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Split-increment Technique: An Alternative Approach for Large Cervical Composite Resin Restorations

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Abstract

Aim: This article proposes and describes the split-increment technique as an alternative for placement of composite resin in large cervical carious lesions which extend onto the root surface.

Technique: Two flat 1.5 mm thick composite resin increments were used to restore these cervical carious lesions. Prior to light-curing, two diagonal cuts were made in each increment in order to split it into four triangular-shaped flat portions. The first increment was applied to cover the entire axial wall and portions of the four surrounding walls. The second increment was applied to fill the cavity completely covering the first one and the rest of the four surrounding walls as well as sealing all cavity margins.

Clinical Significance: This technique results in the reduction of the C-factor and the generated shrinkage stresses by directing the shrinking composite resin during curing towards the free, unbonded areas created by the two diagonal cuts. The proposed technique would also produce a more naturally looking restoration by inserting flat dentin and enamel increments of composite resin of a uniform thickness which closely resembles the arrangement of natural tooth structure.

Keywords: Composite resin, polymerization shrinkage stress, carious cervical cavities, C-factor, split-increment, placement technique

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Introduction

Restoration of cervical lesions with composite resins requires a great deal of effort to achieve a good marginal seal and esthetic result despite their direct access.

These lesions may be produced by caries or may be non-carious. The non-carious lesions are produced by abrasion, erosion, abfraction, or may be a combination of all of these entities. Prepared cervical cavities may contain cavosurface margins which are surrounded by enamel only, by both enamel and root structure, or are completely contained within the root structure.[1]

Large carious cervical lesions extending onto the root surface and restored with composite resins are bonded incisally to enamel and dentin and gingivally to root dentin in addition to retention by a retentive groove.[2] Such restorations, if inserted in one bulk increment, may create an opening or gap especially at the gingival dentinal margin[3]; this may result in marginal leakage of bacterial fluids, molecules, and ions[4-6] leading to post-operative sensitivity, chronic hypersensitivity, recurrent caries, and pulpal complications.[7,8] This opening is caused by the development of shrinkage stresses within the composite resin which are transferred to the interfacial bond between the cavity walls and the composite resin. These stresses pull away the shrinking composite resin from the cavity walls and result in breaking the weak bond with gingival dentin.[9,10] The effect of these stresses on the quality of the marginal seal depends on their magnitude in relation to the interfacial bond strength.[11] The magnitude of these stresses is influenced by several factors including the overall shrinkage of the composite resin restorations.[3,10]

Several incremental placement techniques[12-17] were introduced for restoring such cervical lesions in order to solve this problem. The most common techniques[12-14] are diagrammatically illustrated in Figure 1.

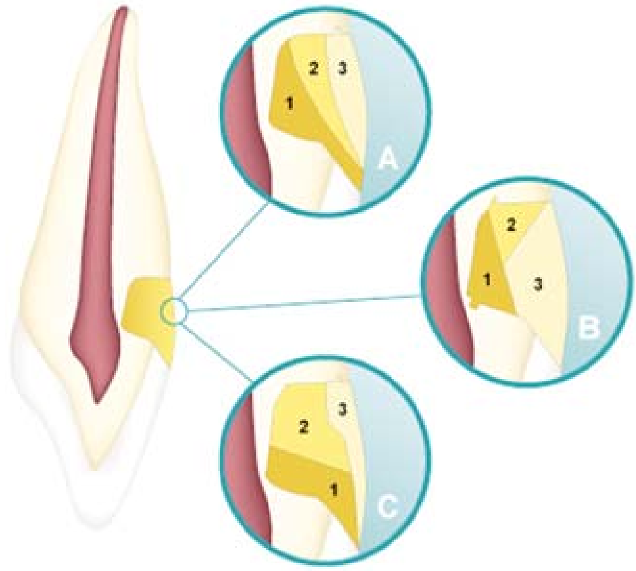


Figure 1. The most common incremental techniques utilized for restoring large carious cervical lesions.

All incremental placement techniques were intended to reduce the C-factor, which is defined as the ratio of the bonded surfaces of the restoration to its unbonded surfaces[18], and to consequently relieve the polymerization shrinkage stresses developed at the bond interface between tooth and composite resin.[11]

In each of the illustrated techniques three increments of composite resin were generally utilized for restoring the prepared cavities, and each increment was light-cured following placement. The first composite increment was placed to contact the incisal wall, while the second increment bonded to the gingival dentinal wall at the root surface. No individual composite increment was allowed to contact simultaneously the incisal and gingival opposing cavity walls during light curing.

In the technique[12] illustrated in Figure 1 A, the first increment was obliquely positioned in the prepared cavity so it covered the entire incisal wall, sealing its enamel margins and bonding to the entire axial wall as well as the incisal parts of the mesial and distal walls. The second increment was added to cover the first increment, the gingival dentinal wall to just short of retention groove, and the gingival parts of the mesial and distal walls. The third increment filled the rest of the cavity, sealing the gingival dentinal margins and providing the tooth cervical contour.

In the technique[13] shown in Figure 1 B, the first increment was obliquely positioned in the prepared cavity and bonded to the dentinal part of the incisal wall and the entire axial wall as well as the incisal parts of the mesial and distal walls. The second increment covered the entire gingival dentinal wall sealing its margins, half of the first increment, and the gingival parts of the mesial and distal walls. The third increment filled the rest of the cavity, covering the enamel portion of the incisal wall, sealing its margins, and providing the tooth cervical contour.

Whereas in the technique[14] presented in Figure 1 C, the first increment was placed in the incisal half of the preparation in such a way so it bonded to the entire incisal wall, sealing its enamel margins and also bonded to the incisal half of the axial wall. The second increment of composite was added to cover the gingival surface of the first increment, the gingival half of the axial wall, the gingival dentinal wall to just short of retention groove, and the gingival parts of the mesial and distal walls. The third increment was added to fill the rest of the cavity, sealing the gingival dentinal margins, and providing the tooth cervical contour.

The objective of this article is to propose an alternative approach for restoring large carious cervical cavities with composite resin utilizing a split-increment technique which would result in reducing the generated polymerization shrinkage stresses.

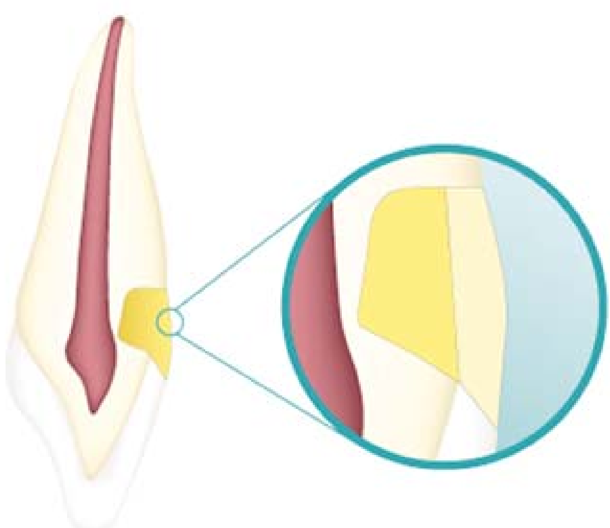


Figure 2. Large cervical composite restoration placed using the proposed technique.

Rationale for the Proposed Technique

Two 1.5 mm thick flat composite resin increments are used for restoring large carious cervical lesions which extend onto the root surface. Two diagonal cuts are made in each increment. Prior to curing they are split into four triangular-shaped flat portions. These cuts are 1.5 mm wide each and extend through the entire thickness. The first increment is applied to cover the entire axial wall and parts of the four surrounding walls. The second increment is applied to fill the cavity, covering completely the first one and contacting during light curing the incisal and gingival walls as well as sealing all cavity margins. This technique would reduce the C-factor and the contraction stresses by directing the shrinking composite resin towards the free, unbonded areas created by the two diagonal cuts.

Description of the Proposed Technique

The following is a step-by-step description of a cervical composite resin restoration placed using the proposed technique. A large typical carious cervical cavity that extends onto the root surface was prepared in a plastic tooth (maxillary right central incisor) of a dentoform model. This cavity was prepared at the cementoenamel junction (CEJ) in such a way it consisted of an incisal enamel margin and a gingival dentin margin. Point-4™ composite resin (Kerr, Orange, CA, USA) was used for restoring this cavity. The cervical composite restoration placed using the proposed technique is diagrammatically presented in Figure 2.

Shade A1 was selected for this restoration. In order to improve esthetics and provide a natural change of color in the gingival third, darker shades of composite resins were recommended for the dentin addition while lighter shades for the enamel addition.[14] In the proposed technique composite enamel shade (A1) was used to replace enamel, while composite dentin shade (A2) was used to replace dentin. Two flat composite resin increments of no more than 1.5 mm thick each were used in this demonstration. The first increment of dentin shade (A2) was placed to cover the entire axial wall and parts of the four surrounding walls and was extended incisally to the dentinoenamel junction (DEJ). This increment was left at this stage without light curing (Figure 3).

Figure 3. The first uncured flat increment (1.5 mm thick) made of shade (A2) dentin composite, covering the entire axial wall and small parts of the four surrounding walls and extending incisally to the DEJ.

Figure 4. The two diagonal cuts made in the first uncured increment splitting it into four triangular-shaped flat portions, followed by light curing for 40 seconds from the buccal direction.

Figure 5. Complete filling of one diagonal cut with shade (A2) dentin composite and light curing for 20 seconds.

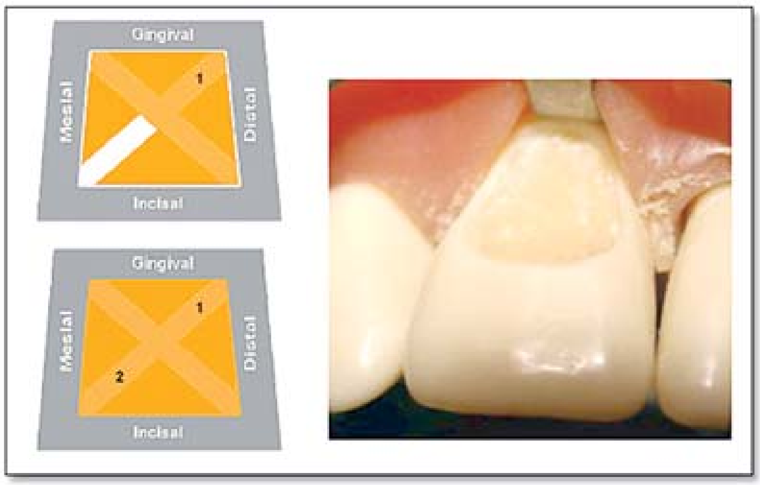


Figure 6. One half of the second diagonal cut filled with shade (A2) dentin composite and light-cured for 20 seconds (top), followed by filling and curing of the second half (bottom).

Two diagonal cuts were made in this first uncured increment using a plastic filling instrument with a blunt blade to split it into four triangular-shaped flat portions. Each cut was 1.5 mm wide and extended through the whole increment thickness. Thus, each portion covered only a small part of one of the surrounding cavity walls and a triangular-shaped part of the axial wall. The four portions were light-cured for 40 seconds from the facial direction using a Elipar® Highlight curing light unit (ESPE America, Inc., Norristown, PA, USA) as shown in Figure 4.

One diagonal cut was completely filled with the same shade (A2) dentin composite and light-cured for 20 seconds (Figure 5).

The second diagonal cut was filled so one half was filled and light-cured at a time (Figure 6).

The second increment of shade (A1) enamel composite resin was used to complete the restoration. It was added to cover the first dentin increment while contacting all "enamel" as well as the cervical "dentin" cavosurface margin of the preparation.

This increment was treated in a manner similar to the first increment. The two diagonal cuts were made in this increment, and the resulting four portions were light-cured for 40 seconds. The two diagonal cuts were then filled using shade (A1) enamel composite and light-cured. The original tooth contour at the gingival area of the crown was reproduced by shaping the enamel shade (AI) composite increment. The restoration was finished and polished with Sof-Lex XT Discs (3M Dental Products, St. Paul, MN, USA) following a standard finishing and polishing technique for cervical composite restorations. Figure 7 shows the finished restoration.

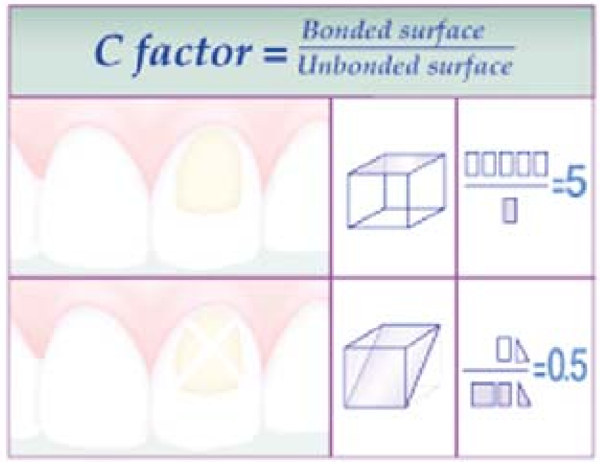
Figure 7. The finished restoration.

Discussion

The ability to achieve a complete and long lasting seal is perhaps one of the major challenges in dentistry. Incremental placement techniques have been used for restoring large cervical cavities with composite resins in order to minimize the generation of polymerization shrinkage stresses.[12-14,16] Control of such stresses improves the bond strength and marginal seal of composite resin to dentin.[15]

In the present technique two 1.5 mm thick flat increments were used. The actual number of increments needed depends on the volume of space undergoing restoration, with larger lesions requiring more incremental applications of composite resin.

The ability of a composite resin restoration to relieve the stresses generated from the polymerization shrinkage is related to the C-factor of such restoration.[19-22] In the proposed technique relief of such stresses was achieved through the use of two diagonal cuts to split each flat increment into four triangular-shaped portions before light curing. This would reduce the C-factor from the ratio of five, obtained when one increment connects the cavity floor with the four surrounding walls, to an approximate ratio of 0.5 when each triangular-shaped portion of the split-



increment was bonded to only one surrounding cavity wall and one fourth of the floor.

The free, unbonded composite surfaces created by the two diagonal cuts would convert the restricted shrinkage occurring on the cavity walls prior to splitting to unrestricted shrinkage. This serves as a reservoir for flow or plastic deformation in the initial stage of polymerization. During light curing, the diagonal cuts would prevent the strong enamel bond at the incisal wall from competing with the weak dentin bond at the gingival wall which would eventually lead to preserving the marginal integrity of the restoration.

Composite filling and light curing of 1.5 mm wide diagonal cuts in each increment were performed so one diagonal cut was completely filled and light-cured, followed by filling and curing of one half of the second diagonal cut at a time. This sequence would prevent composite resin from connecting two opposing cavity walls at the same time, thereby, minimizing the development of the detrimental polymerization shrinkage stresses on adhesive interfaces at cavity walls and margins.

Placement of flat dentin and enamel increments of uniform thickness would produce a more naturally looking restoration by closely resembling the arrangement of natural tooth structure.

Marginal integrity and microleakage *in vitro* experiments are underway in our laboratories in order to evaluate the effect of the proposed technique on the quality of margins in large carious cervical composite restorations and to also compare the findings with those of other existing placement techniques. The effect of reduced curing rates on marginal sealing and adhesive bond strength of composite resins placed using the proposed technique is also being investigated.

Clinical Significance

The split-increment technique proposed for restoring large carious cervical cavities with composite resins would be helpful to minimize the development of polymerization shrinkage stresses on the adhesive interfaces at such cavity walls, especially the gingival dentinal wall. This minimization of stresses is achieved by reducing the C-factor of each flat increment from the ratio of 5.0 before splitting to approximately 0.5 where each triangular-shaped flat portion of the split-increment is allowed to contact only two non-opposing cavity surfaces during light curing. The proposed technique would also result in a more naturally looking restoration by placing flat dentin and enamel increments of uniform thickness which closely resemble the arrangement of natural tooth structure.

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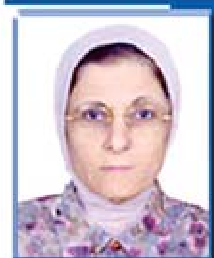

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