Selection Defines Design

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ABSTRACT

The era of "extension for prevention" used restorative materials and cavity preparation designs in an attempt to arrest the caries process. In the new era of "prevention to eliminate extension," many of the old limitations are no longer applicable because of advances in research and technology. The advances in restorative materials and adhesive technology require the use of an adhesive design concept when considering restorative material selection, preparation designs, and adhesive protocol and placement procedures and techniques. This adhesive design concept has been instrumental in the paradigm shift from the principles of extension for prevention to an ultraconservative principle of prevention to eliminate extension. From the early onset of the disease to initial placement of the restoration, this modern philosophy has three clinical objectives: prevention, preservation, and conservation. The clinician should strive to preserve the maximum integrity of the natural dentition by preventing the placement of the initial restoration, preserving and conserving tooth structure during the preparation of restoration, and conserving the tooth and restoration by increasing the longevity of the restoration between replacements. This article describes an incremental layering technique that uses a conservative restorative adhesive design concept (adhesive preparation design and protocol) for preparing, restoring, and finishing a Class IV restoration, and it demonstrates how the selection of a small-particle hybrid composite influences the preparation design.

CLINICAL SIGNIFICANCE

Selection of improved restorative materials that simulate the physical properties and other characteristics of natural teeth in combination with an adhesive design concept and preoperative considerations during the diagnostic and treatment planning phases of the restorative procedures provide the framework that ensures the optimal development of an esthetic restoration while preserving, conserving, and reinforcing the tooth-restoration complex.

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The criteria for tooth replacement, defects, trauma, and caries, as well as the basic definition of cavity preparation, have remained unchanged over the past 100 years. However, the physical preparation design for the replacement of natural tooth structure and/or existing restorations has been continuously altered as scientific advances occur. Changes in restorative material selection, a better understanding of the disease process, and improvements in caries detection and control (arrest and prevention) and in instruments and tissue-cutting concepts have all contributed to the evolution of preparation design.

EVOLUTION IN RESTORATIVE MATERIAL SELECTION

Restorative materials of the past were designed to fill a hollow

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space—the cavity. Cavity designs were formulated with a particular geometric outline form for specific regions on the tooth and designed to prevent the possibility of future caries. Caries was not recognized as a bacterial disease. Surgical removal required the destruction of sound tooth structure to ensure the omission of all the diseased portion of the tooth and to obtain a specific geometric outline form to ensure retention of the restoration.[1] Specific preparation designs dictated by such surgical approaches inevitably led to a weakened remaining tooth crown,[1,2] additional damage to pulp tissue previously affected by disease, possible alterations in occlusal anatomy, and a negative effect on esthetics.[1] Inherent inequities of the most widely used restorative materials, amalgam and gold, required removal of sound tooth structure to compensate for the shortcomings of the restorative materials and techniques.[3] Metallic restorations did not adhere to dental tissues; hence, a retentive cavity form was needed to retain the restoration. Since the cavity form was dictated by the material used, extension into sound tooth structure was necessary.[4] Extension of the preparation into the dentin was also required to increase the volume of restorative material to resist clinical fracture.

The catalyst for adhesive dentistry was initiated with the discovery by Buonocore in 1955 of the acid-etching technique and with the introduction of reinforced dimethacrylate resin as a composite resin restorative material by Bowen in 1962.[5,6] The adhesive process—bonding to enamel—reestablished unity, integrity, and strength to the restorative tooth complex.[7] Adhesive restorative materials bond well to tooth structure and do not require as much volume to resist clinical fracture, which allows for a more conservative preparation design.[8] The depth of the preparation can be more shallow for resin-bonded adhesive restorations than for metallic restorations because adhesives do not require increased axial wall length to provide frictional retention.[9] Consequently, whereas the restorative material selection traditionally defines preparation design, advancements in restorative material formulations and adhesive technology now provide the clinician with options. An adhesive design concept can be individualized based on restorative material selection, preparation designs, adhesive protocol, and placement techniques. This adhesive design concept has been instrumental in the paradigm shift from the principles of "extension for prevention" to an ultraconservative principle of "prevention to eliminate extension." An increase in patient demand for optimal esthetics with less invasive procedures has resulted in the extensive use of freehand bonding in the anterior region.[10] The procedure described below—applied in the restoration of a fractured maxillary right central incisor—demonstrates the significance of how restorative material selection defines design. This case study describes an incremental layering technique that uses a conservative restorative adhesive concept (adhesive preparation design and protocol) for preparing, restoring, and finishing a Class IV restoration with a small-particle hybrid composite (Point 4®, Kerr/Sybron, Orange, CA, USA) while integrating the concepts of function, form, and color.

ADHESIVE PREPARATION DESIGN

Composite resin systems depend upon the use of adhesive preparation designs that are conservative and require thorough adhesive techniques.[11–14] Consideration should be given to the following: tooth type, location in the arch, size and type of the carious lesion, treatment of decayed or nondecayed unrestored teeth or restoration replacement, relationship between occlusal function and preparation boundaries, type of restorative technique, quantity and quality of remaining tooth structure, mechanical forces on remaining structures, presence of defects, and the parameters for extension of the preparation to the esthetic zone.[13,15] The following provides the general guidelines for initial or replacement restorations for the Class IV direct composite resin preparation:

- Prior to administering anesthesia and rubber dam isolation, the preoperative lingual contact zone and excursive guiding ridges are recorded with articulation paper and transferred to a hand-drawn occlusal diagram and/or recorded on an intraoral or digital camera.

- Any preexisting defective composite restoration and/or caries is removed with a no. 4 high-speed round bur (Midwest Dental, Des Plaines, IL, USA), which produces rounded line angles.
- A caries-disclosing solution (Seek®/Sable™ Seek®, Ultradent, Salt Lake City, UT, USA) can be applied to the internal surfaces of the preparation to facilitate carious tissue detection and removal.[16,17] Since a recent study shows that these solutions remove infected and affected dentin, it is advisable to use them cautiously only as a guide in conjunction with radiographs and sound clinical experience and judgment. Routine use without an understanding of the limitations may result in the excessive removal of sound tooth structure and possibly an increase in mechanical pulp exposure.[18]
- The cavity outline is extended only to include carious enamel; provide access to the carious dentin; remove any residual composite, liners, or staining; and provide access for the application of restorative materials.
- Healthy tooth structure should be removed only when the lingual outline requires extension to a point beyond or within the previously indicated functional stops.[19]
- An increase in the incisolingual width of the preparation can trespass into the centric holding areas and increase the wear rate of the restoration since wear is a direct function of dimension.[20]
- To allow for a better resin adaptation, all internal line angles should be rounded and cavity walls smoothed.[21]
- A chamfer 0.3 mm deep and 2 mm long is placed around the entire margin to increase the enamel-adhesive surface and to allow for a sufficient bulk of material at the margins.[22] The lingual aspect of the chamfer can be extended 2 mm onto the lingual surface but not on the occlusal contact area.[23]
- A scalloped bevel is placed with a long, tapered diamond to interrupt the straight line of the chamfer.
- If the margin is located entirely in enamel, a 0.5 mm bevel is placed on the gingival margin to reduce the potential for microleakage.[21,24]
- The preparation is completed with a finishing disk and polished with rubber cups (Figure 1).

The mechanical approach to operative dentistry of the past has transformed into a biologic approach; from the early onset of the disease to placement of the restoration, this approach seeks to preserve the maximum integrity of the natural dentition by preventing the placement of the initial restoration,[3] to conserve tooth structure during the preparation of the restoration, and to increase the longevity of the restoration between replacements.

PREOPERATIVE CONSIDERATIONS

Preoperative considerations during the diagnostic and treatment-planning phases of the restorative procedure provide the framework that ensures an optimal functional and esthetic restoration. These preoperative considerations allow the clinician to organize and communicate information to the patient and also provide a road map of the anticipated final result before initiation of the restorative procedure. Prior to any restorative treatment, the clinician should evaluate procedures involving clinical examination, risk assessment, patient self-assessment, perioesthetic considerations, interdisciplinary treatment, diagnostic aids, occlusal considerations, restorative material selection, and shade selection to ensure that the individual steps of the diagnostic and treatment phases are cohesive

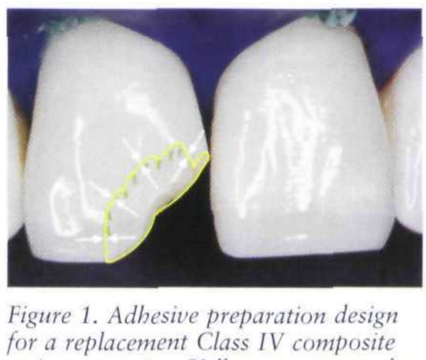

Figure 1. Adhesive preparation design for a replacement Class IV composite resin restoration. Yellow *represents the cavity outline defined by the carious lesion, fracture, or existing restoration. Lingual extension should remain within or beyond functional stops.* Arrows *represent the 0.5 mm bevel on the gingival margin in enamel. The* green *area represents the chamfer, which is 0.3 mm in depth and 2 mm long around entire margin.*

to the overall objective. Comprehensive evaluation and treatment planning prior to restorative treatment also provide a medium by which the patient has complete, informed knowledge of the procedure and becomes part of the decision-making process.

Radiographic, Restorative, Periodontal, and Occlusal Evaluation

In the presented case, the maxillary right central incisor had been prepared two times since the initial fracture, and any repair was most likely unsuccessful owing to inadequate tooth preparation and excessive occlusal deflective contacts (Figure 2). In fractures of teeth, the extent of trauma and pulpal injury must be assessed clinically and radiographically. In the event that acute pathology is observed, all treatment decisions should be altered and all necessary actions taken to resolve them. Upon self-assessment the patient requested the most conservative and esthetic restorative procedure available. After radiographic and clinical evaluation, the patient was informed that the restorative solution would require a combination of operative and periodontal therapies for the maxillary anterior teeth. The patient presented with Class I gingival recession (Figure 3) from a history of parafunctional habits; hence, an occlusal guard had to be constructed after the operative reconstruction of the Class IV fracture on the maxillary right central incisor and before periodontal surgery ensued. A dual-laminate, acrylic occlusal guard was designed and fabricated with a flat plane of occlusion so that all teeth would touch evenly in all excursions without anterior disclusion. Controlling and preventing the progression of soft and hard tissue destruction should be an integral part of the restorative solution (Figure 4).

Figure 2. Preoperative facial view of the fractured maxillary right central incisor displayed upon smiling.

Figure 3. A Class I gingival recession-type defect from a history of parafunctional habits.

Restorative Material Selection

Particle size, distribution, and the quantity incorporated represent crucial factors in the determination of how to best use composite resins. In the past a combination of both a hybrid and a microfilled resin was often required to achieve a restorative result with optimal physical and mechanical characteristics. The hybrid provided the strength and sculptability, and the microfilled resin furnished the polish and its durability.[25,26] This incremental layering technique with composite resins resulted in an optimal depth of cure while reducing the effects of the shrinkage and stress forces during the polymerization process.[27,28] In addition, the clinician observed another phenomenon when restorative composites of varying refractive indexes, shades, and opacities were stratified known as the "polychromatic effect."[26,29] By using an anatomic stratification with successive layers of dentin, enamel, and incisal composite, a more realistic depth of color could be achieved, as well as surface and optical characteristics that mimic nature.[10]

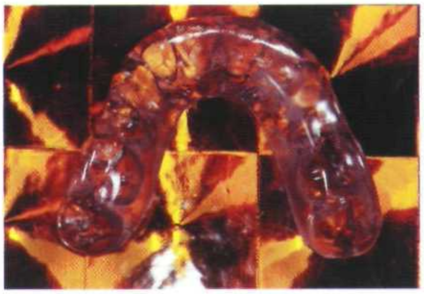

Figure 4. The dual-laminate, acrylic occlusal guard allows a flat plane of occlusion so that all teeth touch evenly in all excursions without anterior disclusion.

The development of the polychromatic restoration from the inequities of the two composite resin systems stimulated scientists, researchers, clinicians, and manufacturers to explore and develop restorative materials that are not only applied in relationship to the natural tissue anatomy but that have similar physical, mechanical, and optical properties to that of tooth structure. Currently developers of these new formulations of microhybrid composite resins continue to alter the particle size, shape, orientation, and distribution, enhancing their physical, mechanical, and optical characteristics.[21,22] These formulations provide the clinician with a single restorative material that has sculptability, fracture strength, color stability, polishability, and durability of polish. This present stratification process requires parameters of the restorative materials to be considered only for the specific clinical situation during diagnosis and treatment planning and not for the particular region on the tooth or restoration. Therefore, the clinician considers only the color parameter in developing the correct interpretation of form and color for the restoration. In addition, the use of these newer formulations of microhybrid composite resins requires a more conservative preparation design since only a single restorative material is selected. Therefore, it is not necessary to compensate for fracture resistance of the restoration by increasing the volume of restorative material at the restorative interface through tooth preparation as would be required of a stratification technique using a hybrid and a microfilled composite. Also, in clinical situations that do not require increased space parameter considerations for optical integration of color (ie, use of the natural color of the dentin), a more conservative preparation allows the elimination of an additional layer of microfill for the enamel layer since these microhybrids have improved polishability and durability of polish.[21,22,26,30]

Composite Mock-Up

The esthetic restoration of a single anterior tooth is extremely difficult to perform using composite resin or porcelain. A composite mock-up was created with the selection of the composite restorative materials and modifiers and their orientation, all of which were charted for application at the restorative stage. The composite or wax mock-up is an excellent intraoral tool; it requires minimal time to make and increases the patient's visual understanding and education of the clinical procedure (Figure 5). The mock-up involves the use of composite resin or orthodontic wax, which is applied in the same manner as direct bonding but without the adhesive.

Figure 5. The composite mock-up provides the restorative recipe, while providing the patient with a visual image from which to gain an understanding and education of the clinical procedure and the final esthetic result.

It allows the patient and the restorative team to establish parameters for lip profile, diastema closure, facial contour, incisal length, and orientation to gingiva and to simulate the final result. The procedure can be performed intraorally without anesthesia and can provide proper lip position and phonetic considerations, which are key to optimal functional, esthetic, and phonetic success.[31] The mock-up provides the patient with immediate visualization of the final dimensions and increases patient confidence for the procedure, which can result in immediate treatment decisions.[32]

Shade Selection

Shade selection should be accomplished prior to rubber dam placement to prevent improper color selection as a result of dehydration and elevated values.[26] The use of color-corrected daylight source illumination (5500 K) is necessary for proper color registration.[10,33] However, to obtain an acceptable shade determination, it is advisable for the viewers (technician, clinician, and assistant) to observe the color matching under various lighting conditions—daylight, color-corrected light, fluorescent light, and dim light.[10,33–35] A shade map or restorative recipe can be used to diagram the existing colors of composite resin and modifiers used when making the mock-up. Additional information that can be helpful when reconstructing the tooth surface includes anatomic morphologic details such as developmental lobes, shapes of embrasures, prominences, convexities, facets, angles, translucency patterns, crazing, hypocalcification spots, stain patterns, and gingival to incisal blending; a complex drawing can detail the opaque, dentin liner, dentin, and intercolor contrasts (Figure 6). Also, notations of the preoperative occlusal stops and excursive guiding planes can be recorded with articulation paper and transferred to a hand-drawn occlusal diagram, recorded on an intraoral or digital camera or indicated and reviewed on a stone model, which can be useful when developing the preparation design and completing the final restoration.

Shade Guide. The shade guide provides a pivotal reference point for the clinician and technician. However, it is limited in application because its color range does not sufficiently match all natural teeth.[34] Variations in shade occur not only among different teeth in the same arch but also within individual teeth. Development of the most natural appearance requires compatibility of the shade of the teeth with the complexion, hair color, and age of the patient.[35]

Figure 6. A color map can be used to diagram and record the selected composite shades and necessary modifiers to mimic the natural anatomic morphology of the tooth. Purple *represents artificial enamel (T-1-shaded hybrid),* blue *represents artificial dentin (XL-shaded hybrid),* white *represents the tints (diluted, white tint), and* red *represents the dentin lobes (B-1-shaded hybrid).*

Because of the variety of colors and their orientation within natural teeth, appropriate shade selection for composite restorations remains challenging. Since composite materials are monochromatic and cannot duplicate the complex orientation of the colors seen in the natural dentition, a variety of resin shades must be selected to provide natural esthetics.[36] Arbitrary and subjective shade designations (eg, universal, yellow, light) further complicate precise shade selection. Since the standard shade guides for composite resins are manufactured with unfilled methacrylates, they do not accurately represent the true shade, translucency, or opacity of the final polymerized restorative material.[37] Therefore, clinicians must translate the final polymerized results to these shade guides for proper color comparison.

To simplify the shade-matching procedure, many of the composite systems are synchronized to a shade guide (eg, Vita Lumin®, Vident, Brea, CA, USA) that was designed for porcelain shade selection for crowns and dentures, not resins.[38–40] This effort to simplify the process has resulted in inherent inconsistencies for the following reasons: the range of shades in the guides is not consistent with natural tooth color,[41–43] dental shade guides contain a limited selection of colors compared with those found in natural teeth,[44–46] shades are seldom fabricated from the restorative material,[41] samples do not match the restorative material and are not a uniform color,[41,47] and shade guides do not match each other—there is even inadequate control of different batches of one shade from the same manufacturer.[41,47] Since many shade tabs are fabricated using this basis, custom shade tabs may be beneficial for a variety of direct and indirect applications for an exact visual reference while fabricating the restoration. When shade tabs are customized by the clinician, they provide a more tangible shade representation (Figure 7).

RESTORATIVE PROCEDURE

Development of the Restoration

Once anesthesia had been administered to the patient, a rubber

Figure 7. Development of a custom shade tab of the exact restorative material allows a more accurate and realistic representation of the natural tooth.

dam was used to achieve tooth isolation and adequate field control and to protect against contamination.[48,49] The preparation followed the aforementioned guidelines for a replacement Class IV composite resin restoration (Figure 8). The preparation was rinsed and lightly air dried, and a soft metal strip was placed interproximally to isolate the prepared tooth from the adjacent dentition. The total-etch technique was used owing to its ability to minimize the potential of microleakage and enhance bond strength to dentin and enamel.[50–52] The preparation was etched for 15 seconds with 37.5% phosphoric acid (Gel-Etchant®, Kerr/Sybron), rinsed for 5 seconds, and gently air dried for 5 seconds (Figure 9). The etch should extend several millimeters beyond the bevels, and the adjacent teeth should be protected from the conditioner with a soft metal strip.[53] A single component adhesive (OptiBond® SOLO Plus, Kerr/Sybron) was applied with a microbrush for 20 seconds with continuous motion and was lightly air dried for 5 seconds. The agent was light cured for 20 seconds (Figure 10). Although a small amount of excess adhesive can be applied over the margins to improve sealing, this excess should be removed during finishing procedures to avoid adverse periodontal sequelae.

Incremental Stratification Technique. Incremental layering has been advocated for use in large composite restorations to avoid the limitation of depth of cure, reduce the effects of polymerization shrinkage, and enhance the esthetic results with a multilayering of color.[27,28] However, it is the anatomy of the tooth that should guide the clinician in developing the correct interpretation of form and color. Incremental layering with successive layers of dentin and enamel composites creates high-diffusion layers, which allow an optimal light transmission within the restoration, providing a 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. Owing to the variations in natural teeth, combinations of composite shades have to be applied in relationship to the natural tissue anatomy and specifically adapted to individual clinical situations. The following technique uses both the incremental layering of composite and the stratification of color to create a natural "chromatic integration."[54]

Figure 9. The preparation was etched for 15 seconds with 37.5% phosphoric acid.

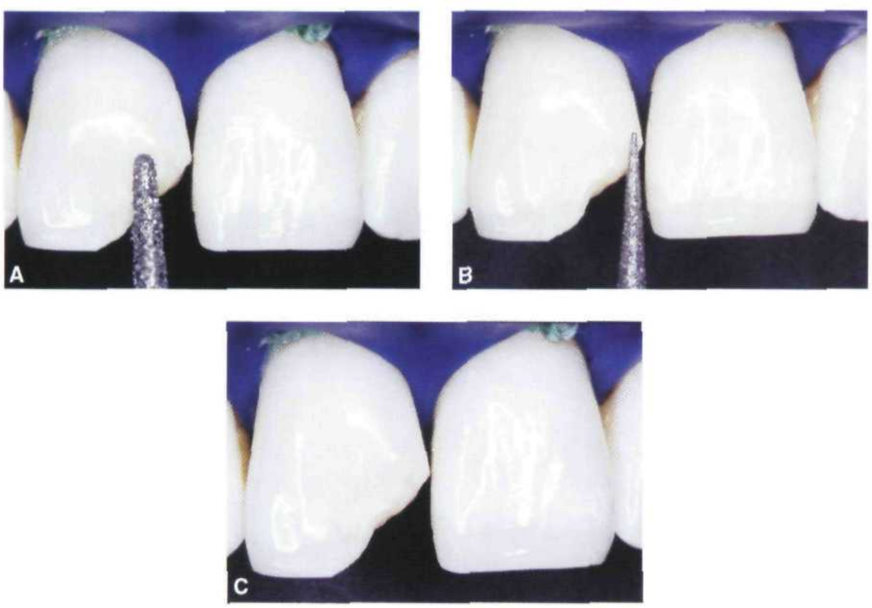

Figure 8. A, *A 2 mm long chamfer was placed around the entire margin.* B, *A scalloped 0.5 mm bevel was placed to interrupt the straight line of the chamfer and to reduce the potential for microleakage.* C, *Notice the minimal removal of tooth structure for this adhesive Class IV preparation design.*

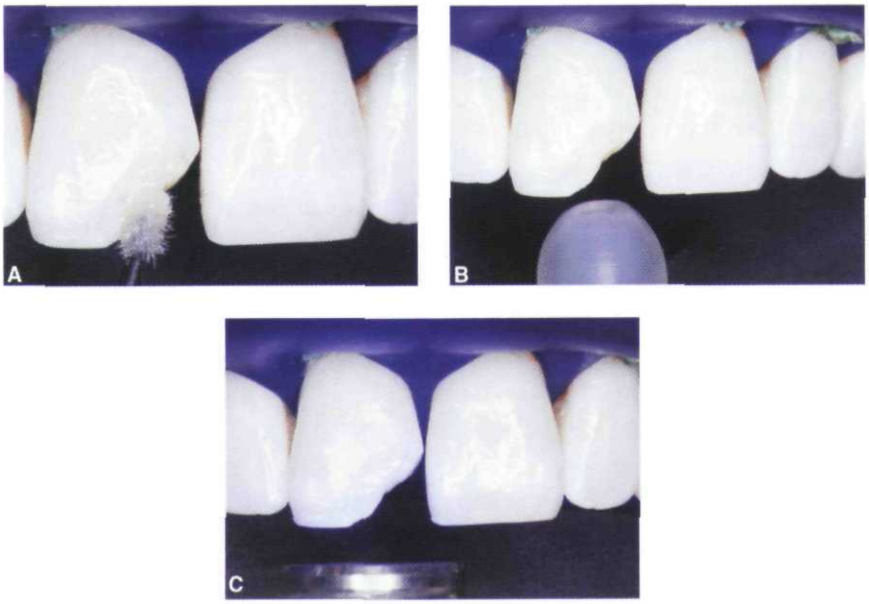

Figure 10. A single component adhesive (OptiBond SOLO Plus) was applied with a disposable applicator for 20 seconds (A), air thinned for 5 seconds (B), and light cured for 20 seconds (C).

Artificial Dentin Layer. A very small amount of glycerin was applied to the mesial surface of the maxillary left central incisor with unwaxed floss (Figure 11). The first layer—the artificial dentin body—of B-1-shaded composite resin (Point 4) was formed into an elliptical shape, applied and contoured with a long-bladed composite instrument, and smoothed out with a no. 4 sable brush (Figure 12). Surface smoothness was crucial since surface irregularities can interfere with the placement of tints for internal characterization. This composite layer was polymerized with a curing unit (Optilux 501®, Kerr Demetron, Danbury, CT, USA) for 40 seconds, which allowed the placement of subsequent increments without deforming the underlying composite layer. This process was repeated with a second layer of B-1-shaded composite to form the dentin lobes (Figure 13). To prevent overbuilding of the artificial dentin layer, it is important to monitor the composite placement from the incisal aspect so as to provide adequate space for the final artificial enamel layer. Although this composite resin exhibits characteristics of opacity, a very small amount of diluted, white tint (Kolor Plus®, Kerr/Sybron) was placed along the interface to disguise the fracture line (Figure 14). To emphasize the tooth form, a small increment of higher-value composite resin XL1 was formed into an elliptical shape, applied vertically at the distofacial line angle, and smoothed with a no. 4 sable brush (Figure 15). This technique raised the value on the mesial line angle to correspond with the contralateral central incisor, while using color variation to impart a three-dimensional effect to the

Figure 11. A very small amount of glycerin was applied to the proximal surface of the maxillary left central incisor with unwaxed floss as a separating medium.

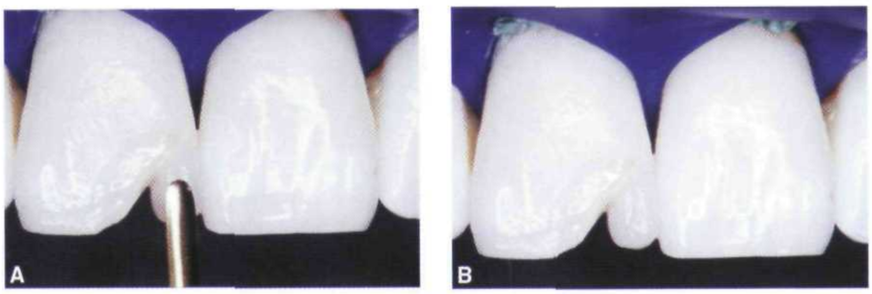

Figure 12. A *and* B, *The first layer of the artificial dentin body, a B-1-shaded hybrid composite resin, was applied, contoured, and smoothed with an artist's no. 4 sable brush.*

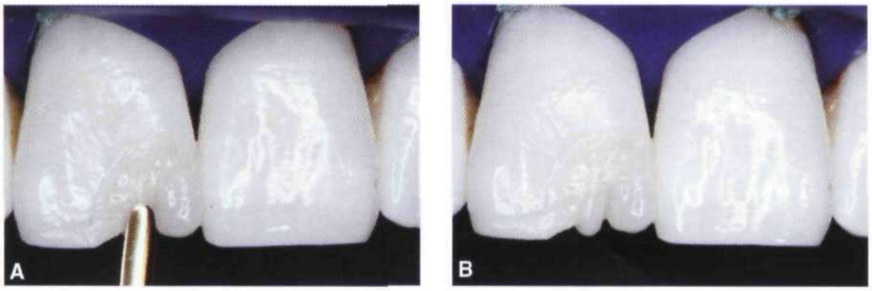

Figure 13. A *and* B, *A second layer of B-1-shaded hybrid composite was placed to form the dentin lobes.*

Figure 14. A thin wash of diluted, white tint was placed along the interface to disguise the fracture line.

Figure 15. To raise the value on the mesial line angle to correspond to the contralateral central incisor, a small increment of higher-value composite XL1 was formed and smoothed with a sable brush.

restoration. The small-particle hybrid (Point 4) used in developing this restoration has three higher-valued shades (bleached shades), which increase in value (brightness) corresponding to an increase in the number (ie, 1, 2, or 3).

Artificial Enamel Layer. The artificial enamel layer is the principal determinant of the value of the tooth or the restoration and can be varied by the thickness of this layer. The artificial enamel is colorless but through its network of rods acts as a fiber-optic conduit and projects the underlying color found in the dentin.[26] The final layer was restored with a clear translucent T-1-shaded composite (Point 4), which was applied with a long-bladed instrument and then smoothed with a no. 4 sable brush (Figure 16). Surface irregularities were carefully eliminated, and the increment was polymerized with a curing unit (Optilux 501) for 40 seconds. The small-particle hybrid used in developing this restoration has three translucent shades. The T-1-shaded composite is a clear translucency, the T-2 a yellow translucency, and the T-3 a gray translucency. Another small-particle composite resin system with similar characteristics that has three translucent shades is Venus® (Heraeus Kulzer, Wehrheim, Germany). Its T-1-shaded composite is a cool translucency, its T-2 a neutral translucency, and its T-3 a yellow translucency.

Final Restorative Phase

The final restorative phase involves contouring and finishing of the restoration, which are critical for enhancing esthetics and the longevity of the restored teeth. Creating surface texture of composite restorations is relatively hard to achieve; it demands intensive training and meticulous attention to technique, coupled with attentive observation of natural teeth.

In this case, particular attention was given not only to the relationship between the expanse and direction of the ridges and grooves and the

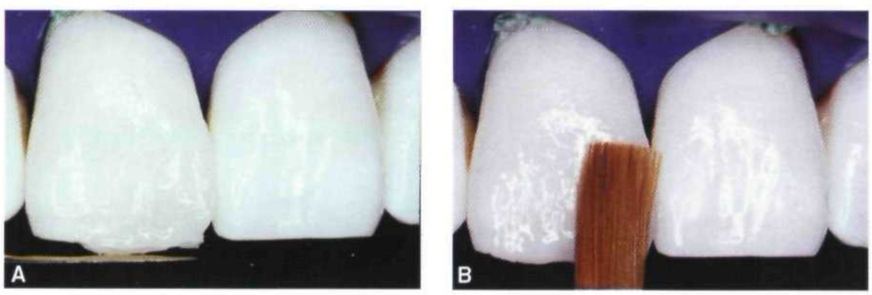

Figure 16. A *and* B, *The artificial incisal enamel layer, a clear translucent T-1-shaded hybrid composite resin, was applied, contoured, and smoothed with a no. 4 sable brush and light cured for 40 seconds.*

anatomic variations of the teeth that are adjacent to the restoration, but also to the light refraction and surface reflection resulting from the microstructure of the tooth surface. Developing the restoration in increments and considering the anatomic morphology and facial contour by anticipating the final result minimizes finishing procedures.[55] This technique typically results in a restoration with improved physical and mechanical characteristics with less microfracture. At least one study reveals that a reduction in finishing results in less damage to the composite and improved wear and clinical performance.[56] To reproduce the shape, color, and gloss of the natural dentition while enhancing the esthetics and longevity of the restoration, the following protocol was implemented.

Figure 17. To reproduce natural form and texture, the initial facial contouring was performed with a 30-fluted, needle-shaped finishing bur.

Figure 18. To refine the lingual anatomy, a 30-fluted, egg-shaped finishing bur was used dry with light pressure to prevent heat buildup.

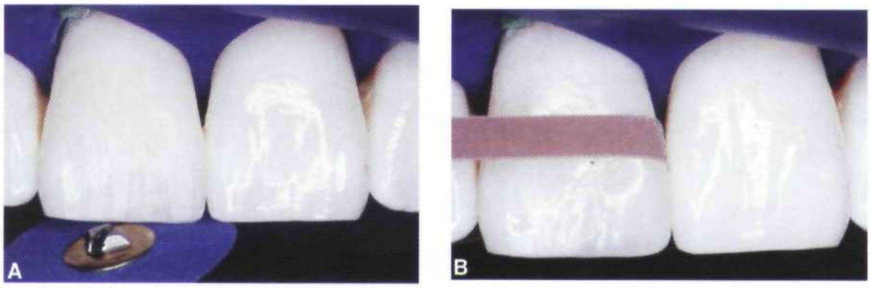

Figure 19. A *and* B, *Finishing of the proximal, facial, and incisal angles was performed with aluminum oxide disks and finishing strips.*

The initial contouring was performed with a series of finishing burs to replicate natural form and texture. The facial contouring was initiated with 12- and 30-fluted, needle-shaped burs (BluWhite® diamonds and carbides, nos. 7714 and 9714, Kerr/Sybron), while closely observing the tooth-resin interface and using a dry protocol (Figure 17). The lingual surfaces were contoured with 12- and 30-fluted, football-shaped burs (BluWhite diamonds and carbides, nos. 7406 and 9406) (Figure 18). Finishing of the proximal, facial, and incisal angles was performed with aluminum oxide disks and finishing strips. These were used sequentially according to grit and ranged from coarse to extra fine (Figure 19). For characterization, finishing burs, diamonds, and rubber wheels and points were used to create indentations, lobes, and ridges. To recreate the micromorphologic surface characteristics of the contralateral central incisor, a knife-edged wheel (KN7 Ceramiste Silicone Points®, Shofu Dental, CA) was used vertically in an intermittent, staccato motion (Figure 20). The knife-edged wheel produces shallow grooves that can be created vertically or horizontally using this staccato motion. To impart a high luster while maintaining the existing texture and surface anatomy, a soft, brown, goat hair brush (Vivere™, Leach and Dillon, Cranston, RI, USA) with composite paste was used to polish the restoration applied at conventional speed (Figure 21). These loose abrasive pastes allow

Figure 20. To re-create the micromorphologic surface characteristics of the contralateral central incisor, a knife-edged wheel was used in an intermittent staccato motion.

Figure 21. A soft, brown, goat hair brush with a loose abrasive composite polishing paste was used to impart a high luster while maintaining the existing surface texture.

the anatomic details to be maintained while imparting an enamel-like appearance to the restored tooth. An additional polishing device that can be used when there is insufficient space for the goat hair wheel is the synthetic foam polishing cup (Enhance® cup, Dentsply, IL). A final high gloss can be achieved with a dry, cotton buff or felt wheel, using an intermittent, circular, staccato motion at conventional speed, when there is adequate space (Figure 22). Once the polishing procedure is completed, a final 2-minute post-curing improves the degree of conversion and ensures the hardest surface possible is achieved.[57,58]

The surface quality of the composite resin is influenced not only by the polishing instruments and pastes but also by the composition and the filler characteristics of the composites.[59,60] Composite surface roughness is directly related to the type, size, distribution, and orientation of the filler particles added to the composite and to the type of composite resin. Advancements in filler technology have resulted in improved formulations of composite resin systems with reduced particle size and increased filler loading, which have significantly improved light-cured composite resins for universal use in anterior and posterior restorations. The improved polishability is attributed to the inherent smoothness of the restoration.[61,62]

To evaluate occlusion, the rubber dam was removed and the patient was asked to first perform closure without force and then centric, protrusive, and lateral excursions. Any necessary equilibrations were accomplished with 12- and 30-fluted, egg-shaped finishing burs, and the final polishing was repeated. The contact was tested with unwaxed floss, and the margins were inspected. The postoperative result demonstrates the optical integration of composite resin with existing tooth structure using minimally invasive tooth preparation to create form, function, and natural esthetics in the anterior interproximal zone (Figure 23).

Figure 22. A high-gloss surface reflectiveness was accomplished with a dry, felt wheel using an intermittent, circular, staccato motion.

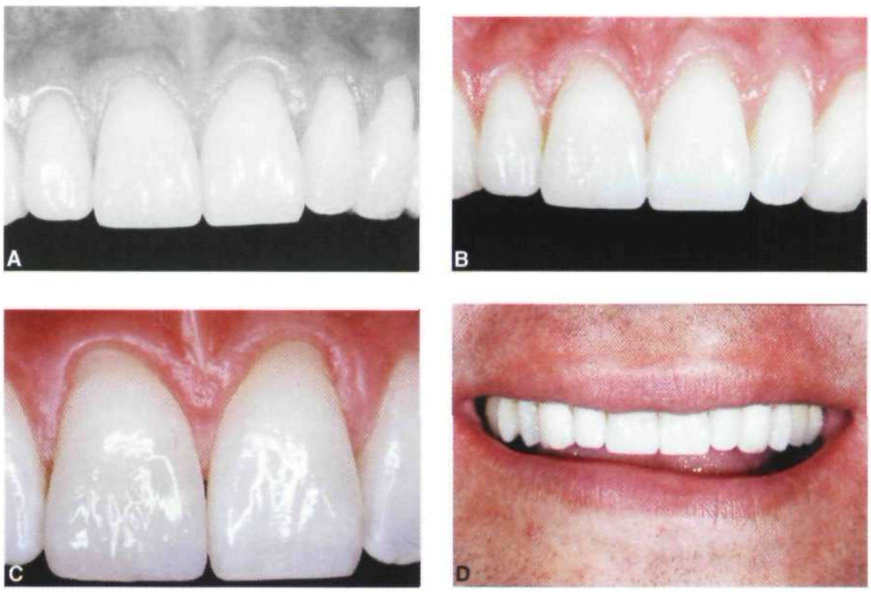

Figure 23. A–D, The postoperative result achieved with the use of this direct composite resin reflects the harmonious integration of natural tooth structure with restorative material and color. Notice the diffuse light reflection created from the developed anatomic morphology.

CONCLUSIONS

The mechanical approach to operative dentistry of the past is transforming into a biologic philosophy, strategy, and design. This modern philosophy has three clinical objectives from the early onset of the disease to placement of the restoration: to preserve the maximum integrity of the natural dentition by preventing the placement of the initial restoration,[3] to conserve tooth structure during the preparation of restoration, and to increase the longevity of the restoration between replacements.

This article has demonstrated the importance of preoperative considerations in the diagnostic and treatment planning stages of restorative treatment. Progress in the development of composite resin systems and adhesive technology allows not only for the creation of esthetic restorations but for the preservation, conservation, and reinforcement of tooth structure, as has been demonstrated herein.

DISCLOSURE

The authors do not have any financial interest in the companies whose materials are discussed in this article.

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