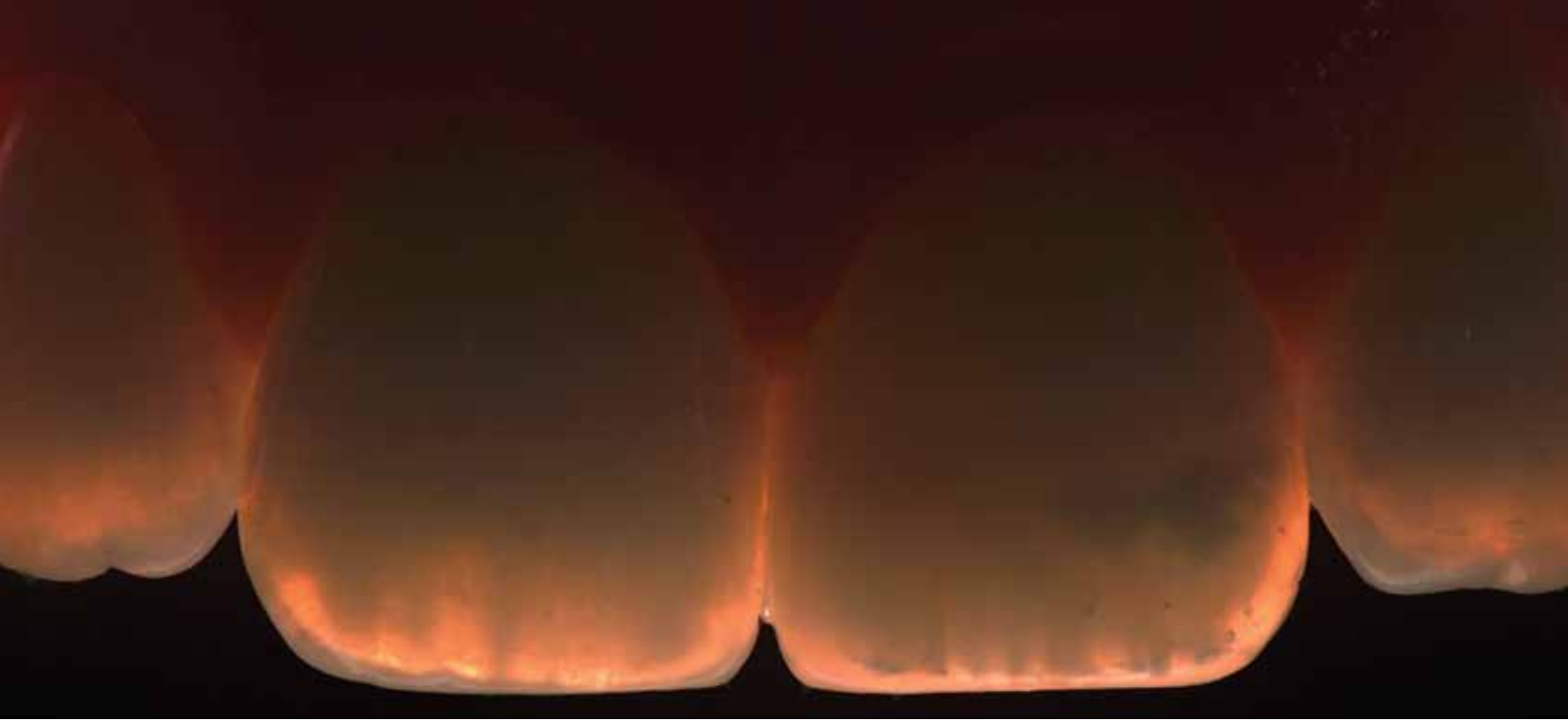

A Solution for Everyday Direct Restorative Challenges

Mastering Composite Artistry to Create Anterior Masterpieces—Part 1

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Abstract

This first part of a two-part series introduces a conservative, effective, and artistic philosophy for performing esthetic direct anterior composite restorations based on the principles of emulating the proper form, color, and function of natural teeth. A step-by-step procedural approach to solving day-to-day anterior direct restorative challenges, which include shade selection, color mapping, color mock-up, tooth preparation, composite resin selection, and artistic implementation, is presented. Clinically relevant aspects, such as how to create seamless transitions from tooth structure to the synthetic composite restoratives by correct finishing and polishing techniques, are thoroughly discussed. Necessary armamentarium, from instruments to restorative materials for the predictable, stress-free realization of esthetic anterior direct restorations, are introduced as clinical cases are detailed.

Material, Optical, and Composite Placement Considerations

Essential to the science and artistry of direct free-hand dentistry, creativity enables dentists to devise and execute esthetic restorations using composite resin systems.[1,2] To understand advanced esthetic treatments, dental professionals must also comprehend the fundamentals of tooth structure, such as color, form, and function.[3] With such a thorough understanding, almost any composite system may be used to achieve excellent results.[3]

In the anterior region, it is important to emulate nature so that both form and color incorporate seamlessly, producing restorations that not only mimic, but are indistinguishable from surrounding natural dentition **(Figs 1 & 2)**.[3] Through developments in composites, which are now equal to or better than some porcelain systems, enhanced optical properties and esthetics can be realized in direct restorations.[4,5] It is, however, up to the artist, as an operator and scientist, to understand the principles of working with composite systems and how to correlate them with natural tooth tissues.[5,6]

Figure 1: Class III and IV defects involving loss of natural enamel and dentin.

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Properties of Composite Systems

When choosing a composite system, material characteristics such as handling, sculptability, and viscosities affect the final restorative outcome, dictate specific manipulation techniques required, and influence delivery format.[5,6] Among others, time from delivery to contouring and brushing, fracture and wear resistance, and polymerization shrinkage rates are important aspects of composite systems to consider before undertaking direct restorative procedures.[7] With new state-of-the-art composites, however, color stability is less of a concern, since nearly all systems demonstrate predictable and balanced color stability throughout treatment and post-procedure.[5]

In the past five years, dental professionals have witnessed major improvements in composite materials in terms of their particle sizes.[5,8] Micro- and nano-hybrids produce enhanced luster and polish, while microfills remain unmatched for polishing ease and longevity when exposed to varying degrees of pH levels (i.e., low pH, high acidity, and brushing).[5] Although polishability is not critical to composite selection, it is important.[5]

Figure 2: Selection of proper composite materials and restorative techniques elicits seamless results.

Figures 3a & 3b: Wear and fracture resistance are necessary characteristics of direct composites in stress-bearing areas.

As operators, dentists and technicians control a limited number of material characteristics and final restorative outcomes.[5,6] With the ability to control only environmental aspects, finishing and polishing, manipulation, and proper polymerization, there is very little dentists can do to ensure the predictability of resins.[5] Also, today's resins demonstrate a range of 0.9% to 1.5% volumetric shrinkage, which supports esthetically pleasing results without pulling away and disrupting the hydrodynamics of the tubuli.[7] This low shrinkage rate reduces the likelihood of postoperative sensitivity, marginal leakage, and creates better margins in restorations.[7]

Although most of today's composites demonstrate excellent color stability, other factors contribute to the lifespan of a direct restoration's color.

Fracture Resistance

When building the incisal edge, Class IV incisal buildups, and restoring worn dentition, composites that withstand the rigors of occlusion and mastication are required.[9] The composite material must resist the abrasion that occurs from bruxing tendencies and brushing.[9] Therefore, wear resistance is a necessary characteristic of direct composites in order for restorations to maintain surface texture and anatomy **(Figs 3a & 3b)**.[9]

Polishability

Composite resins must also provide high polishability to mimic the gloss of natural enamel.[10] Although composite restorations may exhibit a great final polish when the patient leaves the office, they should sustain that gloss over time.[10]

Color Stability

Although most of today's composites demonstrate excellent color stability, other factors contribute to the lifespan of a direct restoration's color.[11] Polymerization and polishing can affect color stability, as can a patient's dietary and other habits.[11] Typically, however, 10 to 20 years of color stability can be expected with current composite systems.[11]

Composite Types

Available composite materials vary based on filler particle size and shape, and there are many options from which to choose.[5,6] Although each encompasses different characteristics, material selection will be determined based on the area in which the restoration is planned and the specifics of the case.[12]

Microfills

Microfills, conventional or reinforced, provide high sculptability and excellent wear resistance.[13] With these composites, dentists can expect high polishability and very good color stability that typically lasts more than 20 years.[13] Fracture toughness, however, is lower than with some other materials, and microfills should not be used over the incisal edge or to build up the incisal edge, as it will eventually break.[13] Reinforced microfills do provide higher fracture resistance and, depending on the case, may be used in high stress-bearing areas.[13]

Conventional Hybrids

Unlike microfills, a key benefit of hybrid composites is fracture toughness or resistance.[13] Color stability is considered very good and sculptability is fair, depending on the specific system used.[13] Wear resistance and polishability of hybrids, however, are not as good as other materials because hybrids present an average of larger particles, which are responsible for pitting of the finished surface, and they tend to be harder to polish than microfill materials.[13]

Micro-Hybrids and Nano-Hybrids

Micro-hybrids are hybrids with a greater content of submicron particles. They demonstrate improved handling and polishability compared to conventional hybrids.[8] Nano-hybrids are the state-of-the-art in the hybrid category

Figure 4: Preoperative view of a fractured central incisor. The intact contralateral incisor depicts marked opalescence at the incisal third.

Figure 5: Current esthetic composite systems present effect enamels that mimic true opalescence. A reflected light shot shows a bluish hue along the incisal third.

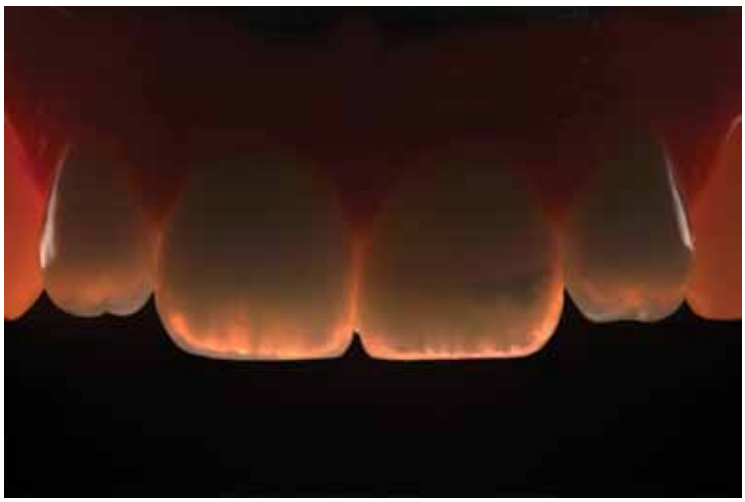


Figure 6: An effect composite enamel that is truly opalescent should allow the perception of amber hues through transmitted light.

and combine fracture toughness, sculptability, improved wear resistance, and color stability. Although the increased content of nano-particles does, in fact, produce a better polish, microfills still remain unchallenged with respect to long-term gloss.

Nano-Fills

Although there are few nano-filled products available, particle size and shape are the most important characteristics of these composites, as a configuration with spherical particles ultimately enables the best polishability.[13] Due to their smaller particle size, nano-fills exhibit very good fracture and wear resistance, along with good sculptability.[13] These composites also demonstrate color stability.[13]

It is important to remember that not all systems exhibit the same properties and that there is no truly perfect material.[12] Ultimately, it is up to the dentist to maximize the best properties in each system and manipulate them to create the comprehensive, customized shades that suit the restoration.[12]

Optical Properties

Crucial to restorative success with any composite system is an understanding of the optical properties of natural dentition and the selected composite material.[14] An integral part of esthetics and a result of how light is transmitted, reflected, defracted, refracted, and absorbed through enamel, halos result from a change of the wavelengths of light called *opalescence* that causes a whitish/amberish effect.[14]

Opalescence

By definition, opalescence is the result of a change in the wavelength of natural light (5000 K), whereby bluish wavelengths are reflected and amber wavelengths are transmitted—a phenomenon perceived in the opal stone and present in tooth enamel. Providing reflection of white, natural, and bluish hue light, opalescence creates a natural halo.[14] The more translucent a tooth, the more opalescence it will display.[14] On the other hand, the more opaque a tooth, the less opalescence it will display.[14] Some products today exhibit the required opalescence, while some reflect blue and others transmit amber **(Figs 4-6)**.[14] When choosing a material, it is incumbent upon clinicians to evaluate the composite for the specific shade required to provide true opalescence in any restorative case.[14]

Opacity

Opalescence is not exclusive from opacity, which has an effect on restoration and natural dentition.[14] A natural tooth exhibits higher chroma and lower value at the cervical third; a lower chroma and higher value at the middle

Figure 7: The interplay of varying thicknesses of dentin and enamel from cervical to incisal thirds accounts for the perception of more translucencies, different chromas, and values.

It is important to remember that not all systems exhibit the same properties and that there is no truly perfect material.

third; and myriad chromas and values at the incisal third. These differences are caused by various thicknesses and opacities of enamel and dentin.[14] To best mimic these characteristics, two different types of translucent composite, one slightly more translucent than the other, can be used.[14]

Translucent does not mean transparent, as there is neither transparency in natural enamel nor in the composites used today.[14] *Transparent* would refer to a glass-like material that allows 100% light transmission, whereas translucent materials are more pearl-like and demonstrate more opacity.[14] The thickness of the material is a very important factor in the translucency of a restoration, since an increase in thickness blocks light transmission and dilutes the underlying coloring.[14]

Composites that are considered of pearly appearance demonstrate similar properties as translucent materials, such as refractive index and optical density, but shade selection typically varies from tooth to tooth.[14] Dentists often must experiment with the many different products and shades to achieve the envisioned final result.[14] Contrary to popular belief, one shade of pearl does not necessarily correlate with the age of a tooth, as there are varying optical properties among different patients of different ages.[14]

Enamel and Dentin

By looking through the enamel, areas of different color saturation, hue, and value can be seen that are generated by the underlying dentin structure.[14-17] The colors observed in natural dentition directly result from the dentin, since no color is present in the outside enamel.[14] Defects or hypo-plastic spots often can be seen in the enamel matrix, whereas maverick colors of the dento-enamel junction are believed to originate from within the dentin.[14-17]

For example, by looking through the center part of a central incisor, varying degrees of opacity and translucency are visible.[14-17] Where the enamel is slightly thinner, light picks up color more readily from the dentin.[14-17] This directly enables those viewing the teeth to see more translucencies, different chromas and values, and the proximal lobes.[15-17] Because of how the enamel rods are positioned, light reflectance, opacity, and value areas are directly affected by enamel thickness **(Fig 7)**.[14-17]

Dentin

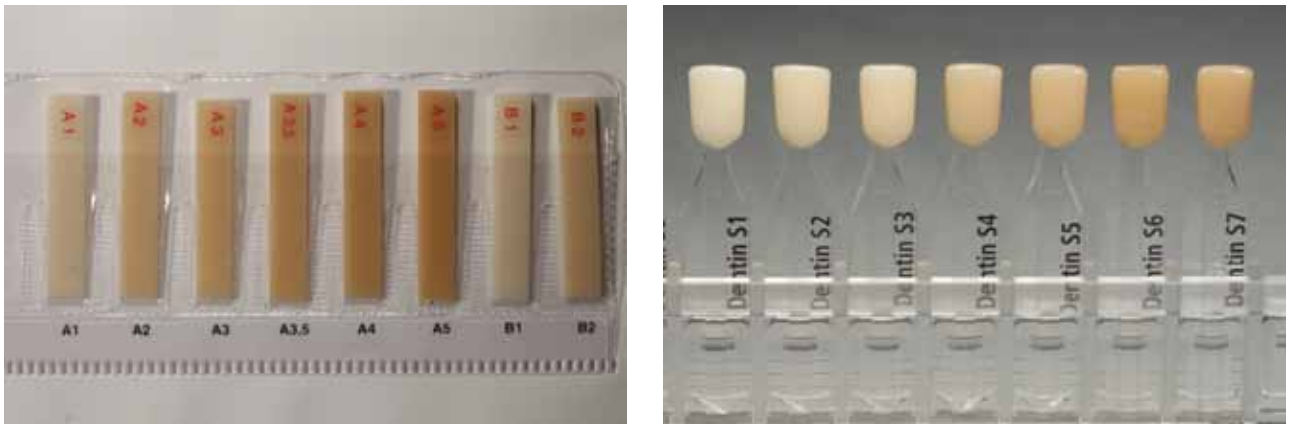
Dentin, both natural and composite, does not exist in amber, gray, or yellow shades.[14-17] Instead, dentin coloring is referred to as yellow/red hue and usually labeled as A1, A2, A3, etc.,[14-17] dependent upon the manufacturer. Many companies also refer to their dentin in terms of saturation (Saturation 0, Saturation 1, etc.).[14-17] The most important thing to remember when working with dentin composites is that all possess a true hue.[15-17] Also, whether they are VITA-based or not, they cannot be achromatic. Dentin composites can only be chromatic, since they bear hue **(Figs 8a & 8b)**.[15-17]

Enamel

Enamels, however, can be either chromatic (VITA-based) or achromatic (non-VITA based) **(Figs 9a & 9b)**.[15-17] Enamel composites offer dentists many options, since they can be value or effect enamels.[15-17] They can be used to impart translucency or to modify the color value.[15-17] It is important to note that achromatic enamel composites are classified as such because they do not have a built-in VITA hue.[15-17]

Color Mapping

By understanding how each of these components of natural dentition influence coloring, dental professionals can create a color map to correlate what is envisioned for the final restoration and the shades of composite necessary to mimic the surrounding dentition.[18] Typically used in the color-mapping stage of the restorative process, the



Figures 8a & 8b: Artificial dentin composites can be VITA-based or non-VITA based but should always generate a yellow-reddish hue of varying chroma.

Figures 9a & 9b: Artificial composite enamels can be chromatic (Vita-based) or achromatic (non-Vita based).

VITA Shade Guide (Vident; Brea, CA) is a tool to help ascertain components of tooth coloring such as hue, chroma, and value.[18] To understand how the guide works, an example would be VITA Classic Shade A2, where A is the color (reddish brown) and 2 is the chroma.[18] However, there is little to no correlation between the tabs and composites with this conventional ceramic shade tab.[18] Dentists must therefore break down the color and its three dimensions and add the fourth dimensions, translucency and opacity, to replicate what A2 actually stands for on the guide.[18]

Two different approaches can be used to undertake such a task when using direct composites.[18] The chromatic enamel approach uses a VITA-based enamel, which gives the restoration a final hue, chroma, and—to some extent—value areas that are missing.[18] The achromatic enamel approach involves the use of a milky-white, semi-translucent layer, which can have varying degrees of translucency, depending on the brand and manufacturer, to modulate the perception of the underlying chroma and value provided by the dentin.[5,6,18]

When interpreting what shade will be needed for a restoration, it is necessary to understand what the hue of the tooth to be restored represents.

Chromatic Approach

Chromatic enamels are best utilized at the thinnest areas of restorations, (e.g., the cervical), where more color and opacity can be seen.[5,6,8] At the middle third, where color appears to come from the tooth surface, VITA-based chromatic enamels should also be used over the dentin composite.[5,6,8] When utilizing the chromatic approach, a minimum of approximately four VITA shades of enamel will be required, including four shades of dentin.[5,6,8] Non-Vita enamels also can be added for achieving effect, adding up to a total of 13 shades to allow for the best esthetic results.

Examples of chromatic materials include Durafill VS (Heraeus Kulzer; South Bend, IN), shades A1, B1, and C1, based on the VITA Shade Guide.[5,6,8] Venus Diamond (Heraeus Kulzer) has chromatic enamels in A and B, while

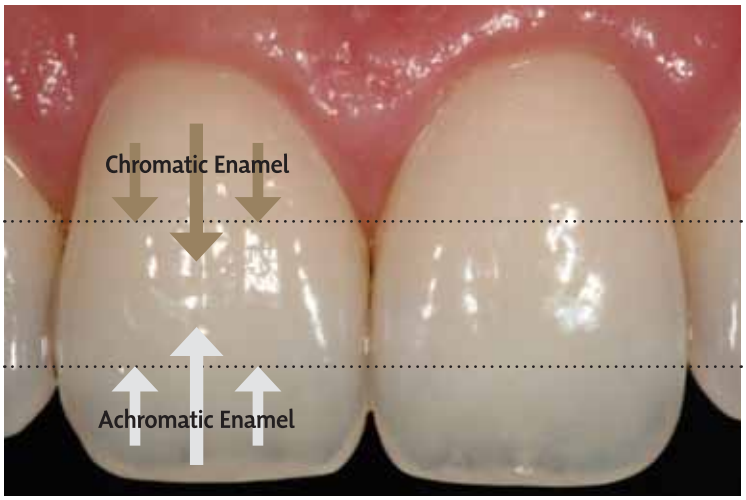


Figure 10: Chromatic and achromatic enamels can be used at specific areas of a tooth to create a gradient of hue, chroma, value, and translucencies.

If the enamel is very translucent and slightly thinner, the underlying dentin will be more prominently displayed.

IPS Empress Direct (Ivoclar Vivadent; Amherst, NY) has chromatic enamel shades A, B, C, and D. Chromatic body enamels generate the hue, chroma, and value (to some extent) of the restoration, while providing color on the outermost surface of the teeth.[5,6,8]

When interpreting what shade will be needed for a restoration, it is necessary to understand what the hue of the tooth to be restored represents. If the tooth is believed to be an A-based color, then the VITA Shade Guide should be used to understand the color, after which the chromatic enamel would be selected according to the shade. Most times, however, the color from the shade guide may not match the composite material selected. To correct this issue, a different technique is required to obtain the final shade.[5,6,8]

First, select an artificial dentin with a higher chroma than the final desired color. This is done because, even in nature, dentin is higher in chroma than outer enamel. Therefore, the dentin composite needs to be one shade higher to better mimic the natural dentition. Then, the outer enamel should be left slightly translucent rather than opaque, so that chroma and effects from the underlying dentin can be seen more clearly. This also allows the enamel to display hue. It is important to note that the opacity and thickness of enamel is crucial in determining how much of the underlying dentin will be seen. Ultimately, the final color of the restoration will be a combination of the underlying dentin composite and the color of the enamel composite.[5,6,8]

Achromatic Approach

Achromatic enamels should be utilized in areas of high translucency, such as the incisal third, where the mammelons can be seen underneath **(Fig 10)**. When there is a greater display of dentin through the natural enamel, achromatic non-VITA based enamels should also be used. When using the achromatic approach, a minimum of four enamel and four dentin shades are required to enable modulation of enamel value and chroma and achieve the required esthetics.[5,6,8,17]

To begin the achromatic approach, evaluate the basic hue of the tooth. Then examine the dentin and how the natural chroma is diluted by the thickness and opacity of the natural overlying enamel. For the achromatic approach, as with the chromatic approach, it is necessary to choose a dentin composite one to two chroma higher than the intended final shade.[5,6,8,17]

Once the dentin composite shade has been selected, non-VITA based achromatic enamels should be chosen to provide higher value areas for the lobes and lower value areas for the center part of the tooth. When the enamel composites are placed over the dentin, the color should be seen coming from within. If the enamel is very translucent and slightly thinner, the underlying dentin will be more prominently displayed. As a result, many of the effects created when layering the dentin also will be clearly seen. However, if the enamel is thicker and very opaque (higher value), the effects will not be seen as clearly.[5,6,8,17]

It is important not to make the dentin too thin near the cervical, as this will make the color insufficiently evident. Therefore, the modulation of enamel thickness and opacity is the deciding factor in determining how much color will be seen.[5,6,8,17]

When selecting a shade of value—and chroma—modifying enamels, only shade guides provided with the composite system that are made of the actual composites should be used, as

Figure 11: Achromatic enamels are used to modulate the chroma and value of the underlying dentin.

Figures 12a & 12b: Customized composite shade tabs are the most effective and predictable way to select the shade because they are true to the actual restorative material's color.

reports demonstrate no correlation of shade pairing between the composite shade and acrylic shade tabs.19-21 For example, when selecting a shade to be used from a suitable composite system (e.g., Vit-l-escence, Ultradent Products; South Jordan, UT), if shade A2 from the shade tabs matches the tooth, then A3 should be used for the dentin (for previously discussed reasons). By using the composite system's shade tabs and not the VITA Shade Guide, the selected enamel will modulate the chroma and value of the underlying dentin as expected, since the guide provides the final shade of the actual composite being used **(Fig 11)**.19-21

Shade Selection

Given the variety of composite systems available, choosing the correct shade for a direct restoration can be difficult.[5,6] Although the VITA Shade Guide is the primary resource for shade selection, research has shown that poor color compatibility of corresponding resin composite shades is notorious.[5,6] Research also has shown that there is no true correlation between the VITA Guide and actual composites, making the selection of the proper shade an even more daunting task.[5,6] Many composite systems have tried to correct this problem by including guides specific to their products, but many are made of acrylic and do not represent the actual characteristics of the cured material. The only way to be sure that a composite shade guide displays the correct color and detail of the material is if the guide is composed of the material itself.[5,6]

For the chromatic and achromatic enamels, dentists must develop their own custom shade guide.[5,6] A fairly simple project, the time used to create this guide will save precious clinical time and patient frustration, as restorations will be completed correctly the first time.[5,6]

To begin, use a VITA Shade Guide and your choice of putty impression material to create an imprint, which should be 2.5 mm at the cervical and 0.5 mm at the incisal third. Then, using the selected dentin and enamel composite material, fill the imprint and place a glass slab over the top. Cure the material and remove the glass slab. After curing, use anything suitable to create handles for the newly developed shade tabs and glue them in place with cyanoacrylate. Print the composite shade brand and

Figures 13a & 13b: A color mock-up is an effective tool for ascertaining the impact that each layer will have individually and collectively and allows for correction before the final restoration.

place it on the tab(s) to complete the custom shade guide **(Figs 12a & 12b)**.

Note that these guides only work for the syringes that they were taken from, since studies show that colors vary from batch to batch of resin composites.[5,6] When a new syringe is ordered, a new guide must be made for the new syringe to ensure perfect shade matching.[5,6] Although this process can be time-consuming, it is much better than redoing an entire restoration because a patient is dissatisfied.

Color Mock-Up

After selecting the correct shade or shades from the custom shade guide, a color mock-up should be completed.[5,6,22] Utilizing a silicone stent or matrix based on the original or final wax-up, create a color mock-up to visualize and rehearse the shading of the final restoration. During this process, the lingual shelf, the dentin, any characteristics (e.g., white spots), chromatic and achromatic enamels should be applied to envision highly esthetic final results.[5,6,22] This tool enables thickness corrections prior to creation of the final restorations and only requires about 15 minutes. Although this may be considered precious clinical time, it will save time during the procedure, which is the ultimate goal of any restorative process **(Figs 13a & 13b)**.

Conclusion

This article, the first of two parts, has introduced an artistic philosophy for performing esthetic direct anterior composite restorations based on principles of emulating the proper form, color, and function of natural dentition. A step-by-step procedural approach to solving day-to-day anterior direct restorative challenges, which include shade selection, color mapping, and composite resin selection has been outlined.

Part 2 of this article, which will address more step-by-step procedures for anterior direct restorative challenges, will appear in the Winter 2011 issue of the Journal.

The only way to be sure that a composite shade guide displays the correct color and detail of the material is if the guide is composed of the material itself.

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Author Disclosure: Dr. Fahl receives honoraria from Ultradent Products.