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Color Agreement of Try-In Paste and Resin Cement on Zirconia Laminate Veneers

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ABSTRACT

Aim: This study investigates the reliability of try-in pastes in determining the final color of zirconia laminate veneer restorations produced with varying thicknesses.
Material and Methods: Phantom teeth were prepared in three thicknesses (0.5, 0.7, 1 mm) using depth gauge burs. The preparations were scanned with an intraoral scanner, and impressions were taken. Thirty resin die models were produced using a 3D printer. Zirconia laminate veneers were fabricated in three specified thicknesses. Initial color measurements (L, a, b values) of the veneers, applied to the die models with transparent petroleum jelly were taken. Color measurements were repeated using try-in paste after removing the petroleum jelly. The veneers were then roughened, ultrasonically cleaned, and ceramic primer applied. They were cemented with resin cement matched to the try-in paste color. Final color data were obtained using a spectrophotometer. Color change values were calculated from the L, a, b values, and data were compared using two-way ANOVA and Bonferroni Test.
Results: The thickness of the material did not influence color change, whereas the use of try-in paste or resin cement resulted in significant color differences.
Conclusion: The study findings indicate that try-in pastes are not reliable indicators of the final restoration color. It is crucial to consider that resin cement can substantially alter the color of zirconia laminate veneers when determining the final shade.

Deneme Pastası ve Rezin Simanın Zirkonya Laminate Veneerlerde Renk Uyumu

Makale Bilgisi

Makale Geçmişi

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ÖZET

Amaç: Bu çalışma, farklı kalınlıklarda üretilen zirkonya laminate veneer restorasyonlarının sonuç renginin belirlenmesinde deneme pastalarının güvenilirliğinin araştırmaktadır.
Gereç ve Yöntemler: Fantom dişler derinlik ölçer frezler ile 3 farklı kalınlıkta (0,5, 0,7, 1 mm) prepare edilmiştir. Preparasyonlar bir ağıziçi tarayıcı ile taranarak ölçüsü alınmış ve 3 boyutlu yazıcı yardımı ile toplamda 30 adet rezin day model üretilmiştir. Zirkonya laminate veneerler, bu day modeller üzerine 3 farklı kalınlıkta üretilmiştir. Şeffaf renk vazelin ile day modele tutturulan laminate veneerlerin başlangıç renk (L, a, b değerleri) ölçümleri yapılmıştır. Ardından vazelin temizlenerek deneme pastası ile renk ölçümleri tekrarlanmıştır. Deneme pastası ile renk ölçümlerinin ardından, laminate veneerler 110 µm çaplı silika modifiye alüminyum oksit partikülleri ile pürüzlendirilmiş, ultrasonik olarak temizlenmiş ve veneerlere seramik primer uygulanmıştır. Laminate veneerler deneme pastası ile eş renkteki siman ile yapıştırılmıştır. Simantasyonun ardından spektrofotometre ile restorasyonun nihai renk verileri elde edilmiştir. Elde edilen L, a, b değerlerinden renk değişim değerleri hesaplanmış ve iki yönlü ANOVA ve Bonferroni Testi ile veriler karşılaştırılmıştır.
Bulgular: Materyal kalınlığı renk değişimine etki etmezken, deneme pastası veya rezin siman kullanımı önemli renk farklılıklarına yol açmıştır.
Sonuç: Çalışma bulguları, deneme pastalarının nihai restorasyon renginin güvenilir göstergeleri olmadığını ortaya koymaktadır. Nihai tonu belirlerken reçineli simanın zirkonya lamina kaplamalarının rengini önemli ölçüde değiştirebileceği dikkate alınmalıdır.

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INTRODUCTION

Patients undergoing dental treatment expect their smile to be restored in a healthy and aesthetically pleasing way. Therefore, treatments capable of altering the shape, size, and color of teeth while minimizing damage to dental tissues have gained popularity. Porcelain laminate veneers represent a conservative and highly aesthetic treatment option that provides long-term predictability and demonstrates good clinical performance.[1]

With technological advances in adhesive systems, it is possible to produce very thin laminate veneers that can be cemented to the tooth surface with minimal preparation.[1,2] In a retrospective study, the 10-year survival rate of laminate veneers was reported as 97,4%.[3]

Currently, materials such as lithium disilicate, feldspathic ceramics, leucite-reinforced feldspathic, fluorapatite, and zirconia-reinforced lithium silicate are commonly favored for the fabrication of laminate veneers.[4]

For many years, high crystal content ceramics, such as yttria partially stabilized tetragonal zirconia, have been frequently used due to their high fracture resistance and masking abilities.[5] However, in recent years, cubic zirconia ceramics have been developed through various alterations in the microstructure and composition of zirconia ceramics to enhance their translucency while retaining their fracture resistance.[6,7] The advancement of these translucent zirconia ceramics has enabled the production of laminate veneers with enhanced masking capabilities and greater strength compared to glass ceramics.[8]

In laminate veneers, it has been demonstrated that the color of the aesthetic restoration can be influenced by up to 10-15% due to the color of the resin cement.[9] Manufacturers recommend utilizing try-in pastes to estimate and verify the final restoration color before cementation. The dentist and patient can assess the color compatibility of the restoration by employing try-in pastes that correspond to the same shades as the resin cement.

Studies have been conducted to investigate the color compatibility between try-in pastes and permanent cement.[10-15] Nevertheless, these studies have not yet come to a consensus on this issue.[9-15] While a study.[11] reported a high consistency between the color values of the try-in pastes and the color properties of the resin cement, another study.[15] suggested that dentists should not rely solely on try-in pastes for color evaluation.

There have been limited studies reported on zirconia laminate veneers.[16-19] The definitive impact of try-in pastes on the final color of laminate veneer restorations fabricated from cubic zirconia remains uncertain. The objective of this study is to assess the efficacy of try-in pastes in predicting the final color of cubic zirconia laminate veneers with varying thicknesses. The null hypothesis of this study is: The cementation process of zirconia laminate veneers produced in varying thicknesses showed no significant difference between the color change values obtained with the try-in paste and those acquired after cementation.

MATERIALS AND METHODS

Using the Minitab Statistical Program (Minitab 22, Minitab LLC), the minimum sample size was determined based on data from previous studies [20]. With a statistical power (β) of 0.80 and a significance level (α) of 0.05, each of the four study groups required a minimum sample size of three to detect significant differences in color agreement. Ten samples per group were employed to enhance statistical power and to account for any potential sample loss throughout the study.

Three prefabricated upper right first incisors (Frasaco GmbH, Tettnang, Germany) were utilized for this study. Preparation depths for each tooth were established using depth gauge drills (Meisinger, Germany). A 1,5 mm incisal reduction and a butt-joint finish line were prepared on each tooth, followed by a depth reduction of 0,5 mm, 0,7 mm, and 1 mm on the labial surfaces. The preparations were then finalized with a chamfer finish line.

The impressions of the prepared prefabricated teeth were captured using a digital intraoral scanner (TRIOS3, 3Shape, Copenhagen, Denmark). A total of 30 resin replicas in A1 color were produced using a 3D printer (NextDent 5100, 3D Systems, NextDent B.V., Soesterberg, Netherlands), with 10 replicas for each preparation depth.

The cement gap of the zirconia laminate veneers was set to 40 µm. It was designed using computer-aided design software, with a restoration thickness ranging from 0,5, 0,7 and 1 mm, positioned 1 mm above the labial restoration edge. The designed laminate veneers were milled from presintered monolithic zirconia blocks (KATANA Zirconia STML A1, Noritake Dental Supply Co., Ltd., Miyoshi, Japan) using a computer-aided manufacturing device (Ceramill Motion 2, Amann Girrbach, Austria). Following milling, the zirconia laminate veneers were sintered in accordance with the manufacturer's instructions using a sintering oven. After the sintering process, all samples were manually polished using the Luster Meisinger polishing kit (Hager & Meisinger GmbH, Neuss, Germany). For this purpose, green, blue, red, and yellow burs from the polishing kit were utilized under water cooling. Each bur was applied for 60 seconds by a single researcher, respectively. The thickness of the samples was measured using a digital caliper (Digimatic Caliper IP67, Mitutoyo, Tokyo, Japan). Examples of the produced resin replicas and monolithic zirconia laminate veneers are depicted in Figure 1.

Figure 1: Resin replica model and zirconia laminate veneer example

After sample preparation, the color measurement procedures commenced. All color measurement procedures were conducted three times by a single researcher at the same time of day using a spectrophotometer (Vita Easyshade®, Vita Zahnfabrik, Bad Säckingen, Germany), and L, a, b values were recorded. The average value for each sample was determined by calculating the average of the three measurements.

The initial measurement was taken by applying transparent petroleum jelly between the resin replicas and zirconia laminate veneers, and the resulting L_0, a_0, b_0 values were recorded. The petroleum jelly on the laminate veneers was eliminated using an ultrasonic cleaner. Subsequently, a clear glyserin try-in paste (Panavia V5 Try-in Paste Clear, Kuraray, Japan) was applied to the zirconia laminate veneers, which were then positioned on resin dies, and the resulting L_d, a_d, b_d values were recorded.

Following the removal of the try-in paste using an ultrasonic cleaner, the inner surfaces of the zirconia laminate veneers were sandblasted with silica-modified aluminum oxide particles (Rocatec Plus, 3M ESPE, Seefeld, Germany) with a diameter of 110 µm. After applying the MDP-containing ceramic primer (Clearfil™ Ceramic Primer Plus, Kuraray, Japan), the zirconia laminate veneers were cemented using the same color cement (clear shade) as the try-in paste (Panavia V5 Paste, Kuraray, Japan).

Excess cement was removed, and then the cement was light-cured (Elipar Freelight; 3M ESPE, Seefeld, Germany) for 20 seconds each on the labial and palatal surfaces.

Following cementation, the final L_s, a_s, b_s data were measured and recorded.

ΔE values were calculated using the following formulas:

$\Delta E_d = [(L_d - L_0)^2 + (a_d - a_0)^2 + (b_d - b_0)^2]^{1/2}$ (ΔE_d= color change value with the try-in paste)

$\Delta E_s = [(L_s - L_0)^2 + (a_s - a_0)^2 + (b_s - b_0)^2]^{1/2}$ (ΔE_s= color change value after cementation)

Statistical Analysis

Statistical analyses were conducted using SPSS version 22 (SPSS Inc., IL, USA) statistical software program. The Kolmogorov-Smirnov test and Levene's test were utilized to assess the normality of ΔE values and to confirm the homogeneity of variances, respectively. The ΔE_d and ΔE_s data among zirconia laminate veneers of different thicknesses were compared using two-way ANOVA, followed by the Bonferroni test for post-hoc analysis. The ΔL, Δa, and Δb values calculated from the samples after trial paste and cementation were compared using the independent samples t-test. A p-value < 0.05 was considered significant for all tests.

RESULTS

According to the results of the two-way ANOVA analysis, the parameters of try-in paste and cement usage exhibited a significant effect, while the thickness parameter did not lead to a significant change. Additionally, the interaction between these two parameters demonstrated a significant effect. (Table 1)

Table 1: Two-way ANOVA test results

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	83.629[a]	5	16.726	33.654	0.000	0.757	168.268	1.000
Intercept	835.505	1	835.505	1681.100	**0.000**	0.969	1681.100	1.000
Thickness	1.761	2	0.880	1.771	0.180	0.062	3.542	0.355
Trial/cement	79.640	1	79.640	160.242	**0.000**	0.748	160.242	1.000
Thickness* trial cement	2.228	2	1.114	2.242	0.116	0.077	4.483	0.437

a. R Squared =0.757 (Adjusted R Squared = 0.735) b. Computed using alpha = 0.05

The post hoc Bonferroni test results are presented in Table 2. While the restoration thickness did not lead to a significant change in the ΔE_d and ΔE_s values, there were significant differences in the ΔE_d and ΔE_s values among different thicknesses at all thickness levels. The highest color change value was observed for the ΔE_s value (4,88 ± 0,71) at a thickness of 0,5 mm. The lowest color change values were calculated for ΔE_d values at thicknesses of 0,7 mm and 1 mm (2,56 ± 0,87 and 2,56 ± 0,50, respectively).

Table 2: ΔEd± Standard Deviation, ΔE_s ± Standard Deviation Values and Bonferroni Test results

Thickness	ΔE_d ±SD	ΔE_s ±SD	p
0.5 mm	2.67± 0.41	4.88± 0.71	<0.001
0.7 mm	2.56± 0.87	4.45± 0.87	<0.001
1 mm	2.56±0.50	4.32± 0.80	<0.001
p*	0.844	0.056	

Intragroup comparison results between p, ΔE_d and ΔE_s values. Intragroup comparisons of p ve ΔE_s values between thicknesses

Table 3 presents the ΔL, Δa, and Δb values calculated with both the try-in paste and cement. According to the independent samples t-test results, a significant difference was observed in all of these data when comparing the use of try-in paste and cement. At all thickness values, the ΔL value after cementation was significantly lower than the ΔL value calculated with the try-in paste ($p < 0.001$). In all thickness values, Δa and Δb values decreased after cementation compared to the values calculated with the trial paste ($p < 0.001$).

Table 3: Mean ± Standard Deviations of ΔL, Δa, Δb values of subgroups, comparison of trial and cemented samples with independent samples t test.

		Trial (Mean±SD)	Cement (Mean±SD)	p
0.5 mm	ΔL	-2.35± 0.15	-4.7± 0.22	<0.001*
	Δa	0.76± 0.07	0.36± 0.06	<0.001*
	Δb	0.88± 0.13	-0.43± 0.30	<0.001*
0.7 mm	ΔL	-2.25± 0.28	-4.18± 0.30	<0.001*
	Δa	0.67± 0.45	0.31±0.08	<0.001*
	Δb	0.92±0.12	-0.54± 0.23	<0.001*
1 mm	ΔL	-2.42±0.16	-4.85± 0.26	<0.001*
	Δa	0.54± 0.37	0.03±0.05	<0.001*
	Δb	-0.31±0.52	-2.12±0.18	<0.001*

*p<0.05

DISCUSSION

According to the results of this study, the null hypothesis "There is no detectable color difference between the try-in paste and the corresponding resin cement in zirconia laminate veneers produced in different thicknesses" was partially rejected. Although the material thickness did not have a significant effect on the ΔE_d and ΔE_s values, there was a significant difference between the use of try-in paste and cement across all thicknesses.

Indeed, achieving the desired color match in indirect restorations is crucial for both patients and dentists. Try-in pastes serve as valuable tools to guide the selection of the appropriate color of luting cement, ensuring optimal aesthetic outcomes.

In previous studies, it has been noted that the visually detectable color change value typically falls within the range of 1 to 3.7 units, and any color change exceeding 3.7 units is generally considered clinically unacceptable.[21, 22] Therefore, in this study, the acceptable color change value limit was set at 3.7 units. In this study, while the use of try-in paste at all thicknesses resulted in an acceptable color change, a color change exceeding the acceptable limits was observed after cementation. Additionally, the color change value (ΔE_s) obtained after cementation was significantly higher than the color change value (ΔE_d) calculated with the try-in paste. This result is consistent with other studies indicating that the color of the try-in paste does not necessarily match the color of the corresponding resin cement.[13-15, 19]

In their study on ceramic veneers, Xing et al.[11] demonstrated that neither material thickness nor color significantly influenced the color change. Indeed, this finding is in line with the results of the current study. However, in contrast to this study, Xing et al.[11] reported that the try-in paste and cement color were compatible. This may be due to the different veneer material used. In this research, the material under examination consisted of monolithic cubic zirconia with a super translucent structure, incorporating 4.8% yttria. Cubic zirconia exhibits an isotropic state in various crystallographic orientations, which helps reduce light scattering that occurs at grain boundaries.[23] As a result, cubic zirconia ceramics demonstrate higher translucency properties.

Paken et al.[24] conducted a comparison of the color between try-in paste and post-cementation in zirconia-reinforced lithium disilicate samples. They concluded, similar to the findings in this study, that the restoration color experienced more significant changes with the final cement after cementation. Moreover, this result suggests that the trial pastes have a low masking effect. Therefore, in situations where masking the color of the teeth is desired, it is advisable not to rely solely on the try-in paste result.

Turgut and Bagis[25] assessed the optical properties of monolithic zirconia ceramics cemented with various cements. Their findings indicated that the type of cement used influenced the optical properties of monolithic zirconia restorations. Previous studies have demonstrated that the color of the resin cement used during the cementation of laminate veneers can influence the color of the final restoration.[26-28] Turgut and Bagis[25] investigated the color change of laminate veneers with varying thicknesses, fabricated from leucite-reinforced ceramics. They reported that the color of the resin cement could indeed impact the color of the final restoration. They also demonstrated that the color change decreased as the restoration thickness increased. In this study, the resin cement significantly altered the color of the final restoration. However, while the color change in the final restoration decreased as the thickness increased, this decrease was not found to be significant.

The CIELAB color system is a color space that characterizes color using three axes: L, a, and b values. The L coordinate represents the lightness-darkness continuum of the color. a value of 0 corresponds to pure black, while 100 represents pure white. As the L value increases, the color becomes lighter, and as it decreases, it becomes darker. The a coordinate indicates the ratio of redness to greenness in the color. Positive values of a denote redness, while negative values indicate greenness. The b coordinate represents the ratio of yellowness to blueness. Positive values of b signify yellowness, while negative values denote blueness.[29] As a result of this study, significant differences were found between the color of the try-in paste and the final restoration across all material thickness values, as indicated by ΔL, Δa, and Δb values. A decrease was observed in the ΔL values obtained with the trial paste and after cementation in all thicknesses, suggesting a darkening of the restoration color. Furthermore, upon examination of Δa and Δb values, an increase in the greenness and blueness values was observed after cementation.

In this study, clear color try-in paste and cement were selected, as they were presumed to have the least impact on color change. This choice aimed to achieve a more transparent cement color and minimize the color change between the try-in paste and the final restoration. However, despite these efforts, it was concluded that the color of the final restoration may still vary beyond acceptable limits when rehearsing on the prepared tooth.

One limitation of this study is the absence of try-in paste and cement in different colors. Using try-in pastes and cements with higher color pigment content could potentially yield more compatible results. Additionally, the use of petroleum jelly to provide primary stability to the restoration during initial color measurements might have caused light refraction, affecting color perception. Although applying silica-modified aluminum oxide particles before cementation is a recommended procedure for zirconia cementation, it might have influenced the color of the final restoration. Further clinical studies are warranted to investigate whether the use of trial paste in zirconia laminate veneers aligns with the final restoration color.

CONCLUSION

Within the limitations of this study; it was concluded that during zirconia laminate veneer cementation, the color of the try-in pastes and the final cement may be different, regardless of the restoration thickness. Material thicknesses did not have a significant effect on the ΔE_d and ΔE_s values obtained in zirconia laminate veneers. . When planning the color of zirconia laminate veneers, it should be considered that the color of the permanent restoration may vary beyond perceptible limits after cementation, regardless of the restoration thickness.

Ethical Approval

Ethical approval was not obtained for this study as no human or animal subjects were involved.

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: ETÇ. Data collection and processing: ETÇ. Analysis and interpretation: ETÇ. Literature review: ETÇ. Writing: ETÇ.

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