Restoring the Interproximal Zone Using the Proximal Adaptation Technique—Part 2

CE 1

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Abstract: ***In this era of modern adhesive dentistry, clinicians are still faced with challenges from microleakage, recurrent decay, and sensitivity. Many of the challenges are a result of using yesterday's restorative techniques and principles with the new formulations of biomaterials. Procedures such as the proximal adaptation and the oblique layering techniques offer modifications to the nonadhesive principles discussed in Part I (The Compendium, December 2004), while providing the patient and clinician with the 3 primary objectives of restorative dentistry: prevention, preservation, and conservation. Using stratification techniques and thorough adhesive protocol as illustrated in this article allows clinicians to provide restorations that have improved physical characteristics while reducing the effects of polymerization shrinkage. Other benefits of these adhesive procedures include enhanced chromatic integration, ideal anatomical form and function, optimal proximal contact, improved marginal integrity, and longer lasting directly placed composite restorations.***

Learning Objectives:

After reading this article, the reader should be able to:

- describe the preoperative considerations for developing direct composite restorations.
- explain the guidelines for the adhesive preparation design.
- discuss the fundamental principles for achieving success with directly placed composite restorations.

The first part of this discussion on restoring the interproximal zone, published in the December 2004 issue of the *Compendium*, provided an overview of the evolution of the preparation design and described the modern adhesive design principles. The second part of this discussion is the following clinical presentation explaining the use of these principles with the clinical objective of minimally invasive dentistry. This article describes an innovative proximal adaptation technique for the direct reconstruction of the interproximal zone with a small-particle hybrid composite resin (eg, Venus[a], Esthet-X[b], and Point 4[c]).

Case Report

Preoperative Considerations

A 29-year-old man presented with initial interproximal caries on the distal surface of the maxillary left first bicuspid and mesial surface of the maxillary left second bicuspid (Figure 1). Clinical evaluation and consultation revealed many other incipient carious lesions in posterior teeth of different quadrants that were a result of a recent change in diet and an increased consumption of carbonated beverages containing sugar. The predisposing environment was altered by cessation of the habit and introduction of home fluoride treatments.

Before administering anesthesia and rubber dam isolation, the preoperative occlusal stop and excursive guiding planes were recorded with articulation paper, transferred to a hand-drawn occlusal diagram, and recorded on an intraoral camera. This initial registration is valuable in preparation design for placing centric stops beyond or within the confines of the restoration and mini-

[a]Heraeus Kulzer, Inc, Armonk, NY 10504; (800) 431-1785
[b]Dentsply Caulk, Milford, DE 19963; (800) 532-2855
[c]Kerr Corporation, Orange, CA 92867; (800) 537-7123

Figure 1—Interproximal caries on the distal surface of a maxillary left first bicuspid.

Figure 2—Shade determination was performed before rubber dam placement with custom made composite shade tab.

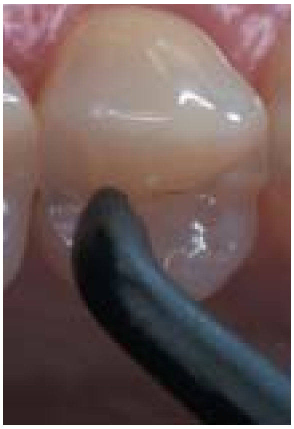

Figure 3A—Caries detection with an argon ion laser source was performed on the occlusal fissure.

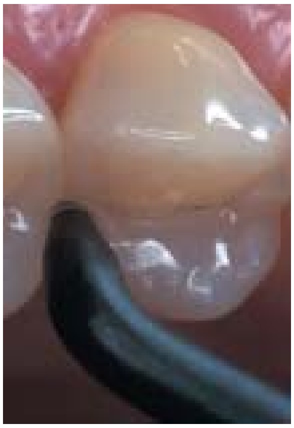

Figure 3B—Caries detection with an argon ion laser source was performed on the marginal ridge of the maxillary left first bicuspid.

Figure 4—Evaluation of caries removal on the proximal preparation of the maxillary left second bicuspid with the argon laser source.

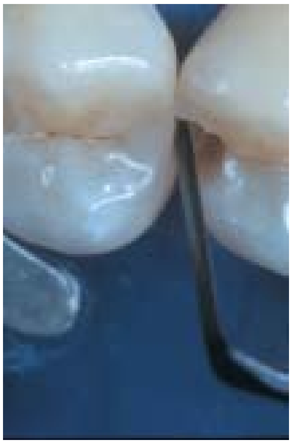

Figure 5A—An artificial enamel layer, a T-3 shaded hybrid composite (Venus) was applied to the proximal surface of the adjacent bicuspid with a long-bladed instrument.

mizing finishing procedures.[1] A preoperative selection of composite resins, tints, and modifiers with their shade and orientation were recorded.

Shade selection should be made before rubber dam placement to prevent improper color selection as a result of dehydration and elevated values[2] (Figure 2). The use of a color-corrected daylight source of 5500 K is necessary for proper color registration. A shade map or restorative recipe can be used to diagram the existing colors of the tooth to be prepared; it will indicate anatomic morphological details such as developmental grooves, shape of embrasures, prominences, convexities, facets, angles, plane areas, and other characteristics that can provide information when reconstructing the tooth surfaces.[3] Notations of the preoperative occlusal registrations can be useful when developing the preparation design and completing the final restoration.

Guidelines for Initial or Replacement Restoration

Differing physical and mechanical characteristics of composite resin and metal restorations require a distinctive adhesive preparation design that is divergent from the classic amalgam preparation design. Composite resin has a greater potential for bonding to tooth structure

Figure 5B—The artificial enamel layer, a T-3 shaded hybrid composite (Venus), was light-cured for 40 seconds.

Figure 6—Final finishing of the proximal surface is accomplished with interproximal finishing strips used sequentially from coarse to extra-fine.

Figure 7A—The preparation was cleaned with 2% chlorhexidine (Consepsis, Ultradent Products, Inc, South Jordan, UT 84095; [800] 446-8337).

Figure 7B—A self-etchant adhesive (iBond, Heraus Kulzer, Inc, Armonk, NY 10504; [800] 431-1785) was applied to the entire cavity surface using an applicator tip in 3 separate coats, slightly agitating for 30 seconds.

Figure 7C—The self-etchant adhesive was lightly air dried.

Figure 7D—The self-etchant adhesive was light-cured for 20 seconds.

compared with amalgam and, therefore, minimal mechanical retention is required. Accordingly, clinicians confined to mechanical principles associated with amalgam must reexamine operative procedures for adhesive restorations and institute a new, nonmechanical ideology.[4,5]

The following steps involved in good preparation design indicate proper methods and explain either the basis for such a method or the differences between the composite resin design and the classic amalgam design.

After administering anesthesia, the treatment site was isolated with a rubber dam to achieve adequate field control and protect against contamination.[6,7] Quantitative light-induced fluorescence was used, in conjunction with radiographic findings, to aid in the detection and identification of the irreversible infected carious tissue on the maxillary left first bicuspid and second bicuspid and served as a guide for its removal[8,9] (Figures 3A and 3B). The carious dentin was removed with a slow-speed carbide round #4 bur and spoon excavators and was reexamined for caries with quantitative light-induced fluorescence (Figure 4).

Figure 8—Glycerin was applied to the proximal surface of the maxillary left second bicuspid with unwaxed floss as a separating medium.

Figure 9A—A translucent envelope is created against the proximal surface of the adjacent bicuspid (proximal adaptation technique). An increment of yellow translucent enamel, T-3 shaded hybrid composite, was placed in the proximal region and adapted and shaped with a long-bladed instrument to the gingival margin and the adjacent bicuspid surface.

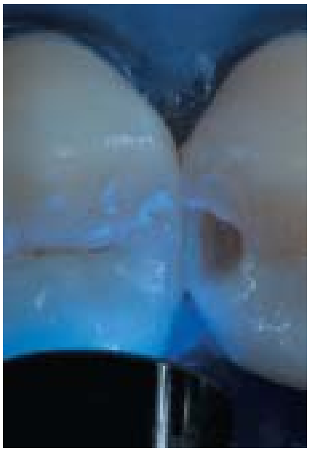

Figure 9B—Using the 3-sited light-cure technique, the T-3 shaded hybrid composite (Venus) increment was initially light-cured from the gingivo-lingual aspect for 40 seconds.

Figure 9C—The composite increment was light-cured from the gingivo-buccal aspect for 40 seconds.

Figure 9D—The composite increment was light-cured from the occlusal aspect for 40 seconds.

Figure 10A—A B-3 shaded flowable composite (FlowLine, Heraeus Kulzer, Inc, Armonk, NY 10504; [800] 431-1785) was injected as the syringe tip was slowly removed.

The occlusal outline and proximal extensions were only extended to include carious enamel, provide access to the carious dentin, remove any residual staining, and provide access for the application of restorative materials. The healthy tooth structure should be removed only when the occlusal outline requires extension to a point beyond or within the previously indicated functional stops. The adhesive preparation design requires maximum preservation of remaining tooth structure and not extension for prevention. The preparation only has access to the lesion or defect because composite requires less volume to resist clinical fracture compared with amalgam.[10,11]

The width of the preparation should be as narrow as possible because the wear resistance of the restoration is a direct function of dimension.[12] Moreover, an increased buccolingual width of the preparation can trespass the centric holding areas. To allow for a better resin adaptation, all internal line angles should be

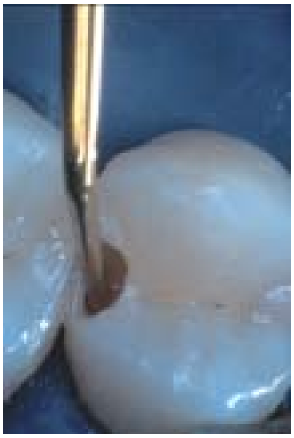

Figure 10B—The cavity liner was uniformly distributed to a 1 mm thickness with a round-tip instrument (M-1, American Eagle Instruments, Inc, Missoula, MT 59808; [800] 551-5127) and light-cured for 40 seconds.

Figure 11A—A B-3 shaded hybrid composite (Venus) was applied in increments using an oblique layering technique.

Figure 11B—Successive increments of hybrid composite were applied in an oblique layering technique and light-cured for 40 seconds.

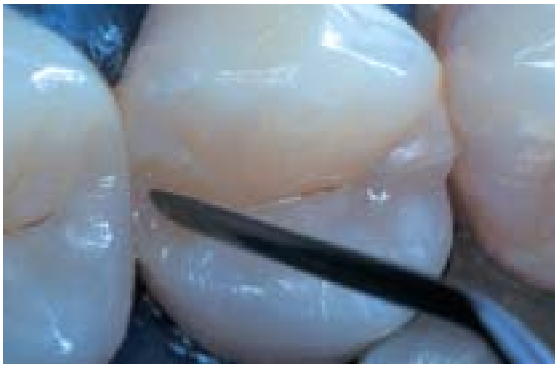

Figure 12—The final preocclusal layer was applied and invaginated with a long-bladed interproximal instrument while the material was still soft.

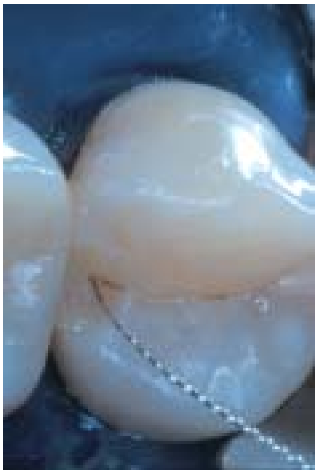

Figure 13—To create the illusion of occlusal fissure staining, a small amount of brown tint was applied according to the shade diagram and polymerized for 40 seconds.

Figure 14—A diluted white wash was applied to specific regions and faded to the adjacent enamel surfaces to correspond to the preoperative shade-mapping diagram and polymerized for 40 seconds.

rounded and cavity walls smooth.[13] The occlusal cavosurface margin should not be beveled because doing so expands the width of the preparation and may infringe on the centric holding area, increasing the restoration wear rate.[12] To increase the potential for bonding when enamel is present, beveling should be restricted to the gingival and proximal margins. This increases the fracture resistance by increasing the volume of the restoration and the bonding surface area, while decreasing microleakage by exposing the enamel rods for etching.[14] In this case, when preparing the proximal surface of the maxillary second bicuspid, we only had access to the lesion from the adjacent preparation.

Adhesive Protocol

The preparations were completed with a finishing diamond, cleaned with a 2% chlorhexidine solution to remove potential contaminants, rinsed, and lightly air dried. Initially, a single-component self-etching adhesive was applied to the proximal preparation of the maxillary left second bicuspid with an applicator tip in 3 separate coats, slightly agitated for 30 seconds, lightly air dried, and light-

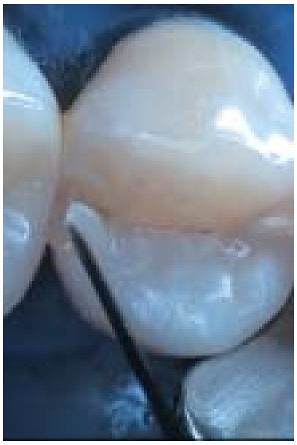

Figure 15—To reproduce the optical effects of the enamel, an increment of yellow translucent, T-3 shaded hybrid composite (Venus) was sculpted and smoothed with a sable brush.

Figure 16A—The interproximal zone was inspected with unwaxed dental floss to verify adequate contact and the absence of a gingival overhang.

Figure 16B—Any excess resin was carefully removed using a #12 surgical blade.

Figure 17—The occlusal margin was finished with a #30 fluted egg-shaped finishing bur (9406, Midwest, Dentsply Professional, York, PA 17404; [800] 989-8825).

Figure 18A—All margins were etched with a 35% orthophosphoric acid, rinsed for 5 seconds, and air dried.

Figure 18B—A composite surface sealant was applied and light-cured to seal any microscopic porosities that may have formed during the finishing procedures.

cured for 20 seconds. Before developing the interproximal zone of the maxillary first bicuspid, an increment of clear translucent enamel, T-3 shaded hybrid composite (yellow translucency), was placed in the preparation from the proximal region and adapted and shaped to the adjacent bicuspid surface with a long-bladed interproximal instrument, smoothed with a #4 artist sable brush, and light-cured for 40 seconds (Figures 5A and 5B).

The interproximal finishing was accomplished with aluminum oxide finishing strips that were used sequentially according to grit and ranged from coarse to extra-fine (Figure 6). The margins were etched with a 37.5% phosphoric acid semi-gel, rinsed, and dried. A composite surface sealant was applied and cured to seal any cracks or microscopic porosities that may have formed during the finishing procedures. Excess resin was removed with a #12 scalpel blade, and final polishing was accomplished with prepolish and high-shine, silicone rubber points. A soft metal strip was placed interproximally to isolate the prepared tooth from the completed restoration and adjacent dentition. The same adhesive protocol was performed on the maxillary left first bicuspid with a single-component self-etching adhesive (Figures 7A through 7D).

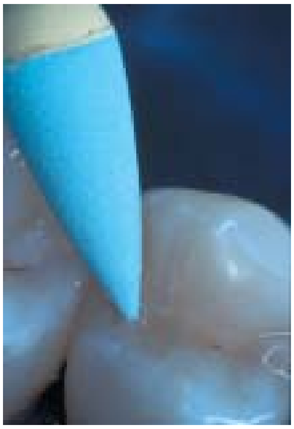

Figure 19A—To eliminate any surface defects, initial polishing was performed with prepolish silicone rubber points.

Figure 19B—High-shine polishing points were used to increase the smoothness and the surface reflectivity.

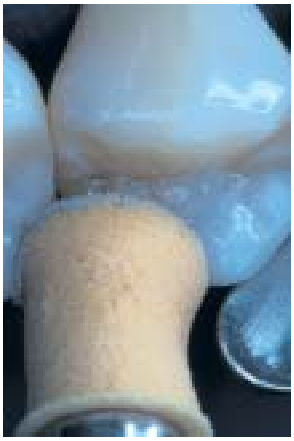

Figure 19C—The final polish was accomplished with a loose abrasive diamond polishing paste and a foam cup.

Figure 20A—The postoperative occlusal view of the definitive restorations. Note the optical integration of composite resin with the existing tooth structure.

Figure 20B—Completed restorations demonstrate the ease of developing proximal contact and marginal integrity with the proximal adaptation technique.

Proximal Adaptation Technique

The proximal adaptation technique replaces tooth structure from the periphery toward the center of the cavity and should be used when the gingival margins terminate in enamel. Many reports indicate that less microleakage occurs when gingival margins terminate in enamel rather than in cementum.[15,16]

A small amount of glycerin was applied to the mesial surface of the maxillary left second bicuspid with unwaxed floss (Figure 8). This allowed optimal adaptation of the artificial enamel layer to the adjacent tooth without using a plastic or metal matrix band. An initial increment of yellow translucent T-3 shaded hybrid composite resin was placed in the proximal region. It was then adapted and shaped with a long-bladed instrument to the gingival margin and the adjacent bicuspid surface and smoothed with a #4 artist sable brush. Each increment was individually light-cured from the gingivo-lingual and gingivo-buccal aspect for 40 seconds (Figures 9A through 9D).

Because the first increment is light-cured toward the gingival aspect, the restorative material shrinks toward the cervical margin, improving the marginal adaptation. Successive increments of T-3 shaded hybrid composite resin were placed, shaped, and smoothed against the proximal surface of the adjacent bicuspid from the gingival floor to the marginal ridge, creating a 3-dimensional translucent envelope while each increment was individually light-cured from the buccal and lingual aspects.

Because this translucent envelope layer has no contact with the axial pulpal walls and the curing light direction is not occlusal, there is less contraction toward this wall and away from the cervical aspect during polymerization.[16-18] Furthermore, because the curing light is directed toward the gingival aspect, the first composite increment shrinks toward the cervical margin, resulting in an enhanced marginal adaptation.[18,19] In addition, this method allows internal curing of the peripheral external envelope; this, in turn, can strengthen the composite and protect against the formation of a cervical gap[20-23] because the consecutive internal layers are adapted toward the gingival floor. After development of the peripheral composite envelope, the preparation can be treated as an occlusal preparation.

The Cavity Liner

The combination of flowable and viscous composite ensures a more intimate contact with the dentin-bonding agent because of lower viscosity and results in enhanced internal adaptation.[24] Because of a low modulus of elasticity, these composites act as an elastomer and buffer the polymerization shrinkage stress by flow, which theoretically eliminates cusp deformation or gap formation and reduces microleakage.[25] If the modulus of elasticity is low, the composite will stretch to accommodate the inherent modulus of the tooth and the internal layer may absorb polymerization shrinkage stress of the resin composite by elastic elongation.[26,27] These lower viscosity flowable composites also may enhance the wetting capacity[24] of the restoration, resulting in a more complete interfacial internal adaptation, and may reduce the formation of voids that can contribute to a weakened surface and to microleakage.

As the syringe tip was slowly removed a B-3 shaded flowable composite was injected and uniformly distributed with a round-tip instrument (Figures 10A and 10B). This technique reduces the possibility of entrapping bubbles and ensures optimal adaptation of the resin material to the adhesive interface. A 1 mm thick increment was applied to the gingival floor of the proximal preparation and light-cured for 40 seconds.

Incremental Layering Technique

Incremental layering has been advocated for use in medium to large posterior composite restorations to avoid the limitation to depth of cure, reduce the effects of polymerization shrinkage, and enhance the esthetic results from the multilayering of color.[28,29] However, the anatomy of the tooth should guide the clinician in developing the correct interpretation of form and color. Incremental layering of dentin and enamel composite creates layers with high diffusion that allow optimal light transmission within the restoration, providing more realistic depth of color, as well as natural surface and optical characteristics.

The polychromatic effect is achieved by stratifying variations in shades and opacities of the restorative composite. Because of the variations in natural teeth, the combinations of different composite shades have to be applied in relation to the natural tissue anatomy and specifically adapted to individual clinical situations. The incremental layering technique uses both layering of composite and stratification of color to create natural chromatic integration.[30]

Artificial Dentin Core

The cavity preparation was filled incrementally with a B-3 shaded hybrid composite from the preoperative shade-mapping diagram. To ensure complete adaptation to the underlying resin and tooth structure, each increment was applied and adapted with a round-tip instrument and light-cured for 40 seconds.

To reduce the possibility of cusp flexure, a composite hybrid having a low volumetric polymerization shrinkage was selected.[31] This problem also can be reduced by diagonally layering the hybrid in increments of 1 mm and feathering it up the cavity wall in a V shape.[15,32] Opposing enamel walls should not have contact with the same increment.[33] This will minimize the wall-to-wall shrinkage and reduce intercuspal stress.[34]

Application of the composite in oblique layers results in fewer contraction gaps at the margins. Therefore, condensing and shaping of the composite resin was continued for cusp development and dentin replacement. Each increment was polymerized for 40 seconds, which allowed placement of subsequent increments without deforming the underlying composite layer (Figures 11A and 11B).

Internal Characterization

After the artificial dentin layer was developed, and while it was still soft, a final preocclusal layer was invaginated with a long-bladed instrument (Figure 12). It is important to anticipate the final result and not trespass into the final artificial enamel zone but instead allow space for the overlying translucent enamel shade.

A thin layer of resin was applied and

cured to create a light diffusion layer and provide an illusion of depth for restorations of limited thickness. This translucent layer caused an internal diffusion of light and control luminosity within the internal aspects of the restoration.[35]

The internal characteristics (creation of pits and fissures, staining of grooves, or the creation of internal color within the restoration) were applied using a #08 endodontic file and fine sable brush. An ocher-tinted resin was applied in the previously formed invagination to correspond to preoperative shade mapping. If the chroma is too high it can be diluted with an untinted resin and a small brush or removed with a clean applicator tip. The tint and the final dentin layer were polymerized for 40 seconds.

To create the illusion of occlusal fissure staining, a small amount of brown tint was applied according to the shade diagram and polymerized for 40 seconds (Figure 13). Also, a diluted white wash was applied to specific regions, faded to the adjacent enamel surfaces to correspond to the adjacent second bicuspid and the shade-mapping diagram, and polymerized for 40 seconds (Figure 14).

Occlusal Envelope

The enamel or the artificial enamel layer is the principal determinant of the value of the tooth or restoration.[36] The enamel is colorless but, through its network of rods, acts as a fiberoptic conduit and projects the underlying color found in the dentin. The small-particle hybrid (Venus) used in developing this restoration has 3 translucent shades. The T-1 shaded composite has a cool translucency, the T-2 a neutral translucency, and the T-3 a yellow translucency. To reproduce the optical effects of the enamel, a final increment of T-3 shaded composite was applied, sculpted, and smoothed with a #4 sable brush according to the functional and anatomical occlusal morphology and polymerized for 40 seconds (Figure 15). A thin layer of glycerin was applied to the surface and cured for 2 minutes, ensuring complete polymerization of the composite resin at the margins. The interproximal zone was inspected with unwaxed dental floss to verify adequate contact and the absence of a gingival overhang. Any excess resin was carefully removed using a #12 surgical blade (Figures 16A and 16B).

Finishing and Polishing Procedure

Developing the restoration in increments and considering the occlusal morphology and occlusal stops allows the clinician to minimize finishing procedures and results in a restoration with improved physical and mechanical characteristics and less microfracture. One study revealed that a reduction in finishing results in less damage to the composite, as well as improved wear and clinical performance.[32]

The occlusal refinement was achieved with #12 and #30 fluted egg-shaped finishing burs, closely observing the tooth–resin interface and using a dry protocol (Figure 17). The lingual surface was finished with #12 and #30 fluted needle-shaped burs.

After the initial finishing procedure, the margins and surface defects were sealed. All accessible margins were etched with a 35% orthophosphoric acid, rinsed, and dried. A composite surface sealant was applied and cured to seal any cracks or microscopic porosities that may have formed during the finishing procedures (Figures 18A and 18B). The use of a surface sealant reduces the wear rate of posterior composite resin restoration.[37] The final polish was accomplished with prepolish and high-shine silicone rubber points and polishing cups with a synthetic diamond polishing paste (Figures 19A through 19C).

The rubber dam was removed and the patient was asked to perform closure without force and then centric, protrusive, and lateral excursions. Any necessary equilibration was accomplished with #12 and #30 egg-shaped finishing burs, and the final polish was repeated. The contact was tested with unwaxed floss to ensure the absence of sealant in the contact zone, and the margins were inspected.

The clinical and radiographic postoperative results of direct composite resin used with the proximal adaptation technique reflect the integration of color with anatomical form and function, which can be achieved while developing optimal proximal contact and marginal integrity (Figures 20A and 20B).

Conclusion

Minimally invasive procedures in medicine and dentistry provide clinicians with alternative methods for preventing disease while preserving and conserving the health of the patient. Although the interproximal zone is only a small area in the human body, the preservation of this zone provides stability and perioesthetic harmony between the soft and hard tissues in the dental arch. Contemporary restorative procedures, such as the proximal adaptation technique, in conjunction with new formulations of restorative materials (ie, small-particle hybrids), provide the clinician with minimally invasive alternatives for restoring incipient lesions while maintaining or establishing the balance in the interproximal zone and the integrity of the gingival margin.

Conclusion

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Quiz 1

1. **The use of a color-corrected daylight source of what temperature is necessary for proper color registration?**
   a. 5500 K
   b. 6500 K
   c. 7500 K
   d. 8500 K

2. **What was used in conjunction with radiographic findings to aid in the detection and identification of the irreversible infected carious tissue?**
   a. dull explorer
   b. sharp explorer
   c. quantitative light-induced fluorescence
   d. transillumination

3. **The adhesive preparation design requires:**
   a. minimum preservation of remaining tooth structure.
   b. maximum preservation of remaining tooth structure.
   c. bevels on all surfaces.
   d. etching for 3 to 4 minutes.

4. **To allow for a better resin adaptation, all internal line angles should be:**
   a. at 90 degrees.
   b. slightly divergent.
   c. slightly convergent.
   d. rounded.

5. **The proximal adaptation technique replaces tooth structure from the:**
   a. periphery toward the center.
   b. center toward the periphery.
   c. coronal toward the apical.
   d. apical toward the cervical.

6. **If the modulus of elasticity is low, the composite will:**
   a. be brittle.
   b. stretch.
   c. shrink.
   d. craze.

7. **Incremental layering has been advocated for use in medium to large posterior composite restorations to:**
   a. avoid the limitation to depth of cure.
   b. reduce the effects of polymerization shrinkage.
   c. enhance the esthetic results from the multilayering of color.
   d. all of the above

8. **To reduce the possibility of cusp flexure, a composite hybrid having what was selected?**
   a. high chroma
   b. low volumetric polymerization shrinkage
   c. opaquing capability
   d. high viscosity

9. **What is the principal determinant of the value of the tooth or restoration?**
   a. light source used
   b. thickness of residual dentin floor
   c. enamel or the artificial enamel layer
   d. lip line

10. **A composite surface sealant was applied and cured to:**
    a. seal any cracks or microscopic porosities.
    b. increase light reflection.
    c. increase light refraction.
    d. decrease light refrac

Please see tester form on page 53.

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