Original Article / Özgün Araştırma

The Effect of Color Selection on the Color Stability of the Resin Cement

Renk Seçiminin Rezin Simanın Renk Stabilitesi Üzerine Etkisi

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Abstract

Objective: The aim of this study was to determine effect of shade selection on resin cement's color stability.

Materials and Methods: Ten resin cement samples in dimensions of 10 mm diameter and 2 mm thickness for each group [group 1: Translucent base and translucent catalyst, group 2: Bleach XL (B1) base and yellow (A3) catalyst, group 3: White (A1) base and A3 catalyst] totally 30 samples were prepared. Color coordinates of each sample were recorded after polymerization and 5000 thermal cycles. Color variation (ΔE) was calculated for each sample and statistical analyses were performed.

Results: The lowest ΔE values were obtained for group 1. Group 2 showed higher ΔE values than group 3 however there were no statistical difference.

Conclusion: Translucent base and translucent catalyst mixture showed clinically acceptable color stability while B1 base and A3 catalyst and A1 base and A3 catalyst mixtures did not show clinically acceptable color stability. Shade of the resin cement partially effected its color stability.

Keywords
Resin cement, color stability, thermal cycling

Öz

Amaç: Bu çalışmanın amacı; renk seçiminin rezin simanın renk stabilitesi üzerindeki etkisini belirlemektir.

Gereç ve Yöntemler: Her grup için [grup 1: Yarı saydam baz ve yarı saydam katalizör, grup 2: Beyazlatma XL (B1) baz ve sarı (A3) katalizör, grup 3: Beyaz baz (A1) ve sarı (A3) katalizör] 10'ar tane olmak üzere 10 mm çapında ve 2 mm kalınlığında toplam 30 adet rezin örnek hazırlandı. Hazırlanan örneklerin renk değerleri polimerizasyonu takiben ve 5000 termal siklus sonrasında ölçüldü. Her örnek için renk değişim değeri (ΔE) hesaplanarak istatistiksel analizler yapıldı.

Bulgular: En düşük ΔE değeri grup 1'de gözlendi. Grup 2'de, grup 3'e kıyasla daha yüksek ΔE değeri elde edilse de her iki grup arasında istatistiksel olarak anlamlı fark bulunamadı.

Sonuç: Yarı saydam baz ve yarı saydam katalizör karışımı sonucunda klinik olarak kabul edilebilir bir renk değişimi gözlenirken, B1 baz, A3 katalizör ve A1 baz, A3 katalizör karışımları ise klinik olarak kabul edilebilir değerlerin üzerinde renk değişimi göstermiştir. Rezin simanın rengi simanın renk stabilitesi üzerinde kısmen etkili olmuştur.

Anahtar Kelimeler
Rezin siman, renk stabilitesi, termal siklus

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Introduction

Esthetic restorations are mostly preferred for dental rehabilitation of patients because they provide esthetic, function and longevity (1). It is important for an esthetic restorative material to be color stable over a long time period during oral function (2). Translucency of ceramic materials makes color matching of the restoration complex (3). The color of the final restoration is effected by various factors such as the color of the supporting tooth structure, thickness, shade and type of the ceramic and resin cement and translucency of the restorative material (4,5).

Resin based cements are recommended for cementation of all ceramic restorations (6). Resin cements provide higher esthetic appearance and also strengthen the ceramic materials. However a color change can occur in resin based materials during aging (7). The color stability of the luting agent is important because it can become visible especially when used for cementation of thin restorations such as laminate veneers with thickness ranging from 0.3 to 0.7 mm (8). A visible color change in esthetic zone may not be tolerated by the patient. Thus several studies were employed to identify the color stability of resin cements under varying conditions (6). Color change of resin composites is both associated with intrinsic factors related with resin's itself and extrinsic factors which can occur during clinical use (1,9-11).

Color change can be detected visually or by using instrumental techniques such as spectrophotometer or colorimeter (11). Color measurement using colorimeters or spectrophotometer has become popular. They provide more proper and standard color records than shade guides (5). Slide color changes can be determined using spectrophotometer or colorimeters (11).

Commission Internationale de l'Eclairage (CIE) L*a*b* coordinates which describes position of the color in 3 dimensional color space are generally used for color expressions (12). L* coordinate represents lightness, a* coordinate represents greenness (positive) and redness (negative), b* coordinate represents yellowness (positive) and blueness (negative) (5,13,14). The numerical distance between L*a*b* coordinates of two color is expressed with ΔE (5,13). No color difference (ΔE=0) means complete color stability of a material (11). ΔE value between 0.0-1.5 means very good color difference, between 1-2 means good color difference, between 2-3.5 means clinically perceptible color difference, >3.5 means unacceptable color difference (13).

Numerous shade selections are available for each commercially available resin cement brand. However generally universal shade is used in studies comparing color stability. The purpose of this *in vitro* study was to evaluate the effect of shade selection on color stability of conventional resin cement following 5000 thermal cycles. The null hypotesis was that resin cement's shade affects its color stability.

Materials and Methods

Different shades of Variolink N (Ivoclar Vivadent AG, Liechtenstein) resin cement were used in this study. Ten disk shaped samples in 10 mm diameter and 2 mm thickness per each group were prepared. Resin cement was mixed according to the manufacturers' recommendations in 1:1 base-catalyst ratio. Mixed cement was placed in teflon molds and two glass slides were compressed on the upper and lower surfaces of the molds to provide standard samples with smooth surfaces. The top surfaces of resin cements were light cured for 40 seconds light-emitting diode; Blue Lex LD-105 (Monitex Industrial CO, Taipei, Taiwan).

Group 1: Resin samples in this group were prepared by mixing translucent base and translucent catalyst.

Group 2: Resin samples in this group were prepared by mixing bleach XL (B1) paste and yellow (A3) catalyst.

Group 3: Resin samples in this group were prepared by mixing white paste (A1) and yellow (A3) catalyst.

The initial color of the polymerized specimens were recorded with a by using CIE Lab color parameters from 3 points for each sample on a white background (VITA Easyshade Compact Advance 4.0, VITA Zahnfabrik H. Rauter GmbH and Co.KG). Mean values of three records for each sample were calculated. Then samples were thermocycled in distilled water by using 5000 thermal cycles between 55-5 °C for 30 seconds for each dwell time. Color coordinates were rerecorded after thermal cycling from 3 points for each sample on a white background and mean values of three records for each sample were calculated. Color variation after thermal cycling was determined by using the following formula.

$$\Delta E^*_{ab} = [(L1^* - L0^*)^2 + (a1^* - a0^*)^2 + (b1^* - b0^*)^2]^{1/2}$$

Color variation results were statistically analyzed. The normal distribution of the data were analyzed by Shapiro-Wilk test ($p>0.05$). The ΔE results were analyzed by using One-Way ANOVA ($p<0,05$).

Results

The One-Way ANOVA results of the mean ΔE values were summarized in Table 1. The lowest ΔE values were obtained group 1. Group 2 showed higher ΔE values than group 3 however there were no statistical difference.

Discussion

This study evaluated the effect of shade on resin cement's color stability following 5000 thermal cycles. One type of resin cement was used to eliminate the brand dependent color changes. Three shades were tested. The null hypothesis was that shade selection effects the color stability. The obtained results partially confirmed the null hypothesis. Group 1 showed the lowest color variation while there were no statistical difference between group 2 and 3.

The thickness of experimental samples used in this study were 2 mm. 2 mm thickness is reported as a proper thickness to reduce background effect (15,16).

Adhesive resin cements are generally chosen as luting material for resin cementation of ceramic restorations because of their esthetics and good mechanical properties (15). Dual cured resin cements are generally used for luting thin and translucent restorations so color stability is needed (17). Both intrinsic and extrinsic factors leads color change in resin materials (10,15,18-20). Intrinsic factors are material related (15). Composition of the resin matrix, conversion rate, water sorption rate, type of the initiator system used are intrinsic factors (18).

Table 1. One-way ANOVA results of the mean color variation values

	$\Delta E_{5000\ \text{thermal cycles (mean ± SD)}}$
Group 1	2.63±1.38[a]
Group 2	5.48±1.72[b]
Group 3	4.44±1.06[b]

*Different letters indicate statistical difference for one-way ANOVA ($p<0.05$)
ΔE : Color variation, SD: Standard deviation

Discoloration by intrinsic factors is accelerated by UV radiation or thermal cycling (20,21). Luting cements at restoration margins are generally exposed to the oral environment and this makes discoloration of resin cements with extrinsic factors such as foods, drinks or smoking possible (15). Discoloration and loss of color match with adjacent teeth is the major reason to replace the esthetic restorations (22).

CIE L*a*b* color system demonstrates uniform color scale including all of the colors which are visible for human eye (23). Also it is commonly recommended system for determining color differences of dental materials (21,24). In this study CIE L*a*b* system was used to obtain standardized color records. Some researchers reported that a unit of color difference in CIE L*a*b* color system is a visual color change which can be detected with human eye (2,25). On the other hand, there are several opinions in literature about the threshold value for a clinically acceptable and visual color difference. This value is reported over 3.33 (6,9,10,17,25), 3.5 (13,19) or 3.7 (23). The authors adopt the threshold value of 3.5 for clinically accepted color difference when interpreting the results of this study. Group 2 (5.48±1.72) and group 3 (4.44±1.06) showed clinically unacceptable color difference following 5000 thermal cycles while group 1 (2.63±1.38) showed clinically acceptable color difference. According to these results it can be concluded that using translucent resin cement may be more useful for cementation of thinner ceramic restorations at esthetic zone. The fact that resin cement shade is not the only factor effecting the final color matching with adjacent teeth must be also considered.

Some researchers (2,5,9) found that lighter shades of composite resins present more color change than darker ones. However results of this study are not in agreement. The translucent shade which was the lightest shade used in this study showed the lowest color change. This may be due to less residual monomer content of the translucent samples which were caused by higher polymerization of the resin by allowing more light transition. Light exposure increases the conversion and increased conversion causes higher color stability (6,17). Color change of dual cured resin based cements is associated with the oxidization of unreacted amine co-initiator from the redox polymerization system and unreacted benzoyl peroxide (7,20).

Study Limitations

This study has some limitations. Samples used in this study had smooth surfaces to provide standardization. However in clinical situations resin cements do not have a flat surface. The surface morphology including roughness can be more exposed to color changes. Sedrez-Porto et al. (26) reported that polishing is essential for color stability of resin composites. Only thermal cycling was used in this study. Colorant solutions such as coffee or tea, saliva including enzymes and proteins; foods, drinks and smoking can also lead color changes. Ceramic material characteristics can affect the light transmitting and resin cement's polymerization (27). Inadequate polymerization can modify physical and mechanical properties of the resin cement (28). No ceramic material was used in this study. Therefore these factors should be also considered in further studies.

Conclusion

Translucent base and translucent catalyst mixture showed clinically acceptable color stability while B1 base and A3 catalyst, A1 base and A3 catalyst mixtures did not show clinically acceptable color stability. Shade of the resin cement partially effected its color stability.

Ethics

Ethics Committee Approval: It was not taken.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: M.Ç.T., C.A., Design: M.Ç.T., C.A., Data Collection or Processing: M.Ç.T., C.A., Analysis or Interpretation: M.Ç.T., C.A., Literature Search: M.Ç.T., C.A., Writing: M.Ç.T.

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