

Alveolar Ridge Preservation Following Tooth Extraction

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 mechanism underlying.
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.

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 ridge 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 composed 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

SECOND EDITION

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relationships to disclose.

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
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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 a 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, Werbitz & 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 prevent 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 prevented partially the resorption in width while it could potentially lead to some gain in height if grafting above the coronal level of the socket (overgrafting) was performed at the time of tooth extraction.

Within the same lines, recent systematic reviews (Darby et al. 2009 and Vignoletti et al. 2012) indicated that ridge preservation procedures are effective in limiting horizontal and vertical dimensional changes in post-extraction sites.

The meta-analyses performed by Vignoletti 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 had an additional benefit over extraction alone by preventing an additional 1.83mm (WMD=1.830 mm; 95% CI [2.95, 0.73]; P = 0.001) and 1.47mm (WMD=1.47 mm; 95% CI [1.982, 0.953]; P< 0.001) resorption in width and height, respectively.

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 included allografts (Freeze-dried bone allograft (FDBA), demineralized freeze-dried bone allograft (DFDBA)), deproteinized bovine bone mineral and autogenous bone. Some studies also reported on the use of alloplastic materials, e.g. bio-glass, hydroxyapatite, calcium sulfate. The most commonly used membranes include resorbable collagen, non-resorbable expanded polytetrafluoroethylene (ePTFE) or dense polytetrafluoroethylene (dPTFE), polylactid/polyglycolic membranes and acellular dermal matrix grafts. Some studies have also successfully used collagen wound dressing materials (e.g. CollaPlug®, CollaTape®) which resorb faster than the previously mentioned resorbable membranes (For review see Darby et al. 2009).

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 that have reported the outcomes following the use of different grafting materials in a side by side comparison. Among them a series of studies that have looked at the advantages and disadvantages of specific grafting materials 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

Table 1 - Ridge Dimension Changes Following Extraction Alone or Extraction With Ridge Preservation (Iasella et al. 2003)

General Type	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

osteoconductive scaffold than DFDBA (Piatelli et al. 1996). Conversely, the demineralization process allow 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

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. Eskow and Mealey (2014) in a similar approach to the previous study showed that the use of cortical FDBA for ridge preservation resulted in more residual graft particle but less non-mineralized connective tissue compared to cancellous FDBA.

The amount of new vital bone and dimensional stability were similar for both grafting materials. Consequently, these two 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) suggest that there is no evidence to support the use of a specific 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 at this time if these parameters will influence short and long-term implant success (Chan et al. 2013).

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 a definitive conclusion as to which technique and material should be recommended for ridge preservation is precluded.

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 few studies have 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 of 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% (Table 2).

A recent 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 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.

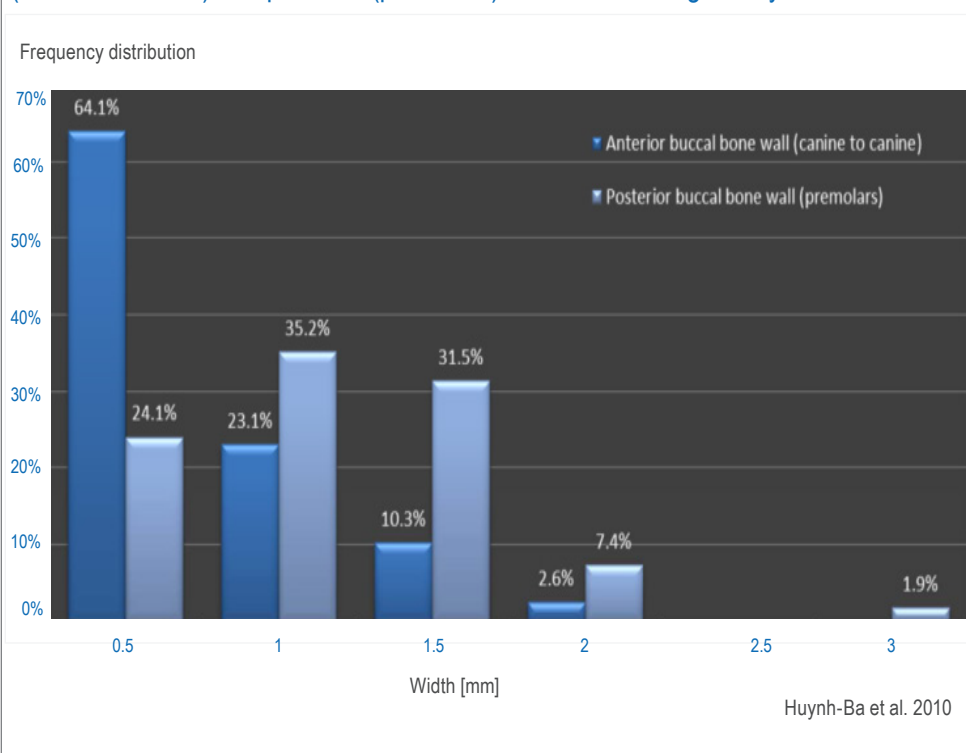
Cardaropoli et al. (2014) showed that in non-grafted premolar and molar sites there was an inverse relationship between buccal plate thickness and ridge width changes. The greater the thickness, the less ridge resorption was observed.

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. If the clinician is in doubt, the more conservative approach would recommend grafting the extraction site to minimize ridge dimensional changes.

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, periostomes 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.

Table 2 - Frequency distribution of buccal bone plate thickness in the anterior (canine to canine) and posterior (premolars) maxilla according to Huynh-Ba et al. 2010



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.

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 1 and 2



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

Figure 3



Tooth #10 has been extracted with a least traumatic technique

Figures 4 and 5



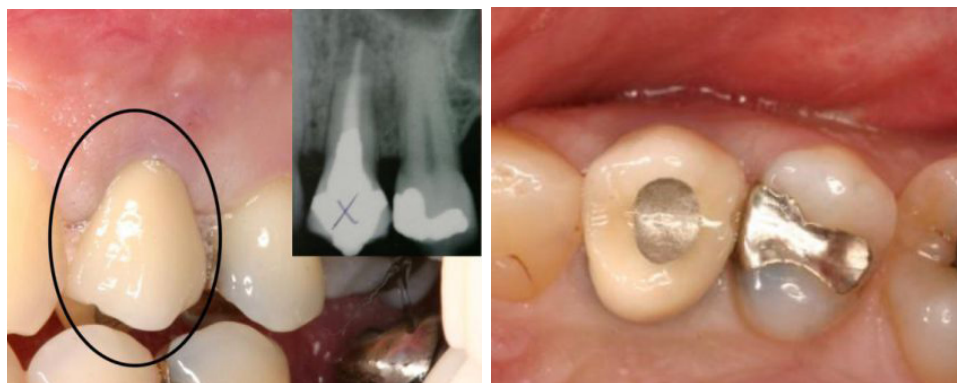
All the walls were intact and the site was grafted with FDBA and a resorbable collagen wound dressing (CollaTape®) was placed over the graft and the site was sutured.

Figure 8



Extracted #12.

Figures 6 and 7



Tooth #12 was symptomatic and deemed as hopeless.

Figure 9



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 10



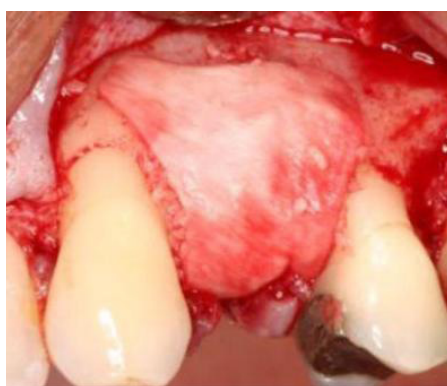
A full muco-periosteal flap was elevated in order to visualize the socket and expose the buccal dehiscence. Note that the incision line went intrasulcular from the disto-facial line angle of #10 to the mesio-facial line angle of #14, where a vertical releasing incision was placed..

Figure 11



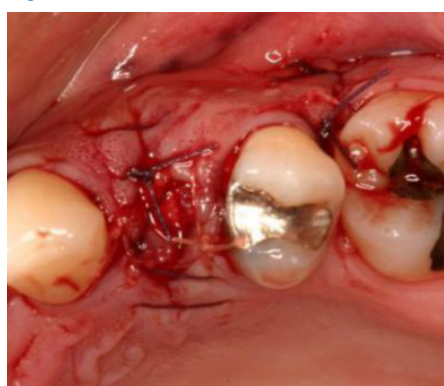
A FDBA bone graft was placed into the socket and the contour of the ridge was recreated at the site of the lost buccal plate..

Figure 12



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

Figure 13



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

Figure 14



Post-operative view at 2 weeks

Figure 15

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 happens during the first three (3) months following extraction?**
 - a. 1/10
 - b. 1/4
 - c. 1/2
 - d. 2/3
- 3. Following tooth extraction, which statement 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.
- 4. The reasons behind the marked height loss of the buccal bone include all of the followings 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 mainly of bundle bone.
- 5. Animal and human studies have demonstrated that an implant placed in a fresh extraction socket:**
 - a. Increases the risk of infection during the wound healing.
 - b. Does not prevent resorptive changes that occur following tooth extraction.
 - c. Decreases the gap to be filled with bone, accelerating wound healing.
 - d. Maintains the alveolar bone contour.
- 6. A ridge preservation procedure following tooth extraction allows all of the following EXCEPT:**
 - a. Limited ridge width resorption.
 - b. Limited ridge height loss.
 - c. Decreased overall treatment time.
 - d. Improved 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 have been shown to be the best.
- 8. If using a mineralized bone allograft 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. Which site is the least likely to need ridge preservation following tooth extraction?**
 - a. Tooth #5
 - b. Tooth #8
 - c. Tooth #11
 - d. Tooth #30
- 10. If the buccal plate has been fractured at the time of extraction, all of 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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- | | 1 | 2 | 3 | 4 | 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 |
| 6. How relevant was the course material to your practice? | ☐ | ☐ | ☐ | ☐ | ☐ | |
| 7. The extent to which the course enhanced your current knowledge or skill? | ☐ | ☐ | ☐ | ☐ | ☐ | |
| 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? <i>(please circle one number below:)</i> | | | | | | |

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.

To Complete Program Traditionally, Please Mail Your Post Test and Evaluation Forms To:

MetLife Dental Quality Initiatives Program
 501 US Highway 22
 Bridgewater, NJ 08807