Quality Resource Guide

Fifth Edition

Alveolar Ridge Preservation Following Tooth Extraction

Author Acknowledgements

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Educational Objectives

Following this unit of instruction, the practitioner should be able to:

1. Describe the ridge dimensional alterations following tooth extraction and explain the underlying mechanism.
2. Describe the ridge dimensional alterations following implant placement in fresh extraction sockets.
3. Understand the advantages and indications of alveolar ridge preservation.
4. Recognize various materials used for alveolar ridge preservation.
5. Identify evidence-based practices for alveolar ridge preservation procedures.
6. Justify clinical situations for which alveolar ridge preservation may not be necessary.

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The following commentary highlights fundamental and commonly accepted practices on the subject matter. The information is intended as a general overview and is for educational purposes only. This information does not constitute legal advice, which can only be provided by an attorney.

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The content of this Guide is subject to change as new scientific information becomes available.

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What happens to the alveolar ridge following tooth extraction?

The dimensional and structural alterations following tooth extraction have been well documented in the literature. As early as 1967, Pietrokovsky published data regarding dimensional alveolar bone changes after tooth extraction.[1] This landmark study demonstrated that following tooth extraction, the ridge resorption was consistently greater on the buccal side compared to the palatal/lingual side. More recent studies have shown that tooth extraction initiates a biologic sequence that results in not only morphologic changes of the alveolar bone contour, but also its overlying soft tissue profile, which can impair esthetic outcomes.[2] Schropp, *et al.* measured the amount of tissue changes after premolar and molar extractions.[3] They concluded that one year following extraction, 50% of the ridge width was lost and two-thirds of this resorption happened within the first 3 months of healing.[3]

In addition to the alveolar ridge resorption in the horizontal dimension (decrease in width), changes in the vertical dimension have been reported. Araujo & Lindhe used a canine model to demonstrate that following a tooth extraction, a consistently greater loss of vertical bone height occurred compared to the lingual bone height.[4] This difference in the resorptive outcome can be explained by the buccal plate being much thinner than the lingual plate and mainly composed of bundle bone. Bundle bone is the portion of the alveolar bone in which collagen fibers of the periodontal ligament are embedded. Its presence is dependent on functional periodontal fibers transmitting an occlusal load from the tooth to the alveolar bone. As the function of these fibers is lost following tooth extraction, the bundle bone undergoes resorption, leading to a subsequent decrease in height and width. In contrast, the lingual plate is thicker and composed of bundle and lamellar bone. Therefore, as the resorptive process occurs, bundle bone is lost, but the unaffected lamellar bone remains, limiting the dimensional reduction of the lingual plate. A systematic review concluded that following tooth extraction, a greater ridge width reduction occurs compared to ridge height reduction, with a mean reduction of 3.87mm and 1.87mm in ridge width and height, respectively.[5]

Can implant placement in a fresh extraction socket prevent alveolar ridge dimensional changes?

Early studies suggested implant placement may prevent ridge dimension alterations following tooth extraction.[6,7] However, it was later demonstrated in both animal and human studies that immediate implant placement does not counteract the physiologic resorptive changes following tooth extraction.[8-11] However, the addition of a soft tissue graft (connective tissue graft) during the immediate implant placement has been shown to offset the underlying bone resorption, preserving esthetic outcomes.[12]

What are the indications for alveolar ridge preservation?

Alveolar ridge preservation (ARP) is a surgical procedure performed at the time of tooth extraction to minimize alveolar bone resorption and maintain the alveolar bone contour for future prosthetically driven implant placement.[13] Preservation of the alveolar bone contour is also beneficial in prosthetic cases where the pontic of a fixed dental prosthesis is to be placed in an esthetically strategic area following tooth extraction.

Evidence for alveolar ridge preservation:

To illustrate the advantage of performing ridge preservation, a closer look at a well-designed study published by Iasella and co-workers is warranted.[14] Twenty-four patients requiring a tooth extraction in a non-molar site and a replacement by a dental implant were randomized to either extraction alone (control group) or extraction and ridge preservation using mineralized freeze-dried bone allograft (FDBA) and a resorbable collagen membrane (test group). Following the extraction, ridge width and height measurements were performed. The patients returned for implant placement four to six months after the extraction, and the ridge measurements were repeated.

Table 1 below indicates the dimensional changes in the two treatment groups.

The authors concluded that intra-socket grafting partially prevented the resorption in width, while leading to a minimal gain in height if grafting above the coronal level of the socket (over-grafting) was performed at the time of tooth extraction. Recent systematic reviews indicated that ridge preservation procedures effectively limit horizontal and vertical dimensional changes in post-extraction sites.[13,15,16]

The meta-analyses performed by Avila-Ortiz, e*t al.* indicated that ridge preservation resulted in significantly less horizontal and vertical contraction compared to extraction alone. The weighted mean difference showed that ridge preservation prevented an additional horizontal resorption of 1.99 mm (95% CI 1.54 to 2.44, P < 0.00001), vertical mid-buccal resorption of 1.72 mm (95% CI 0.96 to 2.48; P < 0.00001) and vertical mid-lingual resorption of 1.16 mm (95% CI 0.81 to 1.52; P < 0.00001) compared to extraction alone.[13]

Table 1 - Ridge dimension changes following extraction alone or extraction with ridge preservation[14]

	Control Group: Extraction alone (n=12)	**Test Group:** FDBA + collagen membrane (n=12)	**Statistical Significance**
Change in width (in mm)	- 2.6 ± 2.3	- 1.2 ± 10.9	p < 0.05
Change in height (in mm)	- .09 ± 1.6	1.3 ± 2.0	p < 0.05

Materials:

Bone grafting materials and membranes used for ridge preservation are similar to those used for guided bone regeneration (**GBR**) or guided tissue regeneration (**GTR**) procedures. Commonly used bone grafts include allografts (freeze-dried bone allograft (**FDBA**) or demineralized freeze-dried bone allograft (**DFDBA**), deproteinized bovine bone mineral, autogenous bone, and alloplastic materials (*e.g.*, bio-glass, hydroxyapatite, calcium sulfate). Commonly used membranes include resorbable collagen, non-resorbable expanded polytetrafluoroethylene (**ePTFE**), dense polytetrafluoroethylene (**dPTFE**), polylactid/polyglycolic membranes, and acellular dermal matrix grafts. Other materials that have also been successfully used are collagen wound dressing materials (*e.g.*, CollaPlug®, CollaTape®), which resorb faster than the previously mentioned resorbable membranes. Darby, *et al.* have published an excellent review of these products.[15] More recent studies have also explored using Leukocyte-platelet rich fibrin (L-PRF) matrices to improve healing at the surgical site.[17]

Most randomized controlled clinical trials have compared ridge preservation to no intervention and have demonstrated the benefit of ridge preservation over no intervention. In contrast, few clinical trials have reported on the outcomes of different materials in a side-by-side comparison. A series of studies have looked at the advantages and disadvantages of specific materials, which are presented below:

FDBA vs. DFDBA

Allografts combine the advantage of unrestricted availability and avoiding a second surgical site for graft procurement, thereby decreasing patient morbidity. FDBA and DFDBA differ in processing, resulting in their respective advantageous properties. FDBA with a higher mineral content was suggested to act as a better space-maintaining osteoconductive scaffold than DFDBA.[18] Conversely, the demineralization process allows for the release of bone morphogenetic proteins from DFDBA, leading to its unique osteoinductive property, potentially improving vital bone formation.[19]

Wood & Mealey performed ridge preservation in 40 patients randomized to receive either FDBA or DFDBA as a grafting material following the extraction of non-molar teeth.[20] The sites were subsequently covered with a resorbable collagen membrane and allowed to heal for 18 to 20 weeks before bone cores were trephined out of the prospective implant site and submitted for histomorphometric analyses. In addition, clinical dimensions of the ridge were recorded at the time of extraction and 18 to 20 weeks post-extraction. There were no differences between FDBA and DFDBA in the amount of ridge dimension alterations at the time of implant placement. However, the histomorphometric analyses showed that the sites grafted with DFDBA generated significantly more vital bone, consistent with its osteoinductive property, and contained fewer residual graft particles. Therefore, the clinician may prefer DFDBA over FDBA for ridge preservation to obtain more vital bone 18 to 20 weeks after grafting. One disadvantage of DFDBA is that, due to its demineralized nature, radiographic evidence of ridge preservation may not be evident until 8-12 weeks have elapsed to allow for bone remodeling. Moreover, DFDBA is usually more expensive than FDBA.

Cortical FDBA vs. Cancellous FDBA vs Cortico-cancellous 50/50 Mix

Cortical FDBA, due to its higher mineral content, has been suggested to be more resistant to compressive forces and could generate better dimensional stability following ridge preservation. In contrast, cancellous FDBA is more porous and could therefore allow for better graft vascularization and improve bone formation due to its increased surface area. Demetter, *et al.*, using a similar protocol to the Wood and Mealey study, showed that the use of cortical FDBA for ridge preservation resulted in more residual graft particles.[21] However, no differences were observed in the relative amount of native bone and non-mineralized connective tissue between the three groups. Additionally, no significant differences were observed in the dimensional ridge changes between the three groups. These three materials seem to work equally well for ridge preservation purposes.

FDBA vs. 70% FDBA + 30% DFDBA

Recently introduced commercial products combine FDBA and DFDBA into a single product, potentially leveraging their respective advantageous properties. Borg and Mealey reported that ridge dimensions were equally well maintained with the combination product and FDBA alone following ridge preservation.[22] However, the combination product generated significantly more vital bone and fewer residual graft particles after 18 to 20 weeks of healing.

Clinical significance

Given the plethora of bone grafting materials and barriers currently on the market, it may be impossible to find scientific data for each. Recent systematic reviews suggest that there is no conclusive evidence to support the use of a specific bone grafting material over another to maintain ridge dimension following extractions.[13,16,23]

While intuitively it would be advantageous to have a grafting material that would result in more vital bone and less residual graft material in the prospective implant site, it is unknown if these parameters influence short and long-term implant success.[13,24] More studies are needed to establish the superiority of one material over another. The available evidence shows that various techniques and materials can be successfully applied for ridge preservation, but a definitive conclusion as to which method and/or material should be recommended for ridge preservation remains elusive.

Leukocyte-platelet rich fibrin

Leukocyte-platelet rich fibrin is an autologous blood derivative embedded in a fibrin matrix and is rich in platelets, leukocytes, and plasma proteins. L-PRF has been promoted to accelerate soft tissue regeneration and faster wound healing, potentially reducing postoperative pain. However, it degrades within a 10-28 day period, restricting its effect to early wound healing.[16] Wang, *et al.* showed that the use of L-PRF had no significant

impact on alveolar ridge preservation and a limited effect on soft tissue healing.[16] Similarly, a systematic review by Al Maawi and Becker compared the use of L-PRF alone against its use combined with other grafting materials in ridge preservation.[25] They found that due to the longer degradation time of bone grafting materials, L-PRF cannot be used as a replacement but rather in combination with these materials. Since the benefits of L-PRF remain unquantifiable, further studies are necessary to establish its role in alveolar ridge preservation.

Timing of implant placement

How long must the clinician wait following ridge preservation before performing implant placement? Healing time among ARP studies varies from 2 to 12 months. While many studies have assessed the clinical and histomorphological outcomes of numerous bone graft materials, the timing of implant placement following ridge preservation varied widely.[20-22,26] In clinical practice, most practitioners wait 3 to 6 months before placing an implant.

Beck and Mealey showed that following ridge preservation, a healing period of 6 months did not lead to increased newly formed bone and less residual grafting material compared to 3 months when using a mineralized bone allograft and a resorbable collagen membrane.[26] While this study supports a healing time of 3 months following ridge preservation using a mineralized bone allograft and a resorbable collagen membrane, an even shorter healing time has been suggested, but needs to be validated. In a study assessing the healing times following ridge preservation with DFDBA and a collagen wound dressing barrier, Whetman and Mealey determined that significantly more vital bone was present after 18-20 weeks compared to 8-10 weeks, while ridge dimensional changes remained similar.[27]

Is ridge preservation always needed?

A study by Nevins, *et al.* assessed the effectiveness of using a deproteinized bovine bone mineral for ridge preservation.[28] The authors reported that 16 out 19 (84.2%) of the sites grafted remained stable as defined by less than 20% of crestal bone height reduction. For the non-grafted control group, 5 sites out of 17 (29.4%) remained stable. While the study demonstrated the advantage of using a xenograft to maintain the alveolar contours, it also revealed that a significant number of patients do not need ridge preservation.

So, how does the clinician determine who truly needs ridge preservation? Unfortunately, the research is limited in answering this vital question. Research does suggest that the resorption pattern following extraction is determined by the thickness of the buccal bone plate.[29-30] Huynh-Ba, *et al.* showed that the buccal bone was consistently thinner in the maxillary anterior sites (canine to canine) than in the maxillary premolar sites.[31] 87.5% of the anterior sites had a buccal bone thickness of 1mm or less, while for the premolar sites, this figure was 59.3%.

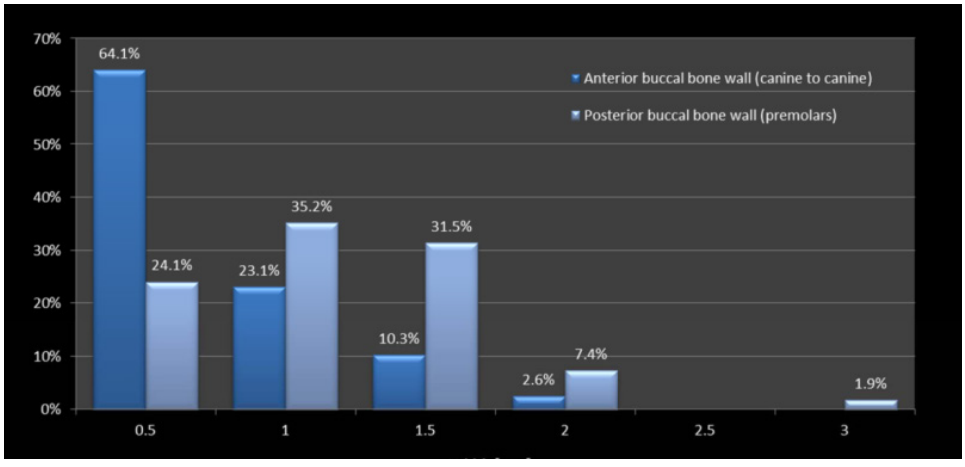
A radiographic study demonstrated that mandibular molars have a thicker buccal bone wall than mandibular premolars.[32] The mean buccal bone thickness measured at 4mm apical to the cemento-enamel junction tooth was 0.13mm, 0.23mm, 0.60mm, 0.99mm for mandibular first premolar, second premolar, first molar and second molar, respectively. Cardaropoli, *et al.* showed that in non-grafted premolar and molar sites, there was an inverse relationship between buccal plate thickness and changes in ridge width.[33] The greater the thickness, the less the ridge resorption.

These studies suggest that ridge preservation is probably warranted in anterior maxillary sites. Sites with thicker bone wall plates, especially molar sites, may be less susceptible to alveolar ridge dimension alterations following extraction.

To illustrate the latter point, Walker, *et al.* compared the healing following single molar extraction with and without ridge preservation.[34] When ridge preservation was performed, a combination of FDBA and a non-resorbable dPTFE membrane was used. Three months after extraction, radiographic ridge dimensions were determined before single implant placement. The authors reported no significant difference in ridge width reduction between the study groups. However, they noted a significant difference in ridge height, with more loss in non-ridge preserved sites. As a result, the non-ridge preserved sites were more likely to require bone grafting during implant placement (25% of the time compared to 10% of the cases with ridge preserved sites).[34]

Figure 1

Frequency distribution



Frequency distribution of buccal bone plate thickness in the anterior (canine to canine) and posterior (premolars) maxilla according to Huynh-Ba, *et al.*[31]

Technique

After local anesthesia has been delivered, the least traumatic possible extraction is performed with care to maintain all the bony walls of the extraction socket intact. For this purpose, periotomes may be preferred over larger, bulkier traditional elevators. Once the tooth has been extracted, the integrity of the buccal bone wall plate should be checked, and if all the walls are intact, the grafting procedure can be performed. Small quantities of graft are applied successively and condensed in the extraction socket. This allows for an optimal filling of the socket. The most coronal part of the socket can be covered with a collagen wound dressing before a figure eight suture is placed over the extraction site to maintain the stability of the graft.

In instances where the buccal plate has fractured, digital pressure applied on the buccal surface of the extraction site will create a soft tissue depression into the extraction site, confirming the loss of the buccal wall plate integrity. A full-thickness mucoperiosteal flap is elevated to expose the full extent of the extracted site, including the buccal dehiscence. A releasing incision, at least a tooth away from the extraction site, may be necessary for flap elevation to visualize the defect. Grafting and contouring of the site are accomplished, and a membrane is placed over the grafted site. A periosteal incision may be necessary to advance the flap coronally before it is sutured back. Given the absence of the buccal bone plate, the healing time should be extended. Post-operative care usually includes the prescription of systemic antibiotics for 7 to 10 days, analgesics and rinsing with a 0.12% chlorhexidine solution twice a day for 7 to 14 days.

Conclusion

Alveolar ridge preservation is a straightforward procedure that, if performed at the time of extraction, may prevent drastic ridge dimension alterations. This, in turn, enhances the opportunity to place the future implant, with little or no need for technique-sensitive guided bone regeneration (**GBR**) procedures.

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This guide is based on the original edition authored by Guy Huynh-Ba, DDS MS.

Figure 4

Tooth #10 has been extracted with the least traumatic technique.

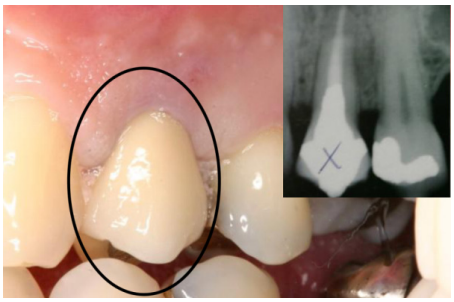
Figures 2 and 3

Tooth #10 is scheduled for extraction and ridge preservation.

Figures 5 and 6

All the walls were intact, and the site was grafted with FDBA. A resorbable collagen wound dressing was placed over the graft, and the site was sutured.

Figures 7 and 8

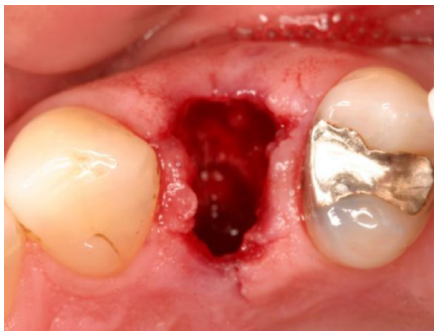


Tooth #12 is determined to be hopeless.

Figure 9

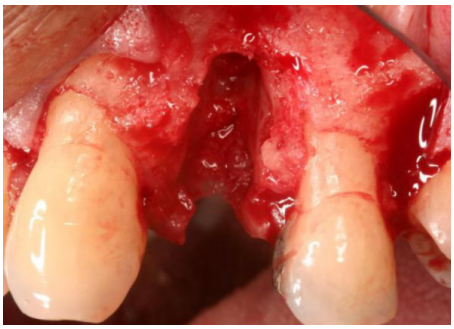
Extracted tooth #12.

Figure 10



Following extraction, loss of buccal plate integrity was confirmed with digital pressure.

Figure 11

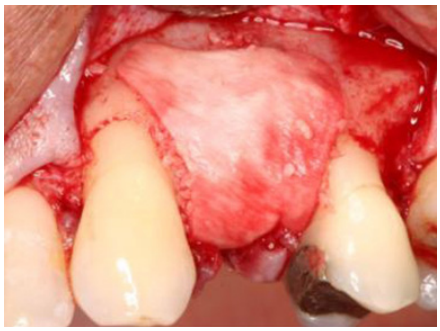


A full muco-periosteal flap is elevated to visualize the socket and expose the buccal dehiscence. Note that the incision line went intra-sulcular from the disto-facial line angle of #10 to the mesio-facial line angle of #14, where a vertical releasing incision was placed.

Figure 12

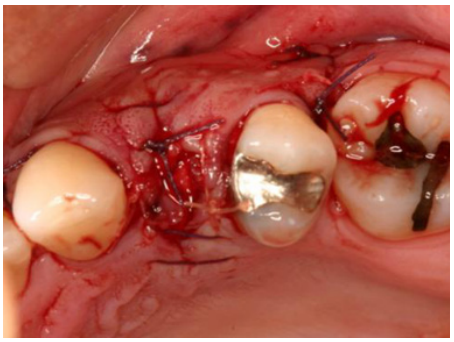
A FDBA bone graft is placed into the socket, and the contour of the ridge is recreated at the site of the lost buccal plate.

Figure 13



A resorbable collagen membrane (BioGide®) is placed over the grafted site.

Figure 14



The periosteum is incised to facilitate the coronal repositioning of the flap before suturing and to limit the membrane exposure.

Figure 15

Post-operative view at 2 weeks.

Figure 16

Implant placement is initiated 8 months following the ridge preservation procedure.

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POST-TEST

Internet Users: This page is intended to assist you in fast and accurate testing when completing the "Online Exam." We suggest reviewing the questions and then circling your answers on this page prior to completing the online exam.

(1.0 CE Credit Contact Hour) Please circle the correct answer. 70% equals passing grade.

1. **Two thirds of the ridge width reduction post-extraction happen within:**
   a. The first year
   b. The first 6 months
   c. The first 3 months
   d. The first month

2. **Following tooth extraction, which of the following statements is correct?**
   a. Ridge alveolar dimension changes will only affect the width of the ridge.
   b. Ridge alveolar dimensions changes will only affect the height of the ridge.
   c. Only the buccal plate will be resorbed in height.
   d. Both the buccal and the lingual plates will be resorbed in height.

3. **The reasons behind the marked height loss of the buccal bone include all of the following EXCEPT:**
   a. The buccal bone is thin.
   b. The buccal bone houses osteoclast progenitor cells.
   c. The periodontal fibers inserting in the buccal bone are no longer functional.
   d. The buccal bone is composed solely of bundle bone.

4. **Animal and human studies have demonstrated that an implant placed in a fresh extraction socket will:**
   a. Increase the risk of infection during the wound healing
   b. Heal similarly to an extraction socket without implant
   c. Decrease the gap to be filled with bone, thereby accelerating wound healing
   d. Maintain the alveolar bone contour

5. **The following is TRUE regarding immediate implant placement:**
   a. It reduces the risk of bone resorption of the ridge height.
   b. It reduces the risk of bone resorption of the ridge width.
   c. It prevents soft tissue from receding.
   d. It provides predictable esthetic results combined with connective tissue graft.

6. **Ridge preservation following tooth extraction allow all of the following EXCEPT:**
   a. Limit ridge width resorption.
   b. Limit ridge height loss.
   c. Decrease overall treatment time.
   d. Improve the ability to place a dental implant.

7. **Which are the best materials to be used for ridge preservation?**
   a. Allografts
   b. Resorbable membranes
   c. Alloplastic materials
   d. No specific materials can be described as being the best.

8. **If using a mineralized bone allograft (*e.g.* Puros®) for ridge preservation, how long should the site be left to heal before implant placement?**
   a. 3 months
   b. 6 months
   c. 9 months
   d. 12 months

9. **If a molar has been extracted 3 months prior to implant placement without ridge preservation, how often can one expect to perform bone grafting at the time of implant placement?**
   a. 10%
   b. 15%
   c. 20%
   d. 25%

10. **If the buccal plate has been fractured at the time of extraction, all the following steps should be undertaken EXCEPT:**
    a. Delay the ridge preservation procedure.
    b. Elevating a full thickness flap.
    c. Placing a releasing vertical incision in the flap.
    d. Incision of the periosteum.

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Evaluation - Alveolar Ridge Preservation Following Tooth Extraction 5th Edition

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