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Fig. 1e



Figs. 1a & b

Figs. 1c & d

Direct bonding in the smile frame:

Merging new technologies and human touch for the best



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Introduction

Restorative dentistry has entered a phase of deep conceptual rupture, demarcating two camps, the traditional one, pursuing the convention of human-conceived and -fabricated restorations, and the modern one, celebrating new technologies in all aspects and steps of a restorative treatment and limiting tremendously the manual contribution of the dentist. However, even the most enthusiastic, modern professionals recognize that no technology can equate to the excellence and perfection of a powerful brain and agile

hands acting in synergy, while the most conservative ones also admit that digital dentistry has the potential to elevate the level of mass dentistry. What is the most reasonable attitude? Probably a position in between the extremes. Freehand direct bonding can then be looked at from different perspectives as well: it will soon be abandoned and replaced by either CAD/CAM and 3-D printed restorations, or on the contrary, even further developed, using some new digital technologies to improve its outcome and practicality, fueled worldwide by a slowing economy and the quest for an ultraconservative treatment approach. The latter vision is from far the most realistic one, as many restorations cannot be approached simply by new technologies owing to the limits of the cavity or restorative geometries and the irrational complexity, preparation imperatives or technology immaturity of CAD/CAM and 3-D printing systems if applied unrestrictedly. This report aims then to discuss and illustrate current and future indications and application protocols of direct bonding, as a way to bridge classical and modern dentistry.

Overall considerations and indications for direct bonding

The use of composite is likely to continue, probably even develop, in the forthcoming decade. Actually, no foreseen new technology seems able to allow soon the intraoral fabrication of highly esthetic and strong restorations in a simple, efficient and cost-effective way. In the case of extraoral fabrication, tapered cavities or at least different cavity designs are required, generating as well undesired complications and costs. Keeping this in mind, direct composite application has unique advantages in the following precise indications (**Figs. 1a–e**):^{1,2} – Class III–V restorations;

- form corrections (tooth shape; proportions and dimensions);
- esthetic enhancements in young patients;
- diastema and black triangle closure;
- veneering of anterior and lateral teeth (if limited discoloration);
- interceptive approach to tooth wear.

The advantages of a direct approach are multifold, including tissue conservation, use in young patients (aiming for treatment reversibility), reduced execution time and lower cost (as opposed to indirect or CAD/CAM restorations), providing also satisfactory longevity.^{3, 4} Conversely, some limits exist, related to the practitioner's experience, composite shading and layering concept (some systems are still overcomplicated and unreliable in terms of esthetic/shade outcome) and application of detailed protocols, although the last point or shortcoming is truly a relative one. The use of direct techniques has only few limits in terms of extent, namely nonvital teeth or very large carious lesions, for which crowns or extended bonded porcelain restorations are usually preferred. Likely in-between indications for direct or indirect solutions – some cases lie within a gray zone – are resolved mainly according to the operator's preference rather than any other strong rationale (**Figs. 2a–s**).

“An optimal result in terms of esthetic integration is feasible today, although it will rarely be achieved without proper material choice and an appropriate layering approach and application, which are largely product-specific”

Shading and layering concept

Overall, layering concepts evolved from a primitive approach to emulating natural dental anatomy and optical properties to more reliable protocols for matching tooth color and its many dimensions.⁵⁻⁷ Actually, color integration as perceived by patients implies correct hue, opacity, opalescence and fluorescence regarding optical determinants and surface gloss and light reflection (mainly related to the restorative microanatomy). An optimal result in terms of esthetic integration is feasible today, although it will rarely be achieved without proper material choice and an appropriate layering approach and application, which are largely product-specific.⁷

We normally classify composite systems in relation to the number of recommended layers, as well as some selected optical properties, which allow for finer differentiation among brands. In parallel, filler technology has considerably evolved, aiming to offer the practitioner various options, such as universal materials (superfine hybrids or homogeneous nanohybrids), which can be used for both posterior restorations, owing to their excellent mechanical properties, wear resistance and esthetics, or specific composite formulations (spherical or mixed-filler composites) aimed to be used mainly in anterior teeth owing to lower mechanical performance. Our preference today is toward universal composites as far as material technology is concerned and a bilaminar application approach, considered simple, reliable and highly esthetic. The use of the natural

tooth as a model has been then a logical evolution of direct restorative materials, leading to an improved shading and layering concept, the natural layering concept (NLC), logically named after nature's original model and source of inspiration.^{8, 9} It resulted from a comprehensive study of natural dentin and enamel optical properties, recognizing the variations in tissue quality related to tooth age and functional maturing. Related findings have logically drawn the lines of this new concept (**Fig. 3**).^{6, 7, 9}

Spectrophotometric measurements (tri-stimulus L*a*b* color and opacity values) of natural teeth belonging to various VITA shade groups led to the conclusion that the use of distinct dentin colors for a direct composite restorative system could be avoided, provided that enamels would offer not only different value/opacity levels but also different tints. Likewise, limited natural dentin opacity within a given chroma level variation did not support the use of different dentin opacities (i.e., translucent, regular or opaque dentins).^{6, 7, 9}

Then, a new concept was born, allowing the emulation of practically all of the VITA shades by using an appropriate combination of universal dentin shades of a single opacity level and presenting a wide chroma range that extends beyond VITA classical shades and multi-tint/multi-translucency enamels (typical brands named after their development period: Miris and Miris2 [COLTENE], ceram.X duo [Dentsply Sirona], Enamel Plus HFO and HRI [Micerium], and inspiro [Edelweiss DR]).

Specific characteristics of NLC dentins and enamels

In summary, in an NLC composite system, the specific material optical properties for dentin are a single hue, a single opacity and an extended chroma range (**Fig. 3**). For enamel, three specific enamel types are needed: to mimic young enamel: white tint and reduced translucency; adult enamel: neutral tint and intermediate translucency; and elderly enamel: yellow tint and higher translucency, maintaining a natural opalescence among the three aforementioned basic enamel types. Various levels of translucency complete the different tints, forming then a multi-tint/multi-translucency system that emulates most natural enamel variations.

Effect shades

For teeth with richer color composition (strong opalescent halo, noticeable dentin mamelons, enamel opacities, etc.), special effect shades produced in a flowable consistency are available in some NLS systems to surpass esthetic boundaries (typical brand: inspiro).

Case presentation

A patient, aged 16, presented with an esthetic complaint, after orthodontic closure of spaces owing to missing lateral incisors. The functional and esthetic analysis revealed improper distribution of teeth and extra space (**Figs. 2a&b**). A more detailed analysis of the smile showed excessive space distal to the maxillary right lateral and mesial to the maxillary left one, associated with an excessive diastema between both central incisors.



Fig. 2a



Fig. 2b



Fig. 2c



Fig. 2d



Fig. 2e



Fig. 2f



Fig. 2g



Fig. 2h



Fig. 2i



Figs. 2j & k



Figs. 2l & m



The simulation of space closure with restorations confirmed the need for orthodontic correction; it was decided to use the Invisalign system (Align Technology; **Figs. 2c–f**) to achieve a better pre-restorative configuration. After better space distribution was obtained (**Fig. 2g**), a new analysis was performed to assess the potential esthetic outcome of smile enhancement using direct bonding and a no-preparation approach (**Figs. 2h–i**). The improved, post-Invisalign configuration confirmed the possibility of obtaining a satisfactory result, although the mesial movement of the four incisors did not allow the possibility of eliminating some remaining excess space.

The preparation of surfaces was limited to sandblasting, after rubber dam placement, as a unique procedure prior to adhesive procedures. Sectional matrices were used to close the diastemas (Adapt system, KerrHawe), the curvatures of which help in recreating the natural convexity of proximal surfaces. The NLC of a bilaminar buildup approach was applied (**Figs. 2j–m**) with one dentin (Body i2, inspiro) and one enamel (Skin White, inspiro) shade. Small additional increments of effect shades (Azur and Ice, inspiro) were applied to emulate chromatic details and enhance the opalescence halo at the incisal edge. Finishing and polishing were performed using conventional discs and fine diamond burs (40µ) for primary anatomy and a combination of two sil-icone instruments for polishing and high gloss (Identoflex Minipoint and HiLuster, KerrHawe; **Figs. 2n–p**).

The 1.5-year post-treatment examination (**Figs. 2q–s**) revealed the satisfactory behavior of the restorations, with absolutely no form or surface alteration, as well as healthy soft tissue and no marginal discoloration. These findings supported the treatment option selected.

Conclusion

As said, the freehand application of composite is to remain and even likely to further develop, and we do not foresee new techniques challenging the



Figs. 2n–p

simplicity and efficiency of direct composites. Actually, on one hand, 3-D intraoral printing of composite restorations with a high filler load seems unlikely to happen soon owing to the viscosity of such material, while on the other hand, extraoral fabrication would require a tapered cavity design with a significant, nonconservative alteration. In short, there is not any technology that can replace direct composites yet. Having said that, achieving optimal forms, smile configuration and color is not so simple, and improved clinical protocols are needed to obtain

highly esthetic results with direct bonding in a predictable manner. This is where existing technologies can make a significant contribution in the form of digital diagnostics (digital smile design)¹⁰ and 3-D printed mock-ups to support treatment planning, constrain clinical difficulties and, therefore expand successful use of direct bonding. The next milestone in treatment reliability is the use of a highly effective and simple layering approach such as the NLC. The last two improvements in direct bonding application are keys to success for the modern practitioner, specialist or not.



Figs. 2q–s

Editorial note:

A list of references is available from the publisher.

Legends

Figs. 1a–e

(a) Pretreatment of a 14-year-old patient after a sport trauma having resulted in major fractures of both maxillary central incisors, repaired in an emergency department in a public hospital. (b) Intraoperative view showing the application of an effect shade (Ice, inspiro) to emulate hypocalcifications. This effect is placed directly over the dentin buildup. (c–e) Post-treatment view showing better smile harmony with proper tooth dimensions and proportions, which would facilitate the scheduled orthodontic treatment as well.

Figs. 2a & b

Pretreatment smile showing major esthetic discrepancies. The space distribution was insufficient to allow for satisfactory forms and proportions to be obtained with restorations.

Figs. 2c–f

(c–e) Intraoral status confirming that existing tooth positions and dimensions were incorrect. Former orthodontic treatment had failed to provide the necessary conditions for the final restorative phase. (f) An esthetic template was placed over the frontal smile photograph to confirm the aforementioned observations.



Fig. 3

Fig. 2g

Better distribution of space and tooth position was achieved by orthodontic correction using transparent aligners.

Figs. 2h & i

A 2-D template (balanced tooth form and smile configuration) was used to confirm the desired smile configuration. This simple digital simulation helps both the patient and practitioner to confirm the extent and outcome of planned restorations.

Figs. 2j–m

Form corrections and change in tooth dimensions and proportions was performed with a no-preparation approach, using composite bonded directly on enamel after sandblasting as the only pretreatment for optimal adhesion.

Fig. 2n

The selected composite masses are shown: **Bi2** = dentin shade; **SW** = Skin White enamel; **A** = Azur effect shade: blue opalescent; **I** = Ice effect shade: whitish, opaque (all shades from the inspiro system).

Fig. 2o

Post-treatment smile showing improved harmony and configuration.

Fig. 2p

Lateral view of the smile with soft inconspicuous integration of the composite restorations.

Figs. 2q–s

Views at 1.5 years post-treatment showing optimal behavior of the direct composite restorations. This treatment can be considered an optimal treatment option for young patients owing to the possibility of further corrections, tissue conservation, cost-effectiveness and esthetics.

Fig. 3

Modern composite systems show a clear simplification of the shading concept, and improved practicability; a proper shade guide is a crucial tool to achieve optimal color integration of the future restoration. Example of a bilaminar shade guide (inspiro), which allows individual selection of dentin and enamel shades, emulating the natural disposition and thickness of dentin and enamel.