Multiple Cuspal-Coverage Direct Composite Restorations: Functional and Esthetic Guidelines

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ABSTRACT

Many factors contribute to the achievement of clinical success with direct posterior composite restorations: (1) analysis of the occlusion and opposing dentition, (2) complete excavation of dental caries, (3) analysis of residual tooth structure, (4) control of polymerization stresses by using appropriate layering and curing techniques, (5) occlusal force equilibration, and (6) patient compliance to maintain good oral health. The goal of this paper was to provide a clinical protocol for the direct restoration of severely damaged posterior teeth, analyzing the benefit and limits of a similar procedure.

CLINICAL SIGNIFICANCE

This paper is intended to introduce specific esthetic and functional guidelines for the placement of cusp-capping restorations using resin-bonded composite.

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INTRODUCTION

There has been a paradigm shift from the routine use of amalgam to adhesive composite resin when restoring posterior teeth. However, teeth needing large cusp replacement restorations are usually treatment planned for indirect laboratory-fabricated composite resin, ceramic, metal, or porcelain metal restorations (onlays or crowns).

Clinical studies have reported no significant difference in the clinical success of direct and indirect composite resin restorations in the short- and long-term evaluations. Annual failure rates of 2.2% for direct posterior composite restorations, 2.9% for resin composite inlays, and 1.9% for ceramic restorations were recently reported.[1] Single-visit direct cuspal-coverage resin-bonded composite (RBC) restorations may be considered a viable alternative to conventional indirect restorations when performed in patients with either ideal[2] or less favorable occlusion.[3]

Amalgam has been the material of choice in the restoration of direct cuspal coverage of posterior teeth for many years. The failure rate of these restorations ranged from 12% at the 8-year recall[4] to 52.2% at the 15-year recall.[5]

Tooth fracture was reported as the leading cause of failure among cuspal-coverage amalgam restorations.[6] This failure was related to a very conservative tooth preparation; when placing large amalgam restorations, the replacement of weak cusps with restorative material is recommended to avoid a catastrophic failure of the tooth. This principle contradicts the

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Figure 1. Preoperative view of teeth #18 (incongruous restoration and decay) and 19 (incongruous cusp-replacing restoration).

basic guidelines of modern adhesive restorations.

Similar long-term data are not available for cuspal-coverage RBC restorations. Wear and bulk fracture resistance are the clinicians main concern when selecting direct RBC for very wide or cusp-capping restoration. Incidence of postoperative sensitivity may be very low or nonexistent for well-placed restorations.[2] RBC bulk fracture is not considered significantly worse than that of dental amalgam[7]; Letzel and colleagues[8] reported that bulk fracture is a primary reason for failure of long-lived amalgam restorations. Conversely, the wear pattern of dental amalgam and RBC differs completely and is reported to be less favorable for extensive RBC restorations.[9,10] Bayne and colleagues[11] reported that little or no net wear is observed on the occlusal surface of amalgam restorations because of a balance between filling expansion and occlusal attrition. Bayne and colleagues[12] described a protective mechanism of the worn restorative surface (macroprotection) produced by the residual occlusal enamel surface for medium-size RBC restorations. Once some RBC wear has taken place, the enamel margins may shelter the restorative surface and prevent further abrasion from the food bolus. However, the macroprotection is performed at the expense of the residual occlusal enamel surface, thus increasing the localized enamel wear rate; interestingly, sheltering may not occur for wide or cusp-replacing RBC restorations.

The aforementioned considerations prompt clinicians to select RBC with improved wear resistance. The clinician should also look to establish alternative occlusal schemes to reduce stress on residual cavity walls and/or cusps as well as provide an even distribution of forces. Forces on the occlusal table of wide RBC restorations that tend to be more evenly distributed can preserve or reduce the change of occlusal morphology (tooth and composite) over time.

The purpose of this clinical report was to introduce esthetic and functional guidelines for the placement of direct cusp-capping RBC restorations.

MATERIALS AND METHODS

Case Presentation

A 46-year-old female patient presented with an incongruous restoration in a lower molar tooth, replacing both the lingual cusps and marginal ridges (#19). The tooth was restored with a composite resin 2 years earlier. Caries on the mesial surface of tooth #18 was also detected (Figure 1). Preoperative occlusal analysis showed the concentration of the occlusal load on the residual facial wall of tooth #19 and an absence of an upper molar palatal centric stop. Because of the unbalanced occlusion, a fracture of the remaining wall can occur under mastication (Figure 2).

Figure 2. Before starting anesthesia, occlusion was checked and centric stops were recorded.

Figure 3. Cavity preparation was completed and a circular matrix was placed.

Restorative Procedure

A rubber dam was placed and the cavity was prepared in a very conservative manner, just removing the decay and/or the existing restoration with a #245 bur (Shofu Dental Corporation, San Marcos, CA, USA), rounding sharp angles with #2 and #4 burs (Shofu Dental Corporation) on both teeth #18 and 19. A caries indicator (Sable Seek, Ultradent Products, South Jordan, UT, USA) was applied onto dentin and stained nonmineralized dental tissue removed with an excavator. No bevels were placed either in the occlusal or gingival margins. A circular matrix (Automatrix-Dentsply/Caulk, Mildford, DE, USA) was placed around tooth #19 and tightened. Interproximal matrix adaptation was secured using wooden wedges (Figure 3). The cavity was disinfected with a 2% chlorexidine antibacterial solution (Consepsis, Ultradent Products). The tooth was etched for 15 seconds using a 35% phosphoric acid (UltraEtch, Ultradent Products) (Figure 4). The etchant was removed and the cavity was rinsed with water spray for 30 seconds, being careful to maintain a moist surface. A fifth generation 40% filled ethanol-based adhesive system (PQ1, Ultradent Products) was placed in the preparation, gently air thinned until the milky appearance disappeared, and light cured for 20 seconds using a Quartz Tungsten Halogen curing light (VIP, Bisco, Inc., Schaumburg, IL, USA) (Figure 5).

Vit-l-escence microhybrid composite resin (Ultradent Products) was used to restore the teeth. Stratification was initiated using multiple 1- to 1.5-mm triangular-shaped (wedge-shaped) increments; apico-occlusal placed layers of pearl smoke (PS) shade were used to reconstruct the enamel portion of the proximal surface first and then the enamel external shell of each lingual cusp (Figure 6). At this point, the stratification of dentin was started, placing a 1- to 1.5-mm even layer of A 3.5 flowable composite (PermaFlo, Ultradent Products) on deeper dentin (Figure 7), which was followed by the application of dentin wedge-shaped increments strategically placed to a single surface, decreasing the C-factor ratio (Figure 8).[13,14] For the same reason, single increments of PS enamel shade were applied to one cusp at a time (Figure 9); each cusp was cured separately, achieving the final primary and secondary occlusal morphology (Figure 10). In order to avoid microcrack formation of the remaining wall and reduce stress from polymerization shrinkage,

Figure 4. Etching was performed using 35% phosphoric acid.

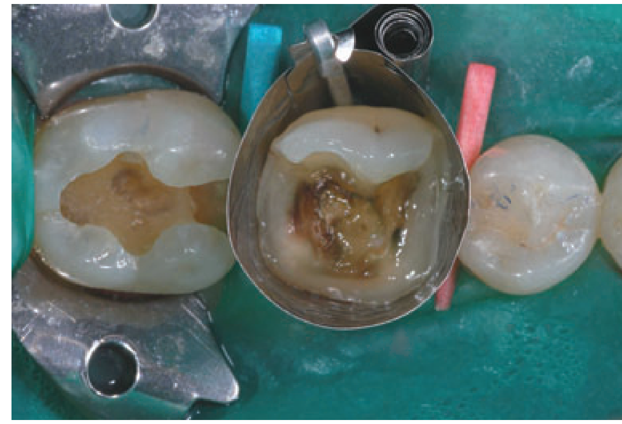

Figure 5. An ethanol-based adhesive system was applied on both enamel and dentin.

Figure 6. The peripherical enamel skeleton was built up first using pearl smoke wedge-shaped increments.

Figure 7. Dentin stratification was started, placing a 1-mm layer of A 3.5 flowable composite resin.

the authors utilized a previously described polymerization technique, based on a combination of pulse (enamel) and progressive (dentin) curing technique.[13,14]

Initial finishing of the restoration on tooth #19 was performed to obtain a smooth and anatomic distal surface. At this point, a sectional matrix (Omni-Matrix, Ultradent Products) was inserted on tooth #18; the same restorative steps described for tooth #19 were repeated for tooth #18 (Figures 11–14).

The rubber dam was removed, occlusion checked, and the restoration finished using the Ultradent Composite Finishing Kit (Ultradent Products). Initial polishing was performed with impregnated silicon rubber cups and points, and final polishing was performed with diamond and silicon carbide impregnated cups, points, and brushes (Finale Polishing System, Ultradent Products). Figure 15 illustrates the final result at the 2-week recall; occlusion was verified avoiding excessive load on the weak facial cusp

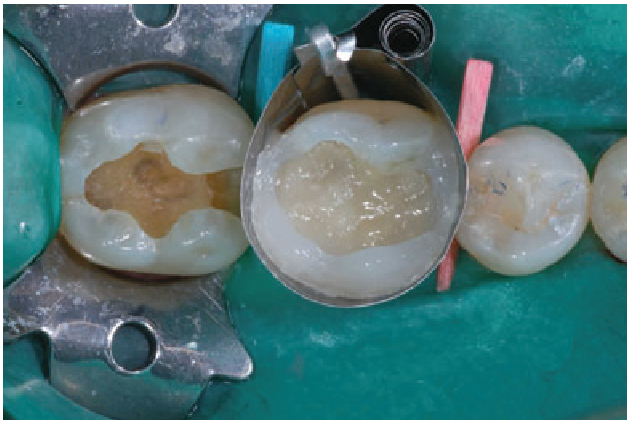

Figure 8. Dentin stratification was completed by using wedge-shaped increments of dentin shades.

Figure 9. Restoration was completed with the application of pearl smoke shade to each cusp in order to develop cusp ridges and supplemental morphology.

Figure 10. Restoration was completed with the application of pearl smoke shade to each cusp in order to develop cusp ridges and supplemental morphology.

Figure 11. A sectional matrix was secured in place using a wooden wedge; etching of the cavity on tooth #18 was performed using 35% phosphoric acid.

and achieving prevalence of an axial load (Figure 16). Interestingly, the occlusion, relative to both pre-op and post-op contact points were of the same intensity on both the canine and premolar, although a modification of the occlusal scheme was performed on molar teeth.

DISCUSSION

Cuspal coverage of severely destroyed posterior teeth may be accomplished using differing materials (composite resin or porcelain) and techniques (direct,[2] semidirect, and indirect[15]). The selection of a specific protocol should be based on bonding technique, thickness and residual tooth structure, occlusion, and the restorations present on the opposing dentition (if any).

Preservation of residual sound tooth structure is based on the concept that RBCs do reinforce weakened teeth, utilizing modern enamel–dentin adhesive systems.

Figure 12. Once hybridization was completed, the mesial proximal surface was built up and flowable composite was applied to deep dentin.

Figure 13. Dentin stratification was completed by using wedge-shaped increments of dentin shades.

Figure 14. Restoration was completed with the application of pearl smoke shade to the final contour of the occlusal surface.

Figure 15. Result at the 2-week recall.

RBC restorations rely on both macromechanical and micromechanical retention; increasing cavity size results in restorations, depending more on micromechanical retention provided by a specific adhesive technique. Adhesive systems produce bond strengths that allows clinicians to bond to tooth structure without the use of aggressive retentive cavity preparations. However, immediate dentin bonding may be challenged by the overlaying composite shrinkage; Magne and colleagues[16] reported increased bond strength following immediate dentin sealing[17] after the completion of tooth preparation for semidirect and indirect restorations. Our protocol for direct RBC restorations adopts a layering technique based on an enamel wall built up first, followed by dentin stratification; this first step requires selective curing to be accomplished, which may allow for initial dentin bonding maturation. The combination of a pulse and progressive curing strategy drastically reduces polymerization

Figure 16. Postoperative occlusal view of the final restorations after occlusion checking.

shrinkage, thus preserving the bond strength to dentin. Nevertheless, major concerns have been recently expressed regarding interfacial aging because of the degradation of the hybrid layer related to water sorption, hydrolysis of the resin, and disruption of the collagen network.[18] As a result, deterioration of the dentin-composite bond may compromise the longevity of both direct and indirect RBC restorations. Occlusal loading may contribute to this process because of the development of fatigue.

In this context, a proper occlusal scheme should be considered for the long-term preservation of structurally compromised teeth; conversely, poor occlusal design may increase the mechanical stress on residual tooth structure and be a determining factor in the failure of extensive direct RBC restorations. When restoring a significant amount of occlusal anatomy, the patient's occlusion is a major determining factor in the success of multiple surface RBC restorations.

Misch and Bidez[19] proposed an implant-protective occlusion for implant-supported restorations to reduce the stress at the bone–implant interface; the occlusal table and cusp inclination are reduced when compared with natural teeth, avoiding the transmission of lateral loads to the crestal bone. However, such criteria can be modified for natural teeth requiring extensive direct RBC restorations. They rely on both root structure and residual coronal tooth. The width of the occlusal table is preserved as well as the general occlusal scheme. Even the distribution of the centric contacts on both the restorative material and the residual cusp/marginal ridge is a key factor in avoiding overload of the weakened residual tooth structure. Centric contacts should be slightly heavier in the central area of the tooth (for instance, central fossa) and distributed along the tooth's long axis.

The thickness of the residual cusp wall both at the base and the cusp tip is a key element in the decision to preserve or eliminate cusps. Cusp coverage with a 2-mm overlap of restorative material is recommended when cusp base thickness is less than 2 mm and occlusal margins are located at the cusp tip.[20] Cusp coverage should be avoided when the cusp base thickness is more than 2 mm; Fennis and colleagues[21] reported that cusp capping increases the incidence of tooth-filling complex catastrophic failures.

The selection of the "most" appropriate restorative material for cusp-replacing restorations is, at best, a difficult choice for the most experienced clinicians. Kuijs and colleagues[22] reported that ceramic, indirect RBC and direct RBC provide comparable fatigue resistance and exhibit comparable failure modes in standardized cusp-replacing restorations. The authors suggest that the choice of restorative material should not be based on strength and failure mode alone.

The advantage of the indirect techniques is laboratory construction, which allows clinicians specific and proper anatomic shape. However, added expense, additional tooth preparation, and increased chair time are needed. Interestingly, the higher degree of conversion for the indirect resin composites, as a result of postcuring methods, does not necessarily result in a better clinical functioning restoration.[23–25] Additionally, occlusal wear of resin cement followed by ceramic and/or enamel marginal chipping and discoloration may occur with inlay/onlay ceramic restorations[26–29]; this phenomenon was related to the differing modulus of elasticity of ceramic and resin composite luting agents. Ceramic has a higher resistance to occlusal wear than resin composite but can cause increased wear of the opposing dentition.

The opposing teeth should be analyzed when performing multiple cusp-replacing restorations. When selecting direct RBC restorations, antagonist virgin teeth as well as teeth with direct or indirect RBC restorations are ideal in achieving similar wear patterns over time; conversely, the presence of partial or complete ceramic restorations as antagonists should outline contraindications for the placement of extensive direct RBC restorations. Although ceramic is considered the most "enamel-like" material, increased wear of opposing natural teeth remains a primary concern.[30–32] The wear of microfilled composite crowns against a porcelain–metal antagonist was reported to be three to four times higher than observed for porcelain or metal crowns.[33]

CONCLUSION

The future is bright with advances in RBC chemistry on the forefront. Improved physical and mechanical properties, a strict operative protocol, and appropriate bonding agents, should spell long-term success for the "direct restoration" of teeth with one or more missing cusps. Success can be achieved by fastidious technique and stepwise protocols; cavity preparation, tooth structure preservation through bonding, layering and curing techniques, and occlusal equilibration and analysis of antagonist teeth.

DISCLOSURE

The authors have no financial interest in any of the companies whose products are included in this paper.

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