

23. Title: "ESTHETIC EVALUATION OF ALL CERAMIC RESTORATIONS" *

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Contextualism is the term used by architects to describe a positive design link between construction and site¹.

The ultimate goal of dental esthetics in restorative dentistry should be the reproduction of reality and beauty of natural teeth². This goal is deceived if the operator strives to autonomously create so called "beautiful teeth" and it will often lead to a lost battle if he tries to accurately duplicate and reproduce nature. What lies within the restorative possibilities today is to produce restorations that aim to be in context and harmony with the surrounding environment of the oral cavity.

The factors that contribute to the fabrication of contextualized restorations are related to the three dimensional anatomical characteristics of the restored teeth (line, form, texture) as well as their optical quality. The optical quality is not an independent and static physical property but relative to incident light. Considering that light is being dynamically modified by natural tooth substances as well as restorative materials, it would be more realistic to refer to their optical behaviour.

Color has been considered a major aspect of this behavior and its importance in tooth matching has been extensively discussed in the dental literature. Light modification takes place within the translucent body of natural tooth substances, and for this reason the depth of translucency provided by the restorations becomes an extremely important factor influencing their contextualized presence in the oral cavity.

The aim of this paper is to explore the parameters of the optical behavior of ceramometal restorations and different all ceramic restorative systems, related to the depth of translucency, and comparatively evaluate their esthetic effects on the clinical level in relation to natural teeth.

Depth of translucency in ceramometal restorations

Ceramic materials are completely different in nature from natural tooth substances. Dental porcelain does not possess the prismatic internal structure of hydroxyapatite. Therefore, identical optical behaviour should not be expected. Porcelain consists of a glassy matrix containing crystalline particles with a different refraction index from the matrix. This property generates scattering of the incident light. Thus a dental porcelain, if fired properly is not transparent but translucent and emulates a "prismatic" optical behaviour similar but not identical to natural tooth substances³ (Fig. 2). The main optical problem that limits the depth of translucency of ceramometal restorations is the presence of a metal substructure and the overlaying opacous material that blocks light transmission (Fig. 1a, 3b, 7a).

Scattering and defusion of the incident light within the body of porcelain can minimize the unfavorable effect of specular reflection that takes place on the surface of the opaque and create the illusion of translucency. Thus, ceramometal restorations usually are clinically ac-

ceptable with relatively successful esthetic results. (Fig. 3a). On occasions when light conditions change, the destructive reflectance of the opaque layer might dominate the optical behaviour and this relative success disappears (Fig. 3b). Therefore, the effort in metal ceramics is to assure adequate scattering and defusion in depth, before the incident light strikes the mirror-like opaque surface. Body porcelain thickness is very critical in this perspective. Also, the application of interchangeable areas of high and low translucency in the porcelain build up is also very helpful. (Fig. 4a, b)

Depth of translucency in all ceramic systems

The absence of a metal substructure in all ceramic crowns permits light transmission throughout the entire body of the restoration. At the present time, the fabrication of such restorations can be classified in two basic categories.

The first involves the fabrication of an opacious high strength core on a refractory die supporting a veneer porcelain built up as indicated by different manufacturers*. The main disadvantage of such an approach is that the opacious core should be at least 0.5 mm and therefore opacity is brought close to the surface of the crown (Fig. 1b, 6a, 8b). The advantage however, is that a color-stable base is introduced which blocks out the potential undesirable dark reflection of the underlying tooth and establishes the main hue of the restoration⁴. Moreover, specific characteristics of the internal optical structure can be incorporated within the entire thickness of the porcelain build-up.

The second category involves the fabrication of the entire crown by a castable translucent material such as glass**. The main disadvantage of this category is that the optical behaviour of the restoration is uniform (Fig. 7b) and highly translucent (Fig. 6b). Also the required characterization can be introduced only at the surface with the application of shading porcelain or at the cement layer (Fig. 1c). The increased translucency however, in many occasions generates a chameleon effect which eventually contextualizes the restoration (Fig. 6c).

Incorporating some of the advantages from both categories, Willi Geller improvised a combination technique involving a cast glass core (Dicor) with a porcelain build-up (Vitadur-N)*** on top of it⁵. Not considering the technical aspects, such an approach esthetically has great potential. The depth of translucency can be controlled by the porcelain build-up that lies over the translucent core. Light defusion which takes place within the layers of body and incisal porcelain minimizes the effect of the highly translucent core build-up. Also, specific characteristics of color structure can be incorporated within the body of the por-

* Hi-Ceram, Vita Zahnfabrik, Bad Sackingen, W. Germany
Excelco, Veneer Porcelain, Excelco Int. Co., Santurce, P.R. 00908 USA

** Dicor, Dentsply Inc., 570 West College Ave., POB 872 York, PA 17405-0872 USA.

*** Vitadur N, Vita Zahnfabrik, Bad Sackingen, W. Germany.

celain (Fig. 7c), while the translucent internal core allows light transmission to occur through the entire crown in a similar way that occurs in natural teeth (Fig. 8c). When an opacious layer is needed to block the undesirable color of the background, it can be established at the cement layer with the application of an opacious cement (Fig. 1d).

Per cent transmittance of all ceramic systems

Esthetic evaluation of all ceramic systems was indicatively related by the authors to measurements of per cent light transmittance values. Samples of 15 mm thickness of Hi-Ceram (0,5mm)+ Vitadur-N (1mm), Dicor (0,5mm)+Vitadur-N (1mm) with and without glaze and plain Dicor (1,5mm) with and without a thin layer of shading porcelain were evaluated with a single beam spectrometer* .

Hi-Ceram samples were found to be rather opaque (transmittance 3,0%, opacity 99,5 in a scale of 100). These values were not affected by glaze. Plain Dicor samples presented increased translucency (transmittance 24,5%, opacity 84) that was slightly reduced after shading porcelain was applied (transmittance 18,5%, opacity 88). The translucency of Dicor + Vitadur-N samples was found in between the two others but closer to plain Dicor values (transmittance 14,5%, opacity 91,5).

Comparable clinical esthetic evaluation

In order to project the above figures on the clinical level, esthetic comparisons were also made by the authors intraorally between anterior crowns (incisors) and comparable natural teeth. The parameters that were taken into consideration were the depth of translucency provided by the restorations, as well as their masking ability of undesirable reflectance from the underlying tooth structure.

Ceramometal vs. All-ceramic (high strength ceramic core) (Fig. 5a, b, c).

All restorations were able to adequately mask the dark reflection of the underlying tooth. All ceramic crowns were preferred because they presented increased depth of translucency in the cervical area.

All ceramic (high strength core) vs. Castable Glass-ceramic (Dicor) (Fig. 6a, b, c)

All restorations failed to emulate the depth of translucency of natural teeth. All ceramic crowns with high strength core were less translucent (Fig. 6a), while Dicor crowns were too translucent and the underlying darkness was not totally masked (Fig. 6b). Dicor crowns cemented with opacious cement, were preferred (Fig. 6c).

* American Optical, Buffalo N.Y., 14215 USA

Castable Glass-ceramic (Dicor) vs. Porcelain fused to Glass-ceramic core (Willi's Glas) (Fig. 7a, b, c)

Dicor crown presented a rather monochromatic appearance which was not able to emulate the internal optical structure of the natural tooth especially in the incisal one third (Fig. 7b). The porcelain build up in the Willi's Glas crown was able to incorporate interchangeable areas of increased and decreased translucency which were esthetically needed in this area (Fig. 7c). Both restorations provided an acceptable amount of depth of translucency cervically.

All ceramic (high strength core) vs. Porcelain fused to glass ceramic core (Willi's Glas) (Fig. 8a, b, c)

The all ceramic crown on the endodontically treated tooth that was restored with a cast post and core was able to mask the undesirable underlying darkness. The appearance of the crown cervically was comparable to the one placed over a vital tooth. Nevertheless, both restorations did not produce the depth of translucency that the adjacent natural teeth presented in this area (Fig. 8b). The Willi's Glas crown on the vital tooth presented the appropriate depth of translucency. On the discolored tooth however, this crown was not able to mask totally the undesirable darkness before cementation (Fig. 8c). After cementation, the application of an opacious cement layer was able to provide adequate masking combined with the preservation of adequate depth of translucency as well (Fig. 8d).

Summary and Conclusions

The depth of translucency provided by anterior restorations is a critical factor influencing their contextualized presence in the oral cavity. The absence of a metal substructure in all ceramic crowns introduces an improved esthetic potential in this perspective. Nevertheless, the various methods of fabricating all ceramic restorations present various advantages and disadvantages concerning the provided depth of translucency as well as their ability of masking undesirable darkness reflected by the underlying tooth.

Clinical observations led to the assumption that esthetically the state of the art in all ceramic restorations is presented by porcelain fused to a castable glass ceramic core (Willi's Glas crown). It produces an adequate and controlled depth of translucency and provides adequate masking of the underlying tooth when cemented with an opacious cement (if required). Moreover, the internal optical structure of natural teeth can be adequately reproduced by incorporating interchangeable areas of high and low translucency within the porcelain build up.

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Fig. 1.

- Diagramatic cross section of cemented crowns fabricated by different restorative materials.
- a. Ceramometal crown. The metal substructure is covered by a highly reflective opaque layer. The translucent body and incisal porcelain reduces the undesirable reflectance.
 - b. Porcelain fused to a ceramic high strength core. An opacious core is also highly reflective. It allows however, for some light transmission.
 - c. Castable glass. The undesirable effect of increased translucency is reduced either at the surface or at the cement area.
 - d. Porcelain fused to a glass core. Light defusion that is provided by the layers of body and incisal porcelain minimizes the effect of the highly translucent core, while increased depth of translucency is preserved. An opacious layer, if required, is provided at the cement layer.

Fig. 2.

The ceramometal restoration on the patient's right, emulates adequately the optical behaviour of the adjacent natural tooth.

Fig. 3.

- a. The ceramometal restoration on the left lateral presents an acceptable esthetic result.
- b. The undesirable reflectance of the opaque layer dominates over the optical behaviour when light conditions change.

Fig. 4.

- a. Ceramometal restorations on both central incisors and right lateral
- b. Transilluminating the restorations, interchangeable areas of high and low translucency are revealed.

Fig. 5.

Ceramometal vs. All ceramic (high strength ceramic core).

- a. Cast post on core built-ups require adequate masking.
- b. All restorations provide adequate masking of the dark background. The ceramometal crowns on the right incisors present reduced depth of translucency than the all ceramic crowns on the left (Exelco Veneer Porcelain, Exelco Int. Co.).
- c. All ceramic crowns are preferred and cemented.

Fig. 6.

All ceramic (high strength core) vs. Castable glass ceramic

- a. High strength core crowns (Exelco Veneer Porcelain) on the left central and lateral incisors do not present the depth of translucency of the natural teeth in the cervical third.
- b. Castable glass ceramic crowns (Dicor, Dentsplay, York Div.) are too translucent before cementation.
- c. Glass ceramic crowns cemented with an opacious cement are preferred.

Fig. 7.

Castable glass ceramic vs. Porcelain fused to a glass-ceramic core (Willi's Glas)

- a. The ceramo-metal crown on the left central is not translucent enough cervically.
- b. The glass ceramic crown (Dicor,) is too monochromatic and fails to emulate the internal optical structure of the natural tooth especially in the incisal third.
- c. Willi's Glas crown (Dicor + Vitadur-N, Vita Zahnfabrik, Bad Sackingen, W.Germany) is preferred because it presented adequate depth of translucency cervically, combined with interchangeable areas of high and low translucency in the incisal third that were required by the natural tooth.

Fig. 8.

All ceramic (high strength core) vs. Porcelain fused to glass ceramic core (Willi's Glas)

- a. Preoperative view - Note the dark color of the left central incisor
- b. The all ceramic crown which involves a high strength opacious ceramic core (Hi Ceram + Vitadur-N, Vita Zahnfabrik, Bad Sackingen, W.Germany) on the discolored central incisor is able to mask the underlying darkness. In both central and lateral left incisors, increased opacity is observed in the cervical third.
- c. The Willi's Glas crown on the lateral incisor (vital tooth) presents adequate depth of translucency cervically comparable to the natural tooth. The increased translucency provided by the Willi's Glas crown on the discolored central incisor is followed by the undesirable darkness, that is reflected from within.
- d. After cementation with an opacious cement, adequate masking is provided, combined with acceptable depth of translucency.