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Porcelain thickness and cement shade effects on the colour and translucency of porcelain veneering materials[☆]

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ARTICLE INFO

Article history:
Received 8 July 2013
Received in revised form
20 August 2013
Accepted 22 August 2013

Keywords:
Porcelain veneering materials
Colour
Translucency
Porcelain thickness
Dental cement shades

ABSTRACT

Objective: Purposes of this *in vitro* study include evaluating colour changes in combinations of feldspathic porcelain and cement resulting from different thicknesses of porcelain and different shades of composite luting agent, and evaluating relative translucency parameter (RTP) values.

Materials and methods: Porcelain discs of shade A1 at nominal thicknesses of 0.5 and 1.0 mm were bonded to cements of three shades in a factorial design. Colours were calculated for CIE D65 Illuminant and Standard Human Observer on black, grey and white backings. A colour difference (CD) was calculated of 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. RTP was analyzed by ANOVA and selected pairwise comparisons.

Results: All mean CDs studied were perceptible and most were at or greater than the clinical acceptability threshold, with the notable exception that the mean CDs and their confidence limits were below the clinical acceptability threshold for a change in porcelain thickness when utilizing the Clear cement shade. Variation in the shade of the resin luting cement will result in CDs which are near or beyond clinical acceptability. A decrease in porcelain thickness did significantly increase RTP when bonded to the resin cement shades studied.

Conclusion: Changes in porcelain thickness or cement shade may adversely affect basic aesthetic properties of these materials. Development of methods for analyzing aesthetic effects over greater ranges of thickness for these materials would improve the prognosis for using these materials.

1. Introduction

The popularity of porcelain veneers stems from their superior optical properties, translucency, and minimally invasive preparation of natural tooth structure.[1] The survival rate for feldspathic porcelain laminate veneers for over 20 years was reported to be 96%.[1–3]

When bonded to tooth structure, translucent feldspathic porcelain veneer creates a life-like appearance. The support-

☆ This research was conducted as Dr. Kürklü was a Visiting Professor to The Ohio State University, College of Dentistry, Division of Restorative, Prosthetic and Primary Care Dentistry, Columbus, OH, USA.

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0300-5712/$ – see front matter
http://dx.doi.org/10.1016/j.jdent.2013.08.017

ing tooth structure or restorative foundation material is typically considered a major source for ultimate restoration colour.[1] The final restoration colour may be influenced by the thickness and translucency of the veneer restoration, depending on the amount of light scattering and reflection.[4,5] In addition to the type, thickness and colour of the porcelain material used, the colour of supporting structure or luting agent may also influence the final colour of veneer restorations.[1,6–13]

Porcelain laminate veneer thickness has been reported to range between 0.3 and 1.5 mm.[14–18] It has been shown that with a decrease in veneer thickness, light transmission was significantly increased.[19] Previous studies have shown that changes in thickness of translucent feldspathic porcelain as well as the underlying cement may dramatically influence the final shade of the restoration.[6–8]

A relatively thin feldspathic porcelain laminate veneer allows for a minimally invasive approach but requires a strong bond with the tooth structure for resistance to failure under functional loading.[1] Composite resin cements have been used for the cementation of the porcelain laminate veneers for several years since feldspathic porcelain is etchable, enabling the effective bonding of the porcelain to tooth structure.[2,20,21] Resin cements are supplied in different shades by the manufacturers to allow for final colour enhancement of porcelain/cement restorations.

Colorimetry for dental materials and systems has traditionally involved the CIE method[22] which allows for a relationship[23] between a determined colour difference and clinical judgments of perceptibility and acceptability, and for determination[24] of a translucency parameter. Since the major appearance properties of colour and translucency of an aesthetic material are related to its inherent optical properties,[25–27] it may be advantageous to consider these properties together.

Purposes of this *in vitro* study include evaluating the colour changes in a feldspathic porcelain and cement combination resulting from the use of two different thicknesses of the porcelain material and from the use of three different shades of composite resin luting agent, and putting any colour changes found in terms of perceptibility and acceptability. An addition purpose is to compare the relative translucency parameters of selected combinations. The null hypotheses were that the change in thickness of the porcelain material and a change of shade of the resin luting agent would not affect the final colour and relative translucency of combinations of feldspathic porcelain and composite resin luting agent.

2. Materials and methods

2.1. *Preparation of the feldspathic porcelain specimens*

Thirty six, porcelain disc specimens of shade A1 (Noritake EX-3, Kizaeco, Japan) were fabricated using a cylindrical Teflon mould of diameter 8.0 mm. The porcelain powder and modelling liquid were mixed, packed and dried and then placed onto a platinum foil and fired according to the manufacturer's instructions. For standardization purposes, preparation of all disc specimens was performed by the same operator. The veneers were then randomly assigned to the two groups and placed into metal moulds of depths 1.0 and 0.5 mm, respectively. After reduction of the porcelain thickness to nearly the depth of the metal mould, both surfaces of the porcelain discs were finished with 600-grit silicone carbide sandpaper using an automatic grinder/polisher (Model AP 50; Leco, St Joseph, MI) in an attempt to achieve finished thickness values within 0.05 of 1.00 mm and 0.50 mm respectively. After finishing and cleaning, measurements before application of the cement were obtained with a digital calliper (Model number NB60; Mitutoyo American Corporation, Providence, RI, USA). Each porcelain thickness group was further divided into 3 subgroups for the three different shades of the resin cement.

2.2. *Preparation of resin cement on feldspathic porcelain*

On each porcelain disc, the surface to be in contact with the luting agent was etched with 9.6% hydrofluoric acid gel (Porcelain Etch gel, Pulpdent, MA), applied for 60 s, then rinsed with running water for 20 s and dried with oil-free air. Following this, a silane-coupling agent (Clearfil Ceramic Primer, Kuraray, Japan) was applied to the etched porcelain. A light-activated resin cement (Clearfil EX, Kuraray, Japan) at three different shades, Chroma (CA), Clear (CR), and Opaque White (O), was used as the luting agent. Each porcelain disc was placed into a metal ring approximately 0.2 mm thicker than the porcelain. The luting material was mixed according to the manufacturers' instructions and applied to the porcelain disc. A Mylar strips were placed over the cement and a glass slab was placed on top of the strip and stabilized with hand pressure during polymerization. The cement was light-cured through the glass slab and Mylar for 40 s, and then through the porcelain disc for an additional 20 s. The specimens ($n = 6$ in each experimental group) were stored for 24 h in a light-proof container at 37 °C in high-humidity (95%) before measurement of the total thickness and spectral radiance. From the thickness values of each porcelain specimen before and after cement application, the thickness of the cement was calculated by subtraction.

2.3. *Radiance measurements, conversion to reflectance and colour and translucency calculations*

A non-contact spectral radiance measuring system[28] consisting of a PR705 spectroradiometer (Photo Research Inc., Chatsworth, CA) and fibre optic light cable (Model 70050; Newport Stratford Inc., Stratford, CT) with a xenon arc lamp (300W; Newport Stratford Inc.) on an optical table (Mecom Inc., Rising Sun, OH) was used to measure the radiance of each porcelain/cement double layer specimen in optical contact with black, grey and white backings. Saturated sucrose solution was used for optical contact between the specimen and the backing. Spectral radiance (W/sr/m^2) was obtained from 380 to 780 nm with a 2-nm interval with Spectrawin software (v 2.0; Photo Research Inc.). The distance between the lens and the specimen was 80 mm and the measuring diameter was 1.1 mm.