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Effect of resin shades on opacity of ceramic veneers and polymerization efficiency through ceramics

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ABSTRACT

Objectives: The aim of this study was to assess the effect of different resin cement shades on the opacity and color difference of ceramics and to determine the polymerization efficiency of the resin cement at different shades after curing through ceramics.

Methods: Two different ceramics (IPS e.max Press and IPS Empress® CAD, Ivoclar Vivadent) were used for this study. A light-cured veneer luting resin (Variolink Veneer, Ivoclar Vivadent) in four different shades of HV+1, HV+3, LV−1, and LV−3 was used for the colorimetric measurements. The color and spectral reflectance of the ceramics were measured according to the CIELab color scale relative to the standard illuminant D65 on a reflection spectrophotometer (ColorEye7000A, USA). Color differences (ΔE values) and the contrast ratios (CR) of the different groups of samples were calculated. In order to analyse the polymerization efficiency of the resin cements, the micromechanical properties of the resins were measured with an automatic microhardness indenter (Fisherscope H100C, Germany). The results were analysed using one-way ANOVA and Tukey's HSD post hoc tests (SPSS 18.0).

Results: The one-way ANOVA test showed that the values of ΔE and CR of the different specimen groups were significantly different ($p < 0.05$). Group 1 (20.7 ± 0.5) (IPS-CAD without resin cement) exhibited the highest and group 10 (14.8 ± 0.5) (e.max:HV+3) exhibited the lowest ΔE value. Significant differences in the micromechanical properties were identified among the tested resin cements in different shades ($p < 0.05$).

Conclusions: Resin cement shade is an important factor for the opacity of a restoration. Furthermore, the resin shade affects the micromechanical properties of the underlying resin cement.

1. Introduction

Since patient demand for aesthetics can be traced back to the earliest times, dentistry has long been part of the quest to enhance the aesthetics of teeth.[1] With the development of new materials, practitioners can develop new artistic skills with conservative techniques. Porcelain laminate veneers are one of the most preferred alternatives when restoring anterior teeth because they offer

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an optimum aesthetic dimension to the restoration of anterior teeth.[2,3]

Porcelain laminate veneers have several advantages such as good bond strength, high inherent strength, resistance to fluid absorption, and superior aesthetics.[4,5] Failures in porcelain laminate veneers include adhesive, mechanical, biological, and aesthetic deficiency such as color mismatch or color change.[6]

Clinically, a successful color match is essential for any ceramic restoration.[7] The final color matching of a ceramic restoration with that of adjacent natural dentition remains problematic.[8,9] Difficulties in shade matching of ceramic restorations luted with resin cements seem to persist since translucent ceramics, such as leucite-reinforced ceramics, can be affected by the different shades of the luting resins. The final appearance of a ceramic restoration may also be influenced by the color, opacity, thickness, and shade of the underlying luting agent.[7,10,11]

Color and its parameters such as hue, value, and chroma; translucency and opacity; light transmission and scattering; and metamerism and fluorescence influence the aesthetic result of a ceramic restoration.[12] Opacity of the ceramic is considered to be one of the most important factors responsible for failures in matching restorative material shades with natural teeth.[13–16] Furthermore, the contrast ratio, which describes opacity, is reported to depend upon the thickness of the material and the reflectance of the backing.[17,18]

Factors affecting ceramic opacity are numerous, including ceramic thickness,[19] crystalline structure,[20] number of ceramic firings, repeated ceramic staining cycles,[21,22] grain size, pigments, porosity, and number, size, and distribution of defects.[23]

Besides all these properties, the success of ceramic restorations depends on a strong, durable bond between the luting resin and enamel and dentine.[23,24] The strength of these bonds is directly proportional to an adequate resin polymerization. Proper polymerization is crucial for achieving optimal physical properties and satisfactory clinical performance of resinous materials.[25]

Inadequate luting resin polymerization beneath the ceramic restorations is related to an insufficient amount of light radiation to activate monomers.[26] The light intensity may be decreased at different extent as a function of restoration thickness and shade. For this reason, ceramic material characteristics may determine the amount of light transmitted, and consequently, the degree of conversion of the luting resins.[27]

Therefore, the aims of this study were (1) to evaluate the influence of different light-cured luting resin shades on the opacity and color difference of a lithium disilicate and a leucite-reinforced glass-ceramic, which are used for the fabrication of porcelain laminate veneers and (2) to assess the performance of the different shades of a light-cured veneer luting resin beneath the two different ceramics, by measuring the micromechanical properties in terms of Vickers hardness (HV), modulus of elasticity (E), creep (C), and elastic–plastic deformation (W_e/W_{tot}).

2. Materials and methods

2.1. *Fabrication of the specimens*

Two different glass-ceramics were selected for this study: a lithium disilicate (IPS e.max Press; Ivoclar Vivadent, Schaan, Liechtenstein) and a leucite-reinforced glass-ceramic (IPS Empress® CAD; Ivoclar Vivadent, Schaan, Liechtenstein). VITA shade A_1 of low translucency was selected for both of the ceramics. The descriptions of the ceramics and the resin cement used in this study are summarized in Table 1.

Concerning the IPS e.max Press ceramic, wax patterns with a thickness of 1 mm and diameter of 10 mm were prepared, invested in StarVest®-SOFT-3 investment compound (Weber Dental, Stuttgart, Germany), and burned out in a furnace (Type CL-V2; Heraeus Kulzer, Hanau, Germany) at different temperatures of 800 °C for 60 min, 600 °C for 30 min, and 850 °C for 60 min. The investment and an ingot of IPS e.max Press were then transferred to the press furnace (EP 500; IPS Empress, Ivoclar Vivadent, Schaan, Liechtenstein) and automatically pressed according to the processing program 16 (930 °C, 60 min). Discs of identical thickness were prepared from the IPS Empress® CAD ceramic bloc by cutting with a low-speed saw (Isomet® Low Speed Saw, Buehler®, Illinois, USA).

Forty discs with a thickness of 1 mm were prepared using each of the two glass-ceramics. All ceramic discs were then grinded with silicon carbide abrasive papers of grit 400, 600, and 1200 (Leco® VP 100, Leco Instrumente GmbH, Germany).

A light-cured veneer luting resin (Variolink Veneer, Ivoclar Vivadent, Schaan, Liechtenstein) at four different shades of HV+1, HV+3, LV−1, and LV−3 was selected for this study. The manufacturer suggests a curing time of 10–30 s in each direction for the use of Variolink Veneer luting resin when luting the restorations to the teeth with anatomical contours.[28] However, the measurements were made from the top

Table 1 – Materials used in this study.

Brand Name	Manufacturer	Composition	Type of the material	LOT number
IPS Empress®CAD	Ivoclar Vivadent, Schaan, Liechtenstein	SiO_2, Al_2O_3, K_2O, Na_2O, other oxides, pigments	Leucite reinforced glass-ceramic	M02654
IPS e.max Press	Ivoclar Vivadent, Schaan, Liechtenstein	SiO_2, Li_2O, K_2O, P_2O_5 ZrO_2, ZnO, other oxides, color oxides	Lithium disilicate glass-ceramic	M13076
Variolink Veneer	Ivoclar Vivadent, Schaan, Liechtenstein	Dimethacrylates, inorganic fillers, ytterbium trifluoride, catalysts and stabilizers, pigments	Light-cured resin cement	M13040

According to manufacturers' information.