Stratification Of Composite Restorations: Systematic And Durable Replication Of Natural Aesthetics

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A thorough knowledge of the internal structure of natural dentition provides invaluable information for increasing the aesthetic potential in dental restorations. To achieve the optimal aesthetic results, this knowledge must be integrated in a systematic therapeutic procedure. The learning objective of this article is to guide the practitioner in clinical case analysis, evaluation, and the application of a personalized technique of stratification for each individual case in direct composite restorations. The article evaluates treatment demarcations, differences in composite stratification between anterior and posterior teeth, color selection, and the "sandwich technique." The treatment protocol section discusses the element of reference, which can be either an adjacent natural tooth or provisional restorations, permitting the diagnostic study of a more extensive case. The structure of the element of reference is analyzed as to the enamel, dentin, and incisal edge, and replicated. Since light penetration is different in the anterior and posterior dentition, the color stratification must differ accordingly. The "worn" tooth must be distinguished from the "unworn" tooth. In color selection, the luminosity and saturation of the teeth are evaluated first; tint is selected from the element of reference.

The understanding of the intimate structure of natural teeth constitutes the basis of knowledge in the field of aesthetics in conservative restorative dentistry. The appearance of the anterior as well as posterior teeth is founded on a common morphologic structure, involving two types of hard tissue—dentin and enamel—distinguishable by their embryonic origin and their respective appearance. Dentin represents the opaque and complex core, rich in hue, chroma, and fluorescence.[1] It is covered by an enamel shell, which is translucent, transparent, and opalescent (Figure 1).[2,3] The diversity of the characteristics and alterations between enamel and dentin explains the unique and individual nature of the appearance of a natural tooth.[4]

Therefore, any attempt to restore a tooth mandates a respect for these morphologic principles. However, the complexity of the dental structure often renders this task difficult and presents to the practitioner the limits set by clinical conditions, techniques, and materials utilized in the restoration. This article attempts to guide the clinician in the restorative procedure by offering a systematic therapeutic approach associated with a personalized technique of stratification for each individual case of direct composite restorations.

Figure 1. A). Facial view of natural teeth transillumination. Light concentrates on the enamel junction. Complex effects of reflection and light transmission take place on the incisal border. **B).** Enamel has been removed from the palatal side of the teeth to observe the internal structure. Note the complexity of dentin: Incisal cut in 3 sections, convergence of tubuli, and zones of intrinsic and extrinsic intensive coloration.

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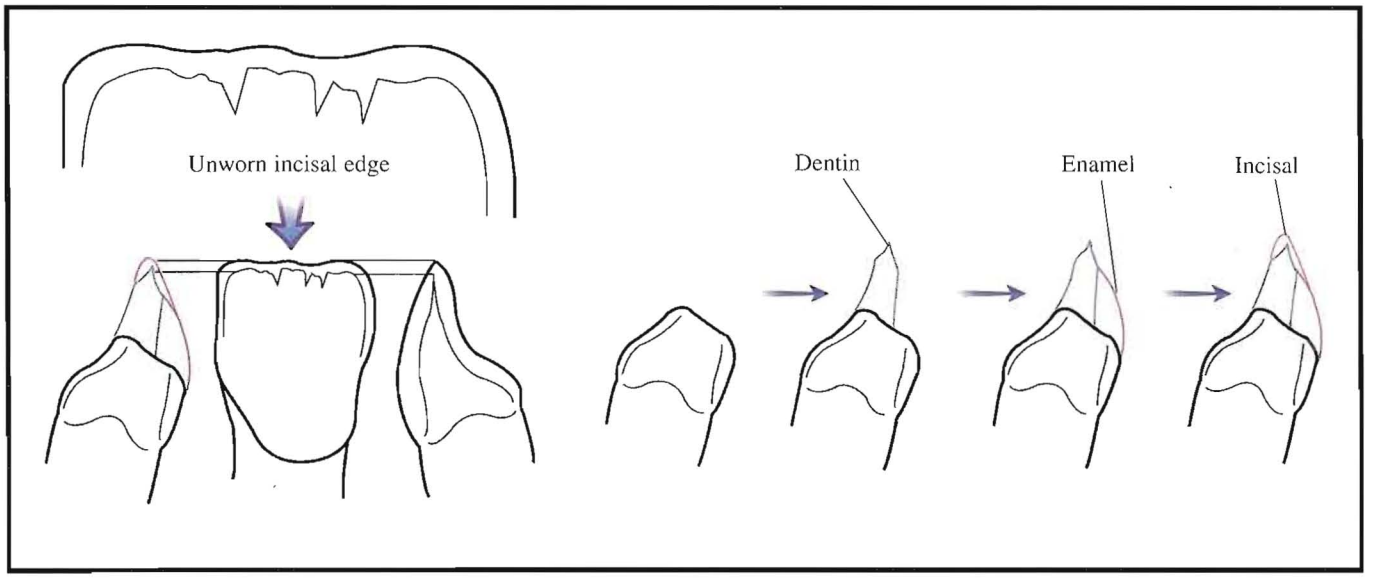

Figure 2. Illustration of the incisal edge, dentin, and the enamel of an "unworn" tooth.

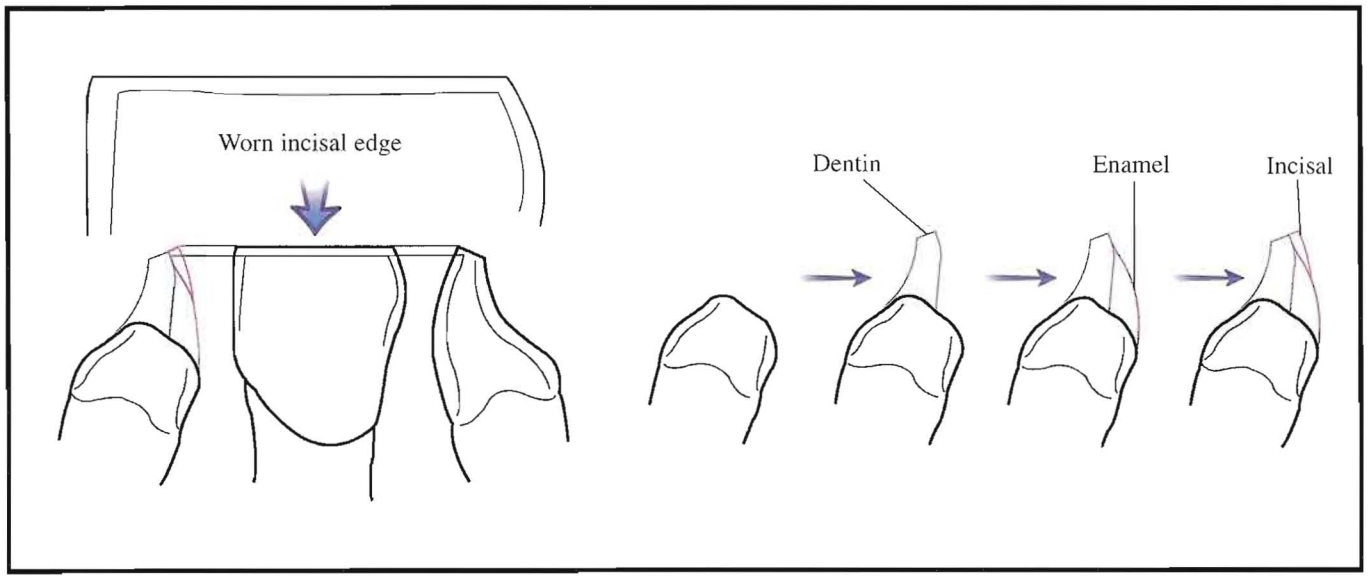

Figure 3. Illustration of the worn incisal edge, dentin, and the enamel of a "worn" tooth.

TREATMENT PROTOCOL

Element of Reference

The basis of any aesthetic restoration consists of a definition of an element of reference, which represents the objective of an aesthetic restoration and the guide to achieve the objective. If extensive alterations are involved (often treated by prosthodontic techniques), it is primarily the provisional restorations that allow a diagnostic study of the case and define and finalize the therapeutic objective.[5-7] In the case of less extensive alterations, which generally are within the parameters of direct composite restorations,[8,9] the treatment procedure is designed to replicate the intact elements of the same tooth or adjacent teeth, which then become the reference guides.

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Analysis of the Element of Reference

The second stage of the treatment consists of a detailed analysis and comprehension of the structure of the element of reference. The procedure for this analysis is selected according to the technique and materials that will be utilized to reproduce the element of reference. Clinically, this analysis involves defining dentin and enamel with regard to color, opacity, and internal characteristics. In the case of anterior teeth, the type of tooth to be replicated must be specified, eg, an

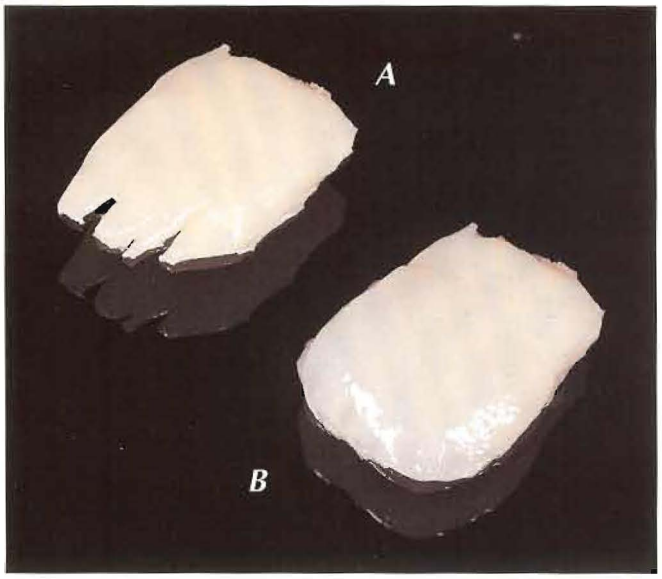

Figure 4. A). Anatomic shaping of dentin composite. **B).** Application and covering by incisal composite.

Figure 5. Two similar samples have been produced: (Left) Incisal border was flattened to simulate certain incisal wear. (Right) Incisal edge was sculpted to achieve a more uneven morphology.

Figure 6. Palatal view of the incisal edges presented in Figure 5. Note the anatomic cutting of the dentin. No intensive coloration was used.

Figure 7. A). Facial view of dentin morphology. Note opalescence and contour of incisal border. **B).** Sophisticated aspects of translucency. The result is comparable to the natural teeth in Figure 1.

"unworn" tooth with a sharp incisal edge, or a "worn" tooth with an abraded incisal border. This fundamental difference will influence the type of stratification to be applied in incisal edge, dentin, and enamel (Figures 2 and 3). The selection of color is generally achieved by utilizing the Vita shade guide (Vident, Baldwin Park, CA).

Replication of the Element of Reference

The element of reference defined in the foregoing text must be replicated with complete fidelity to all aspects to be reproduced, thereby guaranteeing aesthetics and longevity of the result. In the case of composite restorations, the selection of materials and stratification technique will significantly influence this stage of replication.

... an element of reference represents the objective of an aesthetic restoration and the guide to achieve the objective.

STRATIFICATION DIFFERENCES IN ANTERIOR AND POSTERIOR COMPOSITES

The integration of an aesthetic restoration depends primarily on the environment in which it is placed. Therefore, it is important to correctly differentiate the aesthetic restorations placed in the anterior from those placed in the posterior region. Incidental light can thoroughly traverse the maxillary incisors; dentin creates a reflective screen whose opacity varies between the root (rather opaque) and the incisal edge (quite translucent). A restoration placed must similarly act

Figure 8. Preoperative clinical view of a Class IV defect, to be restored with modified stratification — the "sandwich technique." Tooth #9(21) serves as reference for #8(11).

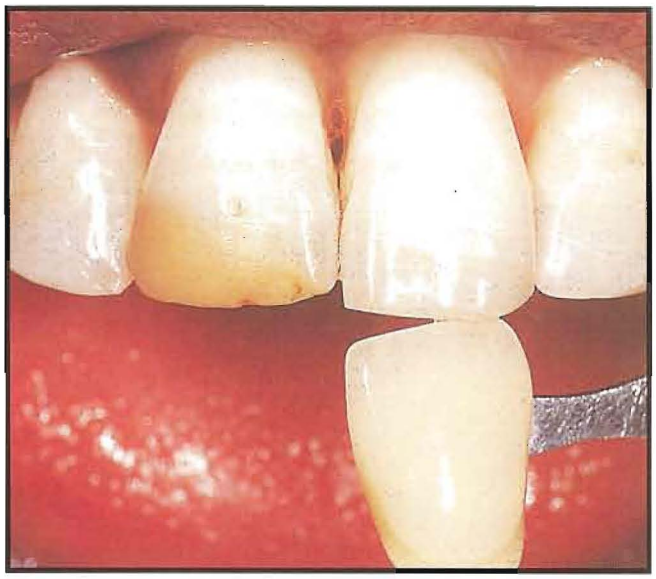

Figure 9. Distinguish the internal and surface tooth structures. Dentin is saturated on its incisal and luminous on its cervical. Initially, color selection (here A3) should not consider tooth surface characteristics.

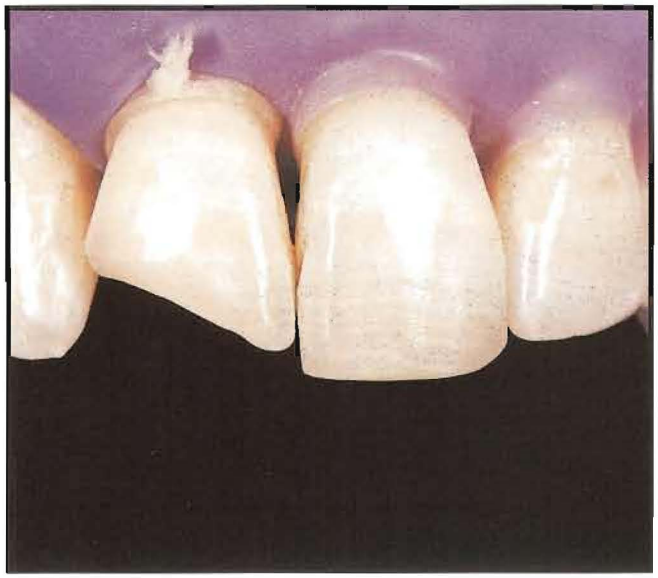

Figure 10. Clinical view after removal of previous restoration. Note the distinct surface of the element of reference.

Figure 11. After bonding, the first layer of composite is applied in the form of A3.5 color dentin on the Vita shade guide.

as a reflective screen, which will necessitate the utilization of a material of dentin-like opacity. Such precaution will prevent the restoration from lacking in luminosity. This problem is frequently encountered when the restoration is too translucent and takes on the gray tone of the oral background. Such circumstances are not found in posterior teeth, where it is usually possible to utilize the more translucent enamel-like composite. The restoration then assumes a "chameleon" quality, taking advantage of the color and character of the underlying natural dentin.

Selection Of Color

Color is selected in natural light using a color blending system such as the Vita shade guide. Evaluation of the value and chroma of the teeth (gradations 1 through 4) is the first step, without considering the hue. Only after the selection of a series of samples of the same gradation is the hue (A, B, C, or D) selected, by placing the edges of two samples at a time against the incisal edge of the reference element. The selected sample indicates the appropriate enamel restorative material; the selection of the dentin restorative material will generally be of a higher chroma. Therefore, if the sample A3 was selected, a composite of dentin shade A3.5 with a cover of enamel A3 will have to be utilized to achieve an appropriate restoration.

Conventional Stratification of Composites in Anterior Teeth

The new generation composite restorative materials, ie, the small particle hybrid composite resins, can be used in anterior as well as posterior regions. However, the direct utilization of light-cured

Figure 12. A second layer, the enamel A3 type composite, is added to cover the bevel and reconstitute the tooth morphology.

Figure 13. Color and opacity are reevaluated 1 week postplacement. Surface stains will be used to compensate for the less luminous aspect.

Figure 14. A thin coating of composite is eliminated with a bur. The touched-up surface is roughened to facilitate adhesion of the dyes.

Figure 15. The growth streaks are simulated by fine grooves, sculpted with a flame diamond bur.

composites does not allow the application of sophisticated stratification techniques, due to the risk of porosity incorporation and the difficulties in contouring. Therefore, a simplified use of three incremental layers is suggested (Figures 2 and 3). This procedure can be utilized in most clinical situations, limiting the constraints of polymerization and rendering an acceptable aesthetic result.

Dentin composite (eg, Herculite XRV Dentin, Kerr, Glendora, CA) must be used to conform to the contour of natural dentin. It, however, can extend in the palatal direction to the limits of the preparation so as to reconstruct the entire palatal section of the restoration. To maintain aesthetics, it is not generally recommended for the dentin composite to exceed the limit of the preparation, due to the excessive opacity of the material. An exception can be made in the case of palatal limits, which permits to simplify the stratification and facilitate the adjustment and finishing sequence. In the incisal third, the dentin material can take a rather sharp form if reconstituting an "unworn" tooth (Figure 2) or a flatter shape for a tooth of the "worn" type (Figure 3).

Enamel composite (eg, Herculite XRV Enamel, Kerr, Glendora, CA) is clear and more translucent, and it reconstitutes the facial portion of the restoration and the bevel of the preparation. The incisal third of the dentin is generally not covered in order to reserve space for the third and final layer.

Incisal composite (eg, Herculite XRV Incisal Light or Herculite XRV Incisal Medium, Kerr, Glendora, CA) is almost transparent and covers the entire incisal dentin material of the "unworn" tooth (Figure 2). However, incisal composite

Figure 16. Intense white tint is applied at the bottom of the grooves, photopolymerized and will then be covered with a very translucent composite.

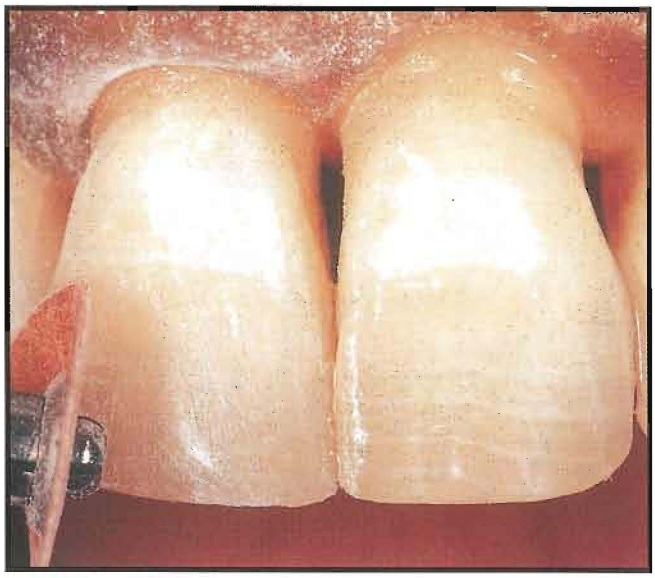

Figure 17. The general contours of the maxillary right central incisor are fashioned by means of an abrasive disc.

Figure 18. The surface morphology of the maxillary right central incisor is achieved using diamond instruments.

Figure 19. An abrasive paste is used on the tooth to regularize the touched-up surfaces.

is not generally used in the case of the "worn" dentition, or it is limited to the facial aspect of the incisal edge (Figure 3). Some rather sophisticated effects can be achieved with texturing the incisal dentin composite, which will be visible through the translucency of the incisal composite. In order to obtain such effects (Figures 4 through 7), utilization of intense tints and opaquers is usually not necessary.

Finishing instruments of rough texture (eg, discs, diamond burs, etc.) permit rapid adjustments in the contour and surface topography of the restoration. Polishing brushes with abrasive polishing paste (eg, Nupro Bleu, Ash Dentsply, York, PA; Depuredent, Dr. Wild & Co., AG, Basel, Switzerland) allow to smooth the surface. The final luster is obtained with finishing discs (Sof-Lex, 3M, St. Paul, MN).

Modified Composite Stratification Techniques in Anterior Segment: The "Sandwich Technique"

Certain teeth present characteristics (aging morphology, stains, etc.) that necessitate the utilization of intense tints (Figures 8 through 10). These tints are composed of liquid resin and cannot be placed on the surface of the restoration, due to wear and rapid degradation. In such cases, the restoration is accomplished in two phases: The conventional restorative method is applied first (Figures 11 through 13); the correct replication of the contour, color, and opacity is assured, and the facial thickness of the restoration is slightly reduced. The surface is then grooved to reproduce the characteristic streaks (Figures 14 and 15). These grooves are

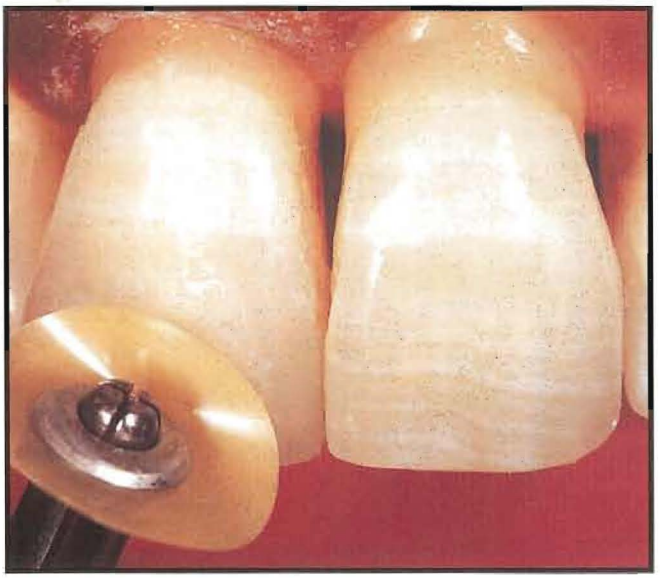

Figure 20. The final luster of the restored tooth is obtained with finishing discs.

Figure 21. Immediate postoperative view of the restored maxillary right central incisor and its element of reference.

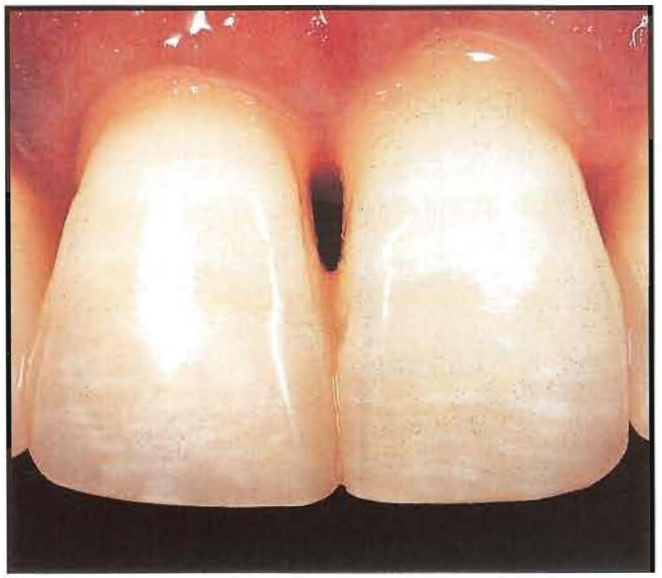

Figure 22. Six-month postoperative view. Note the stability of the results.

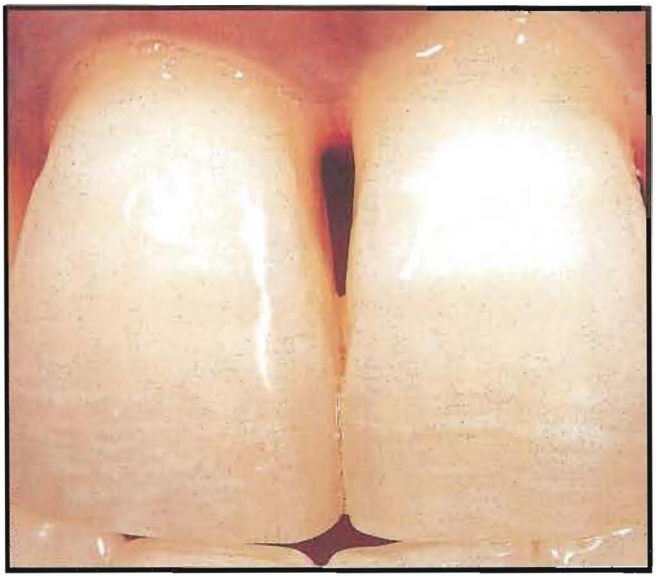

Figure 23. Close-up of the restored maxillary right central incisor and the reference — maxillary left central incisor.

then filled with an intense light-curable tint (eg, Kolor Plus, Kerr, Menlo Park, CA) (Figure 16). Finally, a homogeneous coating of a very translucent composite is applied and polymerized. The finishing steps are identical to those of the conventional method (Figures 17 through 20). The result will produce a durable characterization, since the intense tints are integrated within the depth of the restoration — in the middle of a "sandwich" — consisting of the enamel and incisal composite material (Figures 21 through 23).

Stratification of Composites on Posterior Teeth

Small particle hybrid composites can be utilized in direct techniques in posterior dentition as long as their indications are observed.[10,11] When the cavity dentin is void of intense colorations, the restoration can be stratified without the application of dentin type opaque composite, since the natural dentin subjacent to the restoration can be enhanced by utilizing a more translucent restorative material. A small amount of dentin composite can be applied to conceal a spot of stained dentin or the metallic pigmentations of a previous restoration (Figures 24 through 27). Generally, an error in the color selection will not have any major consequences, due to the "chameleon" effect through which the color of the restoration is conditioned by the underlying tissues.

CONCLUSION

The latest generation of composite resin materials, available in different opacities, permits a direct intraoral utilization of stratification techniques, similar to the indirect fabrication techniques used by the dental ceramist.

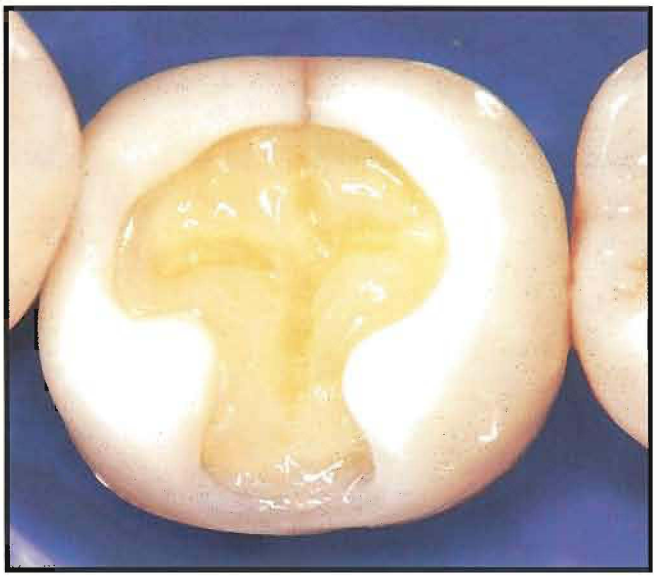

Figure 24. Posterior restoration. Occlusal view of a small amount of dentin composite reconstitutes the base of the cuspidian lobes.

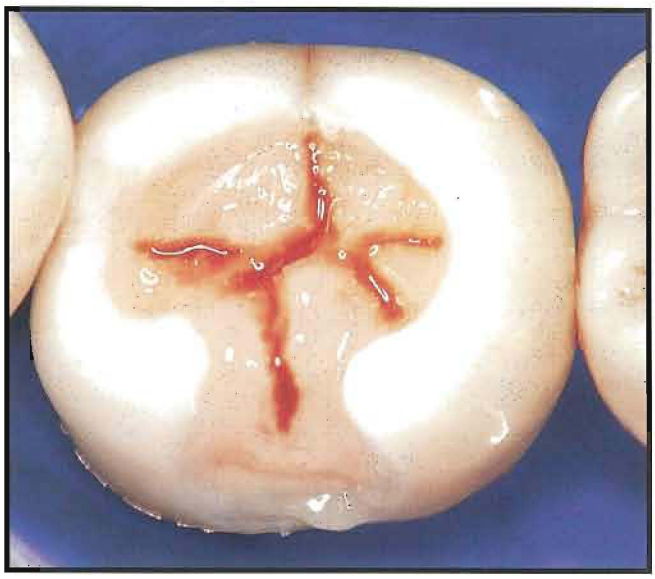

Figure 25. Reconstruction of the dentin is achieved with a saturated enamel composite. Grooves have been sculpted.

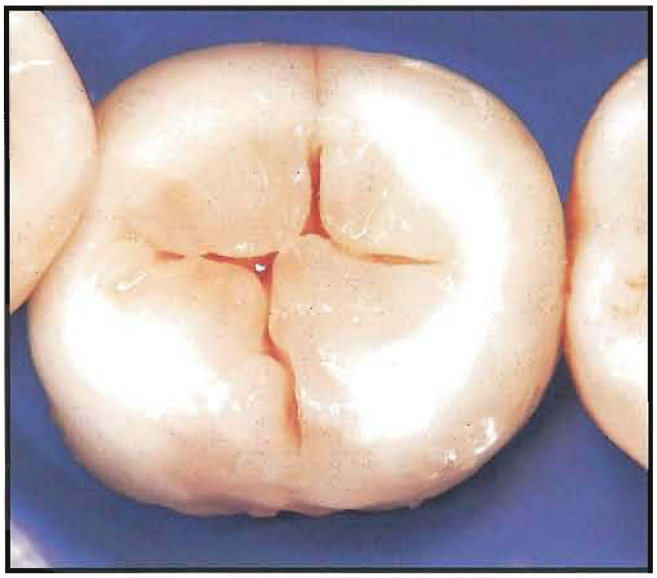

Figure 26. Each triangular ridge is molded in incisal type composite (translucent) and individually polymerized through the cusps.

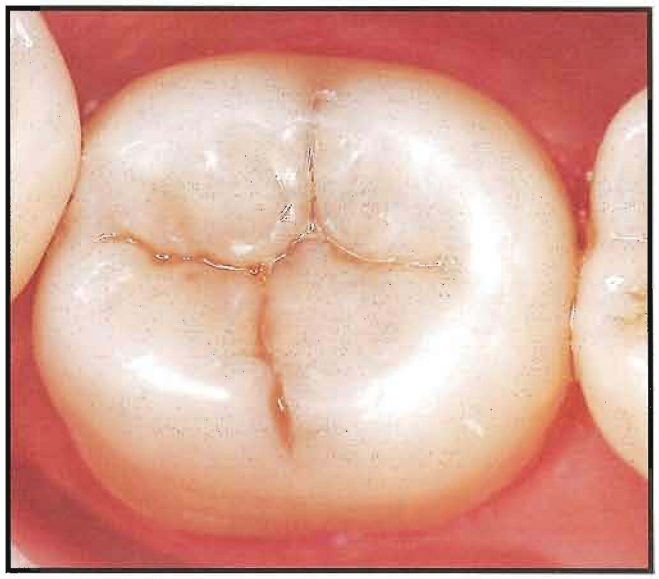

Figure 27. Postoperative occlusal close-up of the posterior restoration.

Sophisticated effects of the incisal edge can be obtained through the combined application of a dentin and an incisal composite. Utilizing the relative thicknesses of these two layers and their respective morphologies, varying types of incisal margins can be replicated, ranging from the "unworn" to the "worn" dentition. The stratification technique, called the "sandwich technique"—whereby the intense tints are integrated in the middle of a "sandwich"—allows additional characterization of the restoration in its thickness, thereby ensuring the durability and longevity of the final restoration.

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