Semidirect Composite Onlay With Cavity Sealing: A Review of Clinical Procedures

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ABSTRACT

The evolution in adhesive dentistry has broadened the indication of esthetic restorative procedures especially with the use of resin composite material. Depending on the clinical situation, some restorative techniques are best indicated. As an example, indirect adhesive restorations offer many advantages over direct techniques in extended cavities. In general, the indirect technique requires two appointments and a laboratory involvement, or it can be prepared chairside in a single visit either conventionally or by the use of computer-aided design/computer-aided manufacturing systems. In both cases, there will be an extra cost as well as the need of specific materials. This paper describes the clinical procedures for the chairside semidirect technique for composite onlay fabrication without the use of special equipments. The use of this technique combines the advantages of the direct and the indirect restoration.

CLINICAL SIGNIFICANCE

The semidirect technique for composite onlays offers the advantages of an indirect restoration and low cost, and can be the ideal treatment option for extended cavities in case of financial limitations.

(J Esthet Restor Dent 26:97–106, 2014)

INTRODUCTION

The trend toward conservative esthetic dentistry has become very popular because of patient awareness of esthetic restorations and improvements in materials' properties. Composite resin is the material of choice in many dental treatments because of improved esthetics, strength, and durability.[1,2] It also allows conservative preparation and easy addition/reparation of the restoration.[3]

When using composite resin restoration, the choice of the proper restorative technique plays an important role in the longevity of the restoration.[4] Three main restorative techniques are available, direct, semidirect, and indirect[2,5] (Figure 1). The selection between those options depends mainly on the number, extension, and location of the restoration.[2] In large cavities, the indirect technique allows the achievement of a good occlusal and interproximal anatomy.[6] In addition, it provides theoretically better marginal adaptation because of the lower polymerization stresses between the restoration, and the tooth as shrinkage is normally confined to the thin layer of resin cement.[7–9] Moreover, the restoration's physical and mechanical properties may be improved due to the effect of the post-curing procedure.[10–12] However, this technique requires two appointments, the fabrication of a provisional restoration, and the contribution of a lab technician that lead to an increase of time and costs. With the introduction of the computer-aided design/computer-aided manufacturing (CAD/CAM) system

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 DOI 10.1111/jerd.12067

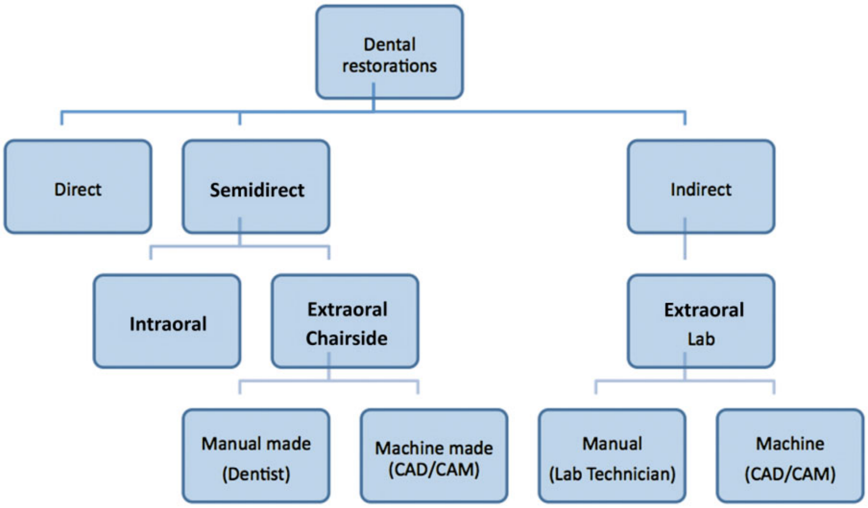

FIGURE 1. General classification of dental restorations. CAD/CAM = computer-aided design/ computer-aided manufacturing.

in 1985,[13] the treatment time and the laboratory steps were reduced. Nevertheless, the cost is still high compared with the direct restoration, and the technology remains expensive.

A simplified chairside method called "semidirect technique" was introduced and developed in the 1980s.[14–17] In this technique, the dentist himself fabricates the restoration with an intraoral or extraoral procedure during a single appointment.[4] In the intraoral approach, the restoration is fabricated by placing directly the composite increments on the isolated tooth's cavity. After in-mouth polymerization, the workpiece is removed and finished/polished extraorally, followed by the luting of the restoration. Although the intraoral approach could be the most accurate[18] in respect to marginal fit, as the restoration is made directly in the cavity, the main disadvantage of this approach is the difficulty of removing the restoration after composite resin hardening. This is mainly due to the cavity configuration and the microretentions created by the diamond burs used for preparation.[4] That confines its use to simple cavities (occlusal, mesio-occlusal, or disto-occlusal) with a regular design and highly divergent walls. In the extraoral approach, a silicon-working model is fabricated from the impression of the cavity in order to build-up the restoration chairside extraorally. This approach offers an advantage over the intraoral one as less divergent cavity walls are required; thus, a more conservative preparation can be realized.[4,19] However, the freehand semidirect technique is more sensitive to the cavity configuration design than the CAD/CAM technique, e.g., the mesial-occlusal -distal (MOD) cavity may cause a problem because of the polymerization shrinkage that tends to be directed toward the axial walls leading to lock of the restoration that will prevent its removal.[2,4]

The major advantage of the semidirect technique is that the dentist can provide his patient with a low-cost indirect restorationt in a single visit.

The aim of this paper is to describe step by step the extraoral semidirect technique with cavity sealing[20] in two clinical cases.

MATERIALS AND METHODS

Case 1

The first case was a 33-year-old female with a large defective occlusal-buccal amalgam restoration on the mandibular first molar that needed replacement (Figure 2). The patient could not tolerate long dental appointments because of a limited mouth opening. In addition to that, patient presented some financial limitations.

 DOI 10.1111/jerd.12067

FIGURE 2. Preoperative view of the mandibular first molar showing the defective amalgam restoration.

All these elements brought the therapeutic solution to the semidirect technique. With this option, cavity was prepared first, the workpiece was then fabricated chairside extraorally, while the patient was waiting, and then the restoration was luted within the same appointment. Thus, the patient received restoration that combined the advantages of the direct and the indirect technique.

Cavity Preparation

A particular attention was drawn to the intraoral steps in respect to the low tolerance of the patient for long dental appointment.

Before starting the treatment, occlusal contacts were checked with a contact-point paper in order to evaluate the occlusal space available for the future restoration. Then, shade was selected based above all on neighboring teeth color, as the presence of a metallic restoration with recurrent caries may affect the tooth color. Alternatively, shade selection can be done after removing old restoration.

Rubber dam was placed, and cavity preparation was completed in a very conservative manner using diamond bur. Cavity preparation was strictly confined to the removal of decayed tooth structure (Figure 3A). In order to seal the free dentin in the cavity, a self-etch adhesive system was used (Syntac Classic, Ivoclar Vivadent, Schaan, Liechtenstein) according to the manufacturer's instructions. Then, a thin layer of restorative nanohybrid composite resin (Tetric EvoCeram, IvoclarVivadent) was used to achieve an ideal cavity geometry with minimal preparation (no undercuts, regular surface, and correct taper)[20] (Figure 3B). Composite resin light-curing was accomplished with a high-power light-emitting diode (LED) curing light for 40 seconds per curing area. Finishing of enamel margins and of the composite surface was done with the use of fine diamond bur before taking the impression of the cavity to clean the enamel and to remove the oxygen inhibition layer on the composite surface and to achieve a slightly beveled surface[21] (Figure 3C). Rubber dam was removed, and the preparation was carefully isolated using cotton pellet to be ready for the impression.

Impression and Working Model Fabrication

The working model should be fabricated with a material characterized by a fast setting time, high rigidity, and prompt easy separation from the impression.[2] Most of the silicones, which can be potentially used for model fabrication, are addition-type materials, so ideally, the impression should be done using a condensation-type silicone material. Speedex (Coltene/Whaledent, Altstätten, Switzerland) was used for this purpose, together with a simple sectional tray. Then, in order to have a certain precision on the working model, a thin layer of light body impression material (Affinis, Coltene/Whaledent) was applied before the completion of the working model by the application of the body mass (Jet Bite, Coltene/Whaledent) (Figure 4)

Work Piece Fabrication

The restoration was completed through several increments of nanohybrid composite resin material (Tetric EvoCeram) of about 1.5-mm thickness; each layer was light-cured by LED lamp for 40 seconds. The first increment was done with dentin shade. Subsequently, enamel and incisal layers were placed and shaped to achieve an ideal anatomy. The final characterization was accomplished by the use of intensive color resin (Kolor+plus, Kerr, Orange, CA, USA). Once the onlay has been completed, its adaptation was checked intraorally (Figure 5).

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FIGURE 3. Cavity preparation. A, Old restoration and the secondary caries were removed, and the cavity was cleaned. B, Immediate Dentin Sealing and composite coating. C, Finishing of the enamel margins with fine diamond bur.

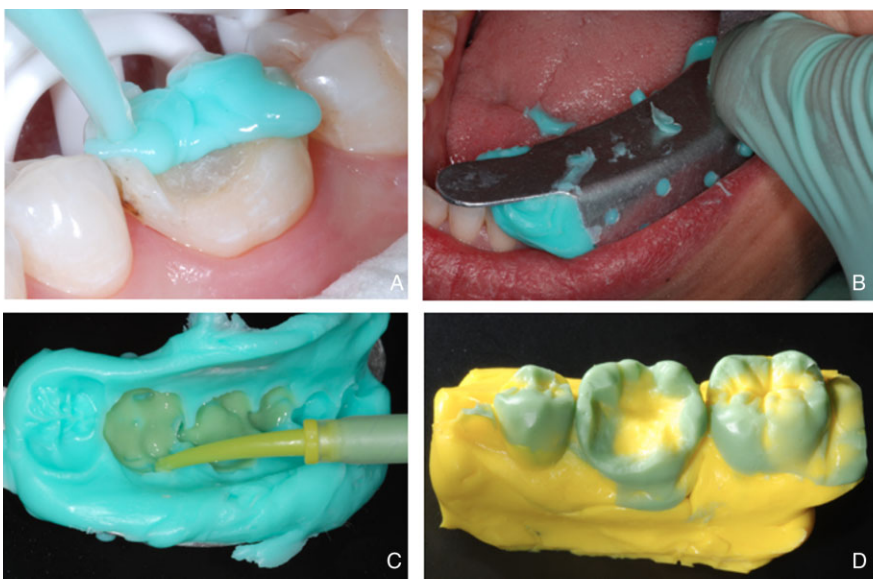

FIGURE 4. Impression and flexible model fabrication. A,B, Sectional final impression (Speedex Coltene/Whaledent). C, First part of the flexible model fabrication was fabricateddone using alight body additional silicons (Affinis, Coltene/Whaledent). D, Flexible model was completed by the body mass silicon (Jetbite, Coltene/Whaledent).

Moreover, in order to achieve a maximum monomer conversion of the resin, dimensional stability, and improved mechanical properties,[22] the semidirect onlay was post-cured in a special oven (D.I. 500, Coltene/Whaledent) for 7 minutes at 120°.[2,6]

Luting of the Restoration

First, the internal surface of the restoration was cleaned with soft air abrasion to remove any contamination during the intraoral try-in. Then, a thin layer of bonding resin was spread over the surface and left uncured. The restoration was placed under light protection[23] (Figure 6).

Under rubber-dam protection, the cavity was cleaned with air abrasion (30 microns Al_2O_3) for about 5 seconds. Enamel was selectively etched with 37% phosphoric acid for 30 seconds, rinsed with water spray for 30 seconds, and air dried. The bonding agent was applied on the entire cavity surface without being light-cured. (Figure 7). Finally, an adequate amount of preheated restorative composite resin (Tetric EvoCeram) was spread all over the cavity surface. The onlay was inserted into the cavity and fixed in place by applying a finger pressure on the occlusal surface. A dental probe was used to remove the excess of luting composite. The restoration was then seated in its final position with the help of ultrasonic energy, and the final removal of the excess was done using a soft brush. A spot cure of 5 seconds per surface was effectuated to fix the restoration in place using high-power LED curing unit, then full polymerization was achieved by light curing for at least 60 seconds per surface from the buccal, oral, and occlusal each. Fine diamond burs

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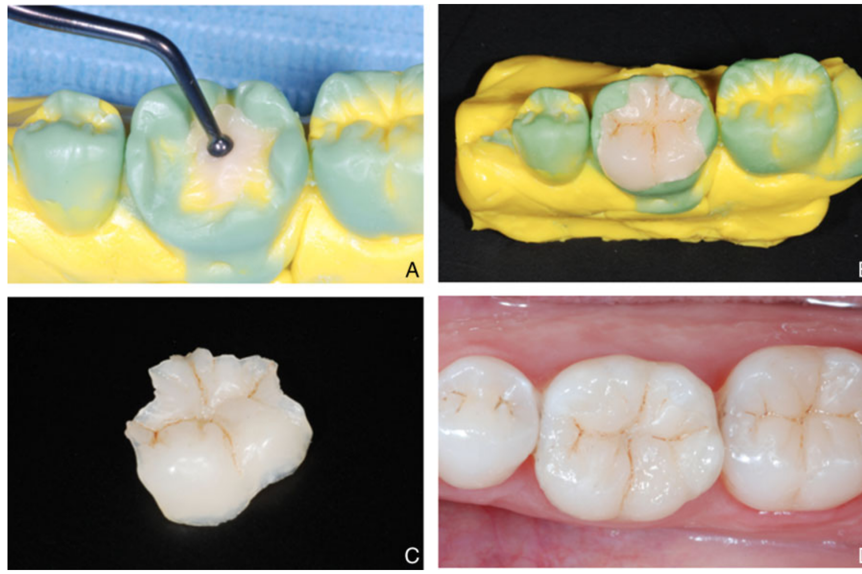

FIGURE 5. Restoration build-up. A–C, Restoration build-up with a restorative hybrid composite resin. D, Try-in of the onlay in the mouth.

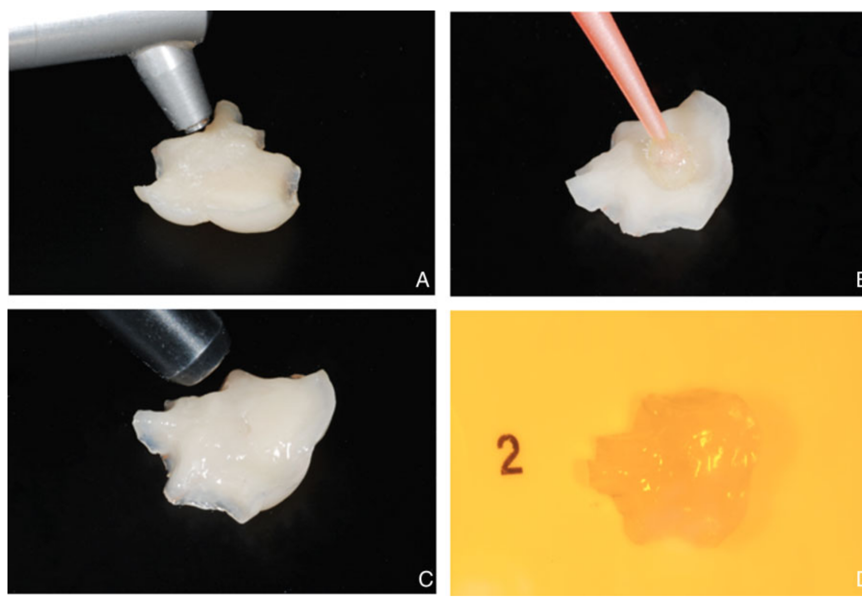

FIGURE 6. Adhesive treatment of the onlay. A, Internal surface of the onlay was cleaned with soft air abrasion. B–D, A thin layer of adhesive resin was placed and left unucured, the restoration was covered in a light protective box.

(Composhape, Intensiv, Grancia, Switzerland) was used to finish the margins, and then the restoration was polished with a diamond-coated discs (PopOn, 3M ESPE, St. Paul, MN, USA) and silicone points (Identoflex, Kerr, Bioggio, Switzerland) (Figures 8 and 9).

Case 2

The second case was a 69-year-old female who presented a Cl II MOD amalgam restoration on the mandibular second molar, which needed replacement (Figure 10A). The tooth was vital with no history of pain. The wide extension of the cavity and the position of the tooth limiting the accessibility to obtain a good anatomy were a clear indication for an indirect restoration, but as the patient had financial limitations, a semidirect technique was chosen.

During the cavity preparation, the lingual cusps were reduced due to the presence of important dentinal fissures. The treatment procedures were the same as

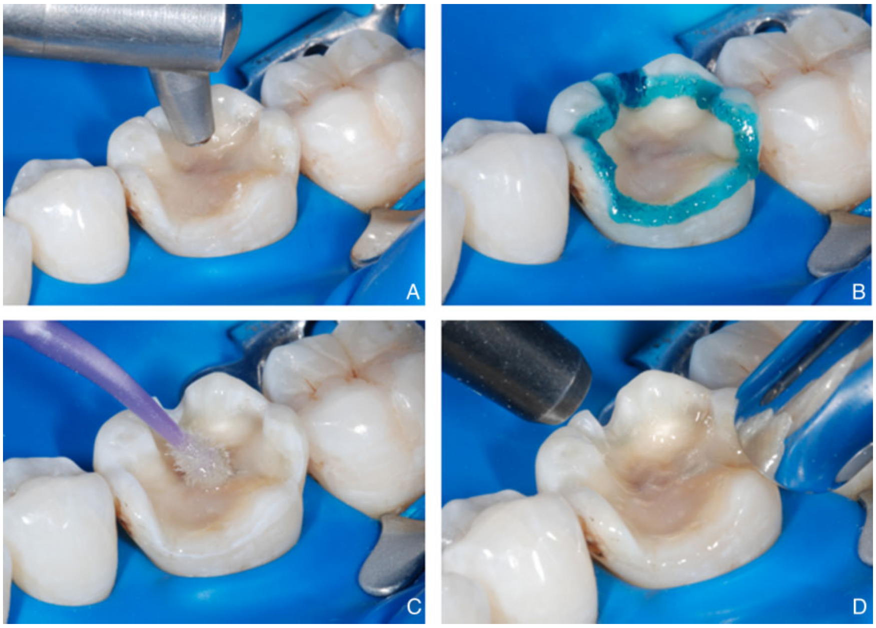

FIGURE 7. Adhesive treatment of the cavity. A, Cleaning of the cavity with soft air abrasion. B, Conditioning of the enamel margin with orthophosphoric acid-etching. C,D, A thin layer of adhesive resin was applied and left uncured.

described for the 1st case, except for some steps in the model fabrication (Figure 10B–F).

DISCUSSION

The main reason to replace posterior composite restoration is secondary caries[24] mainly related to the failure on the bond interface. This failure develops during the polymerization shrinkage of the resin.[25] This phenomenon will create internal stresses on the restoration, which may lead to marginal failure. Various techniques have been described in the literature to overcome this problem,[26–29] e.g., the incremental method, the use of glass-ionomer bases and the indirect technique. The indirect technique in particular allows the initial polymerization contraction, and the following post-curing shrinkage to occur before cementation.[30] Various in-vitro studies have shown that tensile strength, elastic modulus, fracture toughness, hardness, and wear resistance are improved by post-curing.[10–11,31–32] Also marginal adaptation of resin composite inlays has been reported in some studies to be superior to direct fillings, showing less microleakage and better marginal quality.[33–35]

Nevertheless, the cost and the time needed to fabricate indirect restorations remains an important concern of the technique. The use of the chairside semidirect technique overcomes this issue without affecting the restoration quality. In an 11-year clinical trial, Van Dijken concluded that semidirect composite resin inlays/onlays showed a promising clinical longevity with improved marginal adaptation and low incidence of secondary caries.[36] A 3.5-year evaluation for medium-size cavity showed that there were no significant differences for direct and semidirect composite restoration in respect to clinical evaluation and scanning electron microscopy marginal adaptation. These two studies confirm that this technique could be of benefit for large cavites.[6]

Despite the elimination of the lab involvement in the restoration fabrication, the procedure allows the realization of a predictable final result from the esthetic point of view as the restoration is fabricated and corrected chairside.

In contrast with the chairside CAD/CAM system, the free-hand semidirect technique does not need special expensive tools or equipment. However, care should be taken in respect to the choice of the material for impression and model fabrication. These materials should have different chemical composition in order to insure easy separation between the model and impression. During model fabrication, the use of a thin

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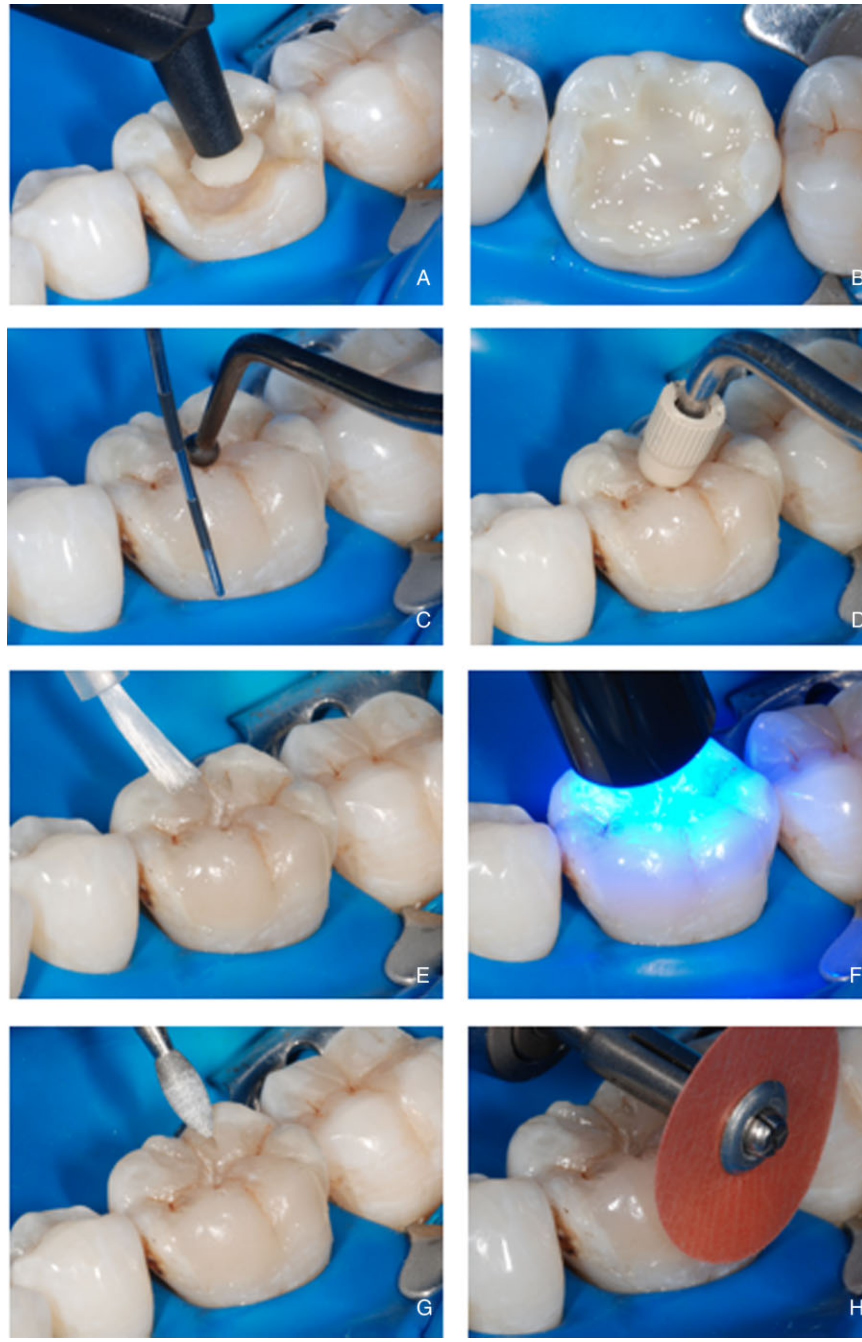

FIGURE 8. Luting procedure of the onlay. A, The warm hybrid composite resin was placed into the cavity. B, The composite resin was spread over all the cavity surfaces. C, The onlay was seated and held in place with a plugger, then the excess material was removed with a probe. D, Complete seating of the restoration was accomplished by the use of ultrasonic tip. E, Final removal of the excesses was done with a soft brush. F, Light-curing of the restoration with the light-emitting diode lamp. G,H, Finishing of the restoration with a fine diamond bur and abrasive discs.

FIGURE 9. Final restoration. A, Occlusal view of the mandibular first molar 1 week after the luting. B, Two years follow up.

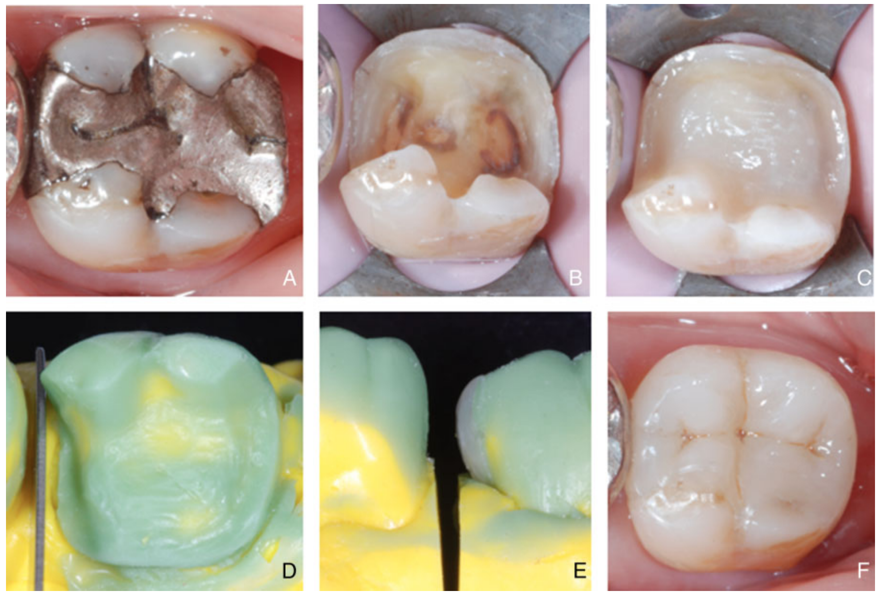

FIGURE 10. Case 2. A, Preoperative view of the mandibular second molar showing the large MOD old amalgam restoration, which needs to be changed. B, During cavity preparation, the lingual cusps were undermined by horizontal fissure and therefore removed. C, Immediate dentin sealing procedure and cavity resin coating. D,E, Silicon working model. The model is partially cut in the interproximal region to facilitate the build up of the marginal ridge and the proximal surface, as in this way, the model can be opened giving a better access for the sculpturing. F, Postoperative view after the luting of the onlay. MOD = mesial-occlusal-distal.

layer of light body silicon was introduced to have a certain precision in the working model. However, the excessive use of light body material may affect the rigidity of the working model. Thus, deformation may occur during the restoration's build up because of the increased model flexibility.

Although the semidirect restoration is done in a single appointment, meaning that the so-called immediate dentin sealing procedure[37,38] would not be necessary, dentin was sealed to eliminate any risk of sensitivity during the period between the two phases of the treatment. Moreover, by using immediate dentin sealing, anesthesia is often not necessary during the second phase. It is well proven that the use of self-etch adhesive system will insure sealing of the freshly cut dentinal tubules, thus reducing the postoperative sensitivity and preventing bacterial contamination.[37] Furthermore, the application of the composite resin layer over the sealed dentin eliminates cavity undercuts, thus allow minimally invasive preparation.[20] The use of sandblasting associated with the subsequent application of a silane solution is employed in the indirect technique to reactivate the composite resin layer before luting.[39] However, its use is probably not essential in the semidirect technique as the composite resin is still chemically reactive.[40] During the adhesive treatment, composite resin of both the restoration and cavity was cleaned with soft air abrasion to remove any potential contamination that could occur during the intraoral try-in or during the break between the two phases.

Restorative hybrid composite resin was used in adhesive luting procedure[23] as it provides rather low polymerization shrinkage and rather low coefficient of thermal expansion compared with low-filled resins (as the common dual-cured resin luting cements).[41] The use of preheated composite resin improved the handling characteristics of the material by decreasing its viscosity, which aided to the attainment of excellent restoration margins.[42] In addition, this treatment enhances the adaptation of the material, decreases the potential of voids formation, and increases monomer conversion, thus resulting in better physical and mechanical properties.[43] Finally, it is important to note that the use of the described technique allows for fabrication of the restoration using the same restorative hybrid composite resin that was used to seal the cavity

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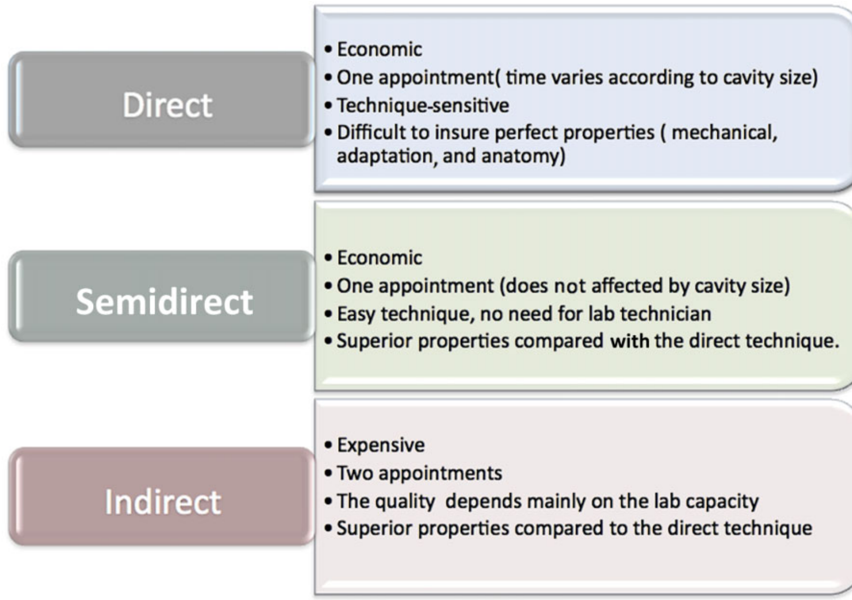

FIGURE 11. General features of the different restorative techniques.

and then to lute the restoration. This leads to perfect chemical compatibility and identical biomechanical properties between the different layers of the restoration, which may offer an additional advantage for this technique.

CONCLUSIONS

The use of the semidirect technique overcomes the disadvantages of the indirect technique, e.g., lab involvement, extra time and cost. It combines the advantages of the direct and the indirect approaches (Figure 11).

DISCLOSURE

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

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 DOI 10.1111/jerd.12067