Review Article

HOW DIFFERENT INFLUENTIAL FACTORS AFFECT THE COLOR AND TRANSLUCENCY OF Y-ZTP: A REVIEW OF THE LITERATURE

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Abstract

Aim: Color change assessment is a complex and psycho-physiological process which is affected by many variables. The dentin tissue which shows variable translucencies and has various thicknesses is considered to be the main source of tooth color. The aim of this study was to evaluate the effect of several influential factors on the color and translucency of Y-ZTP.

Method: Electronic search in PubMed, science direct, google scholar, up-to-date, Wiley online library, between 2006 and 2018.

Result: The thickness and the combination of ceramic layers, such as the core, veneer, and other specialty ceramic materials, have been shown to control the appearance of all-ceramic materials. All-ceramic restorations may need multiple heat treatments, which are required for the condensation process of veneering porcelain and color or contour modification.

Conclusions: Number of firings and ceramic thickness have definitive effect on the final color .It is necessary and important to fabricated veneer with such quality that restoration's satisfactory aesthetic effect is obtained.

Key words: *Translucency, Y-ZTP, Zirconia, Thickness, Number of fringes, Veneering.*

Introduction

Periodontitis Zirconia-based prostheses have attracted extensive attention in prosthetic dentistry for their superior strength, toughness and reliability, as compared with those made from conventional ceramic materials.[1] The use of zirconium-oxide all-ceramic material provides several advantages, including a high flexural strength (>1000 MPa) and desirable optical properties, such as shade adaptation to the basic shades and a reduction in the layer thickness (compared to conventional ceramics) of the veneer ceramic required to achieve the desired color.[2] There is disagreement in the literature with respect to the limitation of the human eye to appreciate differences in color, considering that this limitation differs from individual to individual. Visual color assessments are the result of physiological and psychological responses to radiant-energy stimulation. Alterations in perception are possible as a result of numerous uncontrolled factors.[3] Color matching between a restoration and natural teeth is a common clinical problem. The final color of ceramic restoration is affected by thickness of core, type of resin cement and translucency of core. Ceramic restorations provide excellent esthetics in the restoration of missing tooth structure. All ceramic restorations have been advocated for superior esthetics, and various materials have been used to improve ceramic core strength, but there is lack of information about color being affected by different core substrates and fabrication procedures.[4] The optical appearance of an object is determined by transmittance, reflection and absorbance of incident light. The translucency of the material allows partial light transmittance with irradiance. Attention should be paid to the parameters of structural disorder in determining the color of tooth and color scale and to evaluate the translucencies of framework ceramics.[5]

Color change assessment is a complex and psycho-physiological process which depends on many variables. The dentin tissue which shows variable translucencies and has various thicknesses is considered to be the main source of tooth color. The perceived tooth color is a result of returning light reflected from the enamel surface into the enamel and dentin.[6] Color of the ceramic restorations is affected by various factors such as brand, thickness of the layered ceramic, condensation techniques, smoothness of surface, number of firings, and firing temperature and thickness of dentin.[7-12]

Materials and Methods

PubMed, google scholar, up-to-date and Wiley online library was reviewed up to May 2018. The terms "zirconia", "(Y-TZP)", "Veneering Techniques", "Color", "translucent", "thickness", "number of firings", were used. Out of 126 articles found, 13 articles were selected. [Table1]

The literature search covered all years and focused on publications that contained dental data regarding in vitro studies, case reports, clinical studies and reviews. The publications that did not use zirconia as a superstructure were excluded. Full-text of the articles were obtained from different sources and the abstracts in English were used.

Result

Veneer thickness

The thickness and combination of ceramic layers, such as the core, veneer, and other specialty ceramic materials, have been shown to control the appearance of all-ceramic restorations. Ceramic systems in the present study exhibited visual color changes during firing and demonstrated that changes in the thickness and repeated firings of ceramic have an effect on the final shade.[13]

The translucency of dental ceramics was significantly influenced by both material and thickness. The translucency of all materials increased exponentially as the thickness decreased. All of the zirconia ceramics evaluated in the

Wang *et al* study showed some degree of translucency, which was less sensitive to thickness compared to that of the glass ceramic.[14]

Yilmaz *et al*, used porcelain discs of shade A1 at nominal thicknesses of 0.5 and 1.0 mm which were bonded to cement of three shades in a factorial design. Colors were calculated for CIE D65 Illuminant and Standard Human Observer on black, grey and white backings. A color difference (CD) was calculated for each possible pair of different porcelain thickness values for the same cement shade and each possible pair of different cement shades for the same porcelain thickness. Relative translucency parameter (RTP) was analyzed by ANOVA and selected pairwise comparisons. Their results showed that changes in porcelain thickness or cement shade may adversely affect basic aesthetic properties of these materials. Development of new methods of analyzing of aesthetic effects over greater ranges of thickness for these materials would improve the prognosis of the use of these materials.[15]

Most ceramic systems consist of a ceramic core with a thickness of 0.5 to 1.0 mm and approximately 1.0 to 1.5 mm of space available for veneering ceramic.[16] In the Bachhav VC *et al* study the specimens had ceramic thicknesses of 0.5, 1, or 1.5 mm, with a core thickness of 1 mm L* values, which reflected that brightness of specimens decreased for both systems as the total thickness of specimens increased. Mean color differences caused by various dentin thicknesses and repeated firings were low. The results of this study suggested that dentin ceramic thickness and the number of firings of all tested ceramic systems significantly affect the final color of all ceramic restorations. These are important factors for the definitive color of the restoration, and should be considered during shade selection and fabrication. The number of firings and dentin ceramic thickness have a definite effect on the final color of all tested ceramic system and these factors should be considered during shade selection and fabrication of the restoration.[16] Barizon *et al*, described the influence of core material thickness on its translucency and the influence of core plus ceramic veneer thickness on the overall translucency of specimens.[17]

Chaiyabutr *et al* demonstrated that underlying tooth abutment color, cement color, and ceramic thickness, all influence the resulting optical color of CAD/CAM glass-ceramic lithium disilicate-reinforced restorations.[18]

Number of firings

The number of porcelain firings, and the condensation technique may also affect the final shade of the porcelain. The stain color changes after firing have been studied, and clinically significant color changes have been reported due to pigment breakdown at porcelain firing temperatures.[19]

The number of firings and dentin ceramic thickness have a definite effect on the final color of all tested ceramic systems. The mean ΔE value increased as the dentin ceramic thickness increased for zirconium-oxide based all ceramic specimens tested. However, the mean ΔE values were less than 3.7ΔE units which is rated as a match in oral environment.[16]

Multiple firings could be effective for improving the densification and the hardness of veneering ceramics for zirconia restorations. By 10 firings, the density and hardness of the veneering ceramics used with zirconia frameworks were raised, and porosity was reduced. However, no significant changes occurred in flexural strength, fracture toughness or microstructure.[20] A study performed by Bachhav *et al*, showed that the number of firings and dentin ceramic thickness have a definite effect on the final color of all ceramic system tested and these factors should be considered during shade selection and fabrication of the restoration.[16]

All-ceramic restorations may need multiple heat treatments, which are required for the condensation process of veneering porcelain and color or contour modification. The results of Zeighami *et al* study clearly showed that an increase in firing cycles from 4 to 8 cycles decreased the micro-tensile bond strength (MTBS), and all three groups have statistically significant differences in MTBS. The effect of multiple firings on the reduction of veneering ceramic fracture strength in metal-ceramic systems has been previously shown, by Zeighami *et al*.[21]

Sahin *et al* study, evaluated the effects of 2 different veneering porcelain shades (A1, A3) and number of firings (3, 5, 7, or 9) on the color of an alumina-based ceramic system. They showed L*a*b* values of the ceramic systems were affected by the number of firings (3, 5, 7, or 9 firings) and veneering porcelain shade (A1 or A3). A1 shade specimens maintained their L* value independent of the number of firings, whereas A3 shade specimens became lighter after an increased number of firings. For both A1 and A3 veneering porcelain shades, the a* value decreased after repeated firings, which resulted in less reddish specimens (p=0.001), and the b* value decreased after repeated firings, which resulted in less yellowish specimens (p=0.001). The mean color differences caused by repeated firings were imperceptible (ΔE<1.6) and represent clinically acceptable color changes (ΔE<3.7).[22] Salary *et al*, showed that it seemed firing time affected the color of vita ceramic system; where, more firing time increased discoloration of zirconia based porcelain in vita system.[23]

Veneering Techniques

The ultimate translucency of the core-veneer system is important for optimal esthetics. The translucency of ceramic can be affected by many factors, including thickness, crystal microstructure (crystal volume and the refractive index, particle size), and the number of firing cycles. An all-ceramic restoration is a multi-layered porcelain structure composed of a core and veneer. In the Luo at el study, transmittance significantly decreased after veneering, regardless of the veneering technique. Possible reasons for this decrease include increased specimen thickness, structure of the veneering material (varied crystalline contents and higher porosity volume), and

reflectance at the interface between the core and the veneering material. Pigments such as metal oxides are added to porcelain to enrich the color of ceramic materials, so clinically esthetic requests could be satisfied. Y-TZP core material is composed of densely sintered zirconium oxide crystal (87% to 95%) and yttrium oxide (4% to 6%) as stabilizer, containing few pigments. It is quite necessary and important to fabricate veneers for satisfactory esthetic effect of restorations. A variety of pigments are present in the ingots for heat-pressing and dentin veneering porcelain for layering. Result showed, Y-TZP all-ceramic restorations veneered by the fully anatomical technique were the most transparent, and brightest and restorations veneered by the cutback technique were the least translucent and darkest.[24]

Oh SH *et al*, demonstrated that there were significant influence of the ceramic thickness, abutment shade and type of coping on the resulting color of three different zirconia restorations (Lava, Cercon, and Zirkonzahn). Evaluations of the ΔE values of zirconia specimens (A2 shade) in different shades of abutments led to the following clinical implication.[25] Lava crowns, when placed on a gold alloy post, may not be shade-matched with an adjacent tooth.

Conclusions

1) The number of firings and dentin ceramic thickness have a definite effect on the final color.
2) Number of firings has noticeable effect on restorations' color.
3) It is necessary and important to fabricated veneer with such quality that restoration's satisfactory aesthetic effect is obtained.

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Veneer Thickness	*Ozturk O, Uludag B (2008)*	The effect of ceramic thickness and number of firings on the color of two all-ceramic systems
	Wang F, (2013)	Translucency of dental ceramics with different thicknesses
	Kürklü D, (2013)	Porcelain thickness and cement shade effects on the colour and translucency of porcelain veneering materials
	Bachhav VC, (2011)	The effect of ceramic thickness and number of firings on the color of a zirconium oxide based all ceramic system fabricated using CAD/CAM technology
	Barizon KT, (2014)	Ceramic materials for porcelain veneers: part II. Effect of material, shade, and thickness on translucency
	Chaiyabutr Y, (2011)	Effect of abutment tooth color, cement color, and ceramic thickness on the resulting optical color of a CAD/CAM glass-ceramic lithium disilicate-reinforced crown
Number of firings	*Uludag B, (2007)*	The effect of ceramic thickness and number of firings on the color of ceramic systems: an in vitro study
	Tang X, (2012)	Effects of multiple firings on the mechanical properties and microstructure of veneering ceramics for zirconia frameworks.
	Zeighami S, (2013)	The Effect of Multiple Firings on Microtensile Bond Strength of Core-Veneer Zirconia-Based All-Ceramic Restorations.
	Sahin V, (2010)	The effect of repeated firings on the color of an alumina ceramic system with two different veneering porcelain shades.
	Salary MH, (2015)	The effect of repeated firing of Zirconia based porcelain on the color coordinates in vita system.
Veneering Techniques	*Luo XP, (2010)*	Effect of Veneering Techniques on Color and Translucency of Y-TZP
	Oh S-H, (2015)	Effect of abutment shade, ceramic thickness, and coping type on the final shade of zirconia all-ceramic restorations: in vitro study of color masking ability

Table 1: Selected Articles.