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Extraction Site Bone Grafting in General Dentistry Review of Applications and Principles

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General dentists in the United States perform an estimated 23 million extractions every year.¹ Following an extraction, the alveolar bone decreases 25% in width during the first year and an average 4 mm in height during the first year following multiple extractions.^{2,3} Tatum and Misch⁴ have observed a 40% to 60% decrease in alveolar bone width after the first 2 to 3 years post extraction, and Christensen⁵ reports an annual resorption rate of at least 0.5% to 1% during the patient's life. Preserving bone contour for dental implants, pontic design, denture stability, and soft-tissue aesthetics, and maintaining the periodontal status of adjacent teeth are important considerations following an extraction. To reduce or eliminate potential problems, the general dentist should consider the use of extraction site grafting.



Figure 1. Ridge preservation can improve the cosmetic and functional aspects of dental care.



Figure 2. Pontic design, implant placement, and periodontal health of adjacent teeth can all benefit from ridge preservation.

Bone loss following an extraction can have negative cosmetic, hygienic, prosthetic, and structural consequences. Bone grafting into an extraction site can reduce these negative sequelae^{6,7} (Figures 1 and 2). Therefore, ridge preservation techniques are often indicated after tooth extraction.



Figure 3. After socket grafting, a dental implant can be placed into an ideal position for aesthetics and function.

If performed successfully, extraction socket grafting permits a dental implant to be placed in a position that is more ideal for aesthetics and function (Figure 3). A grafted ridge may also improve denture stabilization, support, and retention, thereby improving the patient care experience. Patients should be told of the persistent bone loss that occurs after extractions, and they should especially be aware of the pronounced changes that occur early in healing.

Bone physiology, the cellular events following grafting, the clinical indications and rationale of extraction site bone grafting, technical requirements for extraction site grafting, knowledge of the available materials, and the treatment sequence when grafting an extraction site area are all important considerations. This article offers an overview of these related concepts for extraction site grafting.

The Keys to Grafting Bone in Extraction Sites

According to Misch⁸, some of the keys to ensure successfully grafting bone into extraction sites include the following: (1) atraumatic tooth removal; (2) asepsis and complete removal of granulosomatous tissue; (3) an evaluation of the remaining walls of bone following the extraction and evaluation of the size of the defect; (4) ensuring adequate blood supply to the graft site; (5) graft containment and soft-tissue closure; (6) choice of the appropriate graft material; and (7) ensuring adequate time for healing.

Atraumatic Tooth Removal

Atraumatic extraction of teeth can be achieved with the use of periostomes, sectioning a tooth when needed, orthodontic therapy to achieve ease of extraction, and minimum forcep rotation. When all of the walls of bone surrounding a tooth are left intact, the grafting material is better contained and immobilized, and osteoprogenitor cells are more readily recruited (Figure 4). When walls of bone are missing (ie, the facial plate as a consequence of periodontal disease or the extraction procedure), the graft procedure is more complicated.

Asepsis and Removal of Granulosomatous Tissue

Before an extraction site can receive a graft, any granulosomatous tissue present must be removed. This can be accomplished with a Molt curette or other similar surgical instrument. In order for the osteoprogenitor cells to reach the graft site and allow for bone formation and remodeling, infection must also be controlled. Ideally, bone remodels through cell-mediated resorption. If infection is present in an extraction site, the graft will undergo solution-mediated resorption due to the lower (acidic) pH, and bone will not form.⁹ Socket grafting does not normally require a completely aseptic field. However, the use of sterile instruments is essential, and postoperative antibiotics in conjunction with sound surgical protocols are suggested. If exudate is present, an antibiotic is suggested prior to the extraction to reduce adverse effects on the procedure.

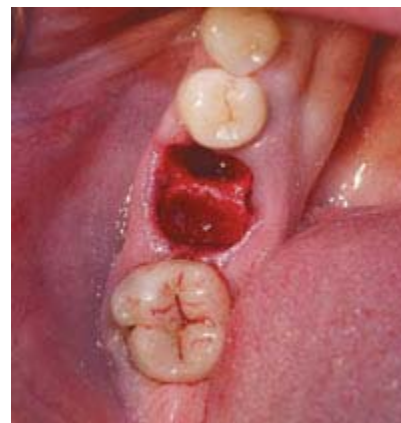


Figure 4. When all of the walls of bone about a tooth are intact, the grafting material is well-contained.

An Evaluation of the Remaining Walls of Bone at an Extraction Site and Evaluation of the Size of the Defect



Figure 5. Assessing the remaining walls of bone with a dental explorer.

Once a tooth is removed, the first step is to evaluate the remaining walls of bone that form the socket. Determination of the remaining walls of bone can be accomplished by creation of a mucoperiosteal flap or simply examining the site with a dental explorer (Figure 5). An extraction technique that is the least traumatic to the walls of bone around a tooth is helpful, since the greater the number of walls of bone remaining after an extraction, the more predictable will be the ridge preservation procedure. The choice of grafting material, the need for a membrane (see below), provisionalization of the graft area, and time required for healing time are all affected. Factors that determine the remaining walls of bone are the severity of the dental infection, anatomic

variability, and the extraction technique. Evaluation of the remaining walls of bone is the starting point to successful grafting of an extraction site.

Once the tooth is removed, the walls of remaining bone can be used to classify the area as a 2-, 3-, 4-, or 5-wall defect. For example, a 5-wall defect contains all possible walls of bone, offering the greatest predictability. When a large facial wall of bone is missing, a barrier membrane should be used to contain the graft material. Use of a barrier can prevent ingrowth of fibrous tissue (Figure 6). Membranes can be either resorbable or nonresorbable. Resorbable membranes have many advantages for grafting of an extraction site, and many practitioners prefer them due to their easier handling characteristics. In addition, if the wound opens up during the postoperative phase, a nonresorbable membrane will become infected and reduce the amount of bone regeneration.



Figure 6. When the facial wall of bone is missing, a barrier membrane should be used to contain the graft material.

Ensuring Adequate Blood Supply to the Graft Site

A bone graft requires a blood supply to provide osteoprogenitor cells and associated growth factors. Without an adequate blood supply, the graft will not be successful.¹⁰ While the blood supply from the soft tissue does supply blood to the graft site, osteoprogenitor cells will be supplied only from adjacent bone or in a limited fashion from the periosteum. To ensure the presence of these critical cells, the bone adjacent to a graft site must be stimulated in a nonpathological fashion. This has been called a regional acceleratory phenomenon¹¹ (RAP) by Frost.¹¹ A tooth extraction also provides a RAP, and the periodontal membrane complex provides an excellent blood supply to the extraction site.

If the walls of bone are bleeding after the extraction, the vascular supply to the graft is assured. If little or no bleeding exists, decortication of the bone beyond the apex with a round bur using sterile saline for cooling is suggested. This decortication also allows for an improved physical integration of the graft material.

Graft Containment and Soft- Tissue Closure

When the extraction site is an optimal 5-wall defect, the surrounding walls of bone will contain and immobilize the graft. Grafting bone into a 5-wall defect usually requires only coverage of the graft site with a rapidly resorbing collagen membrane stabilized with sutures.^{4,12}



Figure 7. The clinician should achieve primary closure of defects if 4 or fewer walls of bone are present. This helps the graft material remain in place.

If the extraction site has 4 walls or less, the clinician should consider the use of a barrier membrane to contain the graft material and limit ingrowth of fibrous tissue. The clinician should also create primary soft-tissue closure of defects of 4 or less walls both to minimize bacterial contamination of the membrane in larger defects and contain the graft (Figure 7). Each extraction site grafting situation is unique and must be assessed in consideration of the treatment plan.

Choice of the Appropriate Graft Material

The choice of graft material is based on many factors. The most important determining factor is the number of remaining walls of

bone. As a general rule, the more missing walls of bone, the more autogenous bone should be part of extraction site grafting. Another factor that determines selection of a graft material is the prosthetic treatment plan. Each graft material offers different characteristics and advantages.

The terms osteogenic, osteoconductive, and osteoinductive are useful to explain the different types of grafts.⁸ Osteogenesis is the growth of bone from cells transferred within a graft. An osteogenic material will promote growth of bone in ectopic tissue. Autogenous bone is the only source of osteogenic bone. Osteoconduction is bone growth from surrounding bone. Osteoconductive materials act as a biocompatible scaffold. Osteoconductive materials are biocompatible but will not grow bone without the presence of cells that will form bone. Osteoinductive grafting materials induce bone growth from osteoprogenitor cells created by the influence of inducing agents from the host bone matrix.¹⁰

There are 4 types of grafting materials available for use in the oral cavity: autogenous bone, (demineralized) allograft bone, xenograft bone, and alloplastic materials.

Autogenous bone grafts are provided by the patient receiving the bone graft. This is the gold standard for bone grafting, since it contains both osteoprogenitor cells and scaffolding. Autogenous bone can be obtained from an intraoral or extraoral source. Common intraoral sites for socket grafting include the healing extraction site (usually the posterior region), the mandibular symphysis, mandibular ramus, and maxillary tuberosity. The advantages of autogenous bone include (1) being the only osteogenic material available, (2) a source of bone proteins, (3) no cost for the graft material, (4) an inductive bone material, and (5) predictability. Disadvantages include (1) the need for a second surgical site, (2) possibly postoperative discomfort or complications, and (3) potential limitations on the amount of graft material that can be harvested. As a general rule, however, the more walls of the socket that are missing, the greater consideration that should be given to the use of an autogenous graft.



Figure 8. The cortical fiber form of an allograft (eg, Grafton by Biohorizons) offers advantages, including improved retention and osteoinduction.

Allograft bone is from the same species but a different genotype (individual). This is donor bone obtained by FDA-regulated tissue banks and is both tested for infection (donor) and processed. Allograft bone has been used extensively in dentistry for more than 2 decades. Allograft bone comes in different particle sizes as well as cortical fibers. The putty forms include a carrier such as glycerine or cellulose. The handling characteristics differ for the different preparations, and the choice is dependent on the clinical situation and the clinician. Cortical bone (versus medullary bone) as the source of the allograft material offers advantages for extraction site grafting (Figure 8). These advantages include ease of handling, increased containment in the graft site, and an increase in the osteoinductive effect.^{10,12} There are 2 types of allograft material: mineralized and demineralized. When allograft bone is demineralized, it is processed with an acid solution. This process dissolves the mineral component (hydroxyapatite) and exposes collagen and organic constituents, believed to include bone morphogenic proteins (BMPs). Although allograft bone may contain these growth factors, it is not considered osteogenic.¹³ Preparation techniques vary among manufacturers, resulting in proprietary differences in handling characteristics and relative amounts of growth factors.

Xenograft bone is from a different species and contains the inorganic portion of bone (hydroxyapatite). An example is graft materials derived from a bovine source. It is available in various particulate sizes. The literature has substantiated the role for xenogeneic grafts as extraction site graft material, but the time required for these grafts to resorb has been brought into question.^{14,15} These grafts are osteoconductive, without having any osteoinductive properties. These grafts create a biocompatible scaffold. The osteoprogenitor cells are provided by the recipient. Xenografts can be added to allografts to improve the mineralization potential.

Alloplastic materials are synthetic products and include ceramic and acrylic materials. They can be resorbable or nonresorbable. Nonresorbable material should only be used when an implant will not be placed in the location of the graft.¹⁶ The nonresorbable material cannot attach to the implant surface.

Ensuring Adequate Time for Healing

To allow a graft to mature into lamellar bone, adequate time for healing is needed. The time required is dependent on factors such as the patient's age, the patient's healing capacity, residual infection in the graft site, and size of the defect. In general, the time for a graft to heal varies between 4 and 6 months when autogenous bone is part of the graft.¹⁷

Summary

The clinician can successfully graft dental extraction sites to improve the aesthetics and function of the final restoration. When an extraction site receives a graft, ridge preservation is enhanced, pontic form can improve, dental implants can be placed in the correct position, and the prosthetic outcome will be enhanced.

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Continuing Education Test No. 53.3

After reading this article, the individual will learn:

- â€¢ The clinical rationale for extraction site bone grafting.
- â€¢ The basic clinical procedure of extraction site bone grafting.

1. As described in this article, which is NOT essential for extraction site bone grafting?

- a. asepsis and removal of granulosomatous tissue
- b. obtaining graft containment and soft-tissue closure
- c. ensuring adequate patient selection for proper graft healing
- d. an evaluation of the remaining walls of bone and defect size

2. For extraction site bone grafting, which is not a benefit of a 5-wall extraction site?

- a. better graft material containment
- b. a broader ridge
- c. reduced mobility of the graft
- d. osteoprogenitor cells are more easily recruited

3. Which defect offers the most predictable results for grafting?

- a. a 1-wall defect
- b. a 2-wall defect
- c. a 4-wall defect
- d. a 5-wall defect

4. Which is the most important factor in choosing a graft material?

- a. the handling characteristics of the material
- b. determining the remaining walls of bone
- c. the osteogenic potential of the material
- d. the prosthetic treatment plan at the graft site

5. Which graft material is osteogenic?

- a. alloplast graft
- b. allograft graft
- c. xenograph graft
- d. autogenous graft

6. Which graft material is harvested from the same patient?

- a. alloplastic graft
- b. allogeneic graft
- c. xenogeneic graft
- d. autogenous graft

7. Which is not a determining factor in the healing time for a graft?

- a. age of the patient
- b. size of the graft site
- c. healing capacity of the patient
- d. the degree of mobility of a tooth prior to extraction

8. Grafting of an extraction site offers which advantages?

- a. stabilization of adjacent teeth
- b. the ability to place a dental implant in ideal position for aesthetics and function
- c. preservation of bone to improve pontic design
- d. all of the above