

# Rationale for the Utilization of Bonded Nonmetal Onlays as an Alternative to PFM Crowns



Jose-Luis Ruiz,  
DDS



Gordon J.  
Christensen,  
DDS, MSD, PhD

Patients are becoming more interested in restoring their teeth with tooth-colored restorations, and the demand for these types of restorations continues to increase.<sup>1</sup> The goals of responsible dental clinicians continue to be preserving as much dental tissue as possible and protecting the overall health of the supporting oral tissues.<sup>2,3</sup> When only minimal tooth structure has been destroyed, a directly placed resin-based composite restoration is an ideal choice, since it fulfills the clinical requirements of conservation of tooth structure, protection of the supporting tissues, and adequate aesthetics. When a larger portion of the tooth is missing or carious, an indirect restoration is usually indicated.<sup>4</sup> In ideal circumstances, a partial-coverage cast-gold alloy restoration has been the optimal choice;<sup>5</sup> however, many patients do not want metal restorations and refuse gold (Figure 1) because they prefer aesthetic, tooth-colored restorations. For this reason, porcelain-fused-to-metal (PFM) crowns are the most popular indirect restorations for posterior teeth.

PFM crowns are radical restorations, requiring significant tooth reduction to achieve ideal mechanical retention and aesthetics. In an *in vitro* study reported by Edelhoff and Sorensen, 67.5% to 75.6% of the coronal tooth structure was removed during a crown preparation<sup>6</sup> (Figure 2). Further, a PFM crown can be traumatic to the surrounding tissue, as it usually requires tissue retraction with cords and subgingival extension of the crown margin.

Although metal-free inlays and onlays are good alternatives to PFM crowns, unexpected failure of some of these restorations may have led to their limited use. However, more recent clinical studies have shown promising results.<sup>7-10</sup> The improved results may be due to better understanding of the materials being used, better understanding of the preparation requirements, and improvements in placement techniques to avoid postoperative sensitivity.

This article presents the background and rationale for the use of metal-free inlays and onlays, fabricated from ceramic and resin-based restorative materials and luted with resin cements and adhesive systems, as alternatives to PFM crowns.

## RATIONALE FOR METAL-FREE INLAYS AND ONLAYS

When patients demand aesthetic indirect restorations, most dentists place PFM crowns.<sup>11</sup> These types of restorations have served the profession well for more than 60 years.<sup>12</sup> However, PFM crowns require aggressive tooth preparation, often requiring the removal of healthy tooth structure to achieve the needed mechanical retention form (Figure 3). Achieving an aesthetically acceptable result usually requires aggressive tissue management, which includes cord-packing to allow for the placement of subgingival margins, potentially leading to chronic gingival inflammation<sup>13,14</sup> (Figure 4). Even with subgingival margins, many PFM crowns are not aesthetically pleasing.

## ADVANTAGES OF METAL-FREE INLAYS AND ONLAYS COMPARED TO PFM CROWNS

The following are advantages of using metal-free inlays and onlays instead of PFM crowns.

### Conservative Tooth Preparation

One of the most desirable features of any partial-coverage restoration (versus a full crown) is that radical tooth preparation is unnecessary, and a significant amount of tooth structure can be conserved.<sup>15,16</sup> One of the reasons why the nonmetal onlay requires less tooth reduction is because this restoration is retained in part by adhesive chemistry and thus does not require as much mechanical retention form as is needed with conventional restorations such as PFM or gold alloy restorations. Because less tooth structure is removed, the more conservative inlay or onlay preparation will usually be farther from the vital pulp, decreasing the likelihood of adverse pulpal effects.<sup>17</sup> An added advantage is that conservative tooth preparations can be accomplished in a shorter period of time than is required for full crowns.

### Supragingival Margins

When the margins of restorations are placed supragingivally, gingival health is unaffected. Nonmetal inlays and onlays allow supragingival margin placement because the lack of a metal coping will result in a less conspicuous margin. A second reason why supragingival margins are used with metal-free onlays is

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Figure 1. This female patient was unhappy with the appearance of her gold restorations, choosing to replace them though they were clinically acceptable.

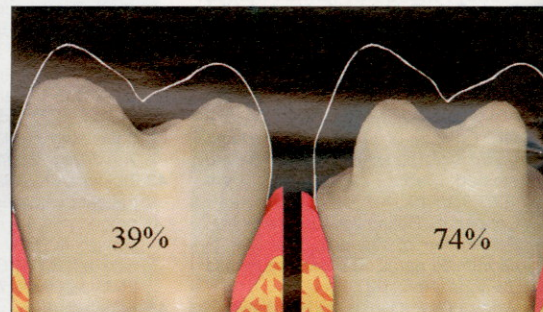


Figure 2. It is clear from these 2 preparations on the same tooth that more tooth structure has to be removed for a conventional crown preparation (right) versus a bonded nonmetal onlay (left).



Figure 3. After the removal of old PFM crowns, aggressive tooth preparation was evident. Note the subgingival margins.

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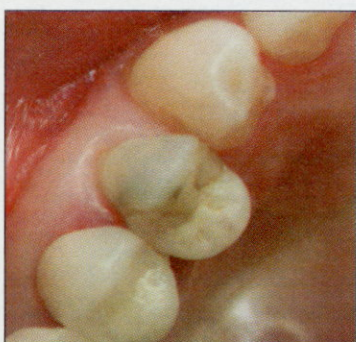
**Figure 4.** It is not uncommon to see gingival inflammation around teeth with subgingival crowns.



**Figure 5.** On the right, the same tooth is prepared for a bonded metal-free restoration. On the left, a mechanically retained-type preparation requires 3-mm axial walls.



**Figure 6.** Observe the darkened root and the opacity of the ceramic on the left central incisor restored with a PFM crown (top). The darkness and opacity disappeared when a more translucent all-ceramic restoration was used (bottom).



**Figure 7.** Metal-free onlays allow for quick detection of secondary caries or microleakage (first premolar).



**Figure 8.** Before cementation the restorations and the teeth have a different color (premolar teeth).

the lack of need for mechanical retention and the typical 3-mm minimal axial wall length (Figure 5). Even with porcelain margins, PFM crowns often have unsightly dark margins because the metal copings prevent light from shining through the crown and into the root, thus creating a shadowing effect and a root that appears darker (Figure 6).

#### Easy Identification of Recurrent Dental Caries

Tooth-colored restorations permit easier diagnosis of recurrent dental caries. One of the most troublesome features of metal restorations is their ability to hide caries radiographically (Figure 7). Experienced clinicians are familiar with removing suspicious crowns and finding extensive caries, which often require endodontic treatment and/or crown lengthening to salvage the tooth. Carious lesions sometimes are discovered too late to save the tooth.

#### Ability to Repair

A desirable benefit of adhesive restorations is their ability to be repaired, which can be accomplished predictably.<sup>18-20</sup> There are well-accepted techniques for adhering or bonding to porcelain or resin-based composite. Often, a repair can be considered instead of removal and replacement of the restoration.

#### Superior Aesthetics

Metal-free inlays and onlays can be aesthetically superior to PFM crowns. Similar to veneers in the anterior area, nonmetal onlays have the ability to blend with the underlying tooth structure and achieve more natural aesthetics. PFM crowns tend to be opaque (Figures 8 and 9).

#### POTENTIAL DISADVANTAGES OF METAL-FREE INLAYS AND ONLAYS

There has been some question concerning the longevity of metal-free indirect restorations when compared to PFM crowns. Concern that metal-free restorations have a shorter life span cannot be substantiated due to a lack of long-term studies. However, as noted previously, clinical studies with follow-up periods of 2 to 8 years have shown

promising results.<sup>7-10</sup> Even in the event that metal-free inlays or onlays require replacement, the fact that these restorations conserve more tooth structure and are less invasive of the surrounding periodontium compared to PFM crowns suggests that the tooth itself will likely remain healthy for a longer period of time.

#### CLINICAL TECHNIQUE

Tooth preparation for non-metal onlays is simple, as long as certain basic principles are followed. Teeth should be prepared with 2 mm of occlusal reduction and 1.5 mm axial reduction (when axial reduction is indicated). Sharp line angles should be avoided, and cavo-margin bevels are not usually placed unless blending the color of the tooth and restoration is important.

If the tooth preparation is close to the pulp, the dentin may be lined with a very thin layer of resin-modified glass ionomer (eg, Vitrebond [3M ESPE]).<sup>21</sup> In the event of subgingival caries or previous restorations with subgingival margins, it is possible to build up subgingival margin areas with composite before final tooth preparation, thus avoiding difficulty with isolation during cementation (Figures 10 and 11). This would be done with a matrix band and proper isolation. If the subgingival margin is too large or too deep, a crown lengthening procedure is more desirable. Impressions can easily be made with any vinyl polysiloxane or polyether impression material. Cord retraction is usually unnecessary, as most cavo-margins are supragingival (Figures 12 to 13). Because the adhesive cementation of these restorations is more challenging and technique sensitive than conventional cementation, attention to detail is necessary. The following technique can be used.

At the cementation appointment, the teeth should be properly cleansed with pumice on a rubber cup. Use of a sandblaster or micro-abrader is desirable to clean the internal areas of the preparation, especially if composite has been used to build up the tooth. A dry field

is imperative for any adhesive cementation procedure. Although use of the rubber dam provides the most predictable means of isolation, it is not compulsory for clinical success. Studies have demonstrated equally successful results with cotton isolation or without use of a rubber dam.<sup>22-24</sup> A dry field can also be achieved by careful isolation using cotton rolls and occasional cord retraction.

Nonmetal onlays must be cemented using resin cement and adhesive systems. Because postoperative sensitivity is a common problem observed when using a total-etch bonding system, and because self-etch bonding systems are more clinically forgiving in regard to humidity,<sup>25</sup> a dual-cure, self-etch bonding agent can be used successfully in combination with a dual-cure resin cement.

#### CONCLUSION

Metal-free inlays and onlays have many advantages. The primary clinical advantage is that they are less traumatic and more conservative with respect to tooth structure and surrounding tissues. Historically, the most conservative and ideal results have been obtained using partial-coverage gold alloy restorations, but their popularity is now reduced because of interest in tooth-colored restorations. At this time, ceramic or resin-based composite inlays and onlays cannot match the longevity of gold alloy restorations,<sup>26-28</sup> but further improvements in materials and techniques may eventually overcome this problem. Partial-coverage, metal-free inlays and onlays are an improvement when compared to gold in that they make it easier to detect secondary caries. This characteristic, coupled with the ease of repair offered by metal-free inlays and onlays, may increase the longevity of the tooth and restoration.

Because of the improved gingival health achieved with supragingival margins and the overall benefits of metal-free inlays and onlays, they are clearly an excellent alternative to PFM crowns. In many cases, these restorations should be considered before a PFM restoration. ♦



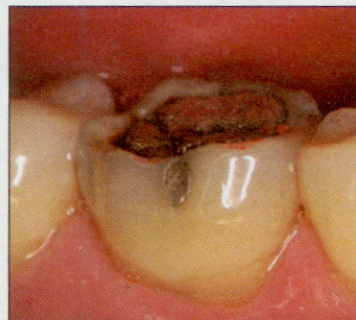
**Figure 9.** Similar to veneers, after seating with resin cement the margin between tooth structure and the restorative material is not detectable due to the optical properties afforded by the clear cement.



**Figure 10.** When carious lesions on existing restorations are subgingival, bonded restorative procedures can be more challenging.



**Figure 11.** By building up the areas of the tooth that are deeply subgingival and using a matrix band and restorative composite during preparation, a more ideal "supragingival" margin can be established. This results in a simple bonding procedure for cementation.



**Figure 12.** This fractured amalgam is carious, and would typically be restored with a PFM crown.



**Figure 13.** Excellent aesthetic result achieved with a porcelain restoration. All the margins are supragingival, promoting gingival health.

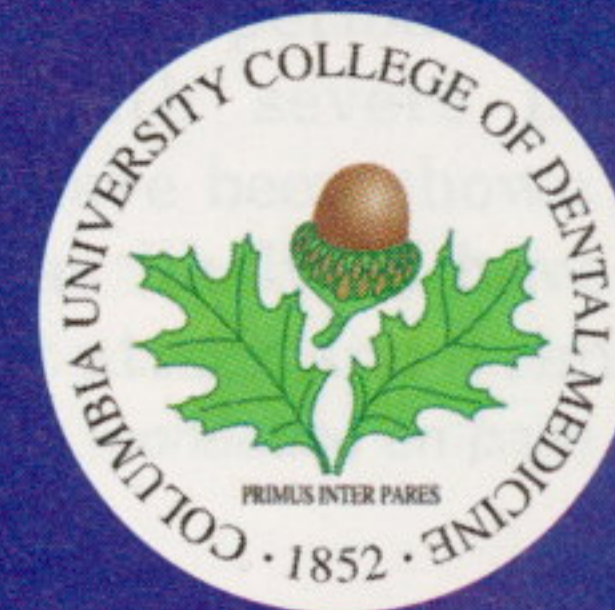
References

1. Christensen GJ. A look at state-of-the-art tooth-colored inlays and onlays. *J Am Dent Assoc.* 1992;123:66-70.
2. Christensen GJ. The coming demise of the cast gold restoration? *J Am Dent Assoc.* 1996;127:1233-1236.
3. Malone M. Cosmetic dentistry and ethics. *J Cosmetic Dentistry.* 2004;19:4.
4. Christensen GJ. A void in U.S. restorative dentistry. *J Am Dent Assoc.* 1995;126:244-247.
5. Donovan TE, Chee WW. Conservative indirect restorations for posterior teeth. Cast versus bonded ceramic. *Dent Clin North Am.* 1993;37:433-443.
6. Edelhoff D, Sorensen JA. Tooth structure removal associated with various preparation designs for posterior teeth. *Int J Periodontics Restorative Dent.* 2002;22:241-249.
7. Arnelund CF, Johansson A, Ericson M, et al. Five-year evaluation of two resin-retained ceramic systems: a retrospective study in a general practice setting. *Int J Prosthodont.* 2004;17:302-306.
8. van Dijken JW, Hasselrot L, Ormin A, et al. Restorations with extensive dentin/enamel-bonded ceramic coverage. A 5-year follow-up. *Eur J Oral Sci.* 2001;109:222-229.
9. Thonemann B, Federlin M, Schmalz G, et al. Clinical evaluation of heat-pressed glass-ceramic inlays in vivo: 2-year results. *Clin Oral Investig.* 1997;1:27-34.
10. Kramer N, Frankenberger R. Clinical performance of bonded leucite-reinforced glass ceramic inlays and onlays after eight years. *Dent Mater.* 2005;21:262-271.
11. Christensen GJ. Restoration or crown? *J Am Dent Assoc.* 1997;128:771-772.
12. Christensen GJ. Porcelain-fused-to-metal vs. nonmetal crowns [published correction appears in *J Am Dent Assoc.* 1999;130:788]. *J Am Dent Assoc.* 1999;130:409-411.
13. Larato DC. Effect of cervical margins on gingiva. *J Calif Dent Assoc.* 1969;45:19-22.
14. Silness J. Periodontal conditions in patients treated with dental bridges. *J Periodontol Res.* 1970;5:60-68.
15. Cho GC, Donovan TE. The versatile and esthetic metal-ceramic crown. *J Calif Dent Assoc.* 1996;24:39-43.
16. Meyer A Jr, Cardoso LC, Araujo E, et al. Ceramic inlays and onlays: clinical procedures for predictable results. *J Esthet Restor Dent.* 2003;15:338-352.
17. Valderhaug J, Jokstad A, Ambjornsen E, et al. Assessment of the periapical and clinical status of crowned teeth over 25 years. *J Dent.* 1997;25:97-105.
18. Gordan VV, Mjor IA, Blum IR, et al. Teaching students the repair of resin-based composite restorations: a survey of North American dental schools. *J Am Dent Assoc.* 2003;134:317-323.
19. Yap AU, Quek CE, Kau CH. Repair of new-generation tooth-colored restoratives: methods of surface conditioning to achieve bonding. *Oper Dent.* 1998;23:173-178.
20. Yanikoglu N. The repair methods for fractured metal-porcelain restorations: a review of the literature. *Eur J Prosthodont Restor Dent.* 2004;12:161-165.
21. Christensen GJ. Tooth sensitivity related to class I and II resin restorations. *J Am Dent Assoc.* 1996;127:497-498.
22. van Dijken JW, Horstedt P. Effect of the use of rubber dam versus cotton rolls on marginal adaptation of composite resin fillings to acid-etched enamel. *Acta Odontol Scand.* 1987;45:303-308.
23. Feigal RJ, Hitt J, Splieth C. Retaining sealant on salivary contaminated enamel. *J Am Dent Assoc.* 1993;124:88-97.
24. Hebling J, Feigal RJ. Use of one-bottle adhesive as an intermediate bonding layer to reduce sealant microleakage on saliva-contaminated enamel. *Am J Dent.* 2000;13:187-191.
25. Werner JF, Tani C. Effect of relative humidity on bond strength of self-etching adhesives to dentin. *J Adhes Dent.* 2002;4:277-282.
26. Donovan T, Simonsen RJ, Guertin G, et al. Retrospective clinical evaluation of 1,314 cast gold restorations in service from 1 to 52 years. *J Esthet Restor Dent.* 2004;16:194-204.
27. Christensen GJ. Longevity of posterior tooth dental restorations. *J Am Dent Assoc.* 2005;136:201-203.
28. Martin JA, Bader JD. Five-year treatment outcomes for teeth with large amalgams and crowns. *Oper Dent.* 1997;22:72-78.

**Dr. Ruiz** is the course director of the University of Southern California (USC) Advanced Esthetic Dentistry Continuum and clinical instructor at USC. He is associate instructor and mentor at Practical Clinical Courses, Provo, Utah (teaching with Dr. Gordon Christensen), and maintains a private practice in the Film Studio district of Los Angeles. He can be reached at [ruiz@drruiz.com](mailto:ruiz@drruiz.com).

**Dr. Christensen** is a prosthodontist in Provo, Utah, and is director of Practical Clinical Courses and co-founder and senior consultant of Clinical Research Associates, Provo, Utah. He is an adjunct professor at Brigham Young University and the University of Utah. He can be reached at [info@pccdental.com](mailto:info@pccdental.com).

*Disclosure: Dr. Christensen does consultant work with up to 2,000 companies. He is not committed financially to any of them.*



# Continuing Education

## Test No. 81.2

To submit Continuing Education answers, use the answer sheet on page 73. On the answer sheet, identify the article (this one is Test 81.2), place an X in the box corresponding to the answer you believe is correct, detach the answer sheet from the magazine, and mail to Dentistry Today Department of Continuing Education.

The following 8 questions were derived from the article *Rationale for the Utilization of Bonded Nonmetal Onlays as an Alternative to PFM Crowns* by Jose-Luis Ruiz, DDS, and Gordon J. Christensen, DDS, MSD, PhD, on pages 80 through 83.

### Learning Objectives

After reading this article, the individual will learn:

- the benefits of partial-coverage, indirect, metal-free restorations versus full-coverage PFM crowns, and
- the difference in preparation requirements between a mechanically retained PFM crown restoration and an adhesively retained metal-free onlay.

1. As reported by Edelhoff and Sorensen, what percentage of tooth structure is removed during a full-coverage PFM crown preparation?
  - a. 20% to 30%
  - b. 40% to 50%
  - c. 45.5% to 55.5%
  - d. 67.5% to 75.6%
2. Which is the most popular aesthetic indirect restoration today?
  - a. porcelain veneer
  - b. gold onlay
  - c. nonmetal onlay
  - d. PFM crown
3. Which of the following is a reason why metal-free onlay preparations require less tooth structure removal than a full-crown preparation?
  - a. Metal-free onlays don't require mechanical retention form.
  - b. Less preparation is better for aesthetics.
  - c. Onlay preparations use different instrumentation.
  - d. A full-crown preparation requires less tooth structure removal than an onlay.
4. A preparation margin placed \_\_\_\_\_ is healthier for the gingiva and also makes for an easier impression.
  - a. 2 mm subgingival
  - b. 1 mm subgingival
  - c. at gingival level
  - d. above the gingiva
5. The fact that metal-free onlays allow for easier detection of recurrent caries is \_\_\_\_\_.
  - a. a false statement
  - b. a benefit for the long-term survival of the tooth
  - c. not important
  - d. bad for the patient, because it may cause restorations to be remade more often
6. Metal-free onlays are readily repairable because \_\_\_\_\_.
  - a. adhesion to ceramics or resin-based composite is readily attainable
  - b. they are expensive to replace
  - c. they can't be repaired
  - d. repairing resin-based composite is possible, but repairing porcelain is not
7. Better aesthetics with metal-free inlays/onlays can be achieved because \_\_\_\_\_.
  - a. resin has better aesthetics, but not porcelain
  - b. there is no metal margin to hide
  - c. PFM has better aesthetics because it covers the entire tooth
  - d. with nonmetal onlays more attention needs to be focused on shade selection than with PFM crowns
8. When cementing metal-free onlays, \_\_\_\_\_.
  - a. a rubber dam must always be used
  - b. careful isolation is necessary, regardless of the technique used
  - c. some minor contamination is acceptable
  - d. zinc phosphate cement should be used

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