Quality Resource Guide

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. Explain the advantages of ridge preservation.
4. Give examples of materials used for ridge preservation.
5. Recognize the available scientific evidence to support specific materials.
6. Justify clinical situations for which 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?

Following tooth extraction, it is well known that the socket will undergo drastic modeling (resorption) and remodeling. As a matter of fact, Pietrokovsky already published data in 1967 regarding alveolar bone dimensions changes subsequent to tooth extraction. While the rationale, nowadays, to conduct such a study is obvious in the light of assessing bone availability for implant therapy, one may wonder what the rationale was in 1967 to design such a study. The aim, at that time, was to determine the morphologic changes and to relate it to the prospective site of a conventional fixed dental prosthesis (FDP) pontic. In other words, when a tooth is extracted and replaced by means of a FDP, where should the pontic be placed in relation to the ridge once it has remodeled? This pioneer study led the authors to conclude that following tooth extraction, the resorption of the ridge was consistently greater on the buccal than on the palatal/lingual side. As a corollary, the pontic has to be placed to the buccal of the remodeled ridged in order to occupy the position of the previous natural tooth.

More recently, Schropp *et al.* (2003) evaluated the tissues changes after premolar and molar extractions and concluded that one year following extraction 50% of the ridge width was lost. Moreover, two thirds of this resorption happened during the first 3 months.

In addition to the alveolar ridge resorption in a horizontal dimension (decrease in width), changes in vertical dimensions have been reported. Araujo & Lindhe (2005), in a canine model demonstrated that a consistently greater decrease in vertical height of the buccal bone plate in comparison with lingual plate was to be expected following tooth extraction. The authors suggested the following to explain the difference in resorptive processes between the buccal and lingual plates: The buccal plate is much thinner than the lingual plate and it is mainly compose of bundle bone, which is the portion of the alveolar bone in which collagen fibers of the periodontal ligament are embedded. The presence of bundle bone is dependent on functional periodontal fibers transmitting occlusal load from the tooth to the alveolar bone. As the function of these fibers is lost following tooth extraction, the functionally dependent bundle bone will resorb. The buccal plate being mainly composed of bundle bone, its resorption will lead to a decrease in height. In contrast, the lingual plate being wider, it is composed of bundle bone and lamellar bone. Therefore, as the resorptive process happens the bundle bone is lost but the lamellar bone remains limiting the lingual ridge height reduction.

The healing pattern of the extraction socket observed in the canine model was also confirmed in human trials (Iasella *et al.* 2003, Barone *et al.* 2008).

A systematic review (Van der Weijden 2009) concluded that following extraction a greater ridge width reduction is to be expected as compared to ridge height reduction. A mean reduction of 3.87mm and 1.87mm in ridge width and height, respectively, were reported.

Can Implant Placement in Fresh Extraction Socket Prevent Alveolar Ridge Dimensional Changes?

Earlier studies have suggested that implant placement may prevent ridge dimension alterations following tooth extraction (Denissen &Kalk 1991, Werbitt & Goldberg 1992). However, more recent animal (Araujo et al. 2005) and human studies (Botticelli *et al.* 2004, Covani *et al.* 2004, Sanz *et al.* 2010) have clearly demonstrated that implant placement could not counteract the physiologic resorptive changes following tooth extraction.

What are the Indications for Ridge Preservation?

The first indication is to minimize alveolar bone resorption and maintain the alveolar bone contour following tooth extraction for future implant placement.

Another situation where preservation of alveolar bone contour is of benefit is represented by cases where the pontic of a FDP is to be placed in an esthetically sensitive area following tooth extraction.

Evidence for Ridge Preservation:

To illustrate the advantage of performing ridge preservation a closer look at a well-designed study published by Iasella and co-workers (Iasella *et al.* 2003) is warranted. 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 extraction ridge width and height measurements were performed. Four to six months after the extraction, patients returned for implant placement and ridge measurements were repeated.

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

The authors concluded that intra-socket grafting partially prevented the resorption in width while it lead to minimal gain in height if grafting above the coronal level of the socket (over-grafting) was performed at the time of tooth extraction.

Table 1 - Ridge dimension changes following extraction alone or extraction with ridge preservation (Iasella *et al.* 2003)

	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	$p < 0.05$

Similarly, recent systematic reviews (Darby *et al.* 2009 and Vignoletti *et al.* 2012, Avila-ortiz 2019) indicated that ridge preservation procedures are effective in limiting horizontal and vertical dimensional changes in post-extraction sites.

The meta-analyses performed by Avila-Ortiz ***et al.*** indicated that ridge preservation resulted in significantly less horizontal and vertical contraction as 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.

Materials

Materials including bone grafts and membranes used for ridge preservation are similar to the ones used for guided bone regeneration (GBR) or guided tissue regeneration (GTR) procedures. Most 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). The most 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 (For review see Darby *et al.* 2009). More recent studies have also explored the use of Leukocyte-platelet rich fibrin (L-PRF) matrices to improve healing at the surgical site.

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

FDBA vs. DFDBA:

Allografts combine the advantage of unrestricted availability and the avoidance of a second surgical site for graft procurement thereby decreasing patient morbidity. FDBA and DFDBA differ in their processing resulting into respective advantageous properties. FDBA with a higher mineral content was suggested to act as a better space maintaining osteoconductive scaffold than DFDBA (Piatelli *et al.* 1996). Conversely, the demineralization process allows the release of bone morphogenetic proteins from DFDBA responsible for its unique osteoinductive property, potentially improving vital bone formation (Urist and Strates 1971).

Wood & Mealey (2012) performed ridge preservation in 40 patients which were randomized to receive either FDBA or DFDBA as a grafting material following extraction of non-molar teeth. 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 at the prospective implant site and submitted for histomorphometric analyses. Moreover, clinical dimensions of the ridge were recorded at the time of extraction and 18 to 20 weeks thereafter.

No differences were found between FDBA and DFDBA in the amount of ridge dimension alterations at time of implant placement. Conversely, the histomorphometric analyses showed that sites grafted with DFDBA resulted in significant more vital bone, consistent with its osteoinductive property, and less residual graft particles. Therefore, the clinician may prefer to use DFDBA over FDBA for ridge preservation purposes in order to obtain more vital bone at 18 to 20 weeks after grafting.

One of the disadvantages of DFDBA is that radiographically, due to the demineralized nature of the graft, the preserved site may not be readily seen on a radiograph unless a long enough time period has elapsed allowing for bone remodeling. Moreover, it has to be mentioned that 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 ultimately could allow better dimensional stability following ridge preservation. On the other side, cancellous FDBA is more porous and could therefore allow better vascularization of the graft and improved bone formation due to its increased surface area. Demetter et al. (2017) in a similar approach to the previous study showed that the use of cortical FDBA for ridge preservation resulted in more residual graft particles. However, no difference were seen 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, commercially available products have come on the market combining FDBA and DFDBA in a single product, potentially taking advantage of their respective advantageous properties. Borg and Mealey (2016) reported that ridge dimensions were equally well maintained with the combination product and FDBA following ridge preservation. However, the combination product led to significantly more vital bone and less residual graft particles after 18 to 20 weeks of healing.

Clinical Significance

Given the plethora of bone grafting materials and barriers on the market it may not be possible to find scientific data for each of them. Recent systematic reviews (Vignoletti *et al.* 2012, Atieh *et al.* 2015, Avila-Ortiz *et al.* 2019) suggest that there is no evidence to supports the use of a specific bone grafting material over another for the purpose of maintaining ridge dimensions following extractions.

Also, 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 will influence short and long-term implant success (Chan *et al.* 2013, Avila-Ortiz *et al.* 2019).

Nonetheless, further studies are needed to establish the superiority of one particular material over another. The available evidence shows that a wide variety of techniques and materials are available and can be successfully applied for ridge preservation, but definitive conclusion as to which technique and material should be recommended for ridge preservation is precluded.

Leukocyte-Platelet Rich Fibrin

Leukocyte-platelet rich fibrin is an autologous blood-derivative rich in platelets, leukocytes, and plasma proteins, embedded in a fibrin matrix. L-PRF has been described to accelerate soft tissue regeneration and promote faster wound healing resulting in potentially reduced postoperative pain. However, it degrades within 10-28 days, restricting its effect to early wound healing. Wang et al. (2021) showed that the use of L-PRF had no significant effect on alveolar ridge preservation and limited effect on soft tissue healing. Similarly, a systematic review by Al Maawi and Becker (2021) compared the use of L-PRF alone to the use of L-PRF combined with other grafting materials in ridge preservation. They found that due the longer degradation time of bone grafting materials, L-PRF cannot be used as a replacement but rather in combination with these materials. While the benefits of L-PRF remain unquantifiable, further studies are necessary to establish its role in alveolar ridge preservation.

Timing of Implant Placement

One of the questions remaining is how long does a clinician have to wait following ridge preservation before performing implant placement. While healing time among studies varies from 2 to 12 months, only one study at present has specifically tried to clarify the issue of timing of implant placement following ridge preservation.

Beck and Mealey (2010) showed that following ridge preservation a healing period of 6 months did not lead to increased newly formed bone and presence of less residual grafting material as compared to a 3 month period when using a mineralized bone allograft (Puros®) and a resorbable collagen membrane. 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 may be supported but not documented at present.

When looking at healing times following ridge preservation with DFDBA and a collagen wound dressing barrier, Whetman and Mealey (2016) showed, that significantly more vital bone was present after 18-20 weeks compared to 8-10 weeks, while ridge dimensional changes were similar.

These two studies shed some light specific to a mineralized bone allograft (Puros®), DFDBA and the respective healing times under investigation. As to what would represent the optimal healing time for other materials, the question remains unanswered.

Is Ridge Preservation Always Needed?

A study by Nevins *et al.* (2006) assessed the effectiveness of using a deproteinized bovine bone mineral (BioOss®) for ridge preservation purposes. The authors reported that 16 out 19 (84.2%) of the sites grafted remained stable as defined by less than 20% of crestal height reduction. The corresponding figure for the control (non-grafted) group was 5 sites out of 17 (29.4%). While these figures demonstrate the advantage of using BioOss® to better maintain the alveolar contour, it is interesting to note that even though no grafting was performed in the control group, some sites remained stable.

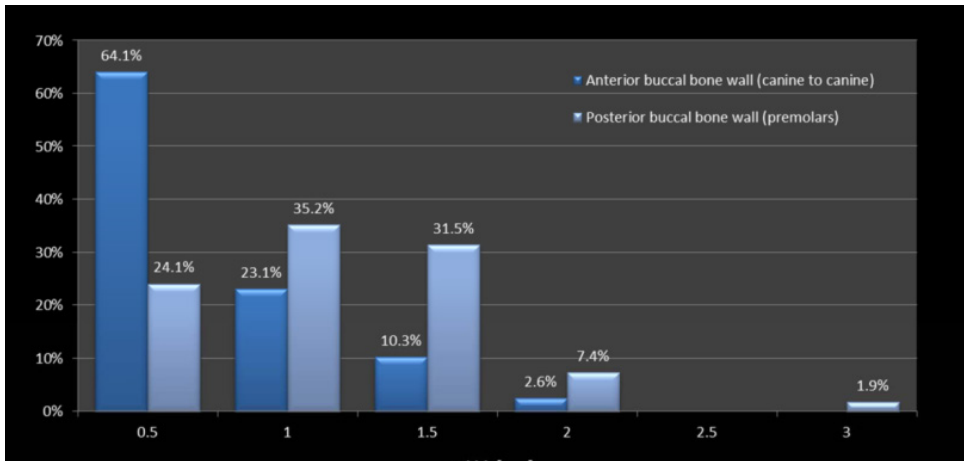
Therefore, it appears that not all extraction sites do need ridge preservation. This raises the questions as to how to identify sites that may not need ridge preservation. The literature is very scarce to try to answer this question. Recent studies suggest that the resorption pattern following extraction is determined by the thickness of the buccal bone wall (Ferrus *et al.* 2009, Brownfield & Weltman 2012).

Huynh-Ba et al. (2010) showed that the buccal plate was consistently thinner in the maxillary anterior sites (canine to canine) as compared to maxillary premolar sites. 87.5% of the anterior sites had a buccal bone thickness of 1mm or less while for the premolar sites this figure amounted to 59.3%.

A radiographic study (Braut, *et al.* 2012) demonstrated that mandibular molars display thicker buccal bone wall than mandibular premolars. The mean buccal bone thickness measured at

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.* 2010.

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. (2014) showed that in non-grafted premolar and molar sites there was an inverse relationship between buccal plate thickness and ridge width changes. The greater the thickness, the less ridge resorption was observed.

Collectively, these studies suggests that ridge preservation is probably warranted in anterior maxillary sites while sites with thicker bone wall plate, especially molar sites may not be as susceptible to alveolar ridge dimension alterations following extraction.

To illustrate the latter point, Walker *et al.* (2017) compared the healing following single molar extraction with and without ridge preservation. 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 assessed prior to single implant placement. The authors reported that no significant ridge width reduction difference was seen. However, the sites which did not received ridge preservation required more frequently bone grafting at the time of implant placement (25% of the time in extraction alone sites vs. 10% in ridge preserved sites).

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 should be applied successively and condensed in the extraction socket. This allow 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.

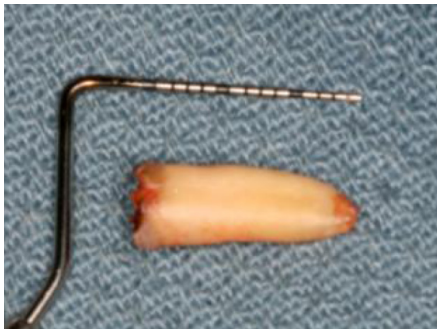
In instances where, despite careful extraction, the buccal plate has fractured, digital pressure applied on the buccal surface of the extraction site will lead to soft tissue depression into the extraction site confirming the loss of integrity of the buccal wall plate. A full-thickness mucoperiosteal flap should be 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 to allow flap elevation and access for visualization of the defect. Grafting and contouring of the site should be performed and a membrane placed over the grafted site. A periosteal incision may help in advancing the flap coronally before it is sutured back. The healing time should be extended considering the absence of buccal bone plate.

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.

Figures 2 and 3

Tooth #10 is scheduled for extraction and replacement with an implant is planned

Figure 4



Tooth #10 has been extracted with a least traumatic technique

Conclusion

Ridge preservation is a straightforward procedure and, if performed at the time of extraction, may prevent drastic ridge dimensions alterations. This, in turn, maximizes the chances to proceed with dental implant placement, once healing has occurred, with little or no need for technique-sensitive guide bone regeneration (GBR) procedures.

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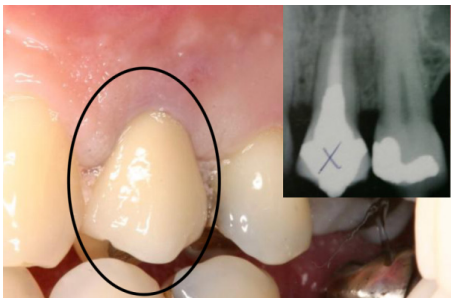
Figures 5 and 6

All the walls were intact and the site was grafted with FDBA and a resorbable collagen wound dressing (CollaTape®) was placed over the graft and the site was sutured.

Figures 7 and 8

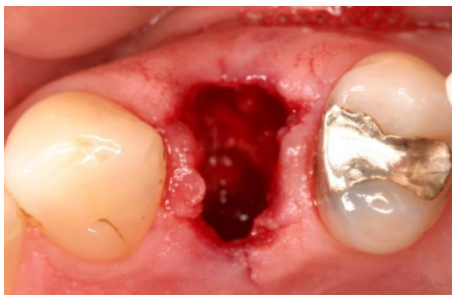


Tooth #12 was symptomatic and deemed as hopeless.

Figure 9

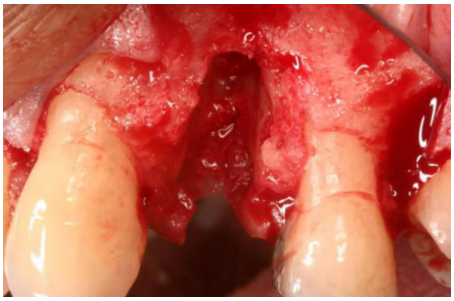
Extracted #12.

Figure 10



Following extraction of #12 all the walls of the socket were inspected. Digital pressure applied on buccal side of the extraction socket depressed the soft tissue, indicating loss of buccal plate integrity.

Figure 11

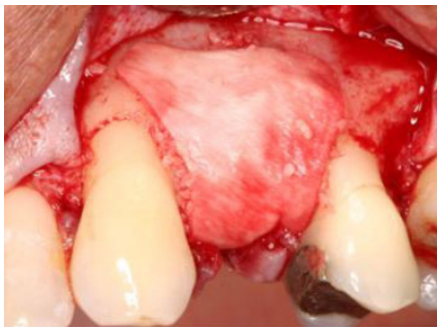


A full muco-periosteal flap was elevated in order to visualize the socket and expose the buccal dehiscence. Note that the incision line went intra-sulcular from the disto-facial line angle of #10 to the mesio-facial line angle of #14, where a vertical releasing incision was placed.

Figure 12

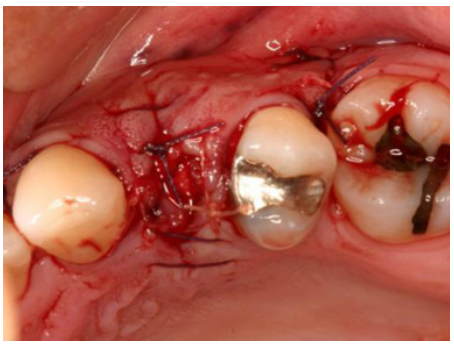
A FDBA bone graft was placed into the socket and the contour of the ridge was recreated at the site of the lost buccal plate.

Figure 13



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

Figure 14



The periosteum was incised in order 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

Site #12 at the time of implant placement, 8 months following 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. **Following extraction of a posterior tooth including molars or premolars, how much ridge width can be expected to be lost within one year?**
   a. 10%
   b. 25%
   c. 50%
   d. 75%

2. **How much of the ridge width reduction mentioned above happen during the 3 first months following extraction?**
   a. 1/10
   b. 1/4
   c. 1/2
   d. 2/3

3. **Following tooth extraction, which of the following statements 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.

4. **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.

5. **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.

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.

Registration/Certification Information (Necessary for proper certification)

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Preferred Dentist Program ID Number: _____ ☐ Check Box If Not A PDP Member

AGD Mastership: ☐ Yes ☐ No

AGD Fellowship: ☐ Yes ☐ No Date: _____

Please Check One: ☐ General Practitioner ☐ Specialist ☐ Dental Hygienist ☐ Other

FOR OFFICE USE ONLY

Evaluation - Alveolar Ridge Preservation Following Tooth Extraction 4th Edition

Providing dentists with the opportunity for continuing dental education is an essential part of MetLife's commitment to helping dentists improve the oral health of their patients through education. You can help in this effort by providing feedback regarding the continuing education offering you have just completed.

Please respond to the statements below by checking the appropriate box, using the scale on the right.

	1 = POOR 1	2	3	4	5 = Excellent 5	
1. How well did this course meet its stated educational objectives?	☐	☐	☐	☐	☐	
2. How would you rate the quality of the content?	☐	☐	☐	☐	☐	
3. Please rate the effectiveness of the author.	☐	☐	☐	☐	☐	
4. Please rate the written materials and visual aids used.	☐	☐	☐	☐	☐	
5. The use of evidence-based dentistry on the topic when applicable.	☐	☐	☐	☐	☐	☐ N/A
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8. The level to which your personal objectives were satisfied.	☐	☐	☐	☐	☐	
9. Please rate the administrative arrangements for this course.	☐	☐	☐	☐	☐	

10. How likely are you to recommend MetLife's CE program to a friend or colleague? *(please circle one number below:)*

10 **9** **8** **7** **6** **5** **4** **3** **2** **1** **0**

extremely likely — neutral — not likely at all

What is the primary reason for your 0-10 recommendation rating above?

11. Please identify future topics that you would like to see:

Thank you for your time and feedback.

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