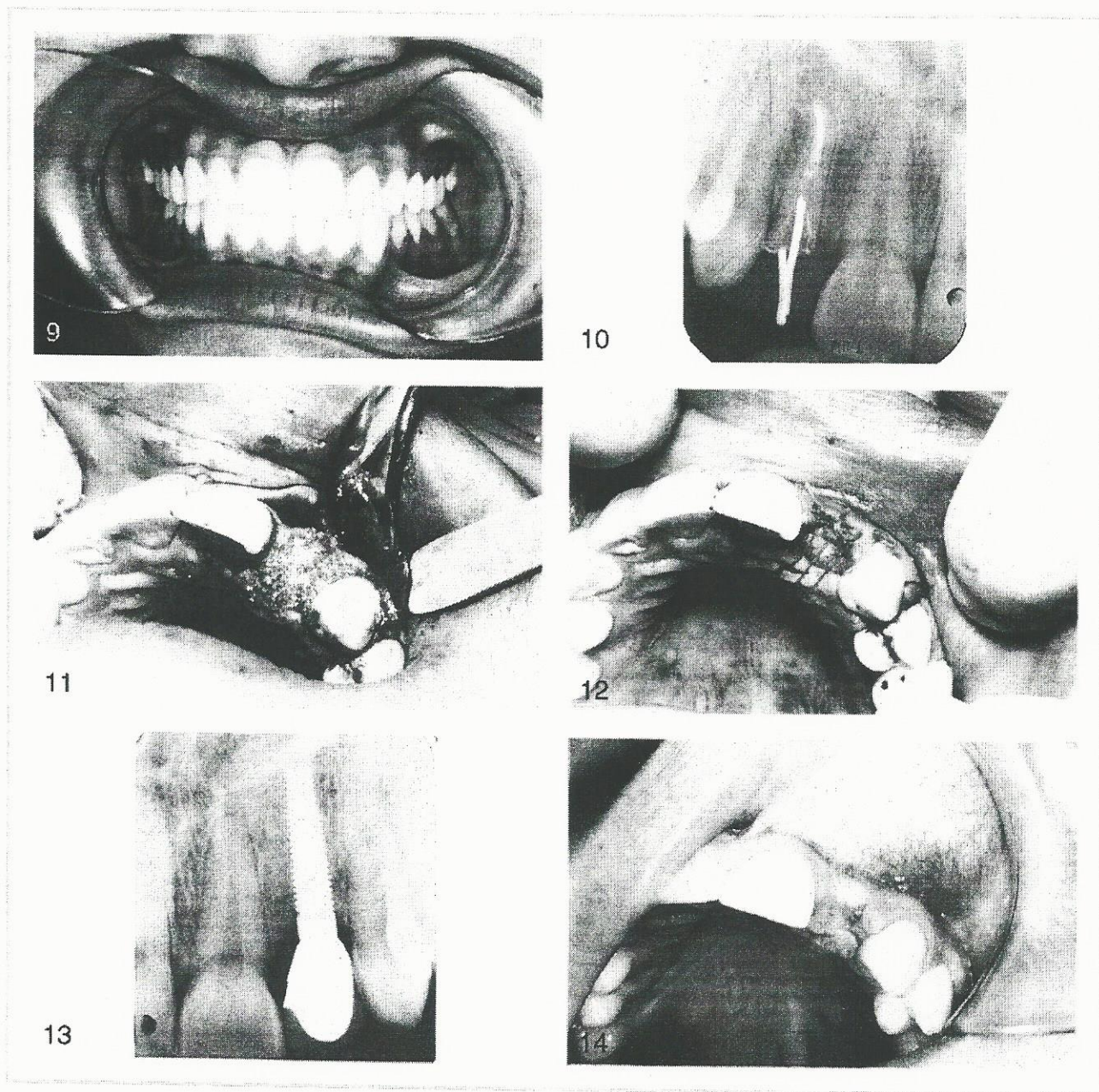
FIGURES 9–14. FIGURE 9. Preoperative view of centric occlusion. FIGURE 10. Periapical radiograph, horizontal root fracture, maxillary left lateral incisor (tooth No. 10). FIGURE 11. Tooth socket grafted with demineralized freeze-dried bone allograph. FIGURE 12. Collagen barrier sutured over allograph material. FIGURE 13. Periapical radiograph: 3.7 × 16 mm tapered screw vent. FIGURE 14. Preoperative view: pre–second-stage (uncovery) surgery.

incisor (Figures 9 and 10). The patient's medical history demonstrated no significant findings. The treatment plan consisted of a staged approach consisting of tooth removal with bone grafting followed by implant placement and restoration.

The patient was administered a local anesthetic consisting of 2 carpules (36 mg) 2% lidocaine with epinephrine 1:100 000 in the buccal and palatal mucosa. The maxillary left lateral incisor was atraumatically removed with a double-ended curette, 301 elevator, and a 150 universal forceps. The tooth socket was debrided of all granulation tissue with a double-
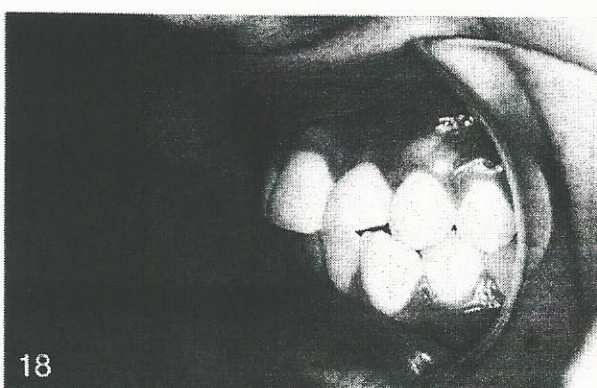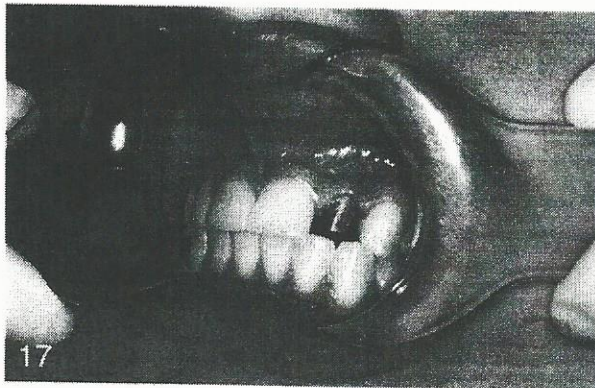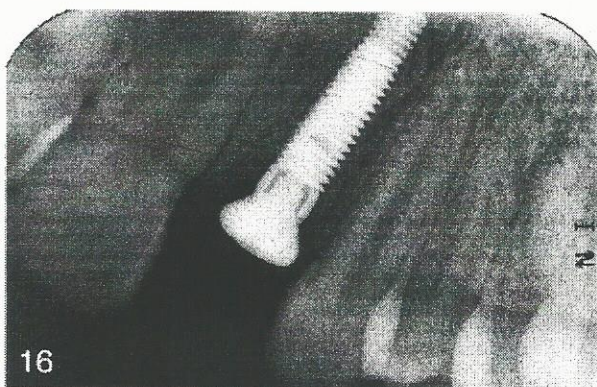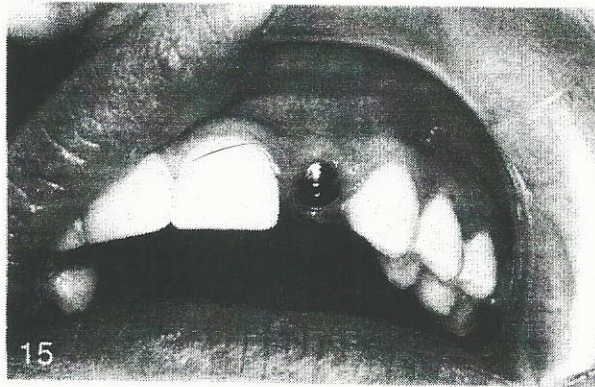
FIGURES 15–19. FIGURE 15. Healing collar 6 weeks after uncovery surgery. FIGURE 16. Periapical radiographs: healing collar attached to endosseous implant. FIGURE 17. Gold custom abutment attached to endosseous implant. FIGURE 18. Lateral view: porcelain-fused-to-gold crown. FIGURE 19. Frontal view: porcelain-fused-to-gold crown.

ended curette, and the buccal plate was inspected for perforations. A demineralized freeze-dried bone allograph (Ceramed, Lakewood, Colo) was placed into the socket with a disposable syringe and compacted with a long shank plugger. A bioabsorbable collagen membrane (BioMend, Zimmer Dental Inc, Carlsbad, Calif) was placed apical to the soft tissue margins of the socket, cervical to the bone graft material, and sutured (4.0 Vicryl, Ethicon, Sommerfield, NJ) (Figures 11 and 12). The transitional removable partial denture was adjusted, and the patient was scheduled for suture removal in 3 weeks.

The implant surgery was performed 6 months after socket grafting and consisted of the placement of a

3.7 × 16 mm hydroxyapitate (HA)–coated tapered screw-vent implant (Zimmer Dental Inc) (Figure 13). The surgical uncovering procedure and healing collar placement was completed 6 months after implant placement (Figures 14 and 15). The implant was well integrated, and the preprosthetic bone levels were well within normal levels (Figure 16).

The prosthetic stage of treatment was initiated 6 weeks after the uncovering of the fixture at second-stage surgery. A fixture level impression was taken with a polyvinyl siloxane material (Imprint 2, 3M, Minneapolis, Minn) and a custom Gold UCLA abutment fabricated. The abutment was placed with hand pressure, and a periapical radiograph was taken to confirm complete seating and was tightened with a calibrated torque wrench delivering 30 Nt/Cm of torque (Figure 17). The porcelain-fused-to-gold restoration was cemented with temporary cement (Tempbond NE) (Figures 18 and 19).

Case 2

A 41-year-old man presented to the office with a displaced porcelain-fused-to-metal crown no. 9, the maxillary left central incisor. The clinical examination demonstrated minimal tooth structure, resulting in a poor long-term prognosis (Figure 20). The medical history demonstrated well-controlled hypertension and hypercholesterolemia. The treatment plan consisted of extraction with bone grafting, implant placement, and an implant-supported, cement-retained, porcelain-fused-to-gold restoration. The patient was informed that the treatment would be performed over a 10-month period in a staged approach.

The patient was administered a local anesthetic consisting of 2 carpules (36mg) 2% lidocaine with epinephrine 1:100 000 via an infiltration approach. The maxillary left central incisor was atraumatically removed with peritomes and a 150 universal forcep (Figure 21). The extraction socket was debrided of all granulation tissue, and the buccal plate of bone was evaluated by tactile sense using a periodontal probe via an intrasocket approach. After confirmation of an intact buccal plate of bone, a mineralized freeze-dried bone allogragh (Puros, Zimmer Dental Inc) was placed into the socket and condensed with a bone plugger and periosteal elevator. The allograph was covered with a collagen wound dressing (Collatape, Zimmer Dental Inc) and sutured in place with 4.0 vicryl sutures (Figure 22). A transitional removable partial denture was placed, adjusted, and polished. The patient was seen 3 weeks postextraction for suture removal.

The surgical placement of a 3.7 × 13 mm HA-coated tapered screw-vent implant (Zimmer Dental Inc) was accomplished with drills and osteotomes (Figure 23). Second-stage uncovering surgery was performed 6 months after fixture placement and demonstrated excellent integration and bone levels. The restorative stage of treatment consisted of a gold custom abutment with a cement-retained, implant-supported, porcelain fused to gold crown (Figures 24 through 27).

Case 3

A 51-year-old man was referred to the office for evaluation of recurrent dental caries associated with tooth No. 11, the maxillary left canine. The maxillary canine is a distal retainer for a 4-unit fixed partial denture (Figure 28). Upon removal of the 4-unit fixed bridge consisting of abutment of the maxillary left central incisor (No. 9), the maxillary lateral incisor (No. 10), and the maxillary left canine (No. 11), the maxillary canine revealed extensive caries (Figure 29). The prognosis of the tooth was poor, and the treatment recommended was extraction. The treatment plan presented to and agreed on by the patient was as follows:

1. No. 11, maxillary canine extraction with socket grafting;
2. No. 11, endosseous implant with a cement-retained porcelain-fused-to-metal crown; and
3. Nos. 9 and 10, 3-unit conventional fixed partial denture.

The patient's medical history indicated well-controlled hypertension, and he exhibited a blood pressure of 130/80 mm Hg. The patient was taking the medication Diovan.

The patient was administered local anesthesia consisting of 2 carpules (36 mg) 2% lidocaine with 1:100 000 epinephrine in the buccal and palatal mucosa. Tooth No. 11 was removed in an atraumatic manner with a double-ended curette, 301 elevator, and a 150 universal forcep (Figure 30). The surgical site was debrided of granulation tissue and the palatal bone decorticated with a No. 2 round bur to initiate bleeding points. A mineralized freeze-dried bone allograph (Puros Cancellous Particulate, Zimmer Dental Inc) was placed in the socket via a syringe and compacted with a large amalgam plugger. The graft was covered with a collagen dressing (Collatape) and closed with 4.0 vicryl sutures (Figure 31). The patient's existing 4-unit fixed bridge was used for the transitional prosthesis by creating an ovate pontic with cold-cure acrylic and cemented with temporary cement (Tempbond NE) (Figures 32 and 33).
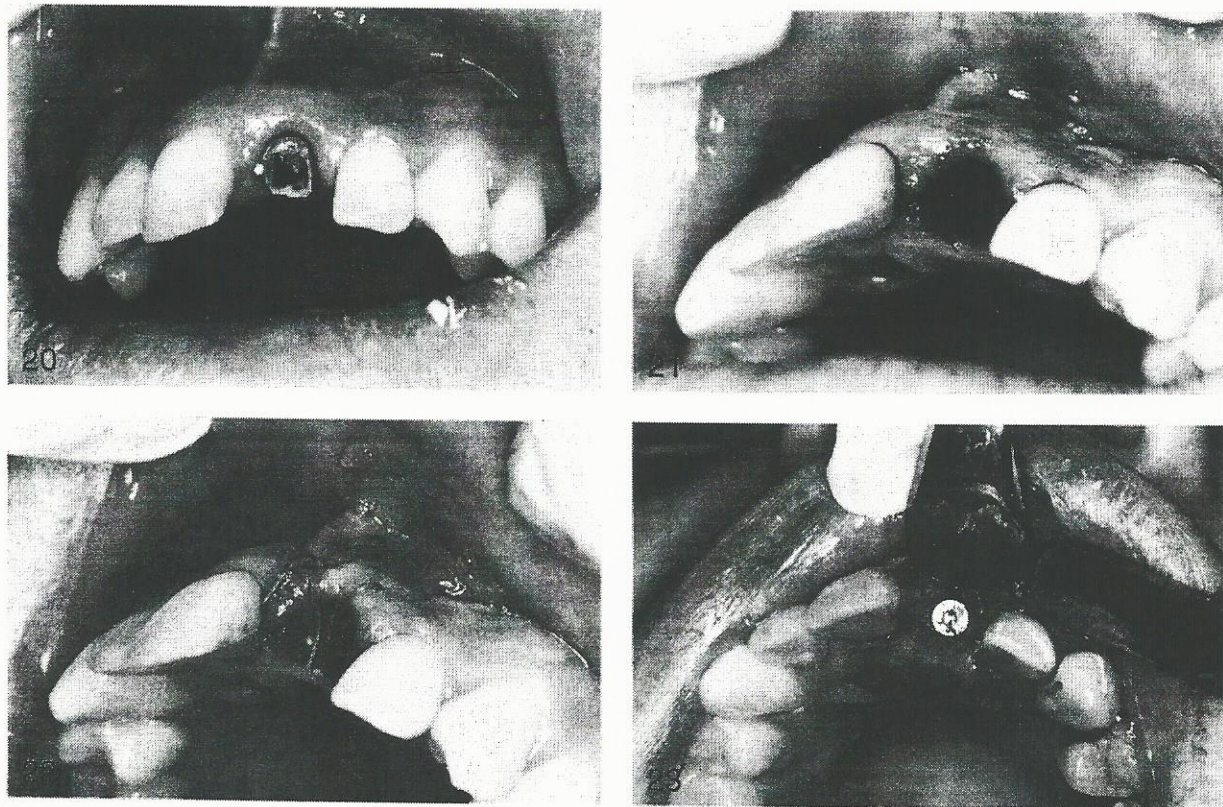
FIGURES 20–23. FIGURE 20. Preoperative view of the maxillary left central incisor (tooth No. 9). FIGURE 21. Postextraction: tooth No. 9 maxillary left central incisor. FIGURE 22. Collagen wound dressing sutured with 4.0 vicryl sutures. FIGURE 23. Endosseous implant 3.7 × 13 mm hydroxyapitate-coated tapered screw vent.

The surgical placement of an endosseous implant in tooth position No. 11, the maxillary left canine, was performed 3 months postgrafting. A 4.7 × 13 mm HA-coated tapered screw-vent implant (Zimmer Dental Inc) was placed with the use of an incremental drill and osteotome sequence (Figure 34). The second-stage surgery was performed 6 months after fixture placement and the prosthetic stage initiated 6 weeks thereafter (Figure 35). A fixture level impression was taken followed by the cementation of a temporary acrylic crown over a prepped impression post (Figures 36 and 37). The final restoration was placed after 3 weeks and consisted of a standard titanium abutment and a cement-retained porcelain-fused-to-metal crown (Figures 38 and 39).

DISCUSSION

Ideal esthetic outcomes in the field of implant dentistry have become the expected norm demanded by our patients. This can be achieved only when sufficient bone volume is present at the time of implant placement. Studies have indicated that a 25% bone loss occurs in the first year postextraction and up to 60% of bone loss occurs over a 3-year period.[25] The bone loss occurs mainly at the expense of the fragile buccal plate. A similar result is seen with the posterior aspect of the maxilla or mandible, but it has less impact on implant placement because of its large initial width prior to tooth extraction. Most important, the long-term prognosis is dependent on the ability of the practitioner to place large-diameter implants, thereby reducing the stress to the crestal bone through enhanced biomechanics.

Research has supported the use of bone-grafting materials for site preservation in sockets.[26,27] The incorporation of autographs, allographs, xenographs, and alloplasts are alternative bone-grafting materials with various advantages and disadvantages. Autografts are when a tissue is transferred from one position to another in the same individual. This is
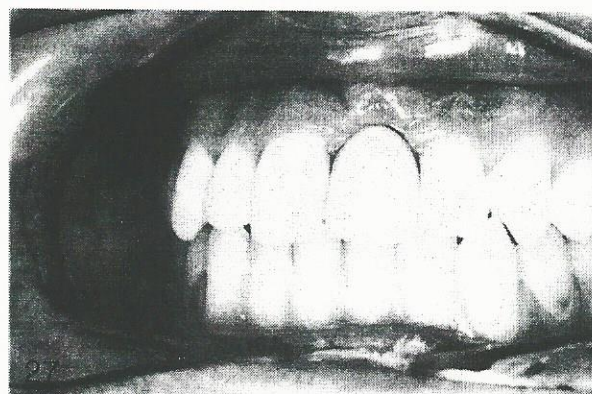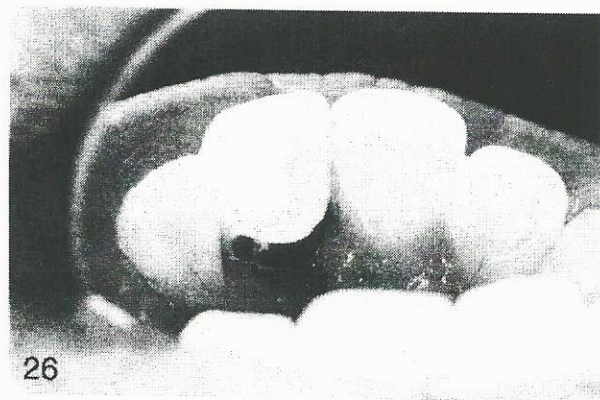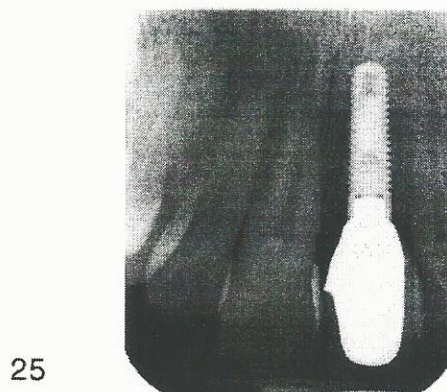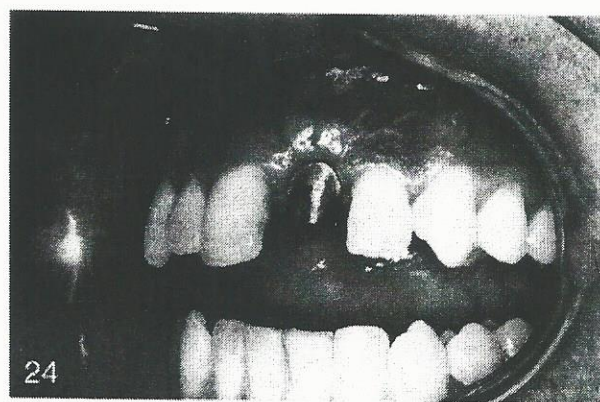
Figures 24–27. Figure 24. Custom gold abutment. Figure 25. Periapical radiograph abutment attached to endosseous implant. Figure 26. Palatal view: porcelain-fused-to-gold crown. Figure 27. Frontal view: porcelain-fused-to-gold crown in centric occlusion.

considered the gold standard of all grafting materials and includes grafts harvested from the iliac crest, parasymphysal area, ramus, and maxillary tuberosity. Allographs are when a tissue is transferred from one individual to another genetically dissimilar individual of the same species. This type of graft material has become popular because of the lack of a secondary surgical site and decreased morbidity. The most important advantage of an allograph bone-grafting material is its ability to initiate or facilitate bone development via an osteoinductive process. The biggest disadvantage is the possible transmission of disease (ie, HIV, mad cow disease, or hepatitis B). It is critical that the clinician select a bone graft material from an accredited Food and Drug Administration–certified bone bank to ensure patient safety.[28–30] Examples of this type of graft can be categorized as demineralized freeze-dried bone or mineralized freeze-dried bone.[31–33] Xenografts are when tissue is transferred from one species to a different species. The most common type of xenograph is composed of

bovine bone.[34] Finally, alloplasts are a synthetic graft or inert foreign body implanted into tissue. Hydroxyapitate and bioactive glass polymers are common examples of synthetic bone graft materials.

The clinical decision made by the dentist with regard to the type of graft material used will affect the way bone growth will ensue. The major concepts associated with bone growth are osteogenesis, osteoinduction, and osteoconduction.[35] Osteogenesis is the growth of bone from viable cells transferred within the graft. The autografts are the only type of graft that exhibits all 3 bone development processes. This is the major reason why they are considered the gold standard for bone grafting. Osteoinduction is bone formation from osteoprogenitor cells derived from primitive mesenchymal cells under the influence of 1 or more inducing agents that emanate from the bone matrix. When placed subcutaneously in the absence of bone, these materials have been shown to induce bone formation. The autographs and allographs have inductive properties for bone growth
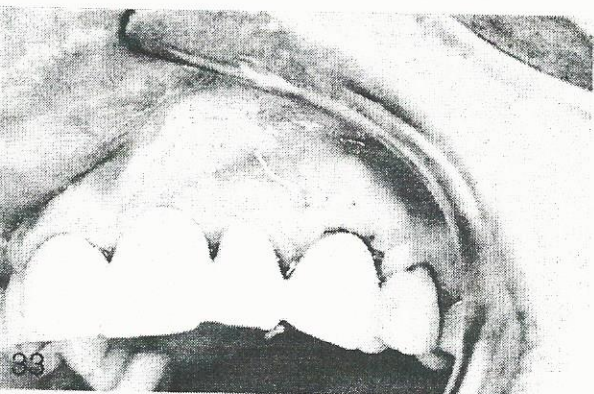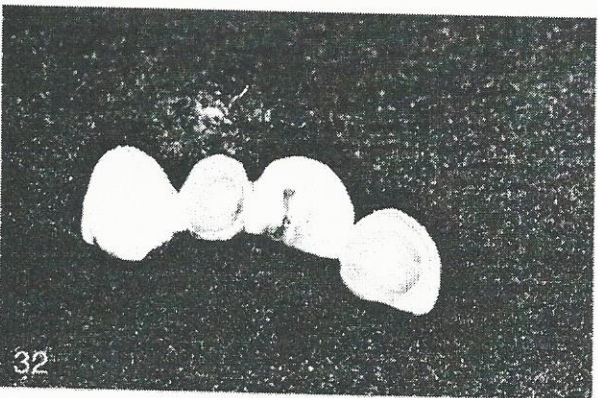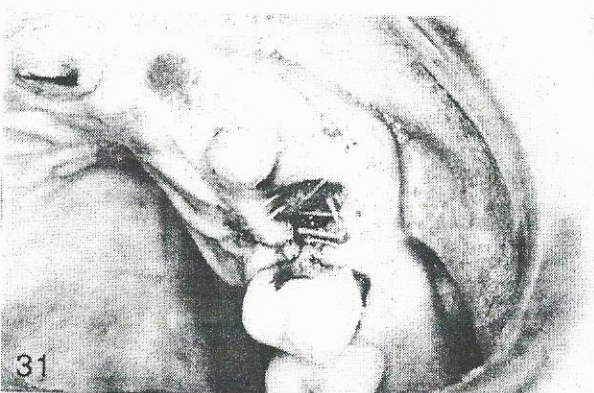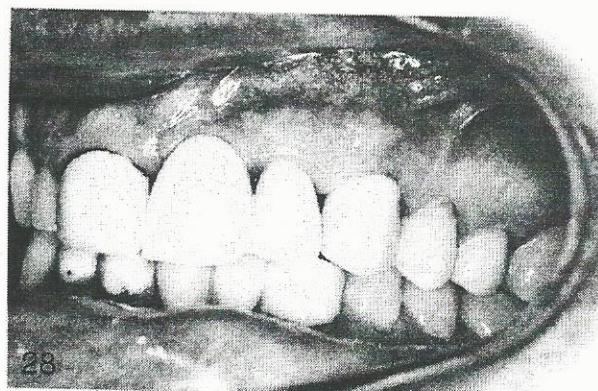
FIGURES 28–33. FIGURE 28. Preoperative view: fixed bridge from tooth No. 9, maxillary right central incisor, to No. 11, the maxillary left canine in centric occlusion. FIGURE 29. Incisal view: lingual caries tooth No. 11, the maxillary left canine. FIGURE 30. Tooth socket postextraction of maxillary left canine (tooth No. 11). FIGURE 31. Grafted socket collagen dressing and 4.0 vicryl sutures. FIGURE 32. Transitional prosthesis with ovate pontic design. FIGURE 33. Four-unit fixed transitional prosthesis.

processes via bone morphiogenic protein (BMP). Osteoconduction is the process whereby bone growth occurs by opposition from the surrounding bone. Therefore, this process will occur only in the presence of bone. This process is evident with autografts, allographs, xenografts, and alloplastic materials.

This article illustrated the use of mineralized and demineralized freeze-dried bone allographs for site preservation in extraction sockets.[36–39] Allograph materials are osteoinductive, readily available, and do not require a donor site. Demineralized freeze-dried bone allograph requires an additional step in
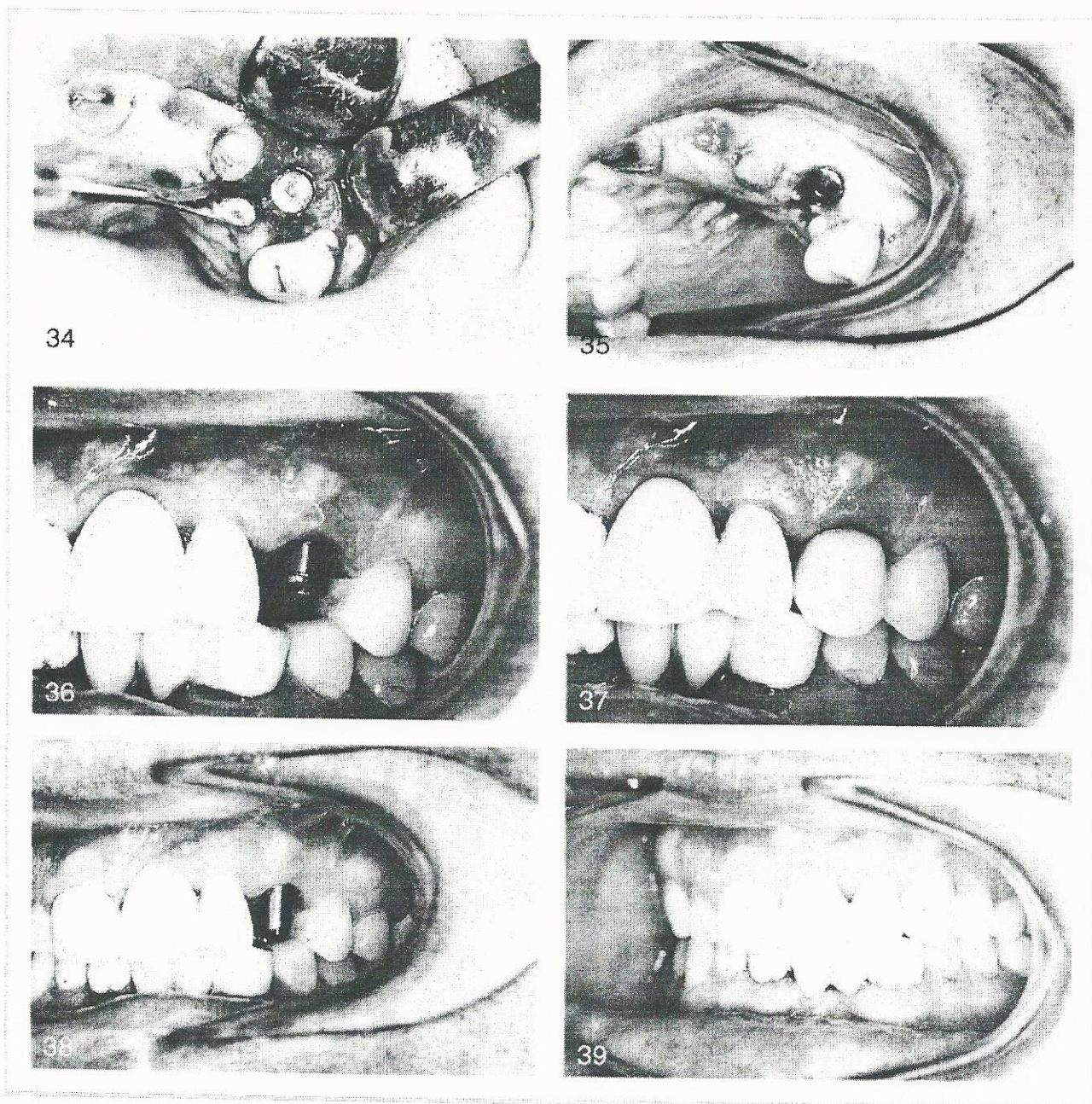
FIGURES 34–39. FIGURE 34. Endosseous implant 4.7 × 13 mm hydroxyapitate-coated tapered screw vent. FIGURE 35. Healing collar: second-stage surgery. FIGURE 36. 4.7-mm transfer pin-prepared temporary abutment. FIGURE 37. Temporary crown, maxillary left canine. FIGURE 38. Titanium abutment, maxillary left canine. FIGURE 39. Centric occlusion, final porcelain-fused-to-metal crown, maxillary left canine.

processing, resulting in the exposure of BMP at the time of placement. This early presence may increase osteoblastic activity, thereby stimulating faster bone formation. On the other hand, osteoclastic activity is required to release BMP into the environment in mineralized freeze-dried bone allograph, retarding bone development. The cases presented in this article exhibited no clinical significance in the quality of the bone grafted with demineralized freeze-dried bone allograph or mineralized freeze-dried bone allograph at implant placement.

Scientific studies have discussed the socket-grafting technique with bone prior to the placement of endosseous implants. The technique emphasizes the

importance of an atraumatic removal of the hopeless tooth and complete debridement of the residual bony crypt. The use of peritomes for removal has emerged as the instrument of choice for the extraction stage. Emphasis should be made not to elevate the periosteum because the cortical bone receives 80% of its blood supply through the periosteum. This article used a mineralized and demineralized freeze-dried bone allograph as the filler of the socket with success. A collagen bioabsorbable tissue dressing was used to cover the bone graft and was stabilized with vicryl sutures. Implant placement was placed between 3 and 6 months without a noticeable clinical significance with regard to implant fixation.

The use of synthetic bone grafting into fresh extraction sockets increases the long-term prognosis of implant therapy. The enhanced width of the ridge for implant placement allows for the insertion of standard- or wide-diameter implants. This allows for improved implant biomechanics when stress is applied to the crestal bone. Narrow-diameter implants have demonstrated higher failure rates because of increased stress to the crestal bone or fractures of the implant body or component parts. Also, there is a reduced need to perform an osteoplasty to establish an adequate bone platform sufficient for standard-diameter implants, thereby maintaining an appropriate crown-to-implant ratio. Finally, socket grafting can prevent the need for subsequent autogenous block grafting to create an ideal ridge for implant placement. Therefore, the clinician is able to reduce or prevent the patient's need for additional surgeries, costs, or morbidity.

A relative contraindication to bone grafting an extraction socket is the presence of an acute infection. A tooth demonstrating swelling, purulence, or a fistula should be extracted without simultaneous placement of any type of bone graft material. The bone-grafting procedure should be performed 6 to 8 weeks postextraction to alleviate the chance of an acute infection. Also, this approach ensures primary closure of the grafted site with keratinized tissue, elevated osteoblast activity, and a newly formed secondary bony spongiosa associated with the healing socket. In addition, it allows the surgeon the ability to evaluate the number of bony walls at the time of extraction to better prepare for the subsequent grafting procedure. The disadvantage of this surgical approach is the need for an additional surgery and a delay in total treatment time by 2 months.

The 3 cases presented in this article demonstrated successful implant restoration in a staged approach. The patients were staged in a manner that was consistent with the methods of many authors: dividing the implant process into extraction and bone grafting and implant placement and restoration over a varied time interval of months. The endosseous implants used were of a threaded, tapered design coated with an HA surface.[40–42] The implants demonstrated excellent fixation at the time of placement and were well integrated at second-stage uncovery surgery. The final restorations were placed 2 months after uncovery surgery and demonstrated excellent hard and soft tissue maturity.

CONCLUSION

As patients continue to demand esthetic implant dentistry, dentists must become more disciplined with regard to long-term treatment planning. The use of bone grafting in extraction sockets provides the foundation for implant placement and subsequent ideal esthetic restorations. The amount of bone graft materials available on the market to the clinician are numerous; however, the dentist must understand that they demonstrate different effects on bone development process. It is the responsibility of the dentist to decide on the best bone graft material available to be used for a given clinical situation. The science of bone-grafting techniques and materials continues to evolve, and so the future of implant dentistry remains promising.

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