



# Noninvasive bilaminar CAD/CAM composite resin veneers: a semi-(in)direct approach

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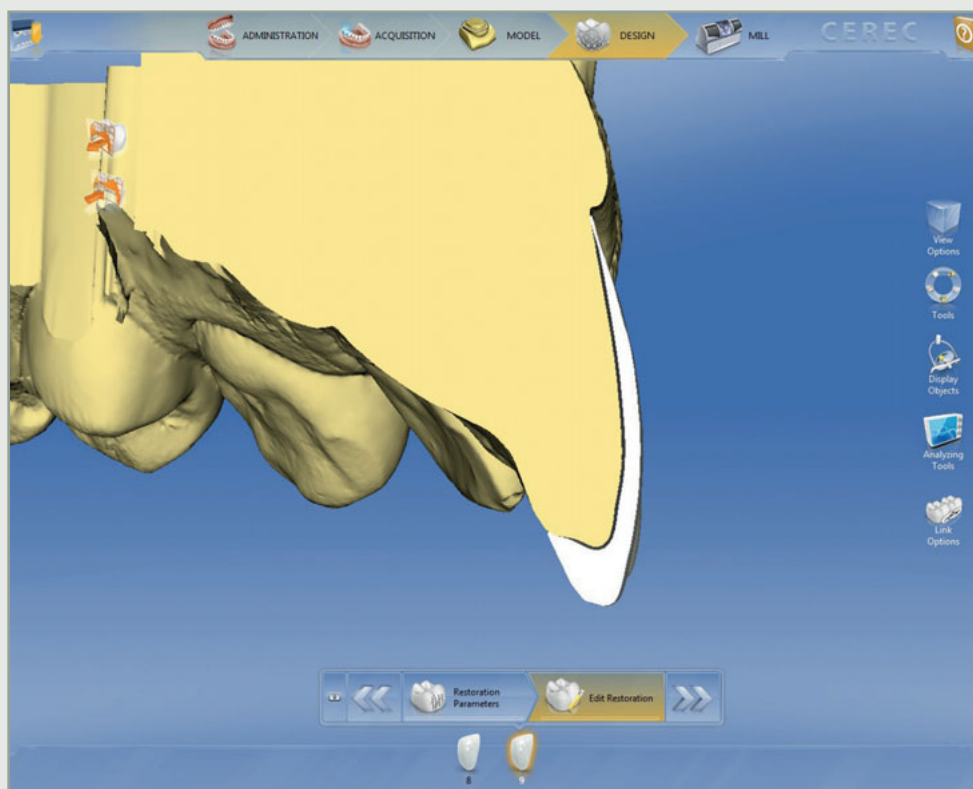


## Abstract

Direct composite resin restorations have been recognized for their valuable clinical service and respect of intact hard tissue. The cost-effectiveness and inherent minimally invasive approach of resin-based materials means that they are also gaining popularity for use in computer-aided design/computer-aided manufacture (CAD/CAM) procedures. Several cases from the student clinics at the Herman Ostrow School of Dentistry of USC are presented that could have been resolved either with direct composite resin restorations or

with indirect porcelain veneers. A novel semi-indirect CAD/CAM approach, characterized by its absolute noninvasiveness and simplicity, was chosen instead. The bilaminar restoration consists of a customized histoanatomical CAD/CAM dentin base (incisoproximal cutback), and a generic enamel skin. The patients can be treated either in one clinical session (semi-directly) or in two clinical sessions (semi-indirectly). The purpose of this article is to present another tool from the anterior restorative armamentarium to bridge the gap between direct and indirect techniques.

*(Int J Esthet Dent 2017;12:134–154)*





## Introduction

### Direct and indirect techniques

Direct composite resin restorations have been providing a valuable service to restore the anterior dentition damaged by caries, trauma, attrition/abrasion, and erosion. The numerous indications also include modifications of tooth shape (Fig 1), size discrepancies, and post-orthodontic restorative corrections. While the physicochemical characteristics of resin-based materials have only slightly evolved since the development of the microhybrid family in the mid-1980s, major esthetic improvements took place during the 1990s.<sup>1-5</sup> These improvements began when manufacturers finally gave consideration to advanced optical properties such as fluorescence and opalescence, with the understanding that the organic nature of the material did not require an extensive range of hues, as was originally thought. Today, more emphasis is placed on the use of the enamel layer as a filter, and the dentin core as a more chromatic base. As a result, simplified materials have been designed with only two or three types of enamels (high, medium,

**Fig 1** (a) Preoperative smile view. Patient requested closure of the diastema between maxillary central incisors. (b) Natural layering technique starts with wax-up and palatal silicone index. (c) Precise location of dentinoenamel junction enabled by guidance from palatal aspect. (d) Smile view of final restorations made in three increments (enamel-dentin-enamel). Note lack of effects in the porcelain veneers (made by a less-experienced ceramist) on the maxillary lateral incisors. [Patient treated in collaboration with student Deborah Loh, DDS class of 2014, Herman Ostrow School of Dentistry of USC.]



**Fig 2 (a)** Postoperative view in 19th year of clinical service of feldspathic porcelain veneers on maxillary centrals, left lateral and canine, right mandibular central, and lateral incisors (laboratory work by Michel Magne, MDT). **(b)** Detail view in 19th year of clinical service of porcelain veneers on right mandibular central and lateral incisors. Note color discrepancy due to aging of natural left central incisor. [Case performed by author but photographed by Dr Stefano Valbonesi (Bologna, Italy).]

and low values), but with a wide range of dentin masses with different chroma (materials include Enamel HRi, Miris2, Inspiro). While these developments have facilitated the placement of direct anterior restorations, a certain level of clinical skill is still needed to achieve the appropriate shape of the enamel–dentin complex, as well as surface texture and gloss. The use of a wax-up and corresponding silicone indexes has proved to help in this process – the so-called natural layering concept.

Conversely, indirect porcelain restorations provide unmatched long-term performance. The surface of the porcelain can be ideally polished in the laboratory, and requires minimal maintenance over the years (Fig 2). Those restorations, however, require the work of an outstanding dental ceramist due to the non-organic nature of the material. Numerous layers and effects must be applied

to simulate the complex optical behavior of the natural tissue. In order to generate flush and finished margins, a light chamfer must be prepared, along with smooth internal contours and minimum clearance for the porcelain (about 0.4 to 0.6 mm). By respecting these principles and agreeing on their related costs, both tissue-wise and money-wise, long-term predictability can be achieved.

### Bridging the gap... again

During the 1980s and 1990s, the restorative community became aware of the possibility of bridging the gap between direct composite resin restorations and full-coverage cemented crowns using indirect bonded restorations.<sup>6-7</sup> By the same token, those who were early adopters of more conservative adhesive solutions in their daily approach were given an additional possibility of bridging

**Table 1** The four restorative approaches and their sequential descriptions

|                                                                                 |                            |             |                                           |                                           |                            |        |
|---------------------------------------------------------------------------------|----------------------------|-------------|-------------------------------------------|-------------------------------------------|----------------------------|--------|
| <b>DIRECT</b><br>1 CLINICAL SESSION                                             | PREPARATION<br>RESTORATION | -           |                                           |                                           |                            |        |
| <b>SEMI-DIRECT</b><br>1 CLINICAL SESSION<br>1 LABORATORY STEP<br>(CHAIRSIDE)    | PREPARATION→               | IMPRESSION→ | RESTORATION<br>FABRICATION<br>(CHAIRSIDE) | LUTING                                    | -                          |        |
| <b>SEMI-INDIRECT</b><br>2 CLINICAL SESSIONS<br>1 LABORATORY STEP<br>(CHAIRSIDE) | PREPARATION→               | IMPRESSION→ | PROVISIONAL<br>RESTORATION                | RESTORATION<br>FABRICATION<br>(CHAIRSIDE) | LUTING                     | -      |
| <b>INDIRECT</b><br>2 CLINICAL SESSIONS<br>1 LABORATORY STEP<br>(EXTERNAL)       | PREPARATION→               | IMPRESSION→ | PROVISIONAL<br>RESTORATION                | EXTERNAL<br>LABORATORY                    | RESTORATION<br>FABRICATION | LUTING |

Note: For all four approaches, when dealing with major morphological modification of anterior teeth, it is recommended to proceed first with a wax-up and a mock-up before the restorative phase itself.

a gap, this time between direct and indirect adhesive approaches, through simplified semidirect (in one clinical session) or semi-indirect (in two clinical sessions) restorations (Table 1). However, this new approach was used mainly in the posterior dentition through various intraoral or extraoral inlay techniques.<sup>8-10</sup> Early computer-aided design/computer-aided manufacture (CAD/CAM) systems were also used for semidirect restorations, but the focus was mainly on generating single session ceramic inlays and onlays.<sup>11</sup> In 2001, the advent of CAD/CAM composite resin blocks<sup>6,12</sup> opened up new possibilities within digital technology. Soon thereafter, the advantages of CAD/CAM polymers over ceramic blocks became obvious,<sup>13-20</sup> including more efficient milling (faster, and with less wear of the milling burs), millability in thin layers (more conservative, and

less marginal chipping), enamel-friendly wear, extreme mechanical resistance, minimal risks of precementation fracture, ease of delivery, reparability, and improved color matching and blending compared to porcelain. Nowadays, composite resin blocks are even available in various translucencies, allowing one to generate a dentin base, and proceed to simple cutback procedures and customization. The use of an analog impression and a working model (semi-indirectly) also facilitates the placement of the high-translucency enamel skin over the customized base. Successful resin-to-resin bonding is essential to this technique, both before the application of the enamel skin to the cutback surface, as well as to the fitting surface of the restoration during its delivery. In this regard, the combination of airborne-particle abrasion (30 to 50  $\mu$  aluminum oxide



or silicoated aluminum oxide)<sup>21</sup> followed by ultrasonic cleaning (in distilled water for 2 min), and the application of a silane (20 s application time and air dry, 2 times) followed by heat drying (1 min at 100°C) is recommended.<sup>17</sup> Wetting with an adhesive resin (no prepolymerization needed) is the last step before the application of the composite resin (either enamel skin or luting composite).

Despite its simplicity, this bilaminar approach yields sophisticated effects (Figs 3 to 5). Three cases from the Herman Ostrow School of Dentistry of USC (student clinics) will be presented: a prepress erosion case, a single tooth trauma, and a smile redesign with wax-up/mock-up. In each case, the decision to use bilaminar CAD/CAM polymer restorations was made together with the patient after discussing all the aforementioned approaches. The noninvasive nature and cost-effectiveness of the semidirect approach was most appealing to these three dental school patients. There is still some concern regarding the fluorescence of some CAD/CAM materials.<sup>22</sup> Future development, however, should provide even more choices of restorative materials as newer composite resin blocks reach the marketplace.

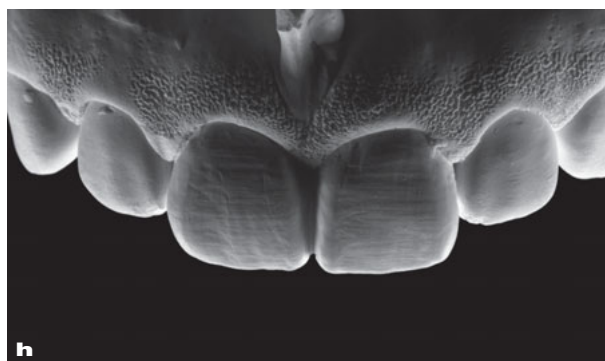
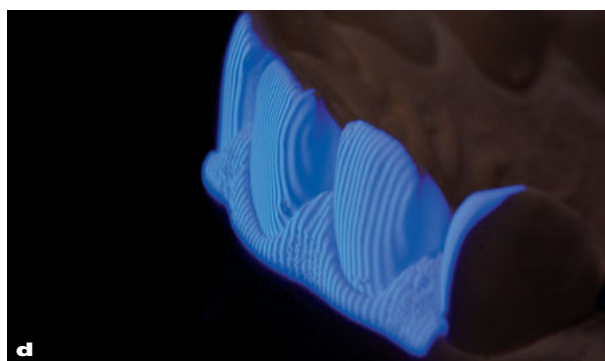
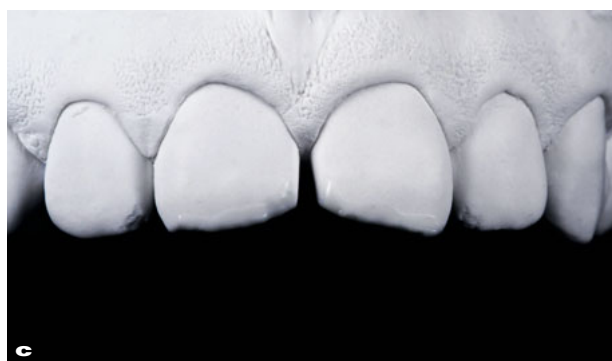
## Case presentations

### Case 1: erosion lesions, prepress approach

The first case was a young female with localized erosion/wear of the maxillary central incisors (Fig 3). A significant volume of enamel had been lost, causing premature aging of the smile. The other

teeth were marginally affected and presented acceptable morphology. Based on the knowledge of tooth morphology, intuition, sensitivity, and a good perception of the patient's individual character, it was possible to reestablish the original enamel thickness. First, two identical type IV white stone casts (Fujirock EP, GC) were obtained from the same polyvinylsiloxane impressions. The first model was modified by slight additions of wax to the incisal edges of both maxillary central incisors. This was carried out to eliminate additively the breached edges of incisal enamel generated by erosion. Rounded internal line angles result in a more precise adaptation of the fitting surface of the CAD/CAM piece. This modified baseline cast was digitized using the Cerec Bluecam system (Sirona) to generate a first dataset.

There are generally two possibilities to generate CAD/CAM restorations. The classic way is to let the software generate a proposal based on the existing databases (such as the Biogeneric Reference in the CEREC system). The second option is to generate a physical wax-up, digitize it, and copy the design (eg, using the Biogeneric Copy mode in the CEREC system). Based on his experience and the fact that it generates more precise and predictable results at this time, the author chose the second option. Therefore, the original baseline casts were used to generate a rapid wax-up using similarly colored wax (white-on-white approach) for improved visual perception. Based on the photographic documentation of the patient, more voluptuous and dominant central incisors were obtained. The design was entirely additive, without the subtraction



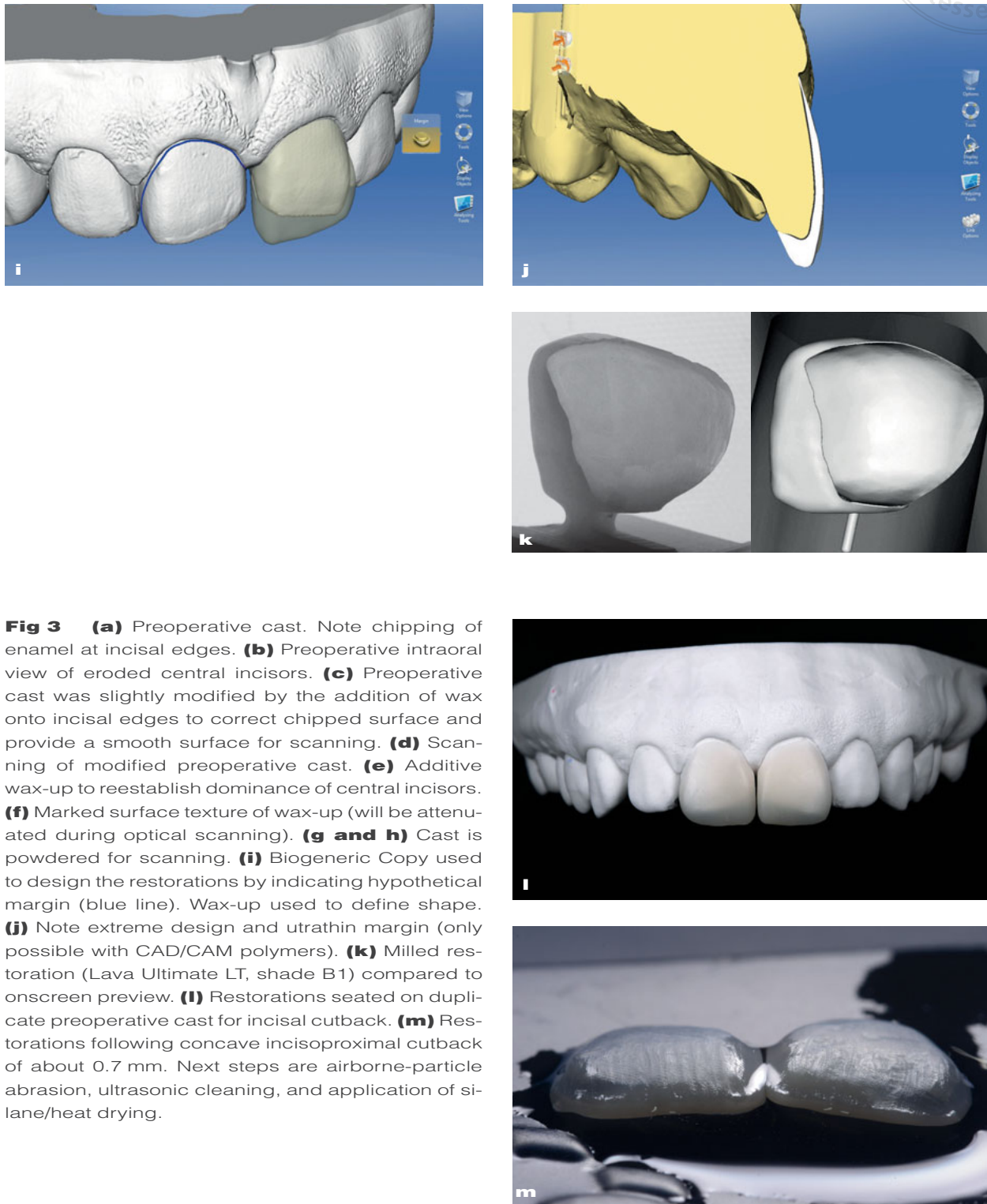


**Fig 3** (a) Preoperative cast. Note chipping of enamel at incisal edges. (b) Preoperative intraoral view of eroded central incisors. (c) Preoperative cast was slightly modified by the addition of wax onto incisal edges to correct chipped surface and provide a smooth surface for scanning. (d) Scanning of modified preoperative cast. (e) Additive wax-up to reestablish dominance of central incisors. (f) Marked surface texture of wax-up (will be attenuated during optical scanning). (g and h) Cast is powdered for scanning. (i) Biogeneric Copy used to design the restorations by indicating hypothetical margin (blue line). Wax-up used to define shape. (j) Note extreme design and ultrathin margin (only possible with CAD/CAM polymers). (k) Milled restoration (Lava Ultimate LT, shade B1) compared to onscreen preview. (l) Restorations seated on duplicate preoperative cast for incisal cutback. (m) Restorations following concave incisoproximal cutback of about 0.7 mm. Next steps are airborne-particle abrasion, ultrasonic cleaning, and application of silane/heat drying.



**Fig 3 (continued)** (n) Detailed view of incisoproximal edge with blue/lavender highlights applied to concave cutback. (o and p) Labial and incisal views following application of adhesive resin (unpolymerized) and enamel skin on left central incisor. (q) Try-in of characterized composite veneers using glycerin gel. Note natural incisal edge characteristics and invisible transition line with underlying incisal edge despite light incidence. (r) 1-month postoperative intraoral view showing excellent integration.



**Fig 3 (continued) (s and t)** Note beautiful incisal edge light scattering and opalescence (halo effect) under tangential light. [Case treated in collaboration with student Andy Truong, DDS class of 2016, Herman Ostrow School of Dentistry of USC.]



of stone. The wax-up cast was then powdered and digitized again using the Biogeneric Copy mode. This second dataset was automatically superimposed to the first dataset without the wax-up. Hypothetical margins of the restorations were designed on the first dataset by following the contour of the gingiva and the interdental surface, and by wrapping the incisal edge using the existing linguoincisor ridge as a lingual margin. Following the definition of a Copy Line on the second dataset with the wax-up, the software was able to generate a precise additive volume representing the restoration for each tooth. This volume is the result of a simple Boolean operation (or volume subtraction) between the two datasets. The restorations were milled with a low-translucency nanofilled composite resin block (Lava Ultimate LT, 3M ESPE) with the sprue located at the mesial surface.

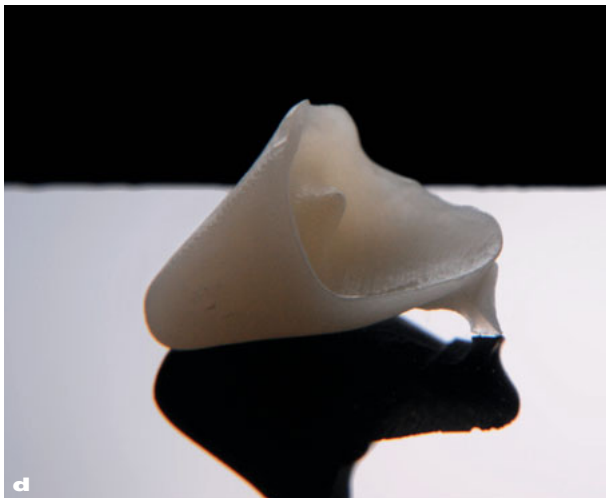
Following the removal of the sprue, the intact second type IV white stone cast was used to check the fit of the CAD/CAM restorations. Using an electric handpiece with a small round diamond bur at low speed, the veneers were modified by creating a continuous concavity at the proximoincisor edge. A slight vertical pattern was created to match the dentin mamelons and interlobe concavities. The modified surface was then roughened with airborne-particle abrasion (aluminum oxide 30  $\mu$ ), cleaned in an ultrasonic bath, silanated (Silane, Ultradent) and heat dried for 1 min at 100°C. To facilitate the next steps, the veneers were glued to the cast with a small amount of glue stick and by infiltrating hot wax at the lingual margin. Mixed blue and lavender col-

oring resins (Optiglaze Color, GC) were then used to characterize the proximoincisor concavity. Special care was taken to outline the dentin mamelons with the colorants, which was facilitated by the vertical surface pattern previously generated by the bur. Following the light polymerization of the colorants, and the wetting of the rest of the modified surface with adhesive resin, a thin layer of a generic enamel-like composite resin (Miris2, shade WR, Coltene) was laid at the surface, carefully shaped to emulate the morphology of the wax-up, and light polymerized. Following additional polymerization through glycerin gel (to limit the formation of an oxygen-inhibited layer), the veneers were retrieved from the model, cleaned, and prepared for try-in using the same glycerin gel. Luting procedures followed the exact same protocol used for porcelain veneers (enamel etching, adhesive resin), except that hydrofluoric etching was substituted with airborne-particle abrasion (aluminum oxide 30  $\mu$ ). Silane treatment of the veneer fitting surface was used after air abrasion, followed by heat drying and coating with adhesive resin. A preheated restorative composite resin (ENA HRI dentin shade, Micerium) was used as a luting agent.

### Case 2: Single tooth trauma without wax-up

A young male patient presented with a traumatized, endodontically treated right mandibular lateral incisor (Fig 4). Endodontic treatment had been performed previously, followed by the application of a bonded composite resin base to seal and partially restore the endodontic

**Fig 4** (a) Preoperative intraoral view with shade guide. Note dark substrate and large amount of missing tooth structure. (b and c) Labial and incisal views of stone cast with labial mini-chamfer preparation. (d) Milled restoration (Lava Ultimate LT) obtained without wax-up (Cerec Biogeneric proposal). (e) Try-in of restoration before cutback. Note high chroma, which is appropriate for cervical area but not for incisal area.



access. A large volume of tooth structure was still missing. Shade selection appeared particularly challenging given the wide range of color observed on neighboring teeth. Tooth preparation only included a mini chamfer at the labial cervical margin, rounding off all internal

sharp edges, and leaving a small fossa facing the incisal edge (for stabilization during delivery). A rather high-chroma low-translucency CAD/CAM block was chosen, knowing that it would be subjected to incisal cutback to provide higher value and translucency to the incisal



**Fig 4 (continued)** (f) Labial view of restoration on cast after incisoproximal cutback, air abrasion, silane application (plus heat drying), and application of blue/lavender highlights. (g) Application of enamel skin with higher value and translucency. (h and i) Postoperative smile and intraoral view showing excellent integration. [Case treated in collaboration with student Robert Chung, DDS class of 2016, Herman Ostrow School of Dentistry of USC.]





edge. The integration of the bilaminar restoration and tissue response was a success despite the numerous challenges (dark single tooth, endodontic treatment, extreme volume of the restoration, etc).

### Case 3: Smile redesign with wax-up and mock-up

A young female presented with large diastemas and worn-down anterior maxillary teeth (Fig 5, parts 1 and 2). She had just completed orthodontic treatment before consulting for the first time with the author. When a radical change in tooth shape and length is planned, it is always safer to proceed with a previsualization mock-up. Hence, an additive wax-up was performed on the anterior maxillary teeth to close all the gaps between the teeth and increase their length. The canines only required a partial addition of wax to their mesioincisal surface. Using a technique described elsewhere,<sup>23</sup> a direct acrylic resin mock-up was performed and evaluated by the patient for several weeks. Following her approval, the mock-up was first removed from the canines only and replaced with a direct composite resin restoration guided by the wax-up. The mock-up was then used as a guide for ultraconservative preparations at a depth of 0.4 mm using round burs for depth cuts. The intact enamel surface was barely notched by the depth cuts. Rubber dam was placed mainly to obtain tissue displacement in the interdental area. Dental floss ligatures helped to press down the papillae. While rubber dam was in place, labioincisal and labio-proximal tooth surfaces were softened with abrasive discs to remove irregulari-

ties and eliminate depth cuts and large retentive areas (mainly in the interdental area). The same technique described above for the other cases (Biogeneric Copy) was used to generate the four veneers, which were then customized, tried-in, and delivered adhesively using a preheated restorative material as a luting agent.

## Conclusions

A simplified bilaminar CAD/CAM semi-direct restoration technique is presented for the treatment of various clinical situations in the anterior dentition. Indications include erosion-based lesions, trauma, and tooth size-length discrepancies. The same adhesive and esthetic principles used in direct composite resin restorations and indirect porcelain veneers were combined. The minimally invasive approach and cost-effectiveness of the semidirect approach was most appealing to the patients. Future developments ought to provide even more choices of restorative materials as newer composite resin blocks reach the marketplace.

## Acknowledgments

The author would like to thank Michel Magne, MDT (901-LA, Beverly Hills Dental Laboratory) for the ceramic restorations in Figure 2 and for his constant mentoring in morphology and esthetic dentistry. Special thanks to Drs Luciana Soares, Priscilla Lazari, and Marco Carvalho (Visiting Scholars, Herman Ostrow School of Dentistry) for their precious assistance, to the students of the Herman Ostrow School of Dentistry of USC, and to Dr Richard Lin (Assistant Professor of Clinical Dentistry, Herman Ostrow CAD/CAM laboratory) for his collaboration. "Commit your works to the LORD and your plans will be established." (Proverbs 16:3, The Holy Bible).



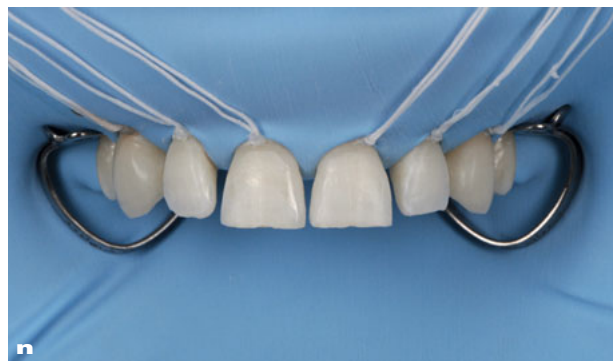
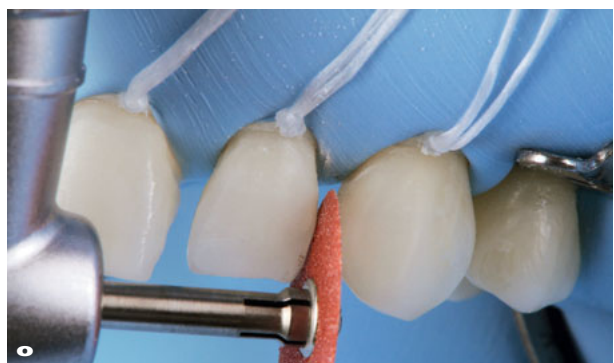


**Fig 5, part 1** (a) Preoperative smile with large gaps and worn incisal edges due to previous malocclusion. (b) Preoperative intraoral view. (c to e) Diagnostic cast after additive wax-up (from canine to canine). (f to h) Mock-up obtained using acrylic resin in a silicone index, paint-on colors, and glazing resin. (i) Removal of mock-up on canines only. (j) Modified rubber dam placement required by the presence of the mock-up on incisors. (k) Direct composite resin restorations on canines guided by the wax-up. (l and m) Ultraconservative (0.4 mm) tooth preparations guided by the mock-up. (n and o) Rubber dam placement for tissue displacement and finishing of the preparations with abrasive discs.



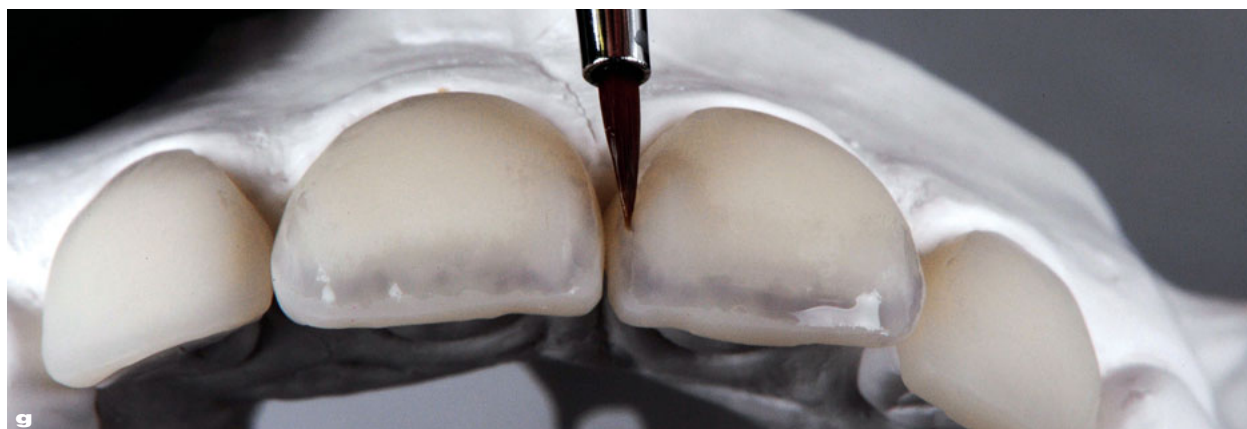




**Fig 5, part 2** (a) CAD/CAM veneers (Lava Ultimate LT) seated on stone cast before incisoproximal cutback. (b) Incisoproximal cutback using round diamond bur. (c) Airborne-particle abrasion of cutback surface. (d) Cleaning of restorations in distilled water in ultrasonic bath for 2 min. (e) Silane application (20 s application time and air dry, 2 times). (f) Silane drying for 1 min at 100°C in small oven. (g) Cutback veneers seated on cast for application of incisoproximal blue/lavender highlights and polymerization. (h) Enamel skin composite (Inspiro SB, Edelweiss DR) is preheated at 68°C in Calset device (AdDent) to facilitate placement. (i) Veneer surface coated with adhesive resin (unpolymerized) before placement of enamel skin. (j) Completed veneers following enamel skin polymerization and air blocking. (k and l) Try-in with glycerin gel. (m) Intraoral view with rubber dam during luting procedure (tooth preparation air abrasion).





**Fig 5, part 2 (continued)** (n and o) Final restoration with different degrees of smile. (p and q) Intraoral view after rehydration and soft tissue healing. (r to u) Various postoperative views with lips showing vitality, natural light scattering, and tissue response of CAD/CAM bilaminar restorations. [Case treated in collaboration with student Saman Mostajabian, DDS class of 2017, Herman Ostrow School of Dentistry of USC.]



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