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The effect of ceramic thickness and number of firings on the color of two all-ceramic systems measured by two types of spectrophotometers

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Introduction

Since the introduction of Aluminum oxide reinforced feldspathic porcelain in 1965 **(McLean et al.,1965)**, new materials and manufacturing technology for all-ceramic restorations with significantly improved mechanical and physical properties are available, **(Kelly et al. ,1996)**.

At present, there are five methods for fabricating all-ceramic crowns: Condensation and sintering, Cast and creaming, Pressing, Slip casting technique and CAD/CAM milling of ceramic ingots **(Deany, 1996; Anusavice, 2003).**

In addition to the development of advanced dental material technologies, the increased demand for esthetic restorations has resulted in the use of all-ceramic restorations in several applications.

Yttria-stabilized tetragonal zirconia polycrystal (Y-TZP zirconia) is preferred in dentistry because of its superior mechanical properties. It is currently used as a core material in all-ceramic dental restorations, **(Meyenberg et al., 1995; Derand et al., 2005**). Compared to other dental ceramics, its superior mechanical properties, such as higher strength and fracture toughness, **(Cristel et al., 1980; Meyenberg et al., 1995; Luthardt et al., 1999)** are due to the transformation toughening mechanism, similar to that observed in quenched steel.

Dentin is the primary source of teeth color; the thickness and translucency of overlying enamel modify the final color. Natural teeth color is a result of reflected light from the enamel surface, in addition to the effect of light scattering within enamel and dentin before it is finally reflected back **(Seghi et al. ,1986)**.

Clinically, there is an important point that ceramic restorations should reproduce the translucency and color of the natural teeth. Many factors affecting the match, such as fluorescence, translucency, surface texture, opalescence and shape **(Judd et al., 1975; Heffernan et al., 2002).**

Most all ceramic systems require the application of two layers of ceramic material, such as a core (strong ceramic) and a veneering porcelain (weak ceramic)

(Isgro et al., 2003) with different shade, opacity, and thickness, to provide a natural appearance **(Mclean, 1995; Dozic, 2003)**.

All ceramic restorations without a metal core allow more light transfer within the restoration, this happened by improving the color and translucency of the restoration; however, a perfect esthetic tooth-colored restoration cannot be ensured **(Wee et al., 2002)**.

The amount of light that is transmitted, reflected, and absorbed depends on, the size of the particles compared to the incident light wavelength and the quantity of crystals within the core matrix, their chemical nature **(Heffernan et al., 2002a)**.

The translucency of the Core was also considered as a primary factor in controlling esthetics and a critical consideration in the selection of the materials **(Kelly, Nishimura et al., 1996).** However, if crystalline content increased to achieve greater strength, that will result in greater opacity **(Nishimura et al., 1996).**

Instrumental measurements can quantify color shade and allow communication to be more uniform and precise. Development of advanced computerized colorimeters and spectrophotometers has increased their use in dental applications (**Johnston et al., 1989).**

Van der Burgt et al. in **1990** stated: "The results of a colorimetric device can be altered because the standardized illuminating light emitted from the device can be scattered, absorbed, transmitted, reflected, and even displaced in a sideways direction as a result of the translucent optical properties of teeth and dental ceramics".

Seghi et al in **1989**concluded that "Data collected by a colorimeter can be significantly affected by ceramics translucency ". **Haywood et al** in **1994** indicates that "Colorimeters work on flat surfaces, rather than the curved, translucent surfaces found on teeth".

Spectrophotometers measure the absorption or transmittance or reflectance factors of an object for one wavelength at one time. They have been used to measure the spectral curves of porcelains and extracted teeth **(Barath et al., 2003)**.

Visual color assessments are the result of psychological and physiological reflexes and responses to radiant-energy stimulation (**Johnston et al., 1989)**. Alterations in perception are possible from numerous uncontrolled factors. The use of colorimetric measurements provides interpretation of subjective evaluations related to perception of color as physical values **(Johnston et al., 1989).**

Many factors affect the ability of a ceramic system to produce good match with corresponding shade guides, such as condensation techniques **(O'Brien et al., 1991)**, firing temperatures **(Hammad et al., 1991)** and dentin thickness **(Douglas et al., 1999)**.

The effects of dentin thickness on the color of metal-ceramics were studied, and the researchers reported that a clinically acceptable shade match was influenced by this parameter **(Jacobs et al., 1987)**.

Studies examining color changes of surface colorants after firing have demonstrated pigment breakdown at firing temperatures **(Lund et al., 1992)**.

Hue, Chroma and Value color parameters of metal-ceramic specimens, which were fired **1.68°C** and **21°C** above the manufacturer's instructions firing temperature, indicated substantial differences in color **(Jorgenson et al., 1979)**.

Aim of the study

Evaluate the effects of various dentin ceramic thicknesses and repeated firings on the color of lithium disilicate glass-ceramic (IPS e.max Press) and zirconium-oxide (ZirCAD) all-ceramic systems in comparison with porcelain fused to metal system, measured by two types of spectrophotometers.