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EFFECT OF TWO BLEACHING PROTOCOLS ON COLOR STABILITY OF THREE DIFFERENT LAMINATE VENEER MATERIALS (AN IN VITRO STUDY)

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ABSTRACT

Aim: The aim of the current study was to assess the effect of two different bleaching techniques; home and in-office bleaching on three different laminate veneer materials; lithium disilicate (E-max), hybrid ceramic (Enamic) and CAD CAM/composite (Crios), after thermocycling in a coffee staining solution.

Methods: In this in vitro study, 42 specimens with 0.6 mm thickness were made from three dental esthetic materials (E-max, Vita Enamic and Brilliant Crios), 14 of each material, with high translucency (HT), shade of A2 and 2M2. The shade of the specimens were measured using spectrophotometer. Then coffee staining under thermocycling condition was done.

Using spectrophotometer, shade was again measured, then half of the specimens, seven of each group were home bleached and the other half was in office bleached. Then, finally the shade was measured using spectrophotometer to evaluate the color stability of each material.

Results: Statistical analysis revealed that there is statistically significant difference in the color change between the three materials as the E-max showed the best color stability ($\Delta E = 3.67 \pm 0.17$), followed by Vita Enamic ($\Delta E = 4.25 \pm 0.29$) followed by Brilliant Crios that showed the highest color change ($\Delta E = 5.33 \pm 0.30$). When comparing the two bleaching techniques, in-office bleaching showed more whitening effect than home bleaching, however, the statistical analysis showed that there is no statistically significant difference between the effect of home bleaching ($\Delta E = 4.38 \pm 0.74$) and in-office bleaching ($\Delta E = 4.46 \pm 0.77$) when used with the three veneering materials.

Conclusion: With introduction of new veneering materials, the E-max (lithium disilicate) showed the best color stability after thermocycling in coffee staining solution and bleached with either home or in-office bleaching agents, followed by Vita Enamic while Brilliant crios showed the worst color stability. There are statistically significant difference in the color change (ΔE) between the three veneering materials used in this study.

KEYWORDS: bleaching – veneering material – E-max - Vita Enamic – Brilliant Crios – color stability.

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INTRODUCTION

Different lines of treatment are available to manage discoloration of anterior teeth in esthetic zone. Bleaching using carbamide peroxide or hydrogen peroxide gel may be considered as an appropriate management for mild and superficial discoloration in structurally intact teeth. Another way for management of mild discoloration is the micro- or macro-abrasion. Moderate to severe discoloration is best treated with laminate veneers[1,2].

Laminate veneers are indirect restorations that can be done with conservative preparations for improving shade, shape and function of teeth with poor esthetics[3,4]. There are many types of veneering materials including resin composite, e-max and enamic veneers. Composite resin initially has excellent esthetic result. Unfortunately, after long term exposure to oral environment, it has high susceptibility to be discolored[5].

The most common glass ceramic material used in the esthetic dental restorations is lithium disilicate (LD) owing to its superior optical and physical properties as well as ease of fabrication. Vita enamic is considered a hybrid ceramic composed of dual network; a polymer network 25% by volume / 14% by weight and a ceramic network 75% by volume / 86% by weight. Resin composite blocks, also referred to as resin-nano ceramics, resin-based composite and nano-hybrid restorative blocks, are manufactured by mixing the polymer and filler components under high pressure and high temperature to maximize the polymer cross-linking.

In the current research, the effect of coffee staining was evaluated on three materials: E-max, vita enamic and brilliant crios. Then, the effect of both bleaching techniques home and in-office in color stability was evaluated for each coffee stained material.

HYPOTHESIS:

Whether the home bleaching or the in-office bleaching will affect the coffee stained laminate veneer materials.

MATERIALS AND METHODS:

Sample size calculation:

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there would be no effect of different materials and bleaching systems on color change. By adopting alpha (α) and beta (β) levels of (0.05), (i.e., power=95%), and an effect size (f) of (5.22) calculated based on the results of a previous study*; the **minimal total** required sample size (n) was found to be (12) samples. The sample size was increased to (42) samples to account for possible procedural errors during testing and to improve the robustness of statistical testing. Sample size calculation was performed using R statistical analysis software version 4.3.2 for Windows**.

Sample grouping (table 1):

TABLE (1) Representing sample grouping.

Technique of bleaching / Material type	Home bleaching	In office bleaching	Total
Composite	N=7	N=7	14
Hybrid ceramic	N=7	N=7	14
Lithium disilicate	N=7	N=7	14
	21	21	42

Fabrication of specimens:

The three materials blocks (E-max, Vita Enamic and Brilliant Crios) were sectioned horizontally into rectangular specimens with final dimensions of 12mm x 14mm and thickness equals to 0.6mm

* Gasparik, Cristina, et al. "Effect of accelerated staining and bleaching on chairside CAD/CAM materials with high and low translucency." Dental Materials Journal 38.6 (2019): 987-993.

** R Core Team (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

using diamond disc of thickness 0.55 mm in a sawing machine Isomet saw 4000*. The thickness and dimensions of each specimen were verified using a digital caliper.

As a result, 42 specimen were obtained from the three materials. 14 specimen of E-max, 14 specimen of Vita Enamic and 14 specimen of Brilliant Crios.

Lithium disilicate Emax specimens were crystallized in a porcelain furnace Ivoclar Vivadent[6] programmat EP3010** according to the manufacturer instructions (firing at 770 °C for 5 min, then 850 °C for 10 min), then they were left to bench cool to obtain the final color, strength and composition.

Measuring the primary shade of the specimen:

The shade of the 42 specimen were measured using Cary 5000 UV-Vis NIR spectrophotometer. All specimen (n = 42) were measured on a gray background [White-Balance Gray-Reference Card, PhotoMed; L* equals 79, a * equals 0, b* equals 0], all shade measurements were done under illumination D65[7].

Coffee staining and thermocycling of the specimen

Each specimen was put in small plastic container and the containers were labeled by the samples' numbers. According to the manufacturer's instructions, the coffee solution was prepared by mixing 1 round tablespoon of coffee*** with 177 mL of boiled tap water. The coffee was left for 5 minutes before filling up the plastic containers.

The containers were then immersed in the thermocycler for 5000 cycles in the coffee solution to simulate 6 months intra-oral circumstances. Cold bath immersion for thirty seconds at five degrees, then hot bath immersion for thirty seconds at 55 degrees with dwell time 10 seconds. The coffee solution was replaced for all samples with a freshly prepared coffee solution every 24 hours in the hot and cold baths. After completion of the thermocycling, the specimens were washed with running water and dried with sterile gauze prior to measurements.

Measuring the shade after coffee staining:

After coffee staining and thermocycling, the shade of the specimen were measured again using Cary 5000 UV-Vis NIR spectrophotometer.

Bleaching:

Home bleaching:

35% carbamide peroxide gel was applied to 7 samples of each material (21 samples) for 60 minutes. Then, the specimens were washed with running water and dried with sterile gauze. This process was repeated for 3 times.

In-office bleaching:

38% hydrogen peroxide gel was applied to the other 7 samples of each material (21 samples) for 15 minutes. Then, the specimens were washed with running water and dried with sterile gauze. This process was repeated for 2 times according to manufacturer's instructions.

Measuring the shade after bleaching:

After bleaching, the shade of the specimen were measured for the last time using Cary 5000 UV-Vis NIR spectrophotometer.

Measurements and data collection:

Data was collected with the same spectrophotometer instrument under same conditions after coffee staining and after bleaching of all samples to obtain L, a and b values and then, delta E was calculated for each sample in each group according to the following equation:

$$\Delta E = [(L1 - L2)^2 + (a1 - a2)^2 + (b1 - b2)^2]^{1/2}$$

* Buehler, USA
** Ivoclar Vivadent, USA
*** Nescafe Classic, Nestle, Cairo, Egypt

Where L1, a1 and b1 are data recorded after coffee staining for each sample, while L2, a2 and b2 are data recorded after bleaching.

RESULTS

Effect of material:

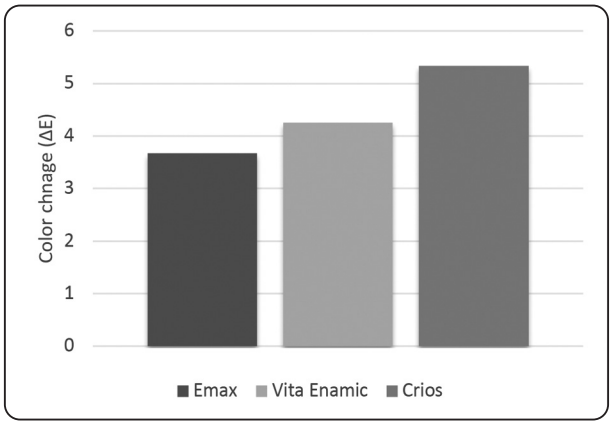
Intergroup comparisons, mean and standard deviation values of color change (ΔE) for different materials are presented in table 2.

There was a significant difference between different materials ($p<0.001$). The highest color change was found in Crios samples (5.33±0.30), followed by Vita Enamic (4.25±0.29), while the lowest color change was found in Emax samples (3.67±0.17). All post hoc pairwise comparisons were statistically significant ($p<0.001$).

TABLE (2) Intergroup comparisons, mean and standard deviation values of color change (ΔE) for different materials.

Color change (ΔE) (Mean±SD)			p-value
Emax	Vita Enamic	Crios	
$3.67±0.17^{C}$	$4.25±0.29^{B}$	$5.33±0.30^{A}$	<0.001*

Values with* different superscripts *are significantly different, * significant (p<0.05).



Bar chart showing average color change (ΔE) for different materials.

Effect of bleaching system:

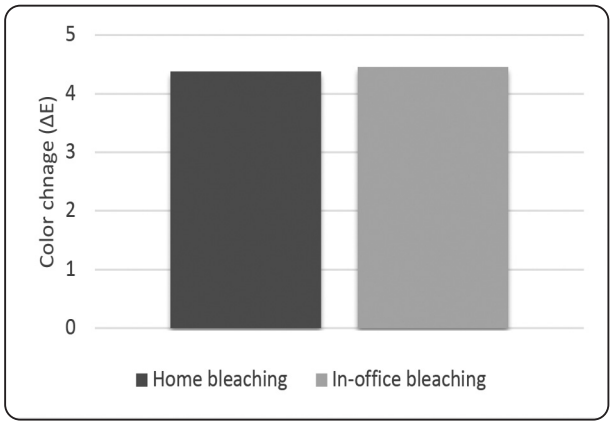
Intergroup comparisons, mean and standard deviation values of color change (ΔE) for different bleaching systems are presented in table 3.

In-office bleached samples (4.46±0.77) had a higher color change than home-bleached samples (4.38±0.74), yet the difference was not statistically significant ($p=0.433$).

TABLE (3) Intergroup comparisons, mean and standard deviation values of color change (ΔE) for different bleaching systems.

Color change (ΔE) (Mean±SD)		**p-value**
Home bleaching	**In-office bleaching**	
4.38±0.74	4.46±0.77	**0.433ns**

ns not significant.



Bar chart showing average color change (ΔE) for different bleaching systems.

DISCUSSION

The main purpose of veneering a tooth is the esthetics on long term. Unfortunately, some laminate veneer materials may be affected by stains in some food and beverages, as well as bleaching materials which may lead to bad esthetic results. Therefore, new laminate veneer materials and different bleaching techniques are introduced for achieving the best esthetics.

Concerning the selection of the veneering materials, the E-max blocks (lithium disilicate) was chosen as the gold standard esthetic veneering material. While Vita Enamic and Brilliant Crios were selected as they represent a new CAD/CAM veneering materials introduced with different microstructure composition that need to be evaluated for their color stability.

The usual thickness of the laminate veneers is ranging from 0.3 to 0.6 mm. In the present study, the selected thickness of the veneering materials was 0.6 mm similar to many authors[8–10], in order to avoid possible sample fracture of less than 0.6 thickness during samples preparation and manipulation. However, other authors preferred to choose thickness ranging from 0.3 to 0.5 mm in order to mimic thin veneers with less tooth preparation[11,12].

The selected shade of the blocks in this study was A2 as it is one of the most common used shade for veneers, crowns and restorations. However, the shade for Vita Enamic blocks was 2M2 as supplied by the manufacturer, because 2M2 vita 3D master shade corresponds to A2 vita classic shade according to the shade conversion table. The three blocks were selected with high translucency as it is commonly used with veneers.

In the present study, thermocycling was performed in order to simulate the aging of the materials to evaluate the degree of the color change after specific duration. The chosen thermocycling solution was coffee which is the most common used hot beverage[13]. In accordance with several studies, the aging of the samples was performed by 5000 cycles of thermocycling in a coffee solution[14–17]. Thermocycling with 5000 cycles in coffee solution simulates six months in the intra-oral circumstances[18].

In the present study we used both whitening methods; in-office and home bleaching agents to assess their effects on the different veneering materials as both techniques are commonly used in the dentistry. The different percentage of hydrogen peroxide content in different bleaching materials results in different whitening effects on the same material[19].

When analyzing the effect of the material on the color change (ΔE) between the color of the samples after coffee staining and after bleaching procedure either in-office or home bleaching, There was a significant difference between different materials ($p<0.001$). The highest color change was found in Crios samples (5.33±0.30), followed by Vita Enamic (4.25±0.29), while the lowest color change was found in E-max samples (the highest color stability) (3.67±0.17).

These results could be explained by the amount of the organic matrix causing discoloration of the material. Similar to other authors, lithium disilicate or feldspar ceramics (E-max) have the best color stability. Hybrid ceramics (Enamic) with decreased content of organic matrix also have color differences below perceptibility threshold. While low color stability was shown in composite based materials (Crios) with high percentage of organic matrix[20,21].

In accordance with our results, Gasparic et al. described that coffee staining and bleaching caused color changes in hybrid ceramics, lithium disilicate and feldspar ceramics below the perceptibility threshold. While composite based materials showed a significant lightness decrease and reddish-yellowish discoloration caused by accelerated coffee staining[22].

Similar results were reported by Quek et al. They demonstrated that whitening with 40% hydrogen peroxide had the ability to remove discolorations effectively only in case of hybrid ceramics and feldspar ceramics[23].

Regarding the effect of the bleaching system on the same material, in-office bleached samples (4.46±0.77) had a higher color change than home-bleached samples (4.38±0.74), yet the difference

was not statistically significant (p=0.433). These results were comparable to many studies in the literature showing statistically insignificant difference between home and in-office bleaching on different veneering materials[24–26].

So, regarding the hypothesis, it was rejected as both bleaching techniques showed statistically insignificant difference in color stability of the three veneering materials.

CONCLUSION

With introduction of new veneering materials, the E-max (lithium disilicate) showed the best color stability after thermocycling in coffee staining solution and bleached with either home or in-office bleaching agents, followed by Vita Enamic while Brilliant crios showed the worst color stability. There are statistically significant difference in the color change (ΔE) between the three veneering materials used in this study.

In-office bleaching showed more whitening effect than home bleaching, however, the statistical analysis showed that there is no statistically significant difference between the effect of home bleaching and in-office when used with the three veneering materials.

REFERENCES

1. Sadowsky SJ, Angeles L. An overview of treatment considerations for esthetic restorations: A review of the literature. 2006;(December):433-442.
2. Jain V, Das TK, Pruthi G, Shah N, Rajendiran S. Comparative evaluation of effects of bleaching on color stability and marginal adaptation of discolored direct and indirect composite laminate veneers under in vivo conditions. J Indian Prosthodont Soc. 2015;15(1):46-52. doi:10.4103/0972-4052.155038
3. Silami FDJ, Tonani R, Alandia-Román CC, Pires-De-Souza F de CP. Influence of different types of resin luting agents on color stability of ceramic laminate veneers subjected to accelerated artificial aging. Braz Dent J. 2016;27(1):95-100. doi:10.1590/0103-6440201600348
4. Radz GM. Minimum thickness anterior porcelain restorations. Dent Clin North Am. 2011;55(2):353-370. doi:10.1016/j.cden.2011.01.006
5. Ronk SL. Dental lamination: clinical problems and solutions. J Am Dent Assoc. 1982;104(6):844-846. doi:10.14219/jada.archive.1982.0315
6. Vivadent I. Scientific Documentation IPS e. max CAD. Liechtenstein[Online] Available from: http://www ivoclarvivadent com/en/p/laboratory-professional/products/all-ceramics/ips-emaxtechnicians/[Accessed: 12th April 2019]}, year={2011}.
7. Bahannan SA. Shade matching quality among dental students using visual and instrumental methods. J Dent. 2014;42(1):48-52. doi:10.1016/j.jdent.2013.11.001
8. Jarad FD, Moss BW, Youngson CC, Russell MD. The effect of enamel porcelain thickness on color and the ability of a shade guide to prescribe chroma. Dent Mater. 2007;23(4):454-460. doi:10.1016/j.dental.2006.03.001
9. Radz GM. Minimum thickness anterior porcelain restorations. Dent Clin North Am. 2011;55(2):353-370. doi:10.1016/j.cden.2011.01.006
10. Ozturk O, Uludag B, Sahin V. The effect of ceramic thickness and number of firings. Prosthodont Dent. 2008;100(2):99-106.
11. Haak R, Siegner J, Ziebolz D, et al. OCT evaluation of the internal adaptation of ceramic veneers depending on preparation design and ceramic thickness. Dent Mater. 2021;37(3):423-431. doi:10.1016/j.dental.2020.11.021
12. Farias-Neto A, Gomes EMDCF, Sánchez-Ayala A, Sánchez-Ayala A, Vilanova LSR. Esthetic Rehabilitation of the Smile with No-Prep Porcelain Laminates and Partial Veneers. Case Rep Dent. 2015;2015. doi:10.1155/2015/452765
13. Erdemir U, Yildiz E, Eren MM OS. Surface hardness evaluation of different composite UHVLQ PDWHULDOV LQÀXHQFH RI VSRUWV DQG HQHUJ \. 2013;21(2):124-131.
14. Al Amri MD, Labban N, Alhijji S, Alamri H, Iskandar M, Platt JA. In Vitro Evaluation of Translucency and Color Stability of CAD/CAM Polymer-Infiltrated Ceramic Materials after Accelerated Aging. J Prosthodont. 2021;30(4):318-328. doi:10.1111/jopr.13239
15. Subaşı MG, Alp G, Johnston WM, Yilmaz B. Effect of thickness on optical properties of monolithic CAD-CAM ceramics. J Dent. 2018;71(August 2017):38-42. doi:10.1016/j.jdent.2018.01.010

16. Heydecke G, Zhang F RM. In vitro color stability of double-layer veneers after accelerated aging. Prosthet Dent. 2001;6(85):551-557.

17. Arif R, Yilmaz B, Johnston WM. In vitro color stainability and relative translucency of CAD-CAM restorative materials used for laminate veneers and complete crowns. J Prosthet Dent. 2019;122(2):160-166. doi:10.1016/j.prosdent.2018.09.011

18. Hallmann L, Ulmer P, Gerngross MD, et al. Properties of hot-pressed lithium silicate glass-ceramics. Dent Mater. 2019;35(5):713-729. doi:10.1016/j.dental.2019.02.027

19. Hubbezoglu I, Akaoğlu B, Dogan A, et al. Effect of bleaching on color change and refractive index of dental composite resins. Dent Mater J. 2008;27(1):105-116. doi:10.4012/dmj.27.105

20. Li RWK, Chow TW, Matinlinna JP. Ceramic dental biomaterials and CAD/CAM technology: State of the art. J Prosthodont Res. 2014;58(4):208-216. doi:10.1016/j.jpor.2014.07.003

21. Acar O, Yilmaz B, Altintas SH, Chandrasekaran I, Johnston WM. Color stainability of CAD/CAM and nanocomposite resin materials. J Prosthet Dent. 2016;115(1):71-75. doi:10.1016/j.prosdent.2015.06.014

22. GASPARIK C, CULIC B, VARVARA MA, GRECU A, BURDE A, DUDEA D. Effect of accelerated staining and bleaching on chairside CAD/CAM materials with high and low translucency. Dent Mater J. Published online 2019. doi:10.4012/dmj.2018-335

23. Quek SHQ, Yap AUJ, Rosa V, Tan KBC, Teoh KH. Effect of staining beverages on color and translucency of CAD/CAM composites. J Esthet Restor Dent. 2018;30(2):E9-E17. doi:10.1111/jerd.12359

24. Al-Angari SS, Eckert GJ, Sabrah AHA. Color stability, Roughness, and Microhardness of Enamel and Composites Submitted to Staining/Bleaching Cycles. Saudi Dent J. 2021;33(4):215-221. doi:10.1016/j.sdentj.2020.08.003

25. Karakaya I, Cengiz-Yanardag E. Changes in Optical Characteristics and Surface Topography of CAD/CAM Materials after Bleaching Applications: An AFM Evaluation. J Prosthodont. 2020;29(3):226-236. doi:10.1111/jopr.13134

26. Alqahtani MQ. Tooth-bleaching procedures and their controversial effects: A literature review. Saudi Dent J. 2014;26(2):33-46. doi:10.1016/j.sdentj.2014.02.002