https://youtu.be/-avjCID6f30 (Kerr Bioplant Technique)



**In this monthly feature, Dr. Gordon Christensen addresses the most frequently asked questions from Dental Economics® readers. If you would like to submit a question to Dr. Christensen, please send an e-mail to info@pccdental.com.**

For more on this topic, go to www.dentaleconomics.com and search using the following key words: implants, ridge preservation, bone-grafting, prosthesis, fees, gingiva, tooth socket, lingual bone, extraction, Dr. Gordon Christensen.

***Q I have seen a recent revival of the technique called "ridge preservation," used to stimulate bone growth in a tooth socket months before placing an implant and to preserve the bony ridge after tooth removal, thus allowing an esthetic pontic to be placed in areas of esthetic concern. Is this technique reliable and predictable? Should different materials be used to accomplish the two purposes, and how difficult is the procedure?***

**A You are asking about one of my favorite clinical techniques. As a prosthodontist, I am frequently faced with frustrating clinical situations in which a previous dentist has removed a tooth, often breaking off the thin facial plate of bone, allowing the site to heal and creating an unsightly gingival and bony defect. Placement of a pontic in these situations almost always creates an unacceptable clinical result, with a long, obviously false pontic extending deeply into the gingival area. If implant placement is planned for such areas, there is usually insufficient bone quantity, and complex and expensive grafting is necessary. Ridge preservation is a proven and successful technique and should be used in many situations when a tooth is extracted, especially when the extraction site is in the esthetic zone.**

I have promoted and taught ridge preservation in continuing-education courses for over 20 years. When speaking with dentists who were in those courses, I found that only some of them have adopted the technique into their practices, and many have not done so. Why? In my opinion, some of the early ridge-preservation techniques were much more difficult and expensive than those I will describe. They called for a membrane over the grafted socket, which often required a separate procedure to subsequently remove the insoluble membrane. Also, one of the ridge-preservation techniques required significant facial and lingual flap procedures for socket preservation, which caused more discomfort, complicated the procedure, and prolonged the healing. The high cost of some of the complicated procedures has been an additional negative factor.

I contend that ridge preservation can be simple, fast, and relatively complication-free; that the procedure can preserve most of the remaining bone if facial and lingual bone has not been removed during the extraction, and if the patient is

careful to avoid traumatizing the grafted site for several days after the procedure.

In the following narrative, I will discuss my views on two simple, effective, and predictable ridge-preservation techniques, one for preservation of a ridge before placement of a fixed prosthesis without the expectation of an implant, and the other for ridge preservation when an implant is planned.

## Ridge preservation when an implant is not planned

Is the ridge preservation procedure different if an implant is not planned for a later time? The answer is both yes and no. A technique long used in the profession, but not well known to most dentists, will be described below. Although the following technique can be used when implants are planned, I prefer to use it when I am not planning an implant, because the bone must heal longer for implant placement when using this material. The following technique preserves almost all of the ridge height, and allows a pontic to be placed on a fixed prosthesis with an optimum esthetic result.

*Fig. 1 — Tooth socket with preserved facial and lingual bone.* Click here to enlarge image

Frequently, after discussing various options for tooth replacement, you and a patient agree that a fixed prosthesis should be used to replace the missing tooth instead of an implant and a crown. This conventional technique is often the most desirable and economical decision when the teeth adjacent to the edentulous space are broken down or heavily restored, and in need of crowns. In these cases, most dentists and patients want to obtain soft-tissue healing rapidly and place the fixed prosthesis as soon as possible. Such a case is shown in Figure 1.

Although most grafting or bone stimulating materials can preserve the majority of the bone around the extracted tooth socket relatively well, there is still some unpredictable bone and soft-tissue shrinkage with most of them. When anticipating unpredictable bone and soft-tissue shrinkage, most dentists are uncomfortable to place a fixed prosthesis until many weeks or even months after the grafting. The technique to be described minimizes that risk, because the grafting material does not resorb. It remains in place, maintaining the ridge contour.

Many bone grafting materials could be used to preserve the majority of the bone height after a tooth extraction. However, some of them require a membrane to reduce or eliminate soft-tissue growth into the socket. Others are relatively difficult to use, and most of them are quite expensive. Using a predictable shrinkage technique for ridge preservation is desirable when you are not planning on placing an implant.

*Fig. 2 — Pulling blood from socket using Bioplant.*
Click here to enlarge image

A simple, relatively inexpensive ridge-preservation technique not requiring a membrane, with long-term successful research and clinical observation, uses Bioplant® from Kerr. It has been used for over 25 years with success. This material is comprised of small, porous, radiopaque spheres (three sizes) made of polymethyl methacrylate, coated with polyhydroxyl ethyl methacrylate and calcium hydroxide. This material does not dissolve, resorb, or migrate. It remains in place, visible on a radiograph. Bone grows into the porous spheres. The clinical result is that nearly all of the original bone height is preserved, with only minimal bone and soft tissue shrinkage.

*Fig. 3 — GELFOAM cut slightly larger than the socket.*
Click here to enlarge image

When using this technique, I suggest making the fixed prosthesis as soon as six or eight weeks after the tooth is extracted and the socket grafting accomplished. An example of the use of this material is shown in Figures 2 to 5. After the extraction and placement of the ridge preservation material into the socket, a piece of GELFOAM® from Pfizer is cut slightly larger in diameter than the soft-tissue defect to be placed over the small spheres, thus reducing the chance of their coming out before the bone grows into them. A suture or two can be placed, connecting the facial and lingual attached gingival tissues to reduce the size of the hole in the attached gingiva where the tooth was extracted, thus reducing the chance of the graft coming out before a clot has formed and the site has stabilized. Attached gingiva grows into the defect where the tooth was extracted in a few weeks.

*Fig. 4 — Vicryl sutures over the socket.*
Click here to enlarge image

Remember, this technique is one of my choices if I am not planning an implant. If, for some future reason, an implant is placed in a Bioplant site at a later date — after the site has healed completely — the bone preparation is similar to any other grafted site material and the technique is successful. In such cases, I suggest waiting about one year before placing an implant in this material, but others may suggest less wait time.

## Ridge preservation when an implant is planned

Many types of grafting or bone-stimulating materials may be used when anticipating placing an implant as soon as the graft is integrated into the bone. These materials can also fill spaces in the bone present during an immediate implant placement when the implant does not fill the entire tooth socket. My answer to you will include only one simple technique that does not require a flap or a membrane. Many more complicated procedures are available.

*Fig. 5 — The fixed prosthesis one year later.*
Click here to enlarge image

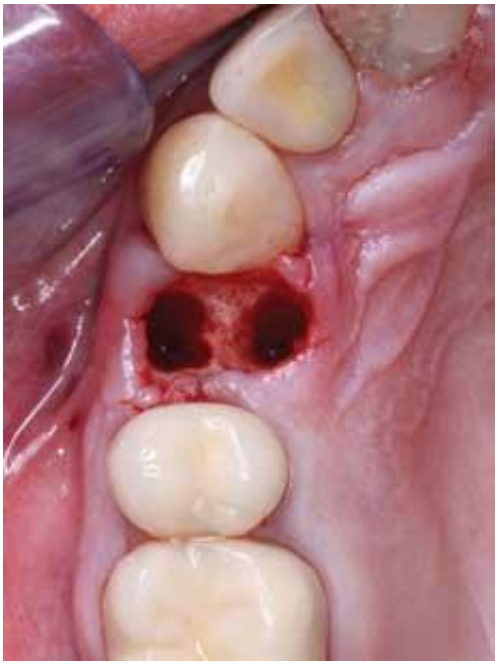
One of the most innovative bone-growth stimulating products is Foundation from J. Morita. This product has had positive research from the mid-1960s as a skin-regenerative material for severe burn wound victims. It has been used in dentistry in Japan for over 10 years as a bone growth-stimulating material. It appears similar to a dense cotton roll, but can be cut into pieces of the desired sizes. Use of the product is easy (see Figures 6 to 11 on pages 46 and 48).

The tooth is extracted without breaking the facial bone. The Foundation is shaped to fit the socket hole or holes. It can be cut to facilitate placement into multiple root sockets as in the example photo (Figure 9 on page 48). There is no need for an expensive membrane. I suggest a suture or two to hold the material in place during the healing period. In a CLINICIANS REPORT (CRA) survey of 26 users (CRA Newsletter, September 2007), it was reported that 96% of the CRA evaluators had success, 56% reported predictable results, and 81% stated that it was easy to use. Implant placement can be accomplished as soon as 10 weeks after use of Foundation. In that survey, CR general dentist and specialist evaluators stated that the material was very successful when the socket had bone remaining on all sides, but less successful if one or more sides of the socket were not present.

*Fig. 6 — Hopeless tooth.*
Click here to enlarge image

The result of placing Foundation is that most, but not all, of the height of the bone around the socket is retained. The bone that grows into the socket, stimulated by the Foundation, is dense, and implant placement is predictable (see Figure 11 on page 48). As with the previous technique, a flap procedure is usually not indicated.

*Fig. 7 — Extraction site preserving facial and lingual bone.* Click here to enlarge image



What are logical and fair patient fees for these grafting procedures? The ADA code for ridge preservation is D7953. The current average fee for a single-tooth extraction in the U.S. is about $120. The cost of the grafting material for a socket can be up to $100 or more, which is a direct overhead cost for you and the patient.

You will probably use a suture. Additionally, you need some income for your time and expertise in placing the material. Add these costs, and you end up with the total fee you should charge for the extraction and the ridge preservation.

*Fig. 8 — Foundation held near extraction site.*
Click here to enlarge image

How can you present the need for ridge preservation to patients and expect them to accept the additional cost of the ridge-preservation procedure? A method I use routinely is to show patients a photo of a resorbed ridge and the resultant unacceptable esthetic result when ridge-preservation techniques are not used. Most patients are eager to accept the procedure when they see the result of not using the ridge-preservation materials.

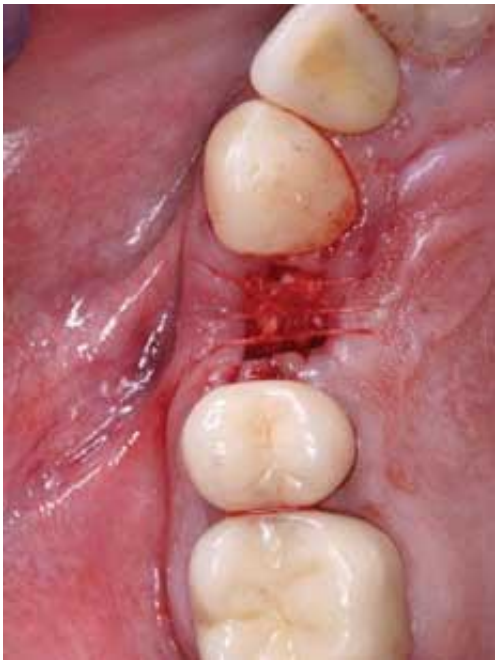
When should ridge-preservation techniques be used? Some clinicians use these techniques on almost all extractions, while others never graft sockets. I suggest having the patient smile as high as possible while doing your treatment-planning.

While observing the smile, determine the teeth and gingival areas for which bone and gingiva shrinkage will produce a nonesthetic result if a specific tooth is extracted. With the patient holding a large hand mirror and observing the tooth area, show him or her the location of the tooth to be removed and estimate the potential defect that may result from extraction of the tooth without grafting. Seldom have I had a patient deny ridge augmentation.

*Fig. 9 — Foundation cut to fit extraction site.*
Click here to enlarge image

In summary, my answer to your first question is: “Yes, ridge preservation is an easy and predictable procedure.” In answer to your second question, I have suggested different materials and techniques for ridge augmentation with and without implant placement. I hope the procedure appears to be relatively simple to you. In my opinion, ridge preservation is well within the capability of a competent general dentist. Other dentists will have their own personal preferences, and they may disagree with my suggestions and conclusions. Additionally, there are many and varied techniques for ridge preservation, and most of them are more complicated and time-consuming than the two I have suggested.

*Fig. 10 —*



*Vicryl sutures over extraction site.*

Click here to enlarge image

Removal of teeth without breaking facial or lingual bone, as suggested in this article, can be difficult! Our Practical Clinical Courses (PCC) video, “Oral Surgery in General Practice,” Video 4116, makes that goal easy. This video shows simple use of Luxators from JS Dental Manufacturing, Inc., and Proximators from Karl Schumacher to accomplish atraumatic tooth removal without difficulty, along with many other useful surgical tips and techniques.

*Fig. 11 — Implant placed 12 weeks later.*
Click here to enlarge image

Call (800) 223-6569 or go to www.pccdental.com for details on the many Practical Clinical Courses videos and courses, including implant surgery and practical oral surgery.

***Dr. Christensen is a practicing prosthodontist in Provo, Utah, and dean of the Scottsdale Center for Dentistry. He is the founder and director of Practical Clinical Courses, an international continuing-education organization initiated in 1981 for dental professionals. Dr. Christensen is a cofounder (with his wife, Rella) and senior consultant of CLINICIANS REPORT (formerly Clinical Research Associates), which since 1976 has conducted research in all areas of dentistry.***

# Rationale for Socket Preservation after Extraction of a Single-Rooted Tooth when Planning for Future Implant Placement

***Tassos Irinakis,*** *DDS, Dip Perio, MSc, FRCD(C)*

**Contact Author**

***Dr. Irinakis***

***Email:*** *irinakis@interchange.ubc.ca*

## ABSTRACT

After tooth extraction, the alveolar ridge will commonly decrease in volume and change morphologically. These changes are usually clinically significant and can make placement of a conventional bridge or an implant-supported crown difficult. If bone resorption is significant enough, then placement of an implant may become extremely challenging. Postextraction maintenance of the alveolar ridge minimizes residual ridge resorption and, thus, allows placement of an implant that satisfies esthetic and functional criteria. Recent advances in bone grafting materials and techniques allow the dentist to place implants in sites that were considered compromised in the past. This article focuses on the healing pattern of sockets, with and without the use of regenerative materials, and the rationale for preserving the dimensions of the extraction socket. Histologic and clinical evidence is reviewed to provide an in-depth understanding of the logic behind and value of socket preservation.

**MeSH Key Words:** alveolar bone loss/prevention & control; bone regeneration; tooth extraction/adverse effects; wound healing

© *J Can Dent Assoc* 2006; 72(10):917–22
This article has been peer reviewed.

Loss of alveolar bone may be attributed to a variety of factors, such as endodontic pathology, periodontitis, facial trauma and aggressive maneuvers during extractions. Millions of teeth are still extracted annually in North America. Most extractions are done with no regard for maintaining the alveolar ridge.[1,2]

Whether due to caries, trauma or advanced periodontal disease, tooth extraction and subsequent healing of the socket commonly result in osseous deformities of the alveolar ridge, including reduced height (**Fig. 1**) and reduced width (**Fig. 2**) of the residual ridge.[2] The severity of the healing pattern may pose a problem for the clinician in 2 ways: it creates an esthetic problem in the fabrication of an implant-supported restoration or a conventional prosthesis; and it may make the placement of an implant challenging if not unfeasible.[3] However, it is possible to minimize such problems by simply carrying out ridge preservation procedures in extraction sockets using grafting materials with or without barrier membranes.[4,5] Several studies, clinical case series and literature reviews in peer-reviewed journals were examined in detail to establish a rationale for using socket preservation as a therapeutic option following tooth extraction. This review offers information that can be useful to the clinician who chooses to implement this procedure in his or her practice, but it should not be viewed as a "recipe" for socket preservation.

**Figure 1:** Reduced height of the alveolar ridge following extraction of the lower left canine and first premolar.

**Figure 2:** "Collapse" of the buccal socket wall 2 months after extraction of the upper left central incisor. Bone grafting will be necessary if the patient wants an implant.

**Figure 3:** The thin, fragile facial socket wall of the upper anterior teeth is susceptible to damage during extraction maneuvers.

**Figure 4:** When a dehiscence is present, the buccolingual dimension of the postextraction ridge is likely to pose challenges for future implant placement.

## Socket–Alveolus Healing

Jahangiri and others[6] provide a current perspective on residual ridge remodelling, beginning with the cascade of inflammatory reactions that is activated immediately after tooth extraction. The socket fills with blood from the severed vessels, which contain proteins and damaged cells. These cells initiate a series of events that will lead to the formation of a fibrin network, which, along with platelets, forms a "blood clot" or "coagulum" within the first 24 hours.[7] Acting as a physical matrix, the coagulum directs the movement of cells, including mesenchymal cells, as well as growth factors. Neutrophils and later macrophages enter the wound site and digest bacteria and tissue debris to sterilize the wound. They release growth factors and cytokines that will induce and amplify the migration of mesenchymal cells and their synthetic activity within the coagulum.[8]

Within a few days, the blood clot begins to break down (fibrinolysis). The proliferation of mesenchymal cells leads to gradual replacement of the coagulum by granulation tissue (2–4 days).[9] By the end of 1 week, a vascular network is formed and by 2 weeks the marginal portion of the extraction socket is covered with young connective tissue rich in vessels and inflammatory cells.[10] By 4–6 weeks, most parts of the alveolus are filled with woven bone, while the soft tissue becomes keratinized. At 4–6 months, the mineral tissue within the original socket is reinforced with layers of lamellar bone that is deposited on the previously formed woven bone.[8–10] Although bone deposition in the socket will continue for several months, it will not reach the coronal bone level of the neighbouring teeth.[11]

## Patterns of Jaw Resorption

Clinical and cephalometric studies from the 1950s to the 1970s described the resorption process in the postextraction anterior ridge of the edentulous mandible.[12–15] Atwood[13] divided factors affecting the rate of resorption into 4 categories: anatomic, metabolic, functional and prosthetic. Tallgren[16] demonstrated 400% higher residual ridge resorption in the mandible compared with the maxilla.

Regarding the surfaces most affected by extractions, some classic studies have demonstrated that postextraction alveolar resorption is significantly larger in the buccal aspect in both jaws.[17–20] This can easily be understood if one looks closely at the labial anatomy of the alveolar bone surrounding the upper and lower teeth. The margins of the facial alveoli are thin, mostly cortical (though in rare cases, they contain cancellous bone), knife-edged and frail (**Fig. 3**). When exposed to the trauma caused by extraction maneuvers, the jaw bone is predisposed to resorptive patterns that may lead to unfavourable conditions for implant placement.[2] Commonly, postextraction osseous remodelling also takes place in the presence of dehiscences and fenestrations that magnify the problem, the end result being buccal concavity in the alveolar bone (**Fig. 4**).

The degree of residual ridge resorption is closely related to the time since tooth extraction[14,21,22] — in both maxilla and mandible. The loss of tissue contour is greatest in the early postextraction period (within 6 months).[17–19] Apparently, the healing of sockets in the maxilla progresses faster (because of the greater vascular supply) than those in the mandible, which could lead to a faster resorption pattern.[23]

Several recent studies have examined resorption patterns following single-tooth extraction. Using subtraction radiography, Schropp and others[11] assessed, in a

**Table 1** Advantages, disadvantages and examples of the 2 major membrane categories used in guided bone regeneration procedures including socket preservation

| Membrane category | Advantages | Disadvantages | Commercial examples |
|---|---|---|---|
| Nonresorbable | • Numerous studies demonstrate their success<br>• May be titanium reinforced<br>• Remain intact until removal<br>• Easily attached with titanium or resorbable tacks<br>• Greater bone fill if membrane not exposed<br>• Minimal tissue response if membrane not exposed | • Require a second surgery for removal<br>• Increase patient morbidity<br>• If exposed, must be removed<br>• Can be technique sensitive | • ePTFE membranes, e.g., Gore-Tex (Gore Medical, Flagstaff, Ariz.)<br>• Titanium-reinforced Gore-Tex |
| Resorbable | • Numerous studies demonstrate their success<br>• Does not require surgical removal<br>• Decreased patient morbidity<br>• Improved soft-tissue healing<br>• Tissue-friendly reaction to membrane exposure<br>• Cost effective; one surgery only<br>• Does not have to be removed if exposed | • Uncertain duration of barrier membrane function<br>• Difficult to tack down<br>• Slightly less bone fill than nonresorbable membranes<br>• Inflammatory response from tissues may interfere with healing and GBR<br>• Can be technique sensitive | • Neomem (bovine collagen matrix; Citagenix Inc., Laval, Que.)<br>• Bio-Gide (porcine collagen matrix; Geistlich AG, Wolhusen, Switzerland)<br>• Ossix (cross-linked collagen barrier; Implant Innovations Inc., Palm Beach Gardens, Fla.) |

*ePTFE = expanded polytetrafluoroethylene; GBR = guided bone regeneration*

12-month prospective study, bone formation in the alveolus and changes in the contour of the alveolar process following single-tooth extraction. The width of the alveolar ridge decreased 50% (from 12 mm to 5.9 mm, on average), and two-thirds of the reduction occurred within the first 3 months. The percentage reduction was somewhat larger in the molar compared with the premolar region. Changes in bone height, however, were only slight (less than 1 mm). The level of bone regenerated in the extraction socket never reached the coronal level of bone attached to the tooth surfaces distal and mesial to the extraction site. The bone surface becomes "curved" apically.

Lekovic and coworkers[3] evaluated the clinical effectiveness of a bioabsorbable membrane in preserving alveolar ridges following single-tooth extraction in a split-mouth prospective study. At the 6-month re-entry appointment, they found an average loss of alveolar height and width of 1.50 mm and 4.56 mm, respectively, in the healed sockets.

## Using Membranes and Bone Grafts in Sockets

In the study by Lekovic,[3] the average loss of alveolar height and width in sockets that were left to heal with only a membrane covering them was 0.38 mm and 1.32 mm, respectively, considerably less than the average loss in sockets that healed naturally. In addition, the quality of the bone in sockets that have healed in the presence of a barrier membrane is excellent for implant placement.[24]

A wide range of barrier membranes have been used in numerous studies over the years, e.g., expanded polytetrafluoroethylene (ePTFE), collagen, polyglycolic acid and polyglactin 910. However, these can be grouped into 2 major categories: nonresorbable and resorbable membranes. The advantages and disadvantages of various membranes are presented in **Table 1** along with examples of commercial products. As the time for resorption of these membranes differs, the clinician should follow manufacturers' directions.

The literature justifies the use of bone grafting materials in freshly extracted sockets.[25,26] When demineralized freeze-dried bone allograft (DFDBA) was used in conjunction with a collagen membrane, the width of the alveolar ridge decreased from 9.2 mm to 8.0 mm, while the width of the socket sites that healed naturally decreased from 9.1 mm to 6.4 mm on average.[25] In addition, the average loss of bone height in the latter group was 1 mm, while the grafted sites actually gained height. Even with no barrier membrane, a socket fill of nearly 85%

**Table 2** Sources of grafting material for guided bone regeneration

| Type of bone graft | Source of the grafting material |
|---|---|
| Autogenous grafts (autografts) | Material is transferred from one position to another within the same individual. Graft may be intraoral or extraoral depending on the site of harvest. |
| Allografts | Material is transferred from a donor of the same species. The most common grafts are freeze-dried bone grafts, which may be mineralized or demineralized. |
| Xenografts | Material is transferred from a donor of another species, processed appropriately. Primarily porous deproteinized bovine bone mineral. |
| Alloplasts | Synthetic materials, usually inert, used as a substitute for bone grafts. |

can be achieved by placing porous bovine bone mineral in fresh extraction sites.[26]

## Bone-to-Implant Contact in Grafted Sockets

Some researchers might argue that the quality of the bone in grafted sockets may not be adequate for implant placement. Thus, various grafting materials have been used to preserve the socket or augment the lateral ridge before implant placement (**Table 2**). When placing xenografts (**Fig. 5**) or DFDBA in fresh extraction sockets, Becker and others[27] found that there was minimal vital bone-to-implant contact (BIC). However, in this study, the histologic core samples were taken within 3–6 months of extraction when it is common to wait 6–9 months to place implants when using these materials. Thus, the cores may have been taken too early to provide appropriate information. In a different study examining the healing of sockets filled with bioactive glass (alloplastic synthetic bone substitute), a very long healing time was required for even a small amount of new bone to be incorporated into the graft.[28]

Several studies have investigated BIC between regenerated or natural bone and rough or machined-surface implants. Trisi and colleagues[29] examined the posterior maxilla, where bone is generally of poor quality, investigating the BIC at 2 and 6 months. For rough-surfaced implants (dual acid-etched), there was 48% BIC at 2 months and 72% BIC at 6 months, compared with only 19% and 34%, respectively, for machined-surface implants. Similar results were noted in an animal study, in which there was 74% BIC in type IV bone (poor-quality bone) at 6 months on titanium porous oxide (TiUnite, Nobel Biocare, Gothenburg, Sweden) implants.[30]

When sockets are filled with grafting material, graft remnants usually remain at the time of implant placement. In one study,[31] bovine bone mineral contained about 30% particles at 6 months. In a different study[32] in which DFDBA was used, the rate at which graft material was replaced by new vital bone was very slow and incomplete even at 4 years; however, from a clinical point of view, the load-bearing capacity of the regenerated bone appeared to be similar to that of normal bone. Valentini and colleagues[33] found that BIC at sites grafted with bovine bone mineral was greater than or equal to that in nongrafted sites; histologic analysis 6 months after grafting showed a BIC of 73% in grafted vs. 63% in nongrafted areas. Comparison of the torque necessary to remove implants 6 months after placement showed no statistically significant differences between grafted and nongrafted sites, supporting the successful osseointegration of implants in grafted sites.[34]

Success rates are also satisfactory when placing implants in previously grafted bone. In a restrospective study of 607 titanium plasma sprayed implants placed in regenerated bone (with DFDBA), 97.2% of maxilla implants and 97.4% of mandible implants were successful for an average of 11 years.[35] Even higher success rates in augmented bone have been reported by Simion and coworkers.[36] These numbers compare very favourably with the success rates for implants placed in pristine bone.[37–41]

## Conclusions

The success of osseointegrated dental implants depends on whether there is a sufficient volume of healthy bone at the recipient site at the time of implant placement. The placement of an implant at a site with a thin crestal ridge (e.g., postextraction ridge) could result in a significant buccal dehiscence. Thus, it seems prudent to prevent alveolar ridge destruction and make efforts to preserve it during extraction procedures.

Maintenance of an extraction socket for future implant therapy does not exclude immediate implant placement, but knowledge and experience are needed to determine the best treatment modality. Postextraction treatment options may include, but are not limited to, immediate implant placement; natural socket healing and delayed implant placement; natural healing and future osseous ridge augmentation (for implant or fixed partial denture); natural healing and future soft tissue ridge augmentation (for fixed partial denture); natural healing and removable partial denture.

There are various reasons why the surgeon may not wish to follow a particular treatment option. These

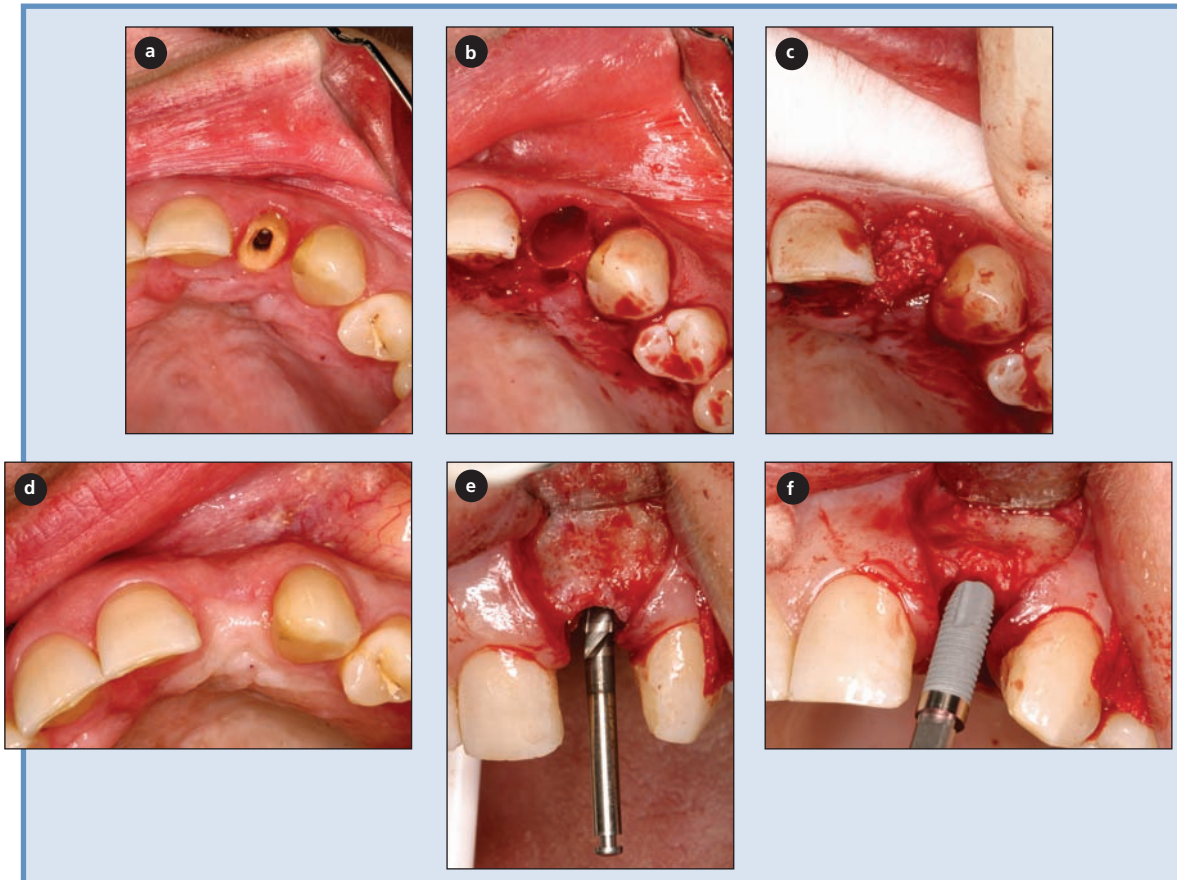



**Figure 5:** Upper lateral incisor (**a**) that was extracted using periotomes (thus avoiding trauma to the socket walls); its socket (**b**) was then filled with porous bovine bone mineral (**c**). Images **d** to **f** were taken after 6 months of healing and show successful preservation of the ridge for placement of a narrow-platform implant.

reasons could also be viewed as limitations to socket preservation with bone grafting. Examples of potential problems are lack of adequate apical bone to begin with for primary anchorage of the implant; lack of buccal socket wall; area where esthetics are important and the surgeon prefers to wait for tissue settlement; the indications for immediate implant placement are stronger; lack of experience of the dentist in selecting appropriate materials and techniques; indecisive patient; inability of patient to cover the cost.

Regardless of the reasons for socket preservation, there seems to be a consensus that sufficient alveolar bone volume and favourable architecture of the alveolar ridge are essential to achieve ideal functional and esthetic prosthetic reconstruction following implant therapy.[1] Preserving or reconstructing the extraction socket of a failed tooth according to the principles of guided bone regeneration enhances our ability to provide esthetically pleasing restorations to our patients without violating the predictability and function of those prostheses.

## THE AUTHOR

***Dr. Irinakis** is associate clinical professor and director of graduate periodontics and implant surgery at the University of British Columbia, Vancouver, British Columbia. He is also in part-time private practice in periodontics and implant dentistry in Vancouver and Coquitlam, B.C.*

***Correspondence to:** Dr. Tassos Irinakis, Faculty of Dentistry, University of British Columbia, 2199 Wesbrook Mall, Vancouver, BC V6T 1Z3.*

*The author has no declared financial interests in any company manufacturing the types of products mentioned in this article.*

## References

1. Marcus SE, Drury TF, Brown LJ, Zion GR. Tooth retention and tooth loss in the permanent dentition of adults: United States, 1988–1991. *J Dent Res* 1996; 75(Spec no.):684–95.

2. Mecall RA, Rosenfeld AL. Influence of residual ridge resorption patterns on implant fixture placement and tooth position. 1. *Int J Periodontics Restorative Dent* 1991; 11(1):8–23.

3. Lekovic V, Camargo PM, Klokkevold PR, Weinlaender M, Kenney EB, Dimitrijevic B, and other. Preservation of alveolar bone in extraction sockets using bioabsorbable membranes. *J Periodontol* 1998; 69(9):1044–9.

4. Zubillaga G, Von Hagen S, Simon BI, Deasy MJ. Changes in alveolar bone height and width following post-extraction ridge augmentation using a

fixed bioabsorbable membrane and demineralized freeze-dried bone osteoinductive graft. *J Periodontol* 2003; 74(7):965–75.

5. Winkler S. Implant site development and alveolar bone resorption patterns. *J Oral Implantol* 2002; 28(5):226–9.

6. Jahangiri L, Devlin H, Ting K, Nishimura I. Current perspectives in residual ridge remodeling and its clinical implications: a review. *J Prosthet Dent* 1998; 80(2):224–37.

7. Amler MH. The time sequence of tissue regeneration in human extraction wounds. *Oral Surg Oral Med Oral Pathol* 1969; 27(3):309–18.

8. Lin WL, McCulloch CA, Cho MI. Differentiation of periodontal ligament fibroblasts into osteoblasts during socket healing after tooth extraction in the rat. *Anat Rec* 1994; 240(4):492–506.

9. Araujo MG, Berglundh T, Lindhe J. On the dynamics of periodontal tissue formation in degree III furcation defects. An experimental study in dogs. *J Clin Periodontol* 1997; 24(10):738–46.

10. Cardaropoli G, Araujo M, Lindhe J. Dynamics of bone tissue formation in tooth extraction sites. An experimental study in dogs. *J Clin Periodontol* 2003; 30(9):809–18.

11. Schropp L, Wenzel A, Kostopoulos L, Karring T. 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(4):313–23.

12. Atwood DA. Some clinical factors related to rate of resorption of residual ridges. 1962. *J Prosthet Dent* 2001; 86(2):119–25.

13. Atwood DA. A cephalometric study of the clinical rest position of the mandible. Part II. The variability in the rate of bone loss following the removal of occlusal contacts. *J Prosthet Dent* 1957; 7:544–52.

14. Tallgren A. The continuing reduction of the residual alveolar ridges in complete denture wearers: a mixed-longitudinal study covering 25 years. *J Prosthet Dent* 1972; 27(2):120–32.

15. Carlsson GE, Bergman B, Hedegard B. Changes in contour of the maxillary alveolar process under immediate dentures. A longitudinal clinical and x-ray cephalometric study covering 5 years. *Acta Odontol Scand* 1967; 25(1):45–75.

16. Tallgren A. Changes in adult face height due to aging, wear and loss of teeth and prosthetic treatment. *Acta Odontol Scand* 1957; 15(suppl. 24); 73–122.

17. Pietrokovski J, Massler M. Alveolar ridge resorption following tooth extraction. *J Prosthet Dent* 1967; 17(1):21–7.

18. Johnson K. A study of the dimensional changes occurring in the maxilla following tooth extraction. *Aust Dent J* 1969; 14(4):241–4.

19. Lam RV. Contour changes of the alveolar processes following extractions. *J Prosthet Dent* 1960; 10:25–32.

20. Carlsson GE, Persson G. Morphological changes of the mandible after extraction and wearing of dentures. A longitudinal, clinical, and x-ray cephalometric study covering 5 years. *Odontol Revy* 1967; 18(1):27–54.

21. Humphries S, Devlin H, Worthington H. A radiographic investigation into bone resorption of mandibular alveolar bone in elderly edentulous adults. *J Dent* 1989; 17(2):94–6.

22. Ulm C, Solar P, Blahout R, Matejka M, Gruber H. Reduction of the compact and cancellous bone substances of the edentulous mandible caused by resorption. *Oral Surg Oral Med Oral Pathol* 1992; 74(2):131–6.

23. Soehren SE, Van Swol RL. The healing extraction site: a donor area for periodontal grafting material. *J Periodontol* 1979; 50(3):128–33.

24. Carmagnola D, Adriaens P, Berglundh T. Healing of human extraction sockets filled with Bio-Oss. *Clin Oral Implants Res* 2003; 14(2):137–43.

25. Iasella JM, Greenwell H, Miller RL, Hill M, Drisko C, Bohra AA, and other. Ridge preservation with freeze-dried bone allograft and a collagen membrane compared to extraction alone for implant site development: a clinical and histologic study in humans. *J Periodontol* 2003; 74(7):990–9.

26. Artzi Z, Tal H, Dayan D. Porous bovine bone mineral in healing of human extraction sockets. Part 1: Histomorphometric evaluations at 9 months. *J Periodontol* 2000; 71(6):1015–23.

27. Becker W, Clokie C, Sennerby L, Urist MR, Becker BE. Histologic findings after implantation and evaluation of different grafting materials and titanium micro screws into extraction sockets: case reports. *J Periodontol* 1998; 69(4):414–21.

28. Norton MR, Wilson J. Dental implants placed in extraction sites implanted with bioactive glass: human histology and clinical outcome. *Int J Oral Maxillofac Implants* 2002; 17(2):249–57.

29. Trisi P, Lazzara R, Rebaudi A, Rao W, Testori T, Porter SS. Bone-implant contact on machined and dual acid-etched surfaces after 2 months of healing in the human maxilla. *J Periodontol* 2003; 74(7):945–56.

30. Huang YH, Xiropaidis A, Sorensen RG, Albandar JM, Hall J, Wikesjo UM. Bone formation at titanium porous oxide (TiUnite) oral implants in type IV bone. *Clin Oral Implants Res* 2005; 16(1):105–11.

31. Zitzmann NU, Scharer P, Marinello CP, Schupbach P, Berglundh T. Alveolar ridge augmentation with Bio-Oss: a histologic study in humans. *Int J Periodontics Restorative Dent* 2001; 21(3):288–95.

32. Simion M, Trisi P, Piattelli A. GBR with an e-PTFE membrane associated with DFDBA: histologic and histochemical analysis in a human implant retrieved after 4 years of loading. *Int J Periodontics Restorative Dent* 1996; 16(4):338–47.

33. Valentini P, Abensur D, Densari D, Graziani JN, Hammerle C. Histological evaluation of Bio-Oss in a 2-stage sinus floor elevation and implantation procedure. A human case report. *Clin Oral Implants Res* 1998; 9(1):59–64.

34. Kohal RJ, Mellas P, Hurzeler MB, Trejo PM, Morrison E, Caffesse RG. The effects of guided bone regeneration and grafting on implants placed into immediate extraction sockets. An experimental study in dogs. *J Periodontol* 1998; 69(8):927–37.

35. Fugazzotto PA. Success and failure rates of osseointegrated implants in function in regenerated bone for 72 to 133 months. *Int J Oral Maxillofac Implants* 2005; 20(1):77–83.

36. Simion M, Jovanovic SA, Tinti C, Benfenati SP. Long-term evaluation of osseointegrated implants inserted at the time or after vertical ridge augmentation. A retrospective study on 123 implants with 1–5 year follow-up. *Clin Oral Implants Res* 2001; 12(1):35–45.

37. Karoussis IK, Bragger U, Salvi GE, Burgin W, Lang NP. Effect of implant design on survival and success rates of titanium oral implants: a 10-year prospective cohort study of the ITI Dental Implant System. *Clin Oral Implants Res* 2004; 15(1):8–17.

38. Buser D, Mericske-Stern R, Bernard JP, Behneke A, Behneke N, Hirt HP, and others. Long-term evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. *Clin Oral Implants Res* 1997; 8(3):161–72.

39. Romeo E, Chiapasco M, Ghisolfi M, Vogel G. Long-term clinical effectiveness of oral implants in the treatment of partial edentulism. Seven-year life table analysis of a prospective study with ITI dental implants system used for single-tooth restorations. *Clin Oral Implants Res* 2002; 13(2):133–43.

40. Ferrigno N, Laureti M, Fanali S, Grippaudo G. A long-term follow-up study of non-submerged ITI implants in the treatment of totally edentulous jaws. Part I: Ten-year life table analysis of a prospective multicenter study with 1286 implants. *Clin Oral Implants Res* 2002;13(3):260–73.

41. Fugazzotto PA, Beagle JR, Ganeles J, Jaffin R, Vlassis J, Kumar A. Success and failure rates of 9 mm or shorter implants in the replacement of missing maxillary molars when restored with individual crowns: preliminary results 0 to 84 months in function. A retrospective study. *J Periodontol* 2004; 75(2):327–32.

# Socket Preservation by Bone Grafting



AMERICAN ASSOCIATION OF DENTAL CONSULTANTS
DEDICATED TO SERVING PATIENTS, THE PUBLIC, PURCHASERS OF HEALTH BENEFITS, AND THE PROFESSION OF DENTISTRY.

*Position Statement*

## Introduction and Background

Routine bone grafting of alveolar sockets after the extraction of teeth has been a controversial subject which relates to a multitude of factors recently reported in the literature. Prior to the introduction of various bone grafting materials and membranes, the socket historically was allowed to heal by secondary intention. Healing by secondary intention is defined as a union by closure of a wound with granulations. This method of wound closure has been the main course of post operative management of the socket.

Bone grafting of extraction sockets has gained in popularity over the last decade as demand for reconstruction of the maxillary or mandibular alveolus has increased. There are several reasons suggested for socket preservation by bone grafting whether performed as an immediate or delayed procedure. Reasons include, but are not limited to, an improved esthetic appearance (especially of the anterior alveolar ridge), conservation/preservation of remaining alveolar bone for reconstruction, decrease in healing time with less post-operative complications and the ability to reconstruct the alveolus sooner by dental implant. However, it must be noted that there are few implant studies that specifically address implant longevity as an outcome measure with grafting vs. natural healing. As a result, bone quantity is used as a proxy measure for implant success. Additional rationale for the necessity of socket preservation may also include pathologic loss of alveolar bone such as occurs with an impacted tooth to eliminate a bony defect.

It has been well documented in the literature that subsequent to extraction of a tooth, the alveolus loses both bone volume and height. Dependent upon the dimensions of the extraction site and remaining alveolar walls, the majority of bone loss occurs in a horizontal and vertical dimension. Studies have shown that as much as 40% of alveolar height and 60% of alveolar width is lost within the first 6 months following extraction of a tooth. The alveolus appears to lose most volume from the buccal or labial aspects. Loss of ridge height creates prosthetic instability as the crest of the ridge approaches muscle attachments and mobile mucosa. This process becomes especially noticeable in the anterior region where labial resorption may leave an undesirable esthetic situation for tooth replacement whether by

conventional means or by dental implant body placement. Many articles report the prevention of ridge resorption as predictable, convenient, and available at a reasonable cost.

There are many studies in the literature that investigate the efficacy of various bone graft materials used for socket preservation. In his paper “Extraction Site Reconstruction for Alveolar Ridge Preservation. Part 1: Rationale and Materials Selection”, Bartee states that non-resorbable materials have been reported as not suitable for use in sockets that will eventually later receive a dental implant body. The most frequently requested reconstructive procedure for replacement of a missing tooth is by dental implant body. Current thinking purports that adequate bone volume is imperative for the successful osseo-integration of the dental implant body. This is certainly a true statement when describing placement of a dental implant body within native bone where there is adequate bone adaptation to the dental implant body. However, it appears that when analyzing the success of osseo-integration as it relates to bone grafting materials, many research articles have not reported the extent of the apical portion of the implant body which is typically placed into native cortical bone that subsequently improves stability.

There has been no correlation in the literature that socket grafting materials (biomaterials or bone) improve or increase the longevity of successful placement of the dental implant body. One such paper, “Bone Formation Following Implantation of Bone Biomaterials Into Extraction Sites” by Liene et al. examined post operative healing of the socket using various biomaterials including measurement of the insertion torque during implant placement. According to the paper, “Because most extraction sockets were deeper than 1 cm, and the implants placed were 13 to 15 mm, the last third of the implant could be placed in native bone. The presence of native bone at the tip of the implant may affect the torque measurements during the last part of the implant insertion.” An additional conclusion would be that the stability and success of the dental implant is quite often the result of adequate placement into apical cortical bone as well as adequate adaptation of the socket walls.

## Position Statement

The purpose of this position statement is not to examine or question the various types of grafting materials used in the extraction site for socket preservation, but rather to address the efficacy of the procedure itself as it relates to certain diagnoses and procedures. Additional bone graft procedures such as augmentation of the alveolar ridges (typically considered a major bone grafting technique) and sinus lift augmentation may be the subject of another position statement.

Certainly research demonstrates a positive benefit of socket grafting to preserve the structural integrity and volume of the dental alveolar ridge. For purposes of prosthetic reconstruction, (whether by conventional means or with dental implants), socket preservation may serve to improve the esthetic and functional outcomes under certain clinical circumstances especially in the anterior ridge where bone resorption is most noticeable. Research is limited related to grafting of socket defects where pathologic bone loss has been diagnosed as a result of an impacted tooth. However, where the defect is clinically significant and has the potential to adversely affect the remaining adjacent tooth/teeth, socket preservation may be an appropriate procedure.

As noted, there is no literature currently available that supports the assertion that socket preservation by bone graft improves the long term outcome of dental implant body placement. However, the literature does strongly support the socket preservation procedure for esthetic and dimensional maintenance of the alveolar ridge. The literature also makes the point that bone quality studies are not well documented and one cannot make the assumption that it is equal in both scenarios (i.e. bone grafted versus natural healing). It should be noted that bone quality, quantity, and composition are important factors that influence implant longevity and therefore merit additional study.

The AADC Positions Committee therefore recognizes the value of socket preservation by bone graft for esthetic and dimensional maintenance of the alveolar ridge. However, it is important to note that current scientific evidence does not support routine use of the procedure. As such, the clinical indications and applications for socket preservation must be carefully evaluated on a case by case basis.

## References


1. Bartee, BK., Extraction Site Reconstruction for Alveolar Ridge Preservation. Part 1: Rationale and Materials Selection; J Oral Impl, August 2001, Vol. 27(4) pp. 187-193
2. Barone, A., et al., Xenograft Versus Extraction Alone for Ridge Preservation After Tooth Removal: A Clinical and Histomorphometric Study; J Periodontol, August 2008, Vol. 79(8), pp.1370-1377
3. Froum, S., et al; Histological Comparison of Healing Extraction Sockets Implanted with Bioactive Glass or Demineralized Freeze-Dried Bone Allograft: A Pilot Study; J Periodontol, January 2002, Vol. 73(1), pp. 94-102
4. Iasella, JM., et al.; Ridge Preservation with Freeze-Dried Bone Allograft and a Collagen Membrane Compared to Extraction Sites Alone for Implant Site Development: A Clinical and Histological Study in Humans; J Periodontol, July 2003, Vol. 74(7) pp. 990-999
5. Liene, M., et al.; Bone Formation Following Implantation of Bone Biomaterials

Into Extraction Sites; J Periodontol, May 2008, Vol. 79(6), pp. 1108-1115.
6. Aghaloo, TL., Moy, PK., Bone Formation Following Implantation of Bone Biomaterials Into Extraction Sites; Int J Oral Maxillo Impl, 2007, Vol. 22 (Suppl.) pp. 49-73
7. Esposito, M., et al., The Efficacy of Various Bone Augmentation Procedures for Dental Implants: A Cochrane Systematic Review of Randomized Controlled Clinical Trails; Int J Oral Maxillo Impl, October 2006, Vol. 21(5) pp. 696-710
8. McAllister, BS., Haghighat, K., Bone Augmentation Techniques, AAP-Commissioned Review; J Periodontol, March 2007, Vol. 78(3), pp. 377-396
9. Statement by the American Association of Oral and Maxillofacial Surgeons Concerning the Management of Selected Clinical Conditions and Associated Clinical Procedures- Bone Grafting After Removal of Impacted Third Molars; March 2008
10. Horowitz, RA., et al; Clinical Evaluation of Alveolar Ridge Preservation with a b-Tricalcium Phosphate Socket Graft; Compendium of Continuing Education in Dentistry; November/December 2009, Vol. 30(9) pp. 588-603
11. Irinakis, T., Rationale for Socket Preservation after Extraction of a Single-Rooted Tooth when Planning for Future Implant Placement; J Can Den Assos, December 2006/January 2007, Vol. 72(10) pp.917-922
12. Darby, I., et al; Ridge Preservation Techniques for Implant Therapy; J Oral Maxillo Impl, 2009, Vol. 24 (Suppl.) pp. 260-271