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Effect of different visible light curing systems on the color stability of resin cements

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color stability, zirconia veneers, curing systems, resin cement

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Abstract

The present study aimed to compare the color stability of zirconia cemented veneers, using self-etch adhesive cement after curing with various systems and aging process. Materials and methods: A total of 27 veneers zirconia samples were cemented using resin cement on 27 labially prepared extracted anterior teeth to reach a flat surface, and classified into three groups according to the light curing units (LCU); Group I (Cured with Polywave Ivoclar Bluephase style LCU), Group II (Cured with Polywave Woodpecker iLED LCU), Group III (Cured with Monowave 3M Elipar LCU). Results: Monowave LCU exhibited significantly higher color changes than the polywave LCU ([$P < 0.05$] [ΔE 2.94 ± 0.44]). Interaction between polywave polymerizing units and resin cement was not significant ($P > 0.05$). Conclusion: This study concluded that different light curing systems have a significant effect on the final color of resin cement used in cementation of zirconia veneers. Polywave LCUs provide better color stability of zirconia veneers.

Keywords

color stability, zirconia veneers, curing systems, resin cement

1. INTRODUCTION

Ceramic, composite resin and esthetic restorative dental materials are continuously developing to meet functional and esthetic demand. These restorations require appropriate cement for long-term outcome in changeable oral conditions and also to meet patient's esthetic expectations (Runnacles P 2014). For successful ceramic restorations, esthetic quality of the material is not the only criterion to be considered, it is important to be firmly attached to the tooth structure with resin-based cement, which has the advantage of superior mechanical and physical properties when compared to the traditional luting cements. Resin cements are classified into 3 groups: total-etch, self-etch, and self-adhesive resin cements. One of the disadvantages of using conventional resin luting cements is their multistep application which renders their quality for being technique-sensitive (Zhu S 2009) .

To overcome this problem, the new self-etch and self-adhesive luting cements are easier to use and require less clinical steps. This is owing to their composition which consists of monomers that have bonding as well as mineralizing capacities (Jiménez-Planas A 2008). The clinical success and durability of luting cements in the oral cavity depend on different properties such as structural integrity, dimensional as well as color stability.

There are still doubts about the efficacy of light activation of resin cements with different light-curing units (LCUs) and under different veneering materials (Malhotra N 2010). Peutzfeldt et al (2016) stated that light activation of dual-cure cements showed improvement in the conversion rate compared to dual-cured cements subject to chemical activation alone, so light activation is important to be used when dealing with dual cured resin cements. Achieving adequate degree of polymerization of resin cement materials beneath ceramic restorations, is challenging, especially when light or dual cured resin cements are used (Leprince J 2010).

Different light sources and veneering materials may affect the polymerization of resin cements used, during adhesive cementation procedures (Shokry 2006, Peutzfeldt A 2016). Various light sources, including quartz halogen (QTH), light emitting diodes (LEDs) and xenon plasma arc (PAC), can be used to polymerize these materials. QTH has a low cost benefit, with estimated lifetime of 50-100 hours. The disadvantages include higher temperatures and a reduction in irradiance over time due to bulb aging and filter aging. LED unites are wireless, with estimated lifetime of about 10,000 hours. PAC curing units are released at higher intensities and were primarily designed to reduce time for irradiation (Azer SS 2006).

In the case of aesthetic restoration materials, such as ceramic veneers, the color stability of resin-based cements employed for cementation procedure may be as important for long-term clinical success of the restoration as the mechanical properties of veneering material. When ultrathin ceramic veneers are used, the color of the resin-based cement plays a major role (Reges RV 2009).

Resin-based cements may be classified based on whether they are chemically cured, light-cured or dual-cured materials (Runnacles P 2014). Light-cured resin cements present increased working time and the removal of excesses of material is easier than for chemically cured materials. On the other hand, dual-cured luting materials contain compounds for both chemical and light curing, and consequentially these materials possess beneficial traits from both polymerization systems (Jiménez-Planas A 2008). The combination of curing systems used with dual-cured resin cements is reported to reduce the number of remaining double bonds, which improves the degree of conversion. As the color of resin-based materials is related to the degree of conversion, dual-cured luting materials should show better color stability than the light-cured resin cements (Miguel-Almeida ME 2012).

Since most manufacturers of direct resin-based restorative materials do not provide details about the photo initiators contained in their products, selecting an optimal combination of restorative resin and LCU is problematic.

While many publications have discussed the physical properties of LED light-cured materials, few have investigated the color stability of resin-based cements when cured with different LED lights. Monowave and polywave LED LCUs have not previously been compared in terms of efficiency in curing resin cement under ceramic restorations.

The aim of this study is to evaluate the color stability of self-etch resin cement with variations in curing units and aging process. The experimental design tested the null hypotheses, that there might be no change in color between the evaluated groups.

2. MATERIALS AND METHODS

27 anterior teeth were prepared labially to reach a flat preparation with a maximum of 30% dentine exposure as recommended for maximum dentin exposure for veneers, and divided into three groups (n=9). 27 zirconia specimens of 0.5 mm thickness, 11 mm length and 9 mm width were prepared having a zero anatomy outline – flat samples, with a shade of 0M3 according to Vita Easy Shade Guide.

The veneer samples were cemented on the prepared teeth using Multilink N self-etch resin cement of a transparent shade, and pressed on a flat glass slab for uniform thickness of cement, excess cement was removed, each group then light cured using one of the following curing units according to manufacture instructions. A list of curing lights, including specifications is given in table 1 (Kassim BA 2013).

Group 1: Multilink N, Polywave Bluephase style – Ivoclar
Group 2: Multilink N, Polywave iLED – Woodpecker
Group 3: Multilink N, Monowave Elipar – 3M

Veneers were given time of 24 hours for full polymerization. Then the shade of each cemented veneer was measured using Vita easy shade guide and recorded for reference.

All samples were stored in distilled water at 37 °C for 150 days, to test the hydrolytic stability of the resin used after artificial aging. This specific storage condition was chosen to allow full water saturation (Attia 2011), after storage time teeth were thermal cycled between 5 and 55 °C in distilled water for 37,500 cycles with a 30 s dwell time at each temperature (Umer F 2011). After aging, they were removed, dried and the shade was re-measured using the same shade guide and the results were recorded.

Color measurements:

The color of each specimen was evaluated 2 times; using Vita Easy Shade Guide 24 hours after cementation and total polymerization, and after aging. According to the CIE L*a*b* scheme, the readings were conducted and the mean L*,a* and b* values were calculated for each tooth (Seghi RR 1989). The complete color change acquired for each specimen was calculated using the equation (Price RB 2014):

Where ΔL^*, Δa^* and Δb^* are differences in the respective values before and after aging. All measurements were made on a white colored sheet for standard color measurement (Watanabe H 2015).

Statistical analysis:

Statistical analysis was performed on SPSS 20.0 (SPSS Inc., Chicago, IL, USA). Means and standard deviations were calculated. Data obtained were analyzed using three-way analysis of variance (ANOVA) followed by Duncan test significant difference tests for comparisons among groups at a 0.05 level of significance.

3. RESULTS:

A total of 27 samples were tested for color stability after polymerization. Colorimetric values (L*a*b*) of the resin cement polymerized between zirconia veneer discs and the teeth with three light polymerizing units before and after aging between three groups are presented in Table 2 and chart 1.

There were color changes in all groups. Group 3 (Monowave Elipar – 3M) exhibited significantly higher color changes than the other groups ($P<0.05$) (ΔE 2.45), while Group 1 and 2 (Polywave Bluephase style – Ivoclar and Polywave iLED – Woodpecker) showed similar color changes.

4. DISCUSSION

This study investigated the color of zirconia veneers, after cementation with self-etching resin cement using differently LCUs. The final combined restoration color veneers and luting materials is important for the esthetics of laminate veneers, all-ceramic crowns, and indirect composite restorations. Gale and Darvell (1999) estimated that10,000 thermal cycles is equivalent to 1 year's clinical service; therefore, this in vitro study simulated about 4 years of service, which leads to hydrolytic effect of water at the luting resin/ ceramic interface and at the luting resin itself, and therefore color changes (Oyagüe RC 2009).

In the current study, three different types of curing systems were used. According to previous studies, LED LCUs have become the gold standard for photo polymerization of resin-based dental materials (Price RB 2014, Arikawa H 2008). Since contemporary LED lights provide superior irradiance, expanded lifetime, little light output degradation over time to QTH light, LED lights are expected to optimally polymerize resin materials as or even more effectively than QTH. LED light curing units are either monowave or polywave. In this study, one monowave curing unit was compared to two polywave LED curing units.

The tested hypothesis was rejected, and color changes in resin cements polymerized with monowave LED were statistically greater than those in polywave LED LCUs($P<0.05$).

Monowave LED devices portrayed as having maximum theoretical polymerization efficacy also have characteristics that need to be developed. In some of these "monowave" LED units, the spectral emission is not uniformly distributed across the light tip (Reges RV 2009), moreover compounding the effects of beam inhomogeneity. Thus, some areas of the resin may not receive the required wavelengths (Kalachandra S 1992). This may explain the color changes in the specimens polymerized with monowave LED LCUs used in this study being greater than the color change values in specimens polymerized with polywave LED LCUs.

It worthy to mention that in this study the same resin adhesion was used in the three tested group in order to eliminate the possible changes in color that may be associated with changes in the resin matrix and in the filler particle silanization method, resulting in greater water sorption (Lee YK 2008). Another explanation may be the size and number of particles that may influence mean, L*, a* and b* values, as well as the translucency of composite resins that may change after polymerization. In our study, the Monowave Elipar – 3M group has showed the best polymerization because of the monowave character leading to color changes which results in higher opacity after aging, affecting the ceramic veneer's final color (Ramez Shahin 2010). This is in accordance with Peutz F. (2002), who stated that degree of conversion of resin cement is affected by light activation.

5. CONCLUSION

Considering the methodology applied and the limitations of this in vitro study, it can be concluded that different light curing systems have a significant effect on the final color of resin cement used in cementation of zirconia veneers. Polywave light curing systems allow more color stability of resin cements than the monowave light curing systems.

More studies are recommended to evaluate the efficiency of polymerization of mono/polywave LED LCUs on color stability of resin cement.

Figures and Tables

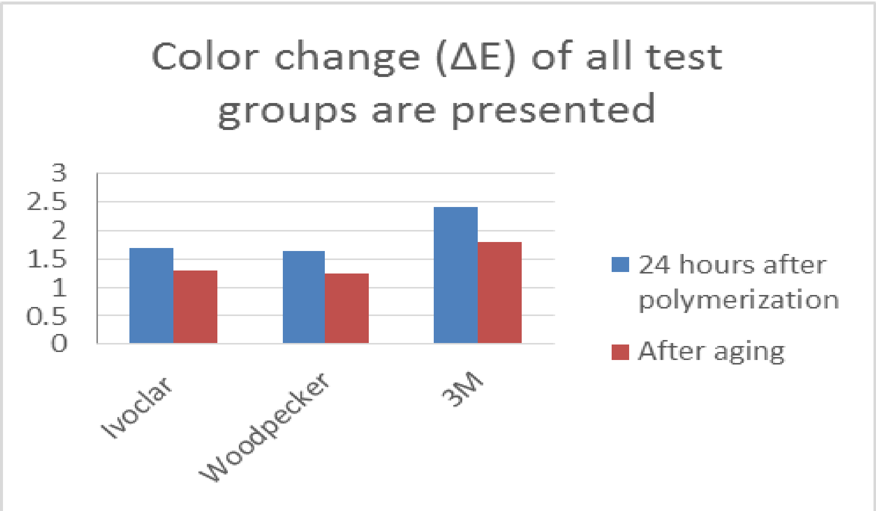

Fig.1: Color changes (ΔE) of all test groups

Table 1: Specifications of light curing systems used.

Reference: The author

Type	Curing unit	Total energy (mW/cm2)
Polywave Bluephase style – Ivoclar (1-6600 Dixie road Mississauga, ON L5T 2Y2, Canada)	LED with halogen-like broad spectrum	1,100
Polywave iLED – Woodpecker (Guilin national high tech Zone Information Industry Park, China)	LED with constant power born for restoration	2,300
Monowave Elipar – 3M (3M Canada Post Office Box 5757 London, Ontario N6A 4T1 Canada	LED photo initiator for the wavelength range of 430-480 nm	1,470

Table 2: Mean and standard deviation L*,a* and b* values between tested groups

Curing system	CIE L*a*b*	Before	After
Group 1 (Polywave Bluephase style – Ivoclar)	**L**	**85.65+/-0.63**	**85.13+/-0.71**
	a	**-1.90+/-2.47**	**-1.73+/-2.34**
	b	**26.93+/-1.46**	**25.42+/-1.87**
Group 2 (Polywave iLED – Woodpecker)	**L**	**84.45+/-0.65**	**85.15+/-0.75**
	a	**-2.05+/-2.1**	**-1.8+/-1.9**
	b	**24.76+/-1.6**	**24.14+/-1.75**
Group 3 (Monowave Elipar – 3M)	**L**	**83.77+/- 0.67**	**85.17+/-0.80**
	a	**-2.83+/-0.17**	**2.18+/-0.29**
	b	**22.06+/-0.72**	**23.78+/-1.08**

1.1 Equations

Eq.

$$\Delta E = \sqrt{(L_f^*-L_i^*)^2 + (a_f^*-a_i^*)^2 + (b_f^*-b_i^*)^2}$$

REFERENCES

- Arikawa, H., Kanie, T., Fujii, K., Takahashi, H., & Ban, S. (2008). Effect of inhomogeneity of light from light curing units on the surface hardness of composite resin. *Dental Materials Journal*, 27(1), 21-28.
- Attia, A., & Kern, M. (2011). Long-term resin bonding to zirconia ceramic with a new universal primer. *The Journal of Prosthetic Dentistry*, 106(5), 319-327.
- Azer, S. S., Ayash, G. M., Johnston, W. M., Khalil, M. F., & Rosenstiel, S. F. (2006). Effect of esthetic core shades on the final color of IPS Empress all-ceramic crowns. *The Journal of Prosthetic Dentistry*, 96(6), 397-401.
- Christensen GJ. (2002). The curing light dilemma. Journal Am Dent Assoc, 133,761-3.
- Gale, M. S., & Darvell, B. W. (1999). Thermal cycling procedures for laboratory testing of dental restorations. *Journal of Dentistry*, 27(2), 89-99.
- Jimenez-Planas, A., Martin, J., Ábalos, C., & Llamas, R. (2008). Developments in polymerization lamps. *Quintessence International*, 39(2),74-84.

- Kalachandra, S., & Wilson, T. W. (1992). Water sorption and mechanical properties of light-cured proprietary composite tooth restorative materials. *Biomaterials*, 13(2), 105-109.
- Kassim, B. A., Kisumbi, B. K., Lesan, W. R., & Gathece, L. W. (2013). Effect of light curing unit characteristics on light intensity output, depth of cure and surface micro-hardness of dental resin composite. *East African Medical Journal*, 90(9), 288-296.
- Lee, Y. K. (2008). Influence of filler on the difference between the transmitted and reflected colors of experimental resin composites. *Dental Materials*, 24(9), 1243-1247.
- Leprince, J., Devaux, J., Mullier, T., Vreven, J., & Leloup, G. (2010). Pulpal-temperature rise and polymerization efficiency of LED curing lights. *Operative Dentistry*, 35(2), 220-230.
- Malhotra, N., & Kundabala, M. (2010). Light-curing considerations for resin-based composite materials: a review. Part II. *Compend Contin Educ Dent*, 31(8), 584-588.
- Miguel-Almeida, M. E., Azevedo, M. L. D. C., Rached-Júnior, F. A., Oliveira, C. F., Silva, R. G., & Messias, D. C. (2012). Effect of light-activation with different light-curing units and time intervals on resin cement bond strength to intraradicular dentin. *Brazilian Dental Journal*, 23(4), 362-366.
- Oyagüe, R. C., Monticelli, F., Toledano, M., Osorio, E., Ferrari, M., & Osorio, R. (2009). Effect of water aging on microtensile bond strength of dual-cured resin cements to pre-treated sintered zirconium-oxide ceramics. *Dental Materials*, 25(3), 392-399.
- Peutzfeldt, A., Lussi, A., & Flury, S. (2016). Effect of High-Irradiance Light-Curing on Micromechanical Properties of Resin Cements. *BioMed Research International*.
- Price, R. B., Shortall, A. C., & Palin, W. M. (2014). Contemporary issues in light curing. *Operative Dentistry*, 39(1), 4-14.
- Shahin, R., & Kern, M. (2010). Effect of air-abrasion on the retention of zirconia ceramic crowns luted with different cements before and after artificial aging. *Dental Materials*, 26(9), 922-928.
- Reges, R. V., Costa, A. R., Correr, A. B., Piva, E., Puppin-Rontani, R. M., Sinhoreti, M. A. C., & Correr-Sobrinho, L. (2009). Effect of light-curing units, post-cured time and shade of resin cement on Knoop hardness. *Brazilian Dental Journal*, 20(5), 410-413.
- Runnacles, P., Correr, G. M., Baratto Filho, F., Gonzaga, C. C., & Furuse, A. Y. (2014). Degree of conversion of a resin cement light-cured through ceramic veneers of different thicknesses and types. *Brazilian Dental Journal*, 25(1), 38-42.
- Seghi, R. R., Johnston, W. M., & O'Brien, W. J. (1989). Performance assessment of colorimetric devices on dental porcelains. *Journal of Dental Research*, 68(12), 1755-1759.
- Shokry, T. E., Shen, C., Elhosary, M. M., & Elkhodary, A. M. (2006). Effect of core and veneer thicknesses on the color parameters of two all-ceramic systems. *The Journal of Prosthetic Dentistry*, 95(2), 124-129.
- Umer, F., & Khan, F. R. (2011). Postoperative sensitivity in Class V composite restorations: Comparing soft start vs. constant curing modes of LED. *Journal of Conservative Dentistry: JCD*, 14(1), 76.
- Watanabe, H., Kazama, R., Asai, T., Kanaya, F., Ishizaki, H., Fukushima, M., & Okiji, T. (2015). Efficiency of dual-cured resin cement polymerization induced by high-intensity LED curing units through ceramic material. *Operative Dentistry*, 40(2), 153-162.
- Zhu, S., & Platt, J. A. (2009). Curing efficiency of three different curing lights at different distances for a hybrid composite. *American Journal of Dentistry*, 22(6), 381-386.