Direct Composite Resin Restorations: A Review of Some Clinical Procedures to Achieve Predictable Results in Posterior Teeth

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ABSTRACT

The interest of patients in having tooth-colored restorations and the development of techniques and materials that make these restorations easier have contributed to make the esthetic restoration of posterior teeth popular. The direct use of composites on posterior teeth is a technique-sensitive procedure. Some difficulties, nevertheless, can be overcome or at least minimized by a heedful clinician by paying thorough attention to the various stages of the restorative technique. The present article seeks to review some concepts about this adhesive restorative procedure and to illustrate the possibilities of the technique with clinical reports.

CLINICAL SIGNIFICANCE

The direct posterior composite restorative technique offers the possibility of closely matching the natural optical characteristics of the lost tooth structure. Aimed at showing the potential of this technique, this article presents two step-by-step case reports and also reviews some concepts related to these clinical procedures.

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For more than three decades composite resins have been used on posterior teeth. Unfortunately, the clinical performance of the initial posterior composites was frustrating.[1] In part owing to these early poor results, clinicians became reluctant to apply composite resins in posterior teeth.[2] Nevertheless, considerable amounts of research and development have succeeded in creating composites with superior mechanical and handling properties.[3] New and improved instruments and restorative techniques make the adequate application of resins to posterior teeth easier and more predictable.[4–8] In addition, the development of effective dentinal adhesives has rendered more popular the esthetic restoration of posterior teeth.[9,10] Also, composites offer the major advantage of preserving dental structure, which is in agreement with the prevailing concepts of restorative dentistry in which a conservative approach is used.[7] However, posterior composites are extremely technique sensitive and should be placed only where indicated.[11]

The present article seeks to review some aspects of the posterior composite technique, in particular, conservative tooth preparations and composite insertion technique. Two

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clinical cases involving direct posterior composite restorations are presented to illustrate the proposed clinical procedures that make it easier to obtain adequately contoured and esthetic restorations.

SELECTION OF COMPOSITE RESINS

In selecting a composite resin, one must consider strength, polymerization, and tonality. The compressive strength and wear resistance exhibited by hybrid composites make them suitable for application on posterior teeth.[12] Such characteristics are a result of the high filler percentage (above 60% in volume) of these composites. They are called hybrid composites because of their mixture of variously sized particles (0.04–3 µm); they contain a minimum of 7 to 15% microfill particles.[13] Traditional hybrid composites have an average particle size of about 1 to 3 µm (Figure 1A).

Another type of composite indicated for posterior teeth is referred to as microhybrid or minifilled hybrid composites. With a filler load percentage similar to that of the hybrid composites, microhybrids have a smaller average particle size (0.8–1.0 µm). Also, they have a more uniform filler load distribution (Figure 1B), which makes them easier to light cure.[13] As a result, microhybrid composites have a greater polishing capacity than do hybrids and exhibit excellent mechanical properties. Their acceptance resulted in the development of minifilled hybrid composites with an even smaller average particle size (0.4–0.6 µm) (Figure 1C).

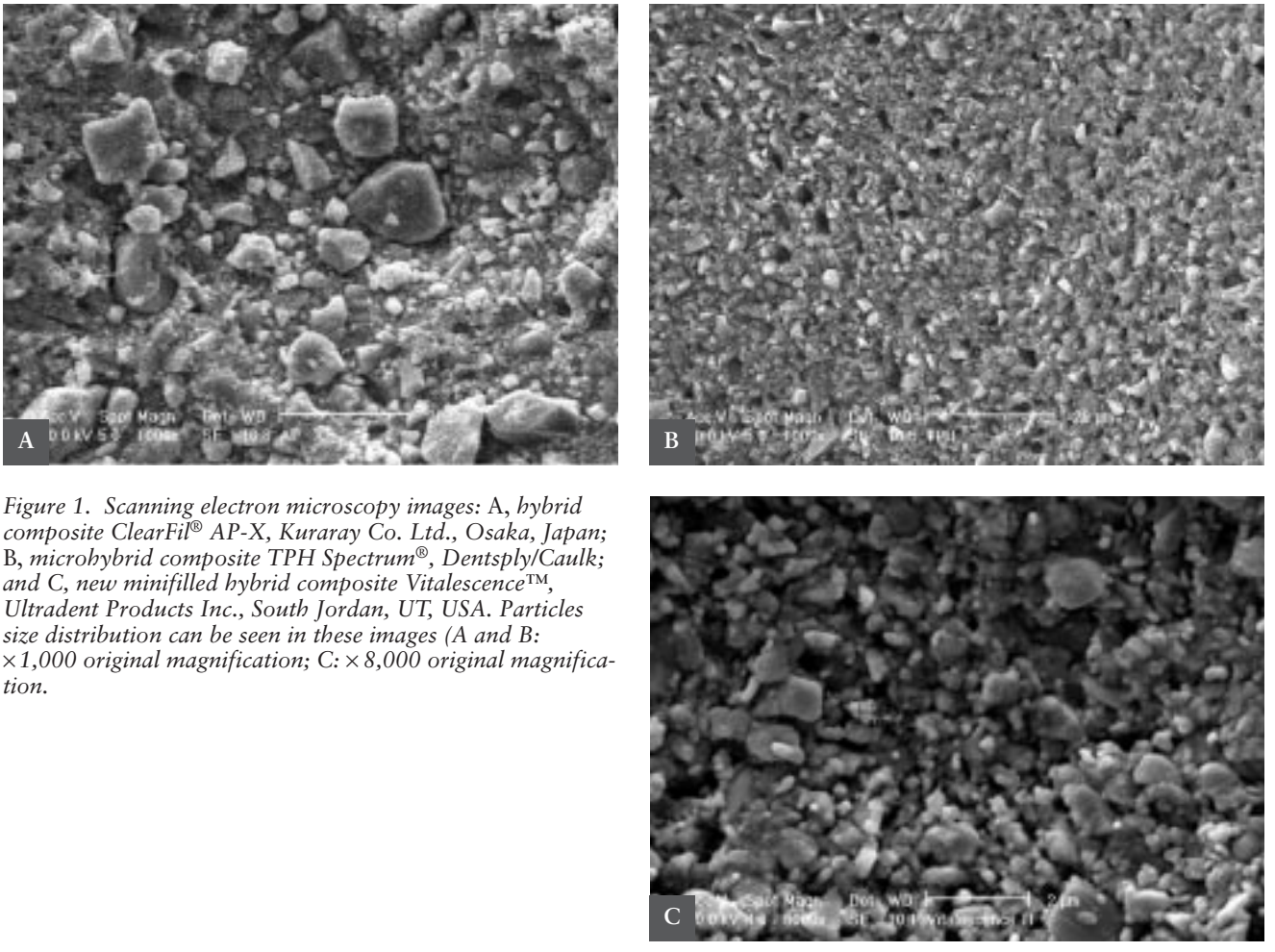

Figure 1. Scanning electron microscopy images: A, *hybrid composite ClearFil® AP-X, Kuraray Co. Ltd., Osaka, Japan;* B, *microhybrid composite TPH Spectrum®, Dentsply/Caulk; and C, new minifilled hybrid composite Vitalescence™, Ultradent Products Inc., South Jordan, UT, USA. Particles size distribution can be seen in these images (A and B: ×1,000 original magnification; C: ×8,000 original magnification.*

Minifilled composites exhibit excellent polishing capacity. Atomic force microscopy images of polished microhybrid and minifilled hybrid composites are presented in Figure 2.

Adequate light curing of resin composites is of paramount importance to impart restorations enough strength to withstand occlusal challenge, both on occlusal surfaces, where they are submitted to great masticatory efforts, and on the proximal sites involved in keeping contacts. Inadequate polymerization may induce early failure of the restoration, seen as fractures or extremely high occlusal wear.

It has been reported that the minimum light intensity necessary to polymerize a 2 mm–thick composite increment is 230 mW/cm^2, as long as the light-curing time is extended to 60 seconds.[14] However, as this measurement was conducted with the light tip contacting a curing radiometer and we hardly ever have the light-curing-unit's tip touching the composite resin when restoring posterior teeth, it seems logical to use light-curing devices with a minimum light intensity of 300 mW/cm^2. This intensity, still apparently low, should be compensated for by an extended exposure time (a minimum of 60 s for 2 mm increments) to ensure active and adequate polymerization the initial increments. Light-curing units with a light intensity below that level are not indicated and should undergo revision as an adequate polymerization would not be obtained no matter how much the time of exposure to visible light were extended.

Compared with minifilled hybrids, traditional hybrid composites are more demanding in terms of polymerization as they associate a percentage of microfiller. In a way, the arrangement of the inorganic fillers prevents the free passage of light.[15] Minifilled hybrid composites destitute of microfiller (0.04 μm) are easier to polymerize. Most minifilled hybrid composites can be light cured in no more than 20 seconds with light-curing units measuring above 350 mW/cm^2. For both traditional and minifilled composites, light colors are easier to polymerize than are dark ones.[15] Thus, for deep preparations, it preferable to use composites of a lighter color for the first increments. To ensure an adequate polymerization, after removal of the metal matrix, a 40-second additional

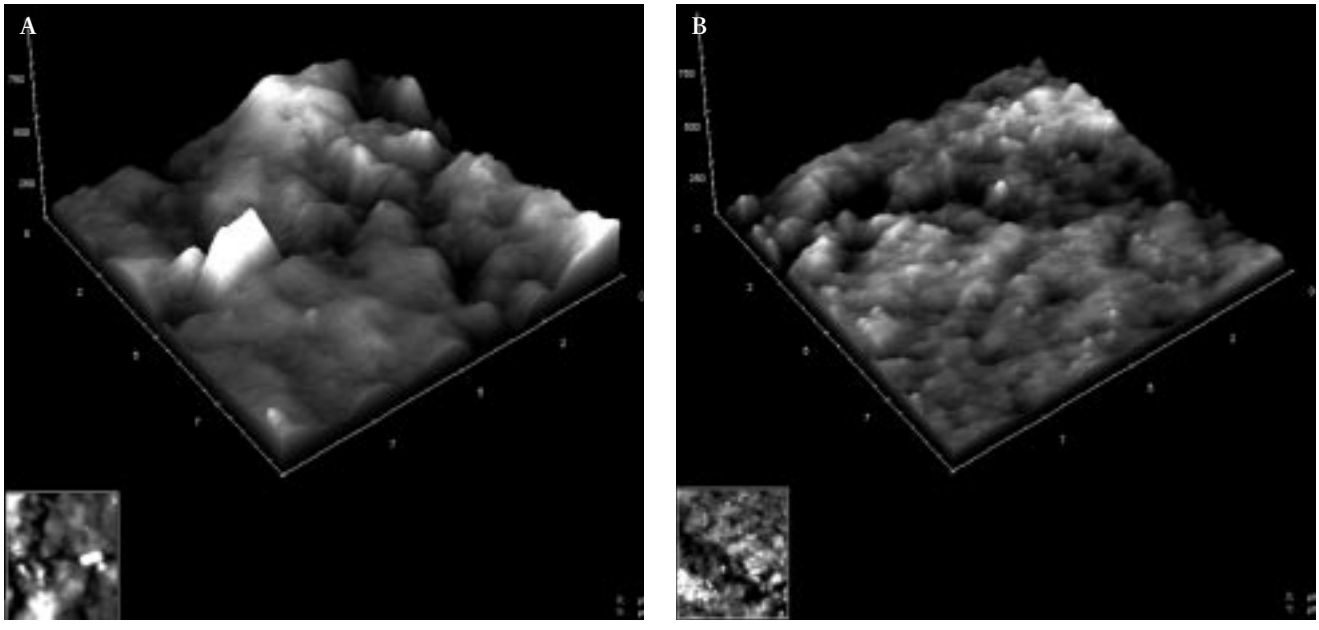

Figure 2. Atomic force microscopy images: A, *polished microhybrid composite Prodigy (Kerr Co.); and* B, *polished new minifilled hybrid composite Point 4 (Kerr Co.).*

light-curing cycle must be performed both buccally and lingually.

When selecting a composite shade, the clinician first selects a basic hue, then its intensity. There is no general rule applicable to all cases as the possible clinical situations are diverse. A valid procedure to make shade selection easier is the application and light curing of a small increment of composite in the selected color upon the occlusal surface. Hardly saturated shades apparently mask the margins on posterior teeth, which is desirable. After hue and intensity have been selected, the translucency of the tooth must be noted; such an observation is valuable at the moment of applying transparent or incisal composites. An important observation is also the characterization of the occlusal surfaces of adjacent teeth. Applying tints might be an option to reproduce surface and fissure characterization. Here, the patient's opinion is the most important factor.

INSERTION TECHNIQUE

Incremental insertion is always preferred as it results in less gap formation at the adhesive interface,[16] with reduced postoperative sensitivity.[17] Also, by using this technique, better esthetic properties of the restoration are obtained. The successive cusp buildup technique makes it possible to secure correct occlusal morphology through the incremental application of composites having different shades and opacities.[4,7] In this technique nonadherent spatulas and special brushes are used to contour the restoration.[4–8] Thus, the composite is applied in small increments to rebuild each anatomic entity of the involved areas.[4–8] First, the dentin portion is reconstituted with small increments to the base of each cusp, in the required shade, using resins with opacity similar to that of dentin. This way each cusp is successively restored. Next, a translucent resin having optical characteristics similar to dental enamel is inserted, imparting to each of the cusps its adequate anatomic form.

CASE STUDY 1

A 20-year-old healthy male presented with a carious lesion on the occlusal surface of the maxillary right first molar (Figures 3 and 4). A bite-wing radiograph confirmed an occlusal caries at tooth no. 16 (Figure 5). Preparation must be restricted to the area of the cavity. Depending on the extension of the lesion into the dentin and enamel, it is usually necessary to enlarge the access to dentinal caries to have better instrumentation and visualization. After local anesthesia initial enamel preparation was made with a round carbide bur in a high-speed handpiece. Access enlargement was performed under refrigeration, using diamond points or round burs in a high-speed handpiece under constant water cooling (Figure 6). Rubber-dam isolation was used to facilitate visualization (Figure 7). To adequately remove the infected dentin, a smooth round or inverted cone with round end burs used at low speed and with a size compatible

Figure 3. Case study 1. Preoperative view showing occlusal carious lesion on tooth no. 16.

Figure 4. Case study 1. Close-up view of tooth no. 16. Observe the pigmentation on the occlusal sulci of tooth no. 16.

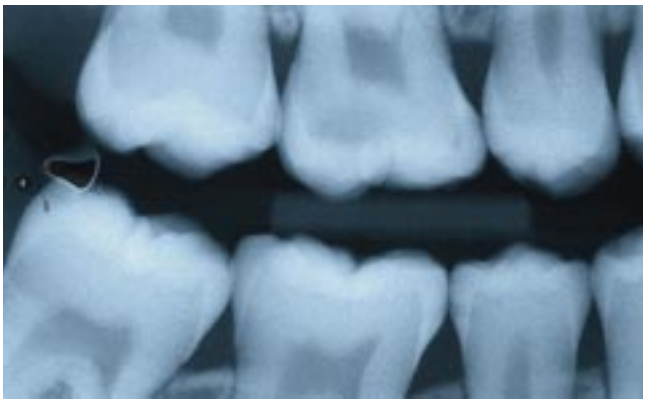

Figure 5. Case study 1. Bite-wing radiograph showing an occlusal carious lesion on tooth no. 16.

with the lesion's extension had to be used (Figures 8 and 9).

In this case the intermittent application and constant flushing of the cavity with water were important to reduce the temperature and prevent damage to the pulp. Binangle spoons were used to remove infected dentin, making diagnosis easier (Figure 10).

When removing carious dentin, it is useful to assess consistency and the presence of humidity; soft and wet dentin must be removed.[18] Figure 11 compares the aspect of the preparation floor before and after the removal of carious tissue. Owing to the extension of the lesion into the enamel and dentin, the preparation often presents enamel unsupported by dentin, which can be maintained.[19] Internal angles must be rounded to reduce stress concentration,[20] improving the adaptation of composite resins to the dental structure. The occlusal cavosurface angle must be clear, without beveling. The absence of dental plaque on an occlusal pit fissure and lingual groove (owing to the patient's adequate brushing technique) permits a more conservative approach. In such situation, the preparation does not need to be extended to these adjacent pits.[19] However, at recalls these areas will deserve special attention.

Enamel and dentin were acid etched with 35% phosphoric acid (3M ESPE, St. Paul, MN, USA) for 15 seconds (Figure 12). The acid etchant is applied first to the enamel and then to the dentin; after that, the etching is timed. Enamel is etched for a minimum of 15 seconds and dentin for a maximum of 15 seconds. Extension of the etching and bonding 0.5 mm beyond the preparation margins seems a good alternative to prevent early microleakage in enamel. The acid was then removed with an air/water stream for an identical period of time. Dentin must be kept wet. Two

Figure 6. Case study 1. Initial enamel preparation with a round carbide bur in a high-speed handpiece.

Figure 7. Case study 1. Rubber-dam isolation is used to make visualization easier.

Figure 8. Case study 1. Initial caries removal with round carbide bur in low-speed contra-angle handpiece.

Figure 9. Case study 1. To avoid overpreparation, constant visual inspection is conducted after rinsing and drying of the cavity.

Figure 10. Case study 1. Binangle spoon is used to remove infected dentin.

coats of a one-bottle adhesive system (Single-Bond[a], 3M ESPE) were applied with a fully saturated brush (Figure 13), as per the manufacturer's instructions. The dentin was fully covered with the adhesive, with the clinical aspect of a bright wet layer. Light curing was conducted for 10 seconds.

To apply flowable composites as a liner may be a good way to improve contact with the preparation walls, reducing bubbles or gaps between the adhesive layer and the composite resin, particularly when high-viscosity resins are to be applied subsequently.[21] In this case a flowable composite resin (Filtek Flow™ shade B2, 3M ESPE) was used as a liner and was light cured for 40 seconds (Figure 14). A microhybrid resin (Tetric Ceram HB® shade A3, Ivoclar Vivadent, Amherst, NY, USA) was inserted in oblique increments and adequately light cured for 20 seconds. Cuspid inclines were reconstructed through the application of small increments of microhybrid resin (Tetric Ceram HB shade A3) using a fine antiadherent spatula (American Eagle) (Figure 15). Small amounts of transparent resin (Tetric Ceram HB shade T) were obliquely layered to restore the enamel portion. Extrinsic painting of sulci to mimic the adjacent sulci characteristics was performed using a brown color modifier (Kolor + Plus®, Kerr Co., Orange, CA, USA) applied with a soft brush (Takanish® 000, Renfert) (Figure 16). The occlusion was checked and no adjustments were necessary. The final restoration was polished with a diamond paste using Robinson brushes. Figure 17 shows the final aspect of restoration after 48 hours.

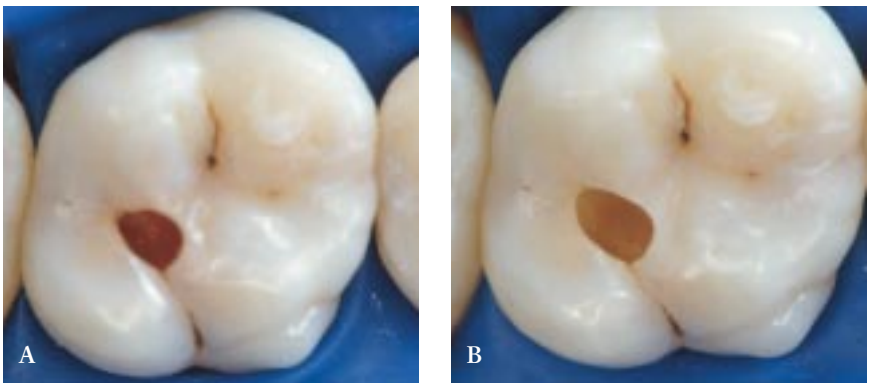

Figure 11. Case study 1. Close-up view. Note the initial color and wet aspect of carious dentin (A), and compare it with the finished occlusal conservative cavity preparation (B).

PROXIMAL RESTORATIONS

Access to the carious lesion in proximal caries can be obtained (1) directly, in a strictly proximal lesion; (2) through the lingual or buccal embrasure; (3) through the occlusal surface, using a tunnel; or (4) through the marginal ridge. Direct access, the option of choice, is possible when a diastema is present allowing direct access to the carious lesion, a restoration or occlusoproximal carious lesion exists in the adjacent tooth, or an intentional separation is planned by means of elastic rings. When those clinical situations are not present, or when there is a large proximal carious lesion, access through the mar-

Figure 12. Case study 1. Enamel and dentin are acid etched with 35% phosphoric acid (3M ESPE) for 15 seconds.

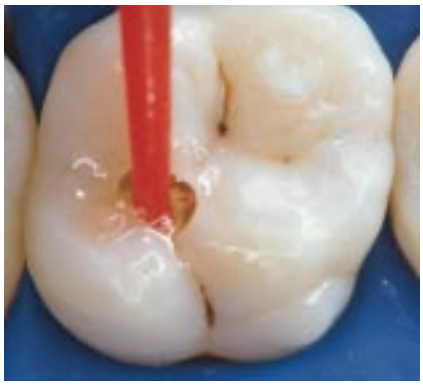

Figure 13. Case study 1. Two coats of Single-Bond adhesive system are applied.

Figure 14. Case study 1. A flowable composite resin (Filtek Flow) is used as a liner.

ginal ridge is preferred and must be as conservative as possible, oriented toward the proximal lesion and avoiding contact with the adjacent tooth. Extreme care is to be exercised to avoid contacting the proximal surface of the adjacent tooth. To minimize such an iatrogenic possibility, the adjacent surface can be conveniently protected with a metal matrix stabilized with an interproximal wedge. Even the more experienced clinician should be careful as a bur can easily touch the adjacent surface when care is not exercised.[22]

Placing a tight interproximal wedge at this point is highly advisable and serves the following purposes:

- It creates a slight dental separation to compensate for the thickness of the matrix applied at the time of restoration. Such a procedure makes it easier to obtain the interproximal contact point.[8]
- It protects the gingival papilla from the bur.[8]
- It protects the marginal cavosurface angle on the gingival wall so as not to inadvertently remove the narrow enamel in that area.

Later, this same wedge will help to stabilize the matrix upon insertion of the composite resin.

Figure 15. Case study 1. Cuspid inclines are reconstructed through the application of small increments of a microhybrid composite (Tetric Ceram HB shade A3) using a fine antiadherent spatula.

Figure 16. Case study 1. Extrinsic painting of sulci to mimic the adjacent sulci characteristics. A brown color modifier (Kolor + Plus) is applied with a soft brush (Takanish 000) close to the main sulcus.

Figure 17. Case study 1. Close-up view 1 week postoperatively.

Access is obtained using a round diamond bur at high speed. Entering the lesion, the sensation is that of invading an empty space. Access is now enlarged and the caries-infected dentin is removed by means of a smooth round bur. Depending on the size of the proximal carious lesion, removal of infected tissue can be made with round burs at a low speed. The proximal cavosurface angle must be free from a bevel, regular, and clearly cut with rotary or manual tools.

In case of replacing amalgam restorations, dark stains must be eliminated after the existing restoration and carious lesion are removed.

MATRIX SYSTEM SELECTION

The restoration of occlusoproximal preparations is made easier when adequate matrices are selected. The correct matrix results in minimal excess resin to be removed during finishing procedures. In addition, adequate form and proximal contour can be obtained when using these devices correctly.

Transparent matrices and reflective wedges are usually more difficult to install and are generally more expensive. The rationale for their introduction was based on old concepts of oriented light curing.[23] With that technique, light curing was made through the dental structure in an effort to lead polymerization shrinkage to the resin-contacted preparation wall.[23] In that way, restorations could theoretically be made with small levels of margin infiltration when using transparent matrices and reflective wedges.[23] It was believed a composite, upon polymerization, contracted toward the polymerizing light, and an enhanced marginal seal would be obtained from a polymerization technique directed toward the preparation walls. Currently, it is believed that composites do not contract toward the light source.[24] It is possible that a good marginal seal obtained with guided light curing occurred because of a reduction in the intensity of light energy, rather than a polymerization vector toward the light source, since the light source has its intensity cut down when passing through the dental structure.[14] Recent research has not found advantages of transparent matrices and reflexive wedges when compared with metal matrices and wooden wedges.[25]

The use of transparent matrices might afford a more adequate polymerization of the composite at the gingival area. However, disadvantages of metal matrices are balanced by additional light curing following their removal. In general, transparent matrices are easily crushed and are about twice as thick as the metal ones; also, transparent matrices are not sufficiently flexible to adapt to the proximal surfaces. Thus, the use of these devices must not be encouraged.

Metal Tofflemire matrices can be used, but thinner matrices are preferable; currently matrices are available that are thinner than the traditional Tofflemire matrices used for amalgam restorations.[26] When using metal matrices, they should be adapted previously with amalgam burnishes under a paper pad to allow for adequate restoration of the proximal contour.

Self-adjustable circumferential metal matrices (Auto-matrix System®, Dentsply/Caulk, Milford, DE, USA) are also a good option for mesio-occlusodistal preparations. However, they should not be too tight, as they might deform weakened cusps.[27] Prior to their application, the parts turned to the proximal surface must be burnished with amalgam burnishes. Ultraslim and partial metal preformed matrices are a better option as they facilitate proper proximal contour and contact.[28] These systems have clamps to stabilize the matrix, improve their adaptation to lingual and buccal walls, and allow for adequate dental separation. A few examples are the Palodent System® (Dentsply/Caulk), Composi-Tight System® (Garrison Dental), 3M Matrices System™ (3M ESPE), and Unimatriz® (TDV).

Once the matrix has been installed, a clinical mirror is used to check that the interproximal wedge is not pressing the matrix toward the interior of the preparation, that the matrix is adequately touching the adjacent tooth, and that the rubber dam has not invaded the space

between the matrix and the gingival wall.

FINISHING AND POLISHING PROCEDURES

When a composite restoration with minimum excess is obtained, recontouring and finishing with rotary instruments are not necessary; the procedures are likely to generate heat and interfere negatively as they refer marginal microleakage and potentially create resin microfissures.[29,30] In a case in which excess composite remains, sequential flexible disks (Sof-Lex™, 3M ESPE) can be used wherever access is possible. With this system a uniform surface smoothness is attained. The extra-thin series (Sof-Lex™ XT, 3M ESPE) make it possible to enter the proximal embrasures and to properly finish the margins, obeying the proximal contour. In cases in which the restoration involves the proximal surfaces, sandpaper strips are always used to remove gingival excess composite, adhesive, or both below the point of contact. Narrow sandpaper strips are indicated, making it possible to maintain the contour and the interproximal contact point.

In the event occlusal adjustments are necessary, diamond points or multibladed burs are a good option. After that, points and rubber cups must be used to provide proper finishing at the occlusal surface.

In all situations polishing pastes applied with Robinson brushes are indicated to impart a final polish.

CASE STUDY 2

A 31-year-old healthy female presented with a darkness aspect on the distal and mesial marginal ridges of the maxillary right second premolar and at mesial ridge of the first molar (Figure 18). A bite-wing radiograph showed the existence of a proximal carious lesion at the distal and mesial surfaces of the maxillary right second premolar (Figure 19). Occlusal contacts were checked previously. Rubber-dam isolation was installed to make visualization easier (Figure 20). A metal matrix was used to protect the mesial surface of tooth no. 16, and a wooden wedge (TDV) was applied to secure it and to obtain interproximal space to compensate for the matrix thickness (Figure 21). Enamel preparation was initiated

Figure 18. Case study 2. Preoperative view of tooth nos. 16 and 15. Observe the darkness aspect on the mesial ridge of tooth no. 16 and on the distal and mesial marginal ridges of tooth no. 15.

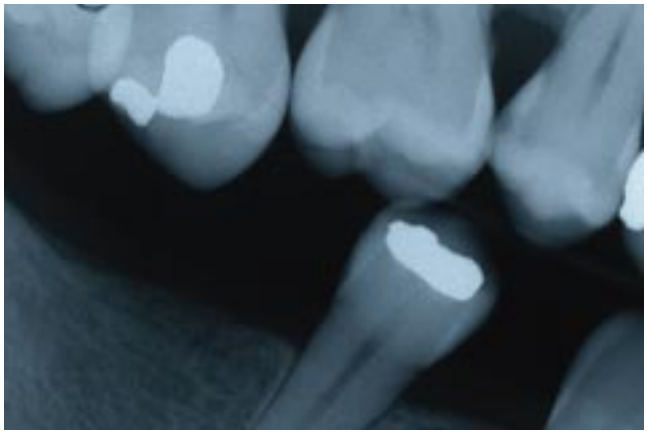

Figure 19. Case study 2. Bite-wing radiograph showing carious lesion at the mesial and distal ridge of tooth no. 15.

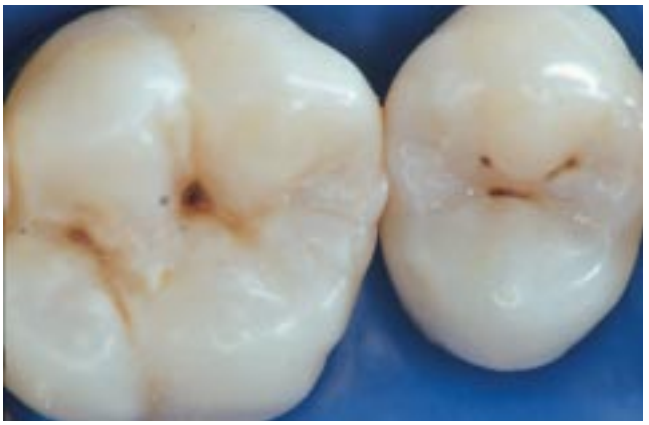

Figure 20. Case study 2. Rubber-dam isolation is used to facilitate visualization and access.

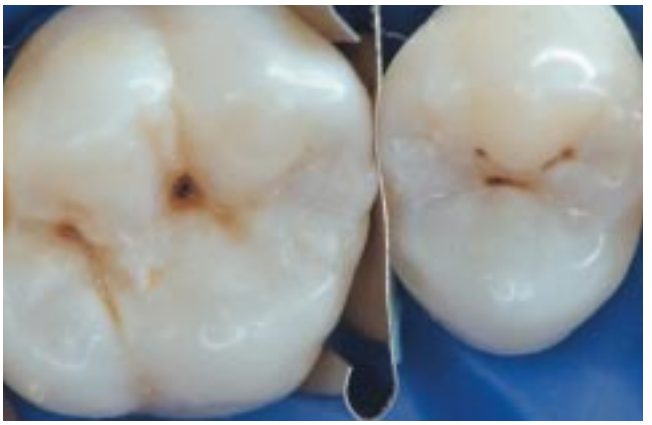

Figure 21. Case study 2. A metal matrix is applied to protect the mesial surface of tooth no. 16. A wooden wedge (TDV) is applied to secure the matrix and to obtain interproximal space to compensate for the matrix thickness.

on the distal marginal ridge of no. 15 with a no. 329 pear-shaped carbide bur in high-speed handpiece. After a conservative occlusodistal preparation on no. 15 was completed, the matrix was removed to inspect the mesial surface of no. 16. A small carious lesion surrounded by demineralized enamel was visible (Figure 22A). With direct access to the mesial surface of the first molar, a conservative preparation was performed with a small round carbide bur (Figure 22B). Enamel and dentin were acid etched with 35% phosphoric acid (3M ESPE) for 15 seconds (Figure 22C and D). After the adhesive was applied, a radiopaque microhybrid resin composite (chosen to allow radiographic control of the restoration) was inserted, light cured, and finished with sandpaper strips (Figure 22E). The distal surface of the maxillary second premolar received a kidney-shaped concave matrix (Unimatriz) and its ring. The matrix was gingivally secured with a wooden wedge, allowing for adequate proximal contour and contact (Figure 23). Enamel and dentin were acid etched with 35% phosphoric acid (3M ESPE) for 15 seconds (Figure 24) and rinsed with water for 15 seconds. A small cotton pellet was placed in the preparation to prevent dentin from being dehydrated during the removal of excess water from the operative field (Figure 25). Adequate humidity control after acid etching is important, since the total dehydration of dentin is contraindicated. On the other hand, an excessively wet dentin can jeopardize adhesion as much as the lack of humidity.[31] This is more important in Class II preparations, in which water might accumulate on the gingival wall. The placement of a cotton pellet apparently keeps this situation under control. Single-Bond (3M ESPE) was applied in two coats with a fully saturated microbrush (Figure 26). A uniform adhesive layer covered the preparation (Figure 27). A microhybrid resin (Filtek Z250™ shade A2, 3M ESPE) was inserted in oblique increments on the proximal box and adequately light cured for 20 seconds (Figure 28A). After the second oblique increment, the dentin portion was completed (Figure 28B). A small amount of transparent composite (Filtek Z250 shade I) was obliquely layered to restore the enamel portion (Figure 29). The restoration was concluded after a little proximal adhesive and composite excess were removed, using sandpaper strips gingivally and flexible extrathin sequential disks at the marginal ridge (Sof-Lex XT). The occlusion was checked, and no occlusal adjustments were necessary. The final restoration was polished with diamond paste using Robinson brushes. The restoration was additionally light cured for 40 seconds

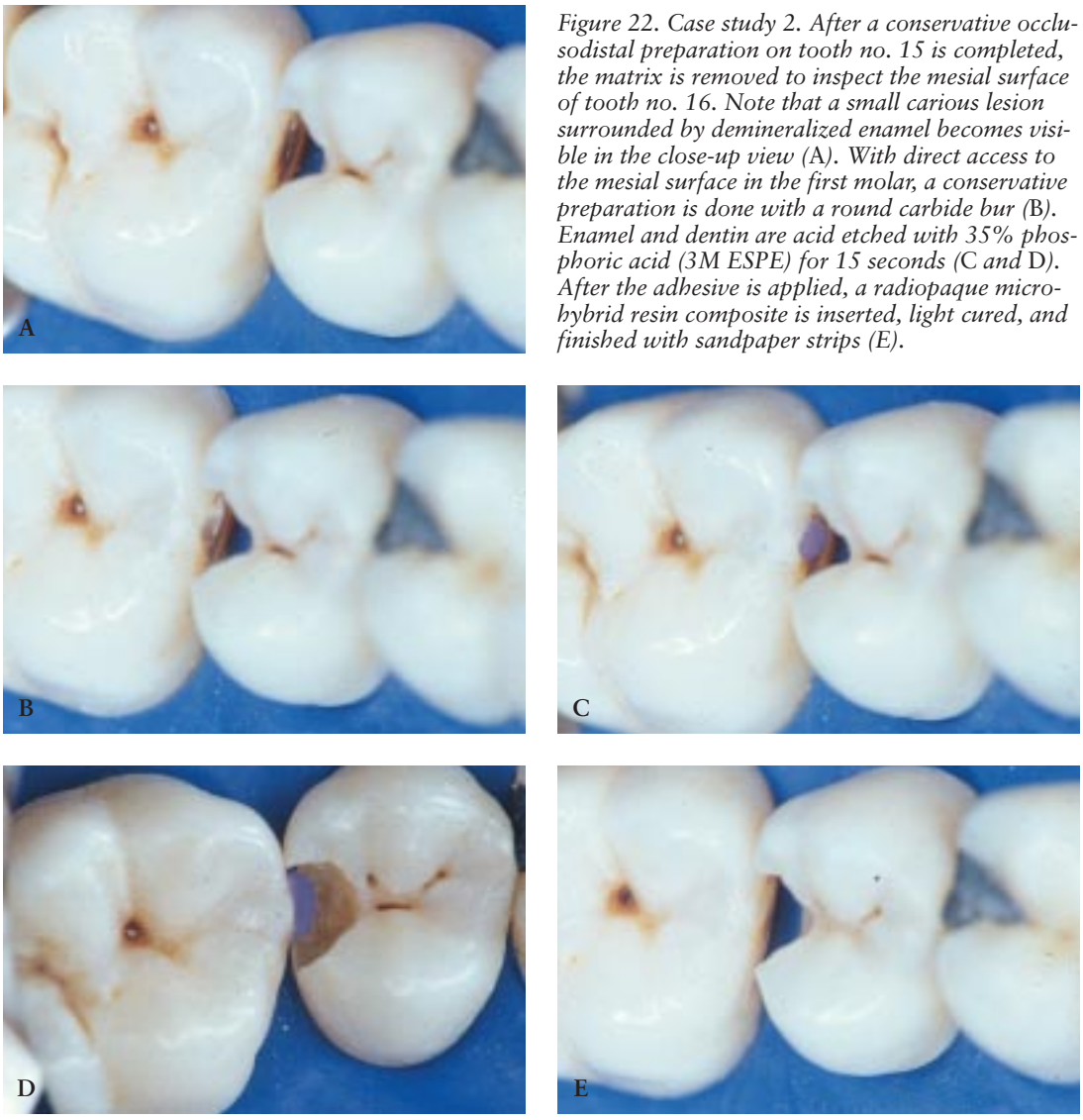

Figure 22. Case study 2. After a conservative occlusodistal preparation on tooth no. 15 is completed, the matrix is removed to inspect the mesial surface of tooth no. 16. Note that a small carious lesion surrounded by demineralized enamel becomes visible in the close-up view (A). *With direct access to the mesial surface in the first molar, a conservative preparation is done with a round carbide bur* (B). *Enamel and dentin are acid etched with 35% phosphoric acid (3M ESPE) for 15 seconds* (C *and* D). *After the adhesive is applied, a radiopaque microhybrid resin composite is inserted, light cured, and finished with sandpaper strips (E).*

both lingually and buccally. Figure 30 shows the final aspect of the restoration after 48 hours.

FINAL CONSIDERATIONS

To achieve excellent results when restoring posterior teeth with composites, the clinician must pay great attention to each of the various steps of the procedure. Correct field isolation, adhesive application, insertion and polymerization of composites, selection and insertion of the matrix system, and proper adjustment and finishing of the restoration are a few of the critical points to receive careful attention. A composite restoration generally requires more chair-time than does an amalgam restoration. Because of such a demand, many clinicians refrain from offering the option of restoration with composites on posterior teeth to their patients.[32] Nevertheless, the direct esthetic restoration with composite resin on posterior teeth cannot be considered a complex procedure; rather, it requires an exact technique and specific instruments to

obtain results corresponding to the expectations of patients who are increasingly informed and demanding. A lack of attention given to technical details results in early failure. However, appropriately inserted and controlled composite resins on posterior teeth often function for 10 years or more.[33]

Figure 23. Case study 2. A kidney-shaped concave matrix (Unimatriz) and its ring are installed on the distal surface of tooth no. 15. The matrix is secured gingivally with a wooden wedge (TDV), allowing for a proper proximal contour and contact.

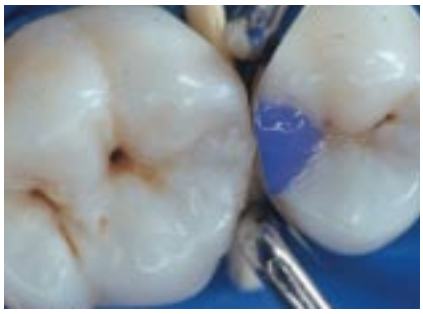

Figure 24. Case study 2. Enamel and dentin are acid etched with 35% phosphoric acid (3M ESPE) for 15 seconds.

Figure 25. Case study 2. A small cotton pellet is placed in the preparation to prevent dentin from being dehydrated during the removal of excess water.

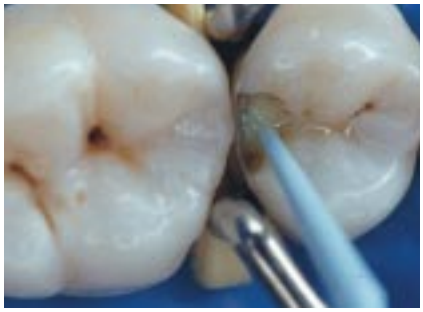

Figure 26. Case study 2. Two coats of Single-Bond adhesive system are applied.

Figure 27. Case study 2. Note the aspect of the preparation after the adhesive has been applied. The entire preparation is covered with a uniform adhesive layer.

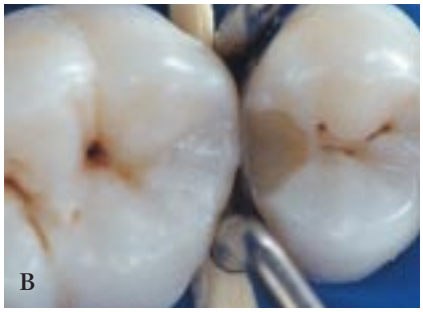

Figure 28. Case study 2. A, *A small oblique increment of microhybrid resin (Filtek Z250 shade A2) is applied.* B, *Note that the dentin aspect is completed after the second oblique increment note.*

Figure 29. Case study 2. Small amounts of transparent composite (Filtek Z250 shade I) are obliquely layered. Note that the enamel portion is concluded.

Figure 30. Case study 2. Close-up view at 48 hours. Note that a direct composite resin restoration is done at the occlusomesial surface of tooth no. 15. Observe that the anatomy is similar to that of adjacent teeth.

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