



RESEARCH ARTICLE

ONLAY PREPARATION TECHNIQUES - CLINICAL PRACTICE GUIDELINES

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ABSTRACT

Aim: The aim of this clinical practice guideline is to help dental practitioners make decisions regarding appropriate materials and techniques for onlay restorations.

Background: Onlay restorations are an excellent choice for the clinicians to restore structurally compromised posterior teeth. These restorations are bonded directly to the tooth using resin cement and can actually increase the strength of a tooth by up to 75%. Many techniques have been suggested for the preparation of onlays. Advances in adhesive system and esthetic dental materials such as composite resins and ceramics have enabled clinicians to use conservative preparations to place restorations that also reinforce the remaining tooth structures. In addition, these restorations satisfy the increasing patient expectations for a natural or enhanced appearance. More technologically developed systems with fiber - reinforced materials which can be placed in a single - visit provides optimism for the future application of these restorations to the daily clinical practice.

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INTRODUCTION

The most commonly placed partial coverage extracoronal restoration would be an onlay where weakened tooth structure can be protected without further extensive tooth removal. A common indication for an onlay would be a root-filled posterior tooth where cuspal protection is required. Root canal treatment in molars and premolars is usually the result of caries and restorative procedures and, as such, these teeth are extensively broken down and have weakened cusps. The access cavity for a root treatment removes the roof of the pulp chamber, weakening the tooth further, and can leave a limited amount of buccal and lingual tooth tissue which might be completely removed if prepared for a crown. Preservation of some part of the buccal and lingual tooth helps to retain the core and reduces the need to consider a post, especially in premolar teeth (Christensen, 2012 and Jackson, 1994). Bonding materials (including gold) to a tooth, using adhesive cements, reduces some of the need for conventional principles of retention. Onlays can be considered when there is no or little intracoronal shape to the preparation and where retention is poor. Despite the retention provided by adhesive cement, conventional concepts of tooth preparation for retention should not be ignored and, where possible, should be incorporated into the design of the preparation; routine use of adhesive cements to achieve retention poses problems if retrieval is ever

necessary (Christensen, 2012 and Jackson, 1994). Composite resin onlay restorations have gained popularity since 1980s. The direct composite onlay restoration is formed in the cavity; after an initial cure, it is removed from the cavity and postcured in a heat-and-light oven. Improved mechanical and physical properties are expected compared with direct light-cured-only composite, mainly due to the overall increase in conversion. Higher stress relaxation and improved marginal adaptation is also expected. Shrinkage is limited to a thin luting composite resin layer (Wendt, 2012). Indirect laboratory-processed composite onlay restorations also have gained increased popularity over the last decade. Heat, pressure, and nitrogen atmospheric treatment may be combined to form a relatively void-free well-polymerized resin matrix, in an attempt to improve the wear resistance of composite resin.

However, the basic chemistry remains similar to that of the direct materials (Swift, 2001). Recently, fiber-reinforced composite has been introduced as a dental restorative composite resin. These single-visit restorations are intended to be used in stress bearing areas since it has the ability to form a strong and reinforcing sub-structure. It can be used as a for the restoration of cavities where inlays and onlays would be indicated (Garoushi, 2013; Garoushi, 2007 and Garoushi, 2008). Long-term clinical studies reported no difference in clinical and mechanical properties between direct and direct heat-treated composite resin inlay/onlay restorations (Wassell, 2000).

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Overview of various onlay preparation techniques

Tooth preparation for the onlay casting

This technique was given by Dr. Jack G. Seymour in 1987. Most posterior teeth can be restored conservatively with a type II gold by using a minimal number of instruments in an organized manner. The instruments needed are No. 1157, No. 170L, and No. 282-010 carbide burs and a ½ inch fine emery disk with No. 80-7-14 and No. 10-7-14 gingival marginal trimmers (Seymour, 1987).

- Place depth penetration grooves on the occlusal surface, develop axial surfaces, and establish the traditional outline form with a No. 1157 carbide bur. Remove existing restorations and excavate caries. This may modify the conventional outline. (Fig. 1, Fig. 2, Fig. 3)

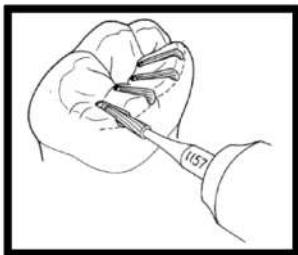


Fig. 1.

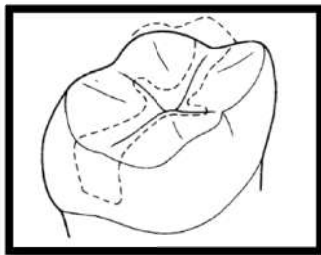


Fig. 2.

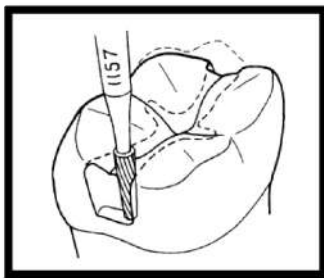


Fig. 3.

- Place the retentive grooves in ¾ crowns and prepare proximal boxes and occlusal offset for onlays with the use of a No. 170 L carbide bur. (Fig.4)

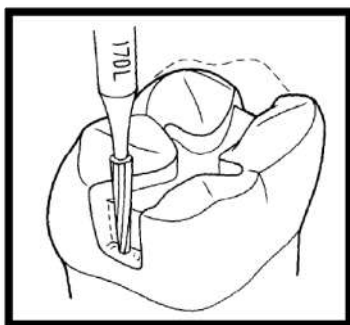


Fig. 4.

- Prepare the gingival bevel, buccal and lingual flares, and occlusal offset with the No. 282-010 bur. (Fig. 5)
- Use a fine emery disk on the proximal aspect of the preparation to finish the flares and slight hollowing that develop during use of the No. 282-010 bur.
- Define the proximal box and refine the reverse gingival

- Make impressions and pour casts of the prepared onlay. (Fig. 6)
- Try the castings on the tooth, adjust the proximal contacts, evaluate occlusal relationship, and cement the casting. Use one or two 5/8 inch "metal center" fine garnets to finish the exposed margins. After the complete set of the cement, review the occlusal surface again (Seymour, 1987).

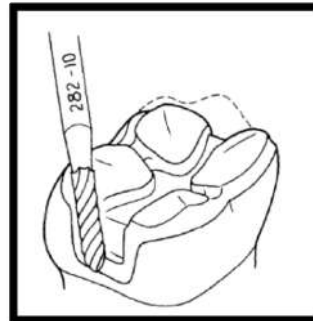


Fig. 5.

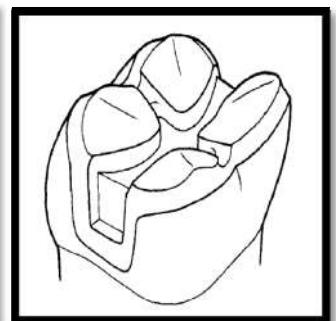


Fig. 6.

Tooth preparation for esthetic onlay

The principles of cavity preparation for esthetic inlays or onlays differ from those for gold restorations. For esthetic inlay or onlay restorations, bevels and retention forms are not needed. Resistance form is generally not necessary but may be required in very large onlay restorations. Cavity walls are flared 5 degrees to 15 degrees in total (10 degrees to 12 degrees ideal), and the gingival floor can be prepared with a butt joint. The internal line angles are rounded, the minimum isthmus width is 2 mm, and the minimum depth thickness is 1.5 mm (Christensen, 2012 and Jackson, 1994).

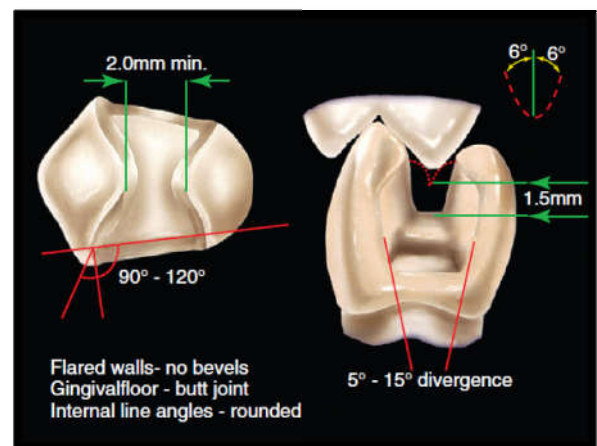


Fig. 7.

For onlay restorations, nonworking and working cusps are covered with at least 1.5 mm and 2 mm of material, respectively. If the cusp to be onlayed shows in the patient's smile, a more esthetic blended margin is achieved by a further 1- to 2-mm reduction with a 1-mm chamfer (Christensen, 2012 and Jackson, 1994). When the occlusal aspect of the cavity is prepared, undercuts should not be eliminated by removing healthy tooth structure, which compromises the conservatism of this approach. The objective is to establish divergence in the enamel, then block out all undercuts. This is possible using bonded resin or a resin-modified glass ionomer. For cemented castings it is generally best to overlay a working cusp when the

cavosurface margin is more than 50% up the incline of the cusp. The cavosurface margin can extend up to 75% up the cuspal incline of a nonworking cusp before overlaying of the cusp is considered. Studies have investigated the use of bonded inlay or onlay restorations for this area, but no clinical consensus on when to remove a cusp has been reached. Because these restorations reinforce the remaining tooth structure, the traditional guidelines for overlaying a cusp as in cast gold onlays have been modified.

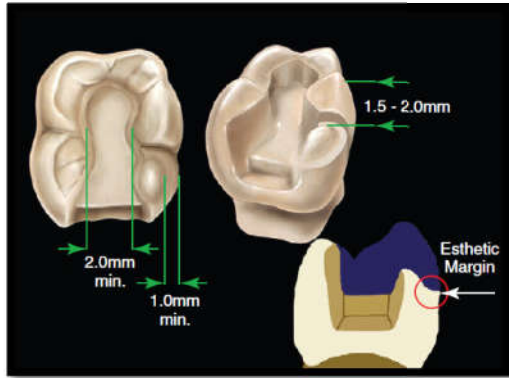


Fig. 8.

When there is no dentin support directly underneath the cusp tip, onlay restorations can be done. The palatal or working cusp is onlayed, even with dentin support if the margin is within 1 mm of the cusp tip. When the margin is beyond 1 mm from the cusp tip, the cusp gains dentin support and bond strength increases. The horizontal lines depict the direction of the enamel rods. At the cusp tip the enamel rods are almost vertical and etching would be on their sides. As the margin moves away from the cusp tip the ends become etched, which has been shown to increase bond strength (Christensen, 2012 and Jackson, 1994). The non-working or buccal cusp is not onlayed in this diagram even when the margin is at the cusp tip. If the posterior teeth are discluded in lateral jaw movements, there are no forces applied to this cusp. It is not uncommon to find cracks on the pulpal floor under cusps when removing amalgams that have been in place for some time, particularly moderate-sized ones. Whether the teeth exhibit pain on chewing (e.g., cracked tooth syndrome) or are asymptomatic, these cusps should be overlayed. A popular technique, called *immediate dentin sealing* (IDS), first described by Paul and Scharer in 1997, this technique has been clinically popularized by Dr Pascal Magne. The technique is based on the logic that the strongest dentin bond is achieved when dentin is bonded immediately after being cut and before becoming contaminated, such as occurs during the provisional phase. Besides the pulpal protection afforded by this procedure, the patient has more comfort while the provisional is in place. Finally, early data show that the ultimate bond of the restoration and the marginal integrity over time are improved.

This technique requires placement of a self-etching adhesive followed immediately after curing by a very thin layer of very-low-viscosity flowable composite resin. Any undercuts are blocked out simultaneously with the flowable resin. After curing, it is necessary to remove the air-inhibited layer. This can be done by wiping the surface with a cotton pledget soaked in alcohol. An alternative technique is to cover the surface with a glycerin product and light curing again. After washing and drying, the vertical enamel walls are prepared again with a

finishing bur to remove any adhesive that may have flowed onto these surfaces. After preparation, an impression is obtained using an accurate re-pourable material. This is sent to the laboratory with any additional models, records, or information needed to fabricate the restoration. The level of esthetics achieved with this restoration is directly proportional to the level of communication between the clinician and laboratory technician. Consequently, the color prescription must contain the occlusal base shade of the restoration, the gradient of shade from central fossa to cavosurface margin, the degree and color of the desired pit and fissure stains, and any maverick highlights present. The shade is taken before preparation to avoid the misleading effects produced in a desiccated tooth. Once this diagnostic information has been obtained, a direct provisional restoration is placed while the definitive restorations are fabricated in the laboratory.

A good deal of science is documented in studies over the past 20 years. Significant evidence details the effectiveness of the enamel bonds in terms of both bond strength and durability. For esthetic inlays or onlays, evidence supports the effectiveness of these enamel bonds with regard to tooth reinforcement. The literature lists tooth reinforcement numbers that indicate that when there are significant enamel bond surfaces, tooth reinforcement is achieved, even up to 70% to 80% of the original strength of the tooth. Clinical evidence also supports the longevity of these restorations. A significant number of patients show longevity greater than 10 years (Christensen, 2012 and Jackson, 1994). Tooth preparation for intra- and extra-coronal restorations follows the similar concepts as used for indirect restorations. The preparation should avoid undercuts between opposing walls within the cavity. All-ceramic restorations depend upon the luting cement for most of the retention, therefore a slightly over-tapered cavity is acceptable provided there are no undercuts. However, gold restorations gain most of their retention from the cavity shape and are therefore more near parallel preparations can be done for these restorations. Inlay and onlay restorations preserves tooth tissue to retain the core. If existing cavities contain undercuts they can be blocked out with composite or glass ionomer cements to provide the necessary cavity shape. Tapered burs provide the most convenient shape to prepare onlays and reduce the chance of creating undercuts. If an onlay preparation is to be cut, occlusal clearance/ reduction will be required consistent with the material chosen. The marginal configuration (shoulder, chamfer or deep chamfer) depends on the material planned (Christensen, 2012 and Jackson, 1994).

Technique for placing tooth-colored onlays

- Anesthetize the tooth if necessary
- Clean the tooth preparation with flour of pumice and water on a rubber cup
- Selectively place phosphoric acid gel on just the enamel portions of the margins and perform a standard acid etch of the enamel; this is the so-called selective etching technique
- Seat the onlay with a self-etching resin cement
- Minimally cure the resin cement residue around the margins and remove it before making the final light cure
- Floss the contact areas before providing a full light cure of the restoration to avoid difficulty in clearing cement from the contact areas

- Finish and polish the margins and correct any high occlusal areas

RECENT ADVANCES

Direct fiber-reinforced composite onlay

Recently, short fiber reinforced composite resin was introduced as a dental restorative composite resin. These direct composite restorations are now intended to be used in high stress bearing areas especially in molars. The results of the laboratory mechanical tests revealed substantial improvements in the load bearing capacity, the flexural strength and fracture toughness of dental composite resin reinforced with short E glass fiber fillers in comparison with conventional particulate filler composite resin. The short fiber composite resin has shown control of the polymerization shrinkage stress by fiber orientation and, thus, marginal micro leakage was reduced compared with conventional particulate filler composite resins (Garoushi, 2012; Garoushi, 2007 and Garoushi, 2008). For direct composite restorations, quadrant isolation is done using rubber dam sheet. The tooth to be restored is cleaned with pumice-water slurry in a rubber cup to remove salivary pellicle and any remaining dental plaque.

using composite finishing and polishing kit. Hence, these direct restorations can be placed in a single visit and allows for maximum preservation of tooth structure as well as strengthens remaining tooth structure. (Fig. 9-14: Clinical pictures of direct fiber-reinforced composite onlay restorations with 3 year follow-up – by Dr. Rubeena)

CAD-CAM approach

The computer-assisted design and computer-assisted manufacturing (CAD-CAM) approach is a valid procedure for fabricating esthetic inlays or onlays. Many of the ceramic inlays or onlays ordered by dentists today are fabricated in the laboratory using milling machines. The two machines available in the marketplace today are the CEREC (Sirona Dental Systems, Charlotte, North Carolina) and the E4D (D4D Technologies, Richardson, Texas). The quality of the restorations that can be fabricated with these milling machines in the dental office today is as good as that of laboratory-fabricated indirect resin or ceramic restorations with respect to fit and function. Both approaches depend on the commitment and skill of the operator. This can be the dentist or a dental auxiliary who actually does the design and operates the milling equipment.

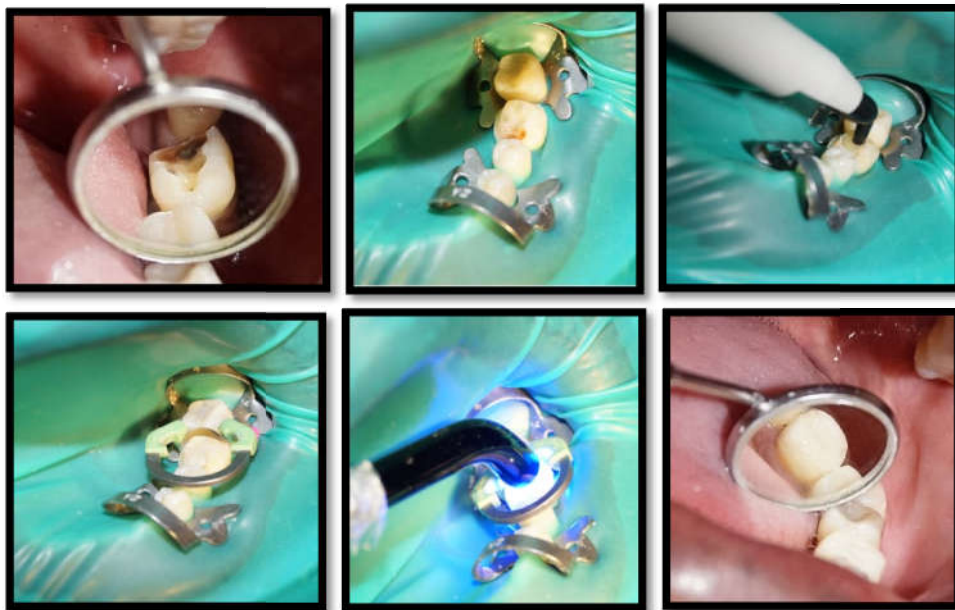


Fig. 9 – 14.

Onlay preparation is done using high-speed burs. Caries removed with low-speed burs and spoon excavator leaving discolored but hard dentin at the cavity floor. The preparations are done according to the principles of minimally invasive dentistry. In cases where the cavity is deep, MTA Plus can be given (PREVEST Denpro). The prepared tooth is restored using sectional matrix system (Triodent) that is stabilized using anatomical wedges. The bonding procedure begins with the application of self-etch adhesive (Gaenial Bond, GC) to the prepared walls. The application and placement of bonding agent is done according to manufacturer's instructions. The fiber-reinforced composite (EverX Posterior, GC) is placed and light cured according to an incremental technique. All restorations are fully covered with a layer (1-2 mm) of hybrid composite resin (Gaenial Posterior, GC). Occlusion is carefully adjusted using articulating paper. Finishing and polishing procedures are carried at same visit after occlusal adjustment

Summary and conclusion

Advances in tooth-colored materials and adhesive technology have expanded the scope of restorative dentistry. Onlays are a more conservative restorative option than are crowns. The results of research are positive regarding onlays' service potential. Numerous well-proven, as well as some new, materials such as ceramics and fiber – reinforced composite make the use of tooth-colored onlays a viable procedure.

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