Create Biomimetic Class II Direct Composite Restorations Using a Sectional Matrix System

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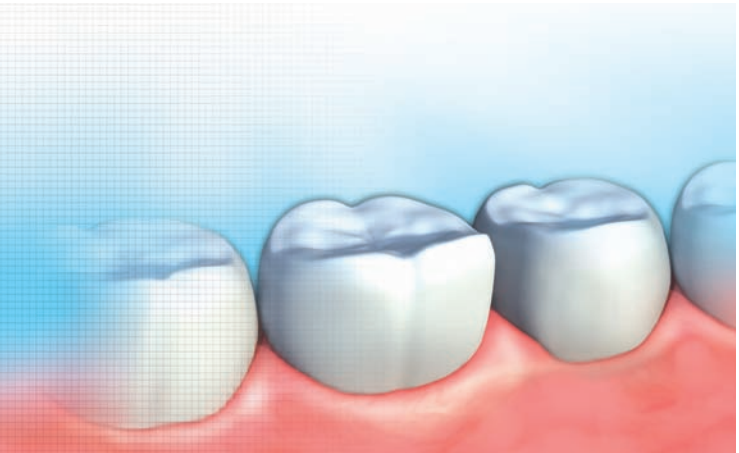

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Educational objectives

Upon completion of this course, participants should be able to achieve the following:

1. Understand the requirements of a matrix for creating Class II restorations.
2. Understand the difference between adhesive preparations and amalgam preparations.
3. Understand the appropriate treatment for structural defects.
4. Understand how different materials replace different parts of the tooth.

The immediate clinical challenge to a successful posterior direct composite restoration is recreating the optimal proximal contour and establishing an ideal contact with the adjacent tooth with a restoration that recreates the tooth's original physical properties (biomimetic dentistry). While several different matrix systems have been successfully used for decades for use with amalgam, they have yielded less predictable results with composite restorations. Matrix systems for composites, due to the unique requirements for composite placement, have evolved to today's products that have improved design specific to the requirements for composite placement. In this article the authors will apply biomimetic concepts to the direct Class II composite resin using an innovative sectional matrix system to create a predictable proximal contour and contact.

Background

Amalgam has been the material of choice for Class II restorations for more than a century.[4] The classic amalgam preparation frequently required breaching sound tooth structure. Restorations, even of minimal proximal lesions, seemed

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to result in the loss of a greater volume of healthy tooth structure than was originally infected with dental caries. Preparations for amalgam restorations required application of the G.V. Black principle of "extension" of the prep for "prevention" of recurrent caries and a geometric, undercut preparation design for retention of the restorative material.

While the general approach today in restoring a Class II lesion with composite can be much more conservative one with minimal extension beyond the caries, it is still very common to treat recurrent decay under failed amalgam restorations. The clinician must often contend with large preparations that need to be restored in a way that the physical properties of the tooth are replicated by the restorative material.

Another conspicuous departure from amalgam preparation design is that there is no need for undercuts to retain the restorative material. Classic amalgam design creates a "gingival" portion that is wider than the "occlusal" portion to provide a mechanical means of retention and a design to prevent dislodgment. Bonded composites, in contrast, are retained by adhesive bonding to dentin and enamel making undercuts unnecessary. Undercuts in indirect restoration preparations can create a high-stress restoration when used with composite. Actually, the "undercuts" might in fact interfere with the easy placement of the restorative material and increase the C-Factor of the final restoration.

Biomimetic Dentistry

The concept of using dental materials to mimic the natural structure of the tooth is the goal of restorative dentistry. The procedures necessary to accomplish this have been described at the Alleman-Deliperi Center for Biomimetic Dentistry* as follows:

1. Eliminating infections and cracks in dentin.
2. Immediately sealing dentin.
3. Bonding the tooth side to side, front to back and top to bottom to prevent re-infection and new crack initiation.
4. Lowering stress/strain in the tooth/restoration.
5. Resisting loss of tooth structure from attrition, abrasion, erosion and abfraction.
6. Matching the tooth's functional anatomy.

The procedure as outlined below is based on the protocol for composite resin placement known as "Six Lessons" that was developed at the Alleman-Deliperi Center for Biomimetic Dentistry in South Jordan, Utah.

The Six Lessons* are as follows:

Lesson 1 – Remove decay and disinfect dentin
Lesson 2 – Remove structural defects
Lesson 3 – Dentin bonding
Lesson 4 – Control of C-factor
Lesson 5 – Onlay preparation
Lesson 6 – Occlusal balancing

*www.allemancenter.com

Clinical Procedure for Class II Direct Composite Restorations

1. Isolate and clean the tooth and pre-etch the enamel


Fig. 1

Once the appropriate case is selected (Fig. 1) the operative field is isolated in the usual manner. Proper isolation greatly aids in retraction of oral structures and in minimizing salivary contamination. While the rubber dam offers the most effective isolation, there are occasions such as insufficient bulk of tooth structure, limited access, and patient cooperation that preclude its use. Nonetheless, the operator should do his/her best to place the rubber dam, especially on lower molars where the tongue and pooled saliva can easily contaminate the preparation surface.

The authors recommend the use of an antibacterial self-etch adhesive on the cut enamel and the cut dentin. The chief reasons for using this specific adhesive product are its relative ease of use, its ability to disinfect the dentin and to create a strong, predictable dentin-resin bond. Self-etch adhesives however, do not etch uncut enamel as well as phosphoric acid, and so the author utilizes a pre-etch treatment of phosphoric acid onto the tooth prior to beginning the preparation (Fig. 2). First, the pellicle layer is removed with either a slurry of coarse pumice or by air abrasion. Also, sodium hypochlorite can be scrubbed into grooves in order to remove organic matter. Then, phosphoric acid gel (K-Etchant Gel, Kuraray) is applied to the uncut enamel, left undisturbed for 15 seconds and then rinsed.

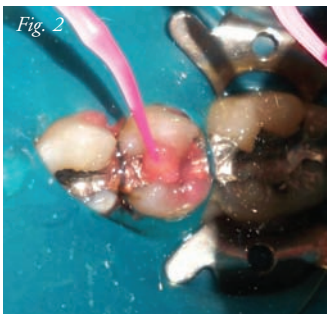
Fig. 2

2. Remove old restorations, cracks and decay without exposing the pulp

Over time and function, old amalgam restorations fail, allowing recurrent decay and cracks to form in the dentin substrate. These cracks are structural defects that will continue to propagate and cause post-operative pain and potential failure unless they are carefully removed. So, the first objective in this protocol is to access the caries with a minimal loss of uninvolved tooth structure. Once the old fillings are removed, then under magnification of at least 4.5x and by using transillumination, the clinician must remove all dentin cracks completely using a #4 round bur or diamond. When a

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crack appears to have propagated into the pulp, the clinician should respect the pulp's integrity and avoid breaching the pulp rather than doing elective endodontics unless irreversible pulpal symptoms and/or a periapical lesion exist. Cracks that undermine cusps must be removed completely, and if only a thin cusp remains, then an onlay restoration needs to be planned.

Next, all caries must be thoroughly debrided from the preparation, however, establishing the proper endpoint for caries removal without pulp exposures is unpredictable if the clinician depends solely on the tactile use of the explorer tip. Consequently, the use of a biologic stain to reveal infected and then affected dentin provides a more consistent yardstick toward effective removal of diseased tooth structure.

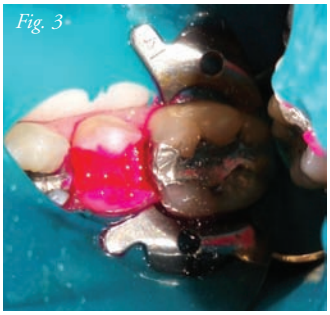
Fig. 3

Caries Detector Solution (Kuraray) (Fig. 3) is applied to cut tooth structure and once rinsed, will reveal caries-infected dentin (stains red) and caries-affected dentin (stains pink). Caries debridement is best accomplished by first using a flat-ended diamond stone (F-60, Pollard Dental Products) to create a "bondable ring" that completely eliminates caries from the periphery of the restoration such that there is no red or pink stain 1.5 to 2.0mm inside of the DEJ. Then, using a sharp #2 or #4 round carbide bur on the low speed handpiece with continuous irrigation to dissipate frictional heat, caries is removed from the dentin surface until the red stain is gone. Then the process is repeated until only a "pink haze" remains. Further cutting can lead to a pulp exposure, which the operator should carefully avoid.

Most Class II preparations utilizing adhesive dentistry are far more conservative of tooth structure than what is required for amalgam or cast gold. This is highly desirable since removal of tooth structure tends to create pulpal changes as well as weaken remaining tooth structure. The preparation design should be as minimal as possible with the following additional distinctions from classic amalgam prep designs:

1. General shape of the preparation should widen slightly toward the occlusal to facilitate composite resin placement.
2. Cavosurface margin should be beveled to prevent bonding only to the side of an enamel rod column that is weaker than bonding across the ends of multiple rod columns.
3. Any undercuts that remain following caries and crack removal should be modified so that the C-Factor of the restoration is minimized. This will give smooth confluent surfaces without sharp angles.

3. Place the sectional matrix band assembly

Dental amalgam is often condensed into the proximal cavity prep by using the Tofflemyre Matrix with a metal band to contain the filling material. With the advent of composite resin materials the Tofflemyre became less useful in creating a proper proximal contour and a consistent contact with the adjacent tooth. Further, its design makes it difficult to use on a tooth that has been clamped for securing the rubber dam. However, it still has certain applications in larger, more complex restorations that require buildup of buccal and lingual surfaces.

The function of a matrix band is to replicate the missing wall of the tooth so that the restorative material can be used to create the proper contour and consistent adjacent tooth contact. An effective means of accomplishing this objective with composite resins is with the use of the sectional matrix. The small section of a sectional matrix band is pre-contoured at the point of manufacture, and sized, then "precurved" and placed interproximally using a specialized forceps (Fig. 4). It is then wedged to create tooth separation and a tight seal at the gingival margin (Fig. 5). The plastic wedges (Wedge Wands Garrison Dental Solutions) represent an advance over the older wooden wedges because they more accurately conform to the embrasure and fit more securely with the ring, especially with the 3D ring that "straddles" the wedge. A correctly sized plastic wedge is selected, then the band is stabilized with the operator's finger, then inserted into the embrasure. The "wand" portion of the wedge facilitates easy placement, then twists off leaving the wedge in its proper position. Even if the operator believes that the sectional matrix is fitting tightly at the gingival margin, the use of the wedge is nonetheless mandatory so to avoid overhangs, bond failures, post-operative sensitivity and recurrent caries.


Fig. 4


Fig. 5

When the ring assembly is seated into position (Composi-Tight 3D-Ring Garrison Dental Solutions) the band and wedge are securely positioned in preparation to contain the restorative material. Air drying the interproximal as well as seating the ring and rotating it into position as far gingivally as possible will improve ring retention. The function of sectional matrix ring is to adapt to and seal the buccal and lingual ends of the matrix band against the tooth and with some models, (Composi-Tight

3D ring) provide a separating force that in turn requires the wedge to be inserted further in order to provide the maximum seal at the gingival margin.

The ring must properly engage the buccal/lingual tooth surfaces to avoid excessive extrusion of restorative material through these unsealed margins that would require extra contouring and finishing. The tooth separation from the dual action of the wedge and ring is needed to compensate for the polymerization shrinkage of the restorative material as well as for the thickness of the matrix band itself.

The final contour of the sectional matrix involves the use of an instrument to burnish the band against the adjacent tooth to assure a tight contact once the band is removed. A specialized multifunctional instrument (TN0009, Garrison Dental Solutions) contains two burnishers that are specifically designed for this purpose. Together, the ring, wedge, and contoured band create a predictably tight interproximal contact that resists food impaction (Fig. 6).

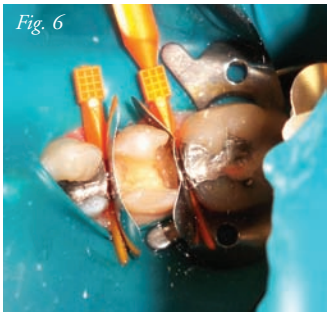
Fig. 6

4. Create the bond to the cut enamel and the dentin

Composite resin restorations require a secure bond to the cut dentin and enamel. The author recommends the use of an antibacterial self-etch adhesive (Clearfil Protect Bond, Kuraray). Self-etching adhesives maintain the smear layer that forms on the cut dentin surface following preparation with burs or diamonds, and use it to create a strong, biocompatible hybrid zone without the technique sensitivity of using a phosphoric acid pretreatment. By avoiding the demineralizing effects of phosphoric acid on cut dentin, the dentinal tubules remain occluded and intratubular fluid movement along with its dentin hypersensitivity is reduced and many times completely eliminated.

Self-etch adhesives, in contrast to the total etch systems, keep the dentin in its mineralized state, and so the protein portion of the dentin, remains upright instead of collapsing down onto the dentin substrate once it is air-dried. Accordingly total etch adhesives require the dentin to remain "moist" but not "wet" following the rinsing of the phosphoric acid gel, a narrow window that makes these kinds of adhesives "technique sensitive" in order to develop a strong dentin-resin bond.

Prior to bonding, the dentin substrate should be disinfected, and while the use of antibacterial agents such as chlorhexidine 2% (Consepsis, Ultradent) represent one means to accomplish this as well as de-activating bond destroying matrix metalloproteinases,[8] the adhesive monomer found in Protect Bond (MDPB) is itself a highly effective antibacterial agent (Fig. 7).


Fig. 7

The use of Protect Bond requires less steps, provides antibacterial cavity cleansing, while also providing a strong, reliable dentin bond.

Protect Bond self-etch primer is first applied to the entire preparation for a 20-second period, then dried thoroughly with filtered air. A drop of bottle #2 (bond) is then applied to the preparation using a brush, and lightly aired to create a uniform thin layer and eliminate pooling of the resin. Then a standard curing light is used for 20 seconds to polymerize the microfilled resin.

5. Apply composite to the proximal enamel creating the proximal wall

The enamel proximal wall is built up using a hybrid composite (Clearfil AP-X) that is applied only to the enamel (the layer will be about 1mm in thickness). [3] This wall is light-cured with a reduced light intensity that facilitates flow, thereby reducing contraction stresses.[6] Clearfil AP-X has been shown if polymerized by exposing to the light for 20 seconds at 200mw/cm2 (from approximately 0.5 inches away), followed by a 10 second pause, followed by another 20 seconds at 600 mw/cm2 (directly up against the prep[6]) the operator minimizes contraction stress. The enamel wall is left undisturbed for five minutes until the setting composite has reached 90 percent polymerization (Fig. 8).


Fig. 8

6. Place a liner of flowable composite to the dentin floor only

In adhesive restorations, the maturing bond strength to dentin is in competition with the developing shrinkage stress.[5] Accordingly, success occurs when the operator creates a restoration such that the bonds are able to withstand the contraction stress of the setting composite. Since polymerizing composite shrinks in the direction of the stronger bond, not "towards the light" as had been commonly believed, the Alleman-Deliperi proto-


Fig. 9

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col calls for a "decoupling" of the bond to enamel from the bond to dentin by waiting at least five minutes following the bond to enamel before connecting it with the dentin (Fig. 9).[3]

The first dentin layer in a Class II restoration consists of a 0.5mm liner of a highly filled flowable composite (Clearfil Majesty Flow) applied with a small tipped instrument such as a ball burnisher or periodontal probe. In larger preparations, a small square of a specific woven fiber (Ribbond) is trimmed with the special scissors, covered with the microfilled resin (from bottle #2) and tamped into place using a small endodontic plugger. One effect of the Ribbond is to act as a stress breaker that can relieve contraction stresses and improve marginal integrity.[1] The Ribbond reinforced liner has also been shown to prevent undesirable fractures of tooth substrate.[2]

7. The bulk of the dentin is now replaced biomimetically

The elastic modulus of Clearfil AP-X (16.74 GPa) is equal to that of dentin (14-18 GPa), and with its stress relief capability,[7] is ideal for use as a biomimetic dentin replacement. AP-X is then placed in 1mm horizontal increments using a condenser; light-cured using the same slow start protocol until the occlusal enamel is reached. Horizontal stacking facilitates "decoupling" the dentin bond from the enamel, thereby lowering the stress on the dentin bond. A denser restoration can be achieved using a "snowplow" technique between layers where the flowable composite (Clearfil Majesty Flow) is applied and cured simultaneously with the AP-X increment. At this juncture, a pause allows the dentin bond to improve from 70 percent polymerized immediately after the cure, to 90 percent polymerized after five minutes.

8. The occlusal enamel is now replaced biomimetically

The clinician completes the enamel portion of the restoration by applying small increments of a heavily filled composite. Clearfil Majesty Posterior is well suited for this purpose, having a high ceramic filler content and a modulus of elasticity of 22 GPa, greater than that of dentin and creating a gradient in the restoration. Small increments are placed against facial and lingual walls, using a carving instrument (shown TN009, Garrison Dental Solutions) to follow the cuspal inclines (Fig. 10). Following the polymerization, the operator removes the matrix by using a Mosquito hemostat or by using a specialized band remover. (Garrison Band Forceps, Garrison Dental Solutions). The tight contact combined with the affinity of the bonding agent to the side of the matrix band can make the removal of the small matrix difficult. Besides using the specially designed forceps, this difficulty can be overcome by treating the restoration side of the band with an emollient (Chapstick) prior to inserting the matrix into the contact.


Fig. 10

9. The restoration is contoured and finished

Another advantage of the precise contour of the sectional matrix and the slow build-up of this biomimetic restoration is the minimal finishing and polishing that is typically required. If the restoration includes axial surfaces of the tooth, a coarse Soflex disk (3M) is useful in creating a smooth enamel/composite interface. Additional rounding of the proximal aspect of the restoration can be effectively achieved with the thin finishing burs and polishing cups found in the G-Block Finishing and Polishing kit (Garrison Dental Solutions). The occlusion is then checked with articulating paper, and adjusted with a shoulder former diamond, keeping its end in the grooves so to maintain the occlusal anatomy as much as possible.

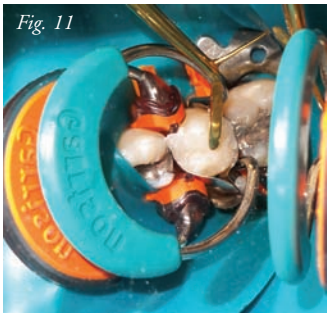
Fig. 11

The final polish can be attained easily by using the polishing cups and points found within the G-Block kit (Fig. 11). Other means of creating a glossy finish to the restoration is to re-etch the entire restoration using 40 percent phosphoric acid (K-Etchant Gel) rinse, dry, and then apply a fluoride-containing pit and fissure sealant (Teethmate F-1).


Fig. 12

Finally, careful attention is given to the gingival tissues by being sure to remove any flash that might have occurred during the bonding process. A sharp curette is used to instrument the tooth and subjacent tissues in order to provide a smooth maintainable surface (Fig. 12).

10. Final check of the restoration

Often, the anesthetic produces proprioceptive changes whereby the patient is uncertain as to whether the restoration is appropriately adjusted. The double paper clench test often reveals small high spots, and they are easily removed with the shoulder former diamond and repolished. Where there is doubt,

the patient should be directed to return to the office after anesthesia has worn off in order to evaluate occlusion and remove any prematurities that might still be present.

Conclusion

Creating successful proximal direct composite restorations requires the clinician to increase his or her understanding beyond "Basic Adhesive Dentistry" into the more sophisticated handling of composites, bonding agents, and matrix systems. These advanced techniques enable the clinician to create not only well-contoured, highly aesthetic restorations, but also composites that are characterized by the preservation of tooth structure, the establishment of a secure bond and the use of particular restorative materials that mimic the physical properties of the natural tooth.

The goal of restorative dentistry is to bring the diseased tooth back to a state of health. An important aspect of this treatment is the proper placement of the restoration so that an effective gingival seal and a proper proximal contour are developed, preventing food impaction and recurrent caries. The use of a sectional matrix will offer the clinician a simplified and predictable means to replace the missing proximal tooth structure. Together with the proper handling of materials that are similar in physical properties to natural tooth structure, the clinician can create restorations that truly mimic the biologic and mechanical properties of teeth, and deliver highly functional and highly aesthetic restorations. ■

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Authors' Bios

Dr. Randall G. Cohen is in private practice of general, cosmetic and restorative dentistry in Bucks County, Pennsylvania, since his graduation from Temple University School of Dentistry in 1982. He has published papers in several journals and has lectured nationally on adhesive dentistry.

Dr. David S. Alleman graduated from the University of the Pacific School of Dentistry in 1978. He spent three years in the U.S. Navy dental corps and 28 years in private practice in the Salt Lake City, Utah area. Dr. Alleman has studied with Dr. Ray Bertolotti since 1995 and has been teaching hands on biomimetic dental courses since 2003. He also partnered with Dr. Simone Deliperi to teach minimally invasive dentistry in 2007.

Disclosure: Dr. Cohen declares having received an honorarium from Garrison Dental and Kuraray America for this course.

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1. Following diagnosis, treatment planning, and anesthesia, the first step toward a successful Class II restoration is:
   a. Selecting the best bonding agent.
   b. Isolating and cleaning the tooth.
   c. Correct placement of the matrix.
   d. None of the above.

2. The difficulty with the Tofflemyre matrix is:
   a. The contour that is developed does not match the original proximal anatomy.
   b. The increased frequency of an open contact when used with composite.
   c. Using it on the rubber dam-clamped tooth.
   d. All of the above.

3. Using a wedge to seal the gingival margin of the matrix band:
   a. Creates an open contact.
   b. Should always be used.
   c. Is not needed with a sectional matrix.
   d. None of the above.

4. When an old restoration in an asymptomatic tooth is removed revealing cracks into the dentin:
   a. The cracks can be bonded over without concern.
   b. The crack needs to be removed but the operator should respect the integrity of the pulp.
   c. The crack must be removed fully, and if it has reached the pulp, then endodontics must be planned.
   d. The crack must be removed unless it undermines a cusp.

5. Dentin caries
   a. Is best detected tactilely using an explorer:
   b. Can remain in the restored tooth since the restorations effectively isolate residual bacteria from their nutrient source.
   c. Should be removed until Caries. Detector Solution stains with a "pink haze."
   d. Does not affect the bond strength to dentin.

6. The undercut design for indirect restoration preparations:
   a. Can create a high stress restoration when used with composite.
   b. Is counter-productive when used with composite.
   c. Is required to retain amalgam restorations.
   d. All of the above.

7. Clearfil AP-X:
   a. Has a "built in" stress relief property.
   b. Has a modulus of elasticity in the center of the range for human dentin.
   c. Should be stacked horizontally to facilitate enamel/dentin decoupling.
   d. All of the above.

8. After placement of the sectional matrix ring, the plastic wedge should be:
   a. Left untouched.
   b. Removed prior to restoration placement.
   c. Seated further.
   d. Replaced with a smaller one.

9. One way to facilitate the removal of the sectional matrix band from the contact without compromising the restoration is:
   a. Coating the entire preparation with lubricant.
   b. Avoiding use of the wedge to prevent excessive proximal contact.
   c. Grasping the sectional matrix band with specialized forceps.
   d. None of the above.

10. A tight gingival seal between the sectional matrix and the tooth is necessary:
    a. To prevent post operative sensitivity.
    b. To prevent bond failure.
    c. To prevent overhanging restorations.
    d. All of the above.

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