Excellence with Metal-free Onlays: Easy, Predictable, Sensitivity-free Bonded Cementation

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Educational objectives:
Upon completion of this course, participants should be able to achieve the following:
• Explain the many benefits of metal-free inlays/onlays.
• Distinguish indications for inlays/onlays.
• Explain biomechanical principles of tooth preparation specific to metal-free inlays/onlays.
• Choose which bonding systems and cements are most appropriate for use with inlays/onlays.
• Describe sensitivity-free and easy cementation techniques.

Clinical Significance
This article presents non-metal onlays as an excellent alternative to porcelain fused to metal (PFM) crowns. Non-metal onlays are slowly becoming more popular and this is due to three main reasons; first, clinicians and their patients expect more natural looking restorations. Secondly, clinicians and patients are becoming more aware of how undesirable it is to remove healthy teeth during tooth preparation. For example: in recent years, patients have become more aware of dental implants and now many of those patients see preparing or “cutting” healthy teeth for a fixed bridge as almost unthinkable. Third, and no less important, non-metal onlays allow us to perform what I call “supra-gingival dentistry,” a new approach that makes dentistry easier, better and more predictable. The combination of tooth preservation, excellent aesthetics and supra-gingival dentistry makes non-metal onlays a superb alternative to PFM crowns. I have performed thousands of non-metal onlays with outstanding results. In my experience the results out-perform...
PFM crowns and have completely replaced the use of PFM crowns in my private practice. Educating patients about their options regarding benefits, consequences and longevity is a mandatory part of the informed consent process. Post-operative sensitivity is a major problem with this type of restoration as is evident in the literature and reported by many clinicians. This article will present a cementation technique with an excellent track record in regards to both long-term results and the lack of post-operative sensitivity, using the self-etch bonding system Clearfil DC Bond and Esthetic Cement both from Kuraray.

Patients are becoming more interested in restoring their teeth with tooth-colored restorations, and the demand for these types of restorations continues to increase. The responsible clinician has the goal of preserving as much dental structure as possible during restorative interventions as well as protect the overall health of the supporting oral tissues. When caries or tooth damage is small, a directly placed resin-based composite restoration is an ideal choice, since it fulfills the clinical requirements of conservation of tooth structure, protection of tissues, and adequate aesthetics. When a larger portion of the tooth is missing or carious, an indirect restoration is usually indicated. Gold onlays are good restorations however, many patients do not want metal in their mouths and refuse gold because they prefer aesthetic tooth-colored restorations. When patients demand aesthetic indirect restorations, most dentists place porcelain fused to metal (PFM) crowns. These types of restorations have served the profession well for more than 60 years. However, PFM crowns require aggressive tooth preparation, needing to remove healthy tooth structure to achieve the needed mechanical retention forms, an estimated 67.5 to 75.6 percent of the coronal tooth structure is removed during a crown preparation. To achieve adequate aesthetic acceptability aggressive tissue management is usually required, which includes cord packing to allow for the placement of sub-gingival margins, potentially leading to chronic gingival inflammation and unsightly gray gingival margins. Even with sub-gingival margins, many PFM crowns are not aesthetically pleasing. As responsible dental clinicians, our goals should be to educate our patients on the different restorative choices, their benefits, options, negative consequences and longevity. Tooth preservation and the protection of the overall health of the supporting oral tissues is a must.

Longevity of Metal-Free Inlays/Onlays

Although metal-free inlays and onlays are good alternatives, in previous years the profession experienced unexpected failure of some of these restorations that may have led to their limited use. These unexpected failures were mostly related to the profession’s lack of knowledge and experience with respect to the specific needs of these new materials, as well as misunderstanding about adhesive dentistry. Presently, better understanding about materials and how to use them has yielded excellent clinical results as the literature can attest.

In a published retrospective clinical report study, Dr. Gordon Christensen and I evaluated 54 non-metal inlay/onlays placed approximately 51 months prior. I placed the restorations in a private practice setting. All restorations were placed on vital teeth and cemented in a dry field, without rubber dam. Clearfil Liner bond 2V was used as the self-etching bonding agent, and three different resin cements were used. The restorations were fabricated with Empress and belleGlass. Results show 100 percent retention of the restorations with 98.2 percent of the restorations having acceptable scores of Alpha or Bravo. Three restorations needed repair, but not replacement. All teeth were symptom-free and none required endodontic ther-
apy. Tissue health was excellent. This retrospective study showed the excellent clinical service provided by bonded ceramic and resin-based composite inlays and onlays cemented using a self-etch bonding system and resin cement in a typical private practice.

**Benefits of Metal-free Inlays/Onlays**

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. One of the reasons why a non-metal onlay requires less tooth reduction is because the restoration retention is assisted by adhesive measures, thus preventing tooth reduction needed to achieve mechanical retention as is needed with conventional restorations such as PFM or gold alloy restorations. Gold onlay preparation needs exact geometrical design, retention grooves, offsets and exact taper to give the necessary mechanical retention. Tooth preparation for non-metal onlays are very simple. By removing less tooth structure, the more conservative inlay or onlay preparation will usually be further from the vital pulp, decreasing the likelihood of negative pulp implications. An added advantage is that conservative tooth preparations can be accomplished in a shorter period of time than crowns.

One of the most challenging and often unsuccessful procedures in dentistry is the impression of a sub-gingival margin for a PFM crown. Sub-gingival crown preparation margins are required on a PFM crown if we hope to have an acceptable aesthetic outcome. The consequences of this sub-gingival margins placement are the need of tissue traumatizing and difficult cord packing procedure; difficult and often unsuccessful impressions procedure; difficulties isolating crown margins for proper cementation, and difficult cement clean up during crown cementation. With all of these complications it is not a surprise to see compromised results (Figure 1 & 2). When restoration margins are placed supra-gingivally, gingival health is unaffected; additionally, impression and cementation of the restoration is much more simple. Non-metal inlays and onlays allow supra-gingival margin placement because the lack of a metal coping allows for less conspicuous margins. Furthermore, bonded restorations make the need for mechanical retention unnecessary, avoiding the additional tooth removal of axial wall for mechanical retention and the required 3mm minimal axial wall length. Even with porcelain margins, PFM crowns often have unsightly dark margins. This is due to the metal copings preventing light from shining through the crown and illuminating the root, thus creating a shadowing effect and a darker looking root. I have published a technique to achieve excellent restoration margin blending using a hybrid onlay made out of pressed and layered VenusCeram porcelain (Heraeus-Kulzer). Excellent aesthetic result may also be obtained with belleGlass (Kerr), a layered laboratory quality resin composite. One more benefit of bonded onlays is their ability to be repaired, which can be accomplished predictably. There are well-accepted techniques for adhering or bonding to porcelain or resin-based composite. Often, repair can be considered instead of complete removal of the restoration.

**Technique**

Tooth preparation for non-metal onlays is simple, as long as some basic principles are followed. Teeth should be prepared with 2mm of occlusal reduction and 1.5mm axial reduction (when axial reduction is indicated) (Figures 3 & 4). Sharpline angles should be avoided and cavo-margin bevels are not usually placed unless blending the color of the tooth and restoration is critical.
Areas in dentin considered to be close to the pulp, or very deep, may be lined with a very thin layer of resin modified glass ionomer, Vitrebond (3M ESPE). It is desirable to leave the preparation margins supra-gingivally on enamel. When this is not possible due to extensive decay or sub-gingival margin of previous restoration, it is possible to perform a composite build-up to elevate the gingival margin. A restorative grade resin modified glass ionomer (RMGI) may also be used. Of course attention must be placed in order to avoid violating the biological width; if that is the case a crown lengthening surgery would be desirable. Elevating the gingival margin, when needed, will make impression and cementation of the final restoration easy and predictable. Impressions can easily be made with any vinyl polysiloxane (VPS) or polyether impression material. Cord retraction is usually unnecessary or minimal, as most cavo-margins are supra-gingival.

The adhesive cementation of these bonded restorations is crucial for success and many times it can be more challenging and technique sensitive than conventional cementation, especially to the clinician with little experience with adhesive procedures. Some techniques can be burdensome, complicated, and very demanding, but I have used the following technique for many years with excellent results.

At the cementation appointment, after the temporary restoration is removed, the tooth or teeth should be properly cleansed with pumice on a rubber cup. The use of a sandblaster or micro-abrader is also 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. Rubber dam provides the most predictable means of isolation, but it is not obligatory for clinical success. Studies by Reich, Van Djiken and others have demonstrated equally successful results with cotton isolation or without rubber dam. A dry field can be achieved by careful isolation using cotton rolls, good auxiliary support and cord retraction.

Non-metal onlays must be cemented using resin cement and an adhesive system. Postoperative sensitivity is a common problem observed by clinicians when using a total-etch bonding system as reported by CRA and also evident in the literature. Examples of these are Bargi’s published study, where three out of 21 restorations had postoperative pain at the six-month recall, and one tooth required endodontic treatment at two years. Another example is Kramer’s published report of 13 percent postoperative pain and two endodontic treatments. Because even experienced clinicians have reported these problems, alternative techniques or materials should be considered. Self-etch bonding systems have the reputation of being less likely to cause post-operative sensitivity, because they are more clinically forgiving in regards to humidity, as shown by Finger & Tani. Dr. Christensen and I have published excellent results in regards to longevity and post-operative sensitivity using Clearfill LinerBond 2V (Kuraray) a self-etch bonding system.

Because non-metal onlays are often thicker than 2mm, especially in the proximal area, a dual-cure resin cement should be used to ensure good polymerization of areas where the light may not be able to penetrate. Esthetic Cement (Kuraray) is an excellent dual cure resin cement with excellent optic characteristics. A dual-cure self-etch bonding system is desirable when using a dual cure resin cement. Clearfil DC Bond is a dual cure bonding system, made with the same technology as Clearfil LinerBond 2V (Kuraray), but with the benefit of being more simple to use with only two bottles versus four for Linerbond 2V. My clinical experience and published clinical report has shown staining of margins being a minor problem, nevertheless, research Dr. Werner Finger and I presented at IADR in 2004 showed...
improved bond strength when enamel was etched with phosphoric acid, versus self-etch bonding alone. Additionally, Perdigao has also shown in vitro that using phosphoric acid etch on enamel yielded better microseal with self-etch bonding systems. For those reasons it is desirable to selectively etch the enamel for 15-20 seconds, avoiding etching dentin as much as possible to limit the minor decrease in bond strength associated with etched dentin and self-etch bonding systems shown by research from Ruiz & Kobashigawa.

Rinse thoroughly and apply two generous coats of Clearfil DC Bond onto both dentin and enamel, continue agitating onto dentin for 20 seconds, wait an additional 10 seconds to allow the material to etch and penetrate into dentin. The surface is then treated with a mild stream of air for a minimum of five seconds to remove the solvent. Do not cure to avoid the possibility of a pool of cured bonding material interfering with the full seating of the restoration. Now the preparation or tooth should be filled with Esthetic Cement, universal shade, immediately followed by fully seating the restoration. Before curing in place remove any excess cement. Once gross cement removal is accomplished, partially cure cement and bond for approximately three seconds buccal and three seconds lingual, then remove the excess semi-firm cement with a #12 bark-parker blade.

After detailed clean up is completed, the restoration should be covered with a water-based petroleum jelly and fully light cured; this step will get rid of the oxygen inhibited layer, thus minimizing the common ditching of the margins. After final curing, the occlusion is checked, properly adjusted and the final polish is done using the Dialite (Brasseler) diamond impregnated rubber cups polishing system (Figure 5).

**Conclusion**

Metal-free inlays and onlays have many advantages, including less traumatic and aggressive tooth preparation and the supra-gingival margins placement, making them more gentle to surrounding tissues. PFM crowns, which are the preferred indirect aesthetic restoration today, have many disadvantages, including the very difficult and often unsuccessful management of sub-gingivally placed margins with all its negative implications. For this reason, non-metal onlays are clearly an excellent alternative for PFM crowns. In many cases, these restorations should be considered before the more aggressive PFM procedure. Post-operative pain has been a major concern for clinicians who perform bonded onlays, as is evident in the literature. This article presented a simple, well-documented and predictable technique for no sensitivity cementation for non-metal onlays, based on previously published success using a dual-cure combination of self-etch bonding system (Clearfil DC Bond) and a dual cure cement, Kuraray’s Esthetic Cement.

**References for this article can be found on www.dentaltown.com.**

**Author’s Bio**

Dr. Ruiz is a clinical instructor and course director of the University of Southern California’s Esthetic Dentistry Continuum. He is an associate instructor at Dr. Gordon Christensen-Practical Clinical Courses (PCC) in Utah and The Scottsdale Center for Dentistry in Arizona. He is also an independent evaluator of dental products for CRA. He is a fellow of the Academy of General Dentistry. Dr. Ruiz has been practicing in the studio district of Los Angeles for more than 18 years and enjoys a clientele of many stars and entertainers. Dr. Ruiz has made numerous television appearances highlighting his aesthetic dental makeovers, including NBC Channel 4 News, ABC’s Vista L.A. and Channel 52’s Telemundo. His focus is on treating complex cosmetic, rehabilitation, and implant cases. He lectures nationally and internationally and has published many research and clinical articles on aesthetic and adhesive dentistry.

Disclosure: Dr. Ruiz declares that neither he nor any member of his family have a financial arrangement or affiliation with any corporate organization offering financial support or grant monies for this continuing dental education program, nor does he have a financial interest in any commercial product(s) or service(s) he will discuss in the presentation.

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1. What percentage of the coronal tooth structure is removed during a crown preparation?
   a. 45% - 55%
   b. 67.5% - 75.6%
   c. 60.5% - 66.5%
   d. 70% - 76.5%

2. What are the problems with subgingival margin placement for good aesthetics on a PFM crown?
   a. Difficult cord packing.
   b. Difficult and often unsuccessful impressions.
   c. Difficult isolation during cementation and cement clean up.
   d. All of the above.

3. Which type of onlay material requires exact geometrical design, retention grooves, offsets and tapering for the necessary mechanical retention?
   a. VenusCeram
   b. Direct composite
   c. Gold
   d. Indirect composite

4. In Ruiz, Christensen et al. retrospective study, what was the mean longevity of the evaluated restorations?
   a. 24 months
   b. 61 months
   c. 51 months
   d. 55 months

5. What amount of occlusal reduction is indicated for non-metal onlays?
   a. 2mm
   b. 1.25mm
   c. 1.5mm
   d. 1mm

6. Which is a benefit for using supragingival margins?
   a. Healthier gingiva.
   b. It doesn’t require mechanical retention.
   c. To hide the margin.
   d. Use of less porcelain.

7. In published onlay studies from Bargi et al. and Kramer et al. using total-etch bonding, what was the pulp response?
   a. Long-term tooth sensitivity.
   b. Both studies had patients who required root canal treatment.
   c. No post-op sensitivity.
   d. a & b

8. What bonding system was used on Ruiz, Christensen et al retrospective study?
   a. Clearfil LinerBond 2V
   b. Gluma
   c. Flowable
   d. Prime and bond NT

9. What are the benefits of using a self-etch bonding system?
   a. You can make mistakes using it and it will be OK.
   b. Moisture control is not as crucial.
   c. Lower post-op sensitivity.
   d. b & c

10. What is an advantage for using metal-free inlays and onlays?
    a. Less costly.
    b. Less aggressive tooth preparation needed.
    c. Seamless margins.
    d. Prevention of mercury poisoning.

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