A simplified aesthetic concept: part one

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A good leader voraciously studies history in an attempt to learn from the past. To fully understand the historical progression of a nation, a people, an industry or a concept, one must look at all of the layers of history. Like a good leader, a good scientist, clinician and manufacturer must also review concepts of the past.

The history of dentistry teaches that each new discovery concerning material science helps the clinician learn from the past scientific and clinical efforts and move forward to the development of future techniques.

Traditionally, the hybrid composite resin was used for its strength and fracture resistance, whereas the microfill was necessary to attain not only an improved polishability, but to maintain the durability of the polish.

However, it was soon discovered that this process of stratification – which used the attributes of both the hybrid and the microfill to create an optimal restoration with enhanced mechanical properties – provided another advantage, a variation in the shades and opacities of colour that created the illusion of three-dimensionality – the polychromatic effect (Kovarik, Ergle, 1993; Rinn, 1990).

By using an anatomic stratification with successive layers of dentine and enamel, a more realistic depth of colour could be achieved (Larson, 1986), as well as surface and optical characteristics that mimic nature (Dietschi, 1995; Donly, Browning, 1992). Therefore, past clinical and scientific efforts and requirements to create a more ideal restorative material for function and anatomical form resulted in the development of colour within a tooth.

Furthermore, advancements in restorative materials continue to enhance the practice of dentistry. Newer formulations of composite resin systems have improved physical, mechanical and optical characteristics, which are directly related to the filler particle size, distribution, orientation and the quantity incorporated.

Prior to the introduction of this small-particle composite resin, it was often necessary to combine hybrid and microfilled composites to achieve proper aesthetics (ie, lustre, colour) and mechanical stability (ie, strength, wear resistance, fracture resistance) in adhesive restorations. Since the development of the small-particle composite resin, it appears that these properties have been incorporated into a single restorative material.

Although polychromatic stratification techniques are still necessary with this revised composite resin formulation, they are used only to attain natural aesthetics and colour rather than physical requisites.

This article describes a simplified concept of utilising a stratification technique of the past with a new biomaterial designed from this concept.

Natural tooth aesthetics

The successful determination and transfer of colour to an aesthetic reproduction of the natural dentition requires an understanding of the interrelationship of optical properties to the anatomical morphology of the tooth.

As light passes through the natural tooth, it is reflected, refracted, absorbed, or transmitted by a multi-layered complex tooth structure that varies according to the optical densities of its hydroxyapatite crystals, enamel rods, and dentinal tubules (Winter, 1993). In natural teeth, differing colours are distributed, and various optical characteristics are observed through the enamel and dentine (Rinn, 1990). This

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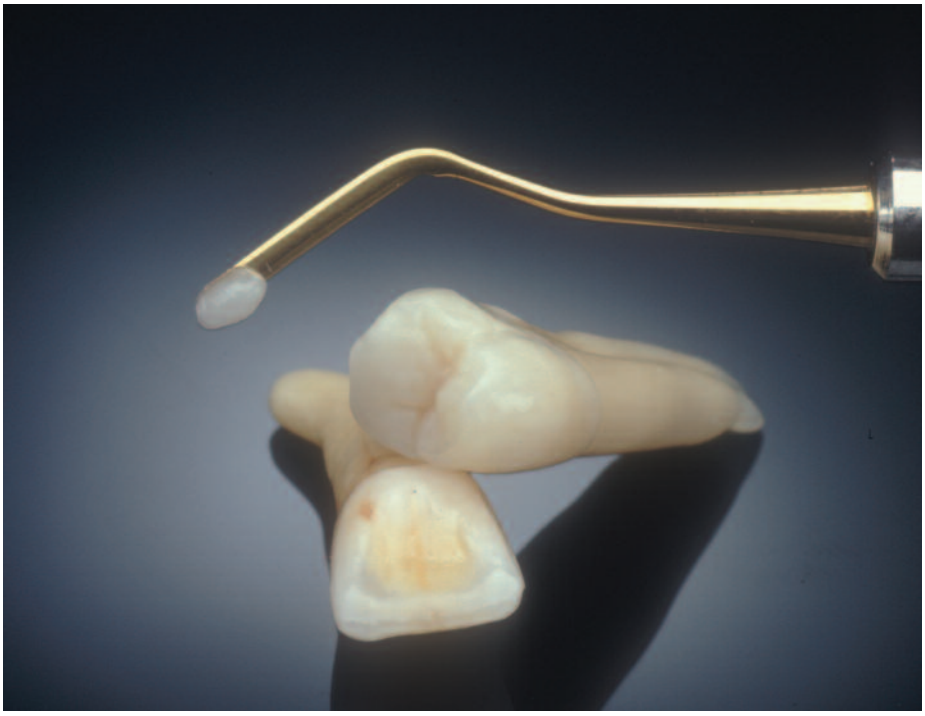

***Figure 1:** Developing natural anatomical morphology with composite resin requires a similar orientation of artificial enamel and dentine. Newer formulations of composite resins possess most of the secondary optical properties that render the tooth polychromatic.*

polychromatic chromatic effect is manifested in different optical characteristics. The relationships between these characteristics and their role in the natural dentition must be properly interpreted so the clinician and technician can fabricate aesthetic restorations (Exner, 1991).

The dentine and enamel have dramatically different optical properties, and the relative contribution of each should be considered separately during shade determination and fabrication of an aesthetic restoration.

To appropriately describe tooth colour and aesthetics, a broader definition has been given to colour that is based upon anatomy, optical properties, and polychromaticity (Terry et al, 2002). This definition is based upon the natural dentition and the relative contribution of dentine and enamel to colour. The primary optical properties are defined as hue, chroma and value. The dentine imparts all the colours of a tooth (ie, determines hue and chroma) while the enamel acts as a fibre-optic structure that conducts light through its rods to capture the underlying colour of the dentine (ie, is a determinant of value) (Fahl, Denehy, Jackson, 1995).

The secondary optical properties include translucency, opacity, opalescence, iridescence, surface gloss and fluorescence. These secondary optical properties contribute significantly to the total aesthetics of the tooth and may be better explained in terms of tooth anatomy.

The degree of translucency or opacity is determined by the structure and the thickness of enamel and dentine as well as the amount of light that penetrates the tooth or restoration. Although both dentine and enamel are translucent in natural dentition, the enamel layer is virtually transparent and colourless. Opalescence is primarily observed in enamel, and in teeth it appears as a light-scattering effect that is associated with the diameter of enamel rods.

Iridescence produces a rainbow effect within the object being viewed. While colours change based upon alterations to viewing direction, location and illumination of an object, the manner in which these parameters change is dependent upon the wavelengths of dispersion, interference, and diffraction of light.

Surface gloss affects the appearance and vitality of teeth and aesthetic dental materials. The surface morphology of natural teeth influences the surface gloss. While macro- or micro-morphologically roughened or coarse surfaces allow diffuse reflection, flat or smooth surfaces allow specular reflection. This optical scattering of light has an effect on the colour perception and translucency of the tooth.

Fluorescence occurs when ultraviolet (UV) light rays are absorbed and blue or white visible light is emitted. Due to

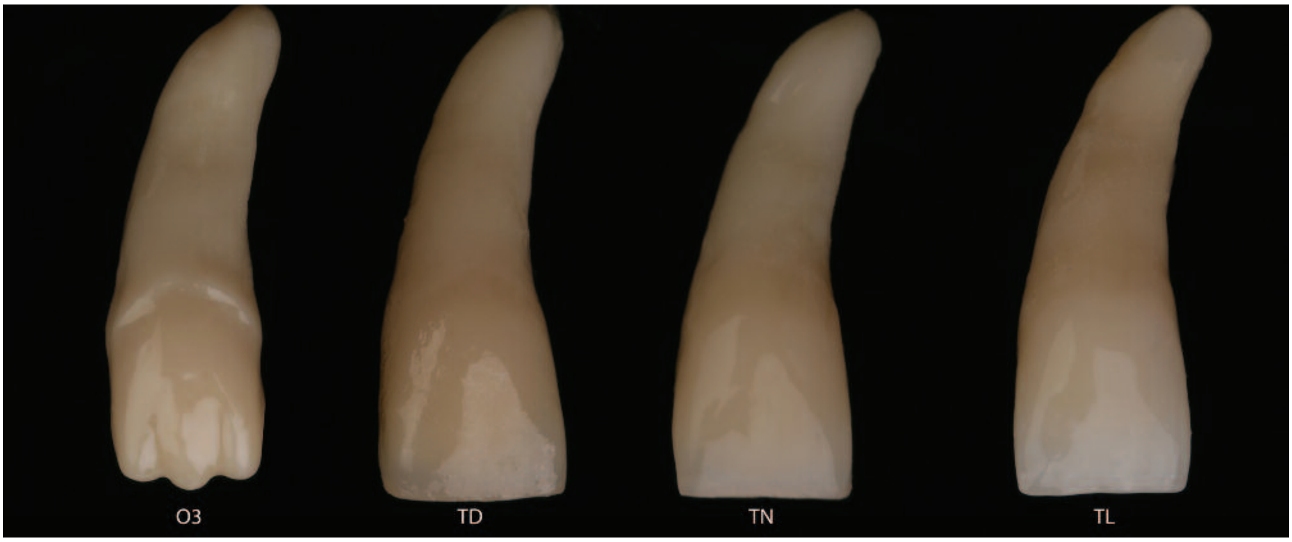

***Figure 2:** An identical 03 opaque dentine shaded composite substrate (Amaris, Voco) is overlayed with three different translucent enamel shaded composites – translucent dark (TD), translucent neutral (TN) and translucent light (TL).*

the organic composition of dentine, UV light rays penetrate the enamel and excite the dentine photosensitivity. The emitted light enhances the brilliance and vitality of teeth. Both dentine and enamel fluoresce, and the combination of these structures enhances the whiteness or value of teeth.

With this expansive interpretation of colour from an understanding of the interrelation of optical properties to tooth morphology, clinical research scientists and manufacturer's can begin to develop restorative systems (ie, composite, porcelain) that are capable of reproducing natural tooth colour within a restoration using simple and predictable methods.

Composite and colour

Since no single monochromatic composite resin can duplicate the complex orientation of the colour evident in the natural dentition, it is necessary to select various colours for the artificial enamel and the artificial dentine layers.

Accordingly, to reconstruct the natural polychromatic effect, the layers cannot be stratified in a uniform layer of equal dimension, such as in plexiglass, which is uniformly distributed in layers, but requires an irregular, undulated placement of variations of composite resin colours. This allows the optical properties of light passing through the natural tooth and the restoration to reflect, refract, absorb, and transmit, according to the optical densities of the hydroxyapatite crystals, enamel rods, dentinal tubules, and restorative material, thus rendering the tooth multi-coloured.

Because composite does not have hydroxyapatite crystals, enamel rods and dentinal tubules, the final composite restoration requires the clinician to develop an illusion of the way light is reflected, refracted, transmitted, and absorbed by these dentine and enamel microstructures when restoring the anatomical surface (Winter, 1993). Recreating a natural anatomical surface requires a similar orientation of enamel and dentine. Newer formulations of composite resins possess most of the optical properties that render the tooth polychromatic (Figure 1).

Dentine shades are available in a variety of shades and translucencies, and enamel shades that are highly translucent, fluorescent, and opalescent have been developed. Utilising these composites, it is now possible for the clinician to fabricate a durable, long lasting restoration that is aesthetically indistinguishable from natural tooth structure.

Exacting shade matching and localised characterisation is entirely possible. However, with some composite systems, the attainment of ultimate aesthetics can take a considerable amount of time and experience.

Most composite systems have standard composite resin shade guides that are manufactured from unfilled methacrylates, and do not accurately represent the true shade, translucency or opacity of the final polymerised restorative material (Baratieri, 1998). Furthermore, the range of shades in these standard shade guides is not consistent with natural tooth colour. In addition, many of the composite resins are synchronised to the Vita Lumin shade guide, which was designed for porcelain systems and not composite resin systems. Unfortunately, many of these composite resin systems do not correspond to the true Vita shades.

These discrepancies are the reason for inconsistent colour matching, which requires a trial and error method through the fabrication of multiple custom shade tabs from the actual restorative material. Also, the use of colour modifiers and opaquing resins can be required to modify and adjust composite colour to attain all the possible natural tooth colours.

A recently developed composite resin system (Amaris, Voco) may provide solutions to these inequities, by offering more accurate shade development. This system was designed from the stratification concepts of the past and a biomaterial fabricated from those concepts. It provides a simplified method of combining dentine colour and enamel value in relationship to the natural tissue anatomy to more evenly distribute and attain natural tooth colour.

This colour management concept was designed with the consideration of varying combinations of enamel and dentine shaded composite instead of using a single monochromatic composite resin colour. The concept that most of the colour (ie, yellow, orange and red) originates from the dentine provided the insight of grouping Vita shades of similar hue and chroma to realistically replicate the optical properties of the natural tooth.

The composite system has six base opaque dentine shades arranged respectively, according to increasing chroma (ie, 01-05 or 0 Bleach-05). There are three enamel translucent shades that provide value (ie, brightness to the restoration) and the aforementioned secondary optical properties (ie, translucency, fluorescence, iridescence and opalescence) (Figure 2). In addition, it provides two additional special shades – a high translucent and opaque shaded flowable composite.

The high translucent shaded composite can be used for incisal edges, enamel or incisal defects and to achieve a high gloss surface reflectivity. The opaque shaded composite can be used for masking discolourations (ie, amalgam staining, improved colour transition for endodontic access openings in ceramic restorations).

This duo shade concept, utilised with these designed shades, allows for an improved and even distribution of the entire tooth colour space.

It provides 18 possible tooth colour combinations while synchronising to the Vita shade guide. Furthermore, this system's shade guides are manufactured from the composite resin material and so they accurately represent the true shade, translucency or opacity of the final polymerised restorative material.

Therefore, the shade matching system provides the best replication of dental composite colour since it is synchronised with the same polymerised restorative material as the composite system that is being matched. This synchronisation process allows the clinician to compare the actual polymerised restorative material of the composite system to the natural tooth colour for a more accurate 'aesthetic colour matching'.

This concept utilised with the Amaris composite resin system not only simplifies the replication of the optical properties of the natural tooth but also provides consistent and predictable results.

Part 2 of this article will describe the process by which anterior and posterior composite resin restorations can be developed in a more efficient period of time using sound scientific principles to achieve ultimate aesthetics using this concept.

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