

10-10-2019

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Recommended Citation

IBRAHIM, Mohamed; FARGHALY, Ehab; and BADIH, Rasha (2019) "A comparison of color stability between hybrid ceramic and veneers: an in vitro study," *International Arab Journal of Dentistry*. Vol. 10: Iss. 1, Article 3.

Available at: <https://digitalcommons.aaru.edu.eg/vol10/iss1/3>

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A COMPARISON OF COLOR STABILITY BETWEEN HYBRID CERAMIC AND VENEERS: AN *IN VITRO* STUDY

Mohamed Ibrahim* | Ehab Farghaly** | Rasha Badih***

Abstract

The aim of the present study is to compare the color stability between hybrid ceramics (Vita Enamic®) and oxide ceramic (Zirconia). Twenty-four square-shaped specimens were cut using a precision saw machine. 0.8mm thick specimens of 10mm diameter were prepared with high-translucent CAD / CAM blocks by slicing them with a water-cooled diamond disk at low speed (150 rpm). The 0M1 color for Enamic® and zirconia specimens was chosen according to the Vita Easy shade guide (Vita Zahnfabrik, Germany). Each group of Zirconia and Enamic® was subdivided into three subgroups, four samples each, immersed in coffee, Pepsi®, and Perio Lacer mouthwash. Then, underwent shade measurement specimens using Vita Easy Shade. Data was collected and statistically analyzed using SPSS version 18.0 (SPSS Inc., Chicago IL, USA). Zirconia showed no difference in color in a specimen immersed in both coffee and Pepsi®. A slight difference in color after immersion in Perio Lacer mouthwash was observed. Regarding Enamic®, there was a change in the color of the specimens when placed in coffee, Pepsi®, and Perio Lacer mouthwash with the highest color change seen in the Perio Lacer mouthwash group. Color changes were mainly found in the Enamic® subgroups. Regarding the Zirconia specimen, changes were found only in the Perio Lacer mouthwash subgroup.

Keywords: Hybrid ceramic – oxide ceramic – Vita Enamic® - Zirconia.

IAJD 2019;10(1):25-30.

COMPARAISON DE LA STABILITÉ DE LA TEINTE ENTRE LES CÉRAMIQUES HYBRIDES ET LES « VENEERS » : UNE ÉTUDE *IN VITRO*

Résumé

Le but de la présente étude était de comparer la stabilité de la couleur entre des céramiques hybrides (Vita Enamic®) et des céramiques oxydées (Zircone). Vingt-quatre spécimens de forme carrée ont été découpés à l'aide d'une scie de précision. Des échantillons de 0,8 mm d'épaisseur et de 10 mm de diamètre ont été préparés avec des blocs CAD / CAM hautement translucides en les découpant avec un disque de diamant refroidi à l'eau à basse vitesse (150 tr / min). La couleur 0M1 pour les spécimens Enamic® et Zircone a été choisie conformément au guide de teinte Vita Easy (Vita Zahnfabrik, Allemagne). Chaque groupe de Zircone et Enamic® a été subdivisé en trois sous-groupes, quatre échantillons chacun, immergés dans un bain de bouche Perio Lacer (à base de Chlorhexidine), dans du café, et dans du Pepsi®. Ensuite, la mesure du changement de la teinte a été faite à l'aide du « Vita Easy Shade ». Les données ont été collectées et analysées statistiquement à l'aide de SPSS version 18.0 (SPSS Inc., Chicago IL, USA).

La Zircone n'a montré aucune différence de couleur pour l'échantillon immergé dans le café et le Pepsi®. Une légère différence de couleur après immersion dans les bains de bouche Perio Lacer a été observée. En ce qui concerne le groupe Enamic®, il y a eu un changement de couleur des spécimens lorsqu'ils ont été placés dans le bain de bouche Perio Lacer, le café et le Pepsi®. Le changement de couleur le plus important a été observé dans le sous-groupe de bain de bouche Perio Lacer.

Les changements de couleur ont principalement été observés dans les sous-groupes Enamic®. En ce qui concerne les spécimens en Zircone, des modifications ont été observées uniquement dans le sous-groupe immergé dans le bain de bouche Perio-Lacer.

Mots-clés: céramique hybride - céramique oxydée - Vita Enamic® - Zircone.

IAJD 2019;10(1):25-30.

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Introduction

Improving dentofacial esthetics in our modern society has become a common concern. Nowadays, patients are seeking different treatment modalities in order to embellish their dentofacial esthetics and yield positive changes in their smile [1].

The beautiful smile has been always the request of many patients. The search for beauty can be traced to the earliest civilizations; both the Phoenicians (app 800 BC) and Etruscians (app 900 BC) carefully carved animal tusks to simulate natural teeth, their shape, their form and their hue [2].

Stained teeth can make a smile look unattractive and can affect the person's self-esteem and confidence. They can create an aesthetic challenge for the clinician.

Tooth stains can be intrinsic or extrinsic. Extrinsic tooth stains are especially caused by the colored components of various food and beverages, such as coffee, tea, red wine and by the use of tobacco products.

These extrinsic stains are observed on the tooth surface; they may be aggravated in areas with enamel defects. Porous and rough enamel surface attracts extrinsic stains and may alter optical properties of the tooth which is consequently perceived as discolored [3].

The etiology of these extrinsic stains differs significantly among population and depends generally on oral hygiene habits, diet, and lifestyle.

The demands for esthetic restorations among patients encourage researchers to develop more esthetic metal-free ceramic restorations.

Enhancing patients' esthetics can be a considerable clinical challenge [4]. Esthetic dentistry has become an established discipline of mainstream practice over the last 20 years, through a convergence of favorable factors [5].

There are many types of ceramic veneers including Zirconia dioxide, feldspathic porcelain, lithium disilicate and lately Enamic® or hybrid

ceramics. The color stability of the veneers is a big issue that dentists all around the world talk about.

Zirconia is emerging as a restorative material of choice for single unit indirect restorations. It comes in many translucencies and can be layered to maximize esthetics in selected cases. Although there are three types of zirconia, Yttrium stabilized tetragonal zirconia polycrystalline (Y-TZP) is most frequently used due to its high esthetics, excellent biocompatibility, and increased resistance to fractures [6, 7].

VITA Enamic® is the first hybrid dental ceramic with a dual network structure that combines the best of what ceramic and composite materials have to offer.

It provides characteristics equivalent to those of natural dentition. Enamic® (Vita Zahnfabrik, Bad Sackingen, Germany), one of the polymer-infiltrated feldspathic ceramic materials, consists of 86% ceramic (by weight). Besides having the properties of both ceramic and composite materials, polymer-infiltrated ceramic-network (PICN) materials are considered to have mechanical and aesthetic properties similar to natural teeth [8].

The color of the restorative materials may be influenced by plaque accumulation, stains from solutions, surface roughness, and chemical degradation, all of which may result from consumption of different beverages (tea, coffee) or the use of mouthwashes [9].

Certainly, color stability is an important clinical factor in esthetic dental restorations. The translucency of dental materials is defined as the translucency parameter (TP). TP describes the color difference between a black and a white background. The "Commission Internationale de l'Eclairage (CIE)" recommends calculating color difference based on the CIE L*a*b* color parameters. Color differences (ΔE^*) in CAD/CAM ceramics are affected by the translucency and the background color [10].

Following the scientific approach to tooth color matching, some devices

were introduced for color measurement. The spectrophotometer is a device developed to measure color by reflection or transmission of an observed object. The spectrophotometer is a commonly used accurate instrument that records color changes in restorative materials. User friendly and electronic instruments were subsequently introduced such as charge coupled devices (CCD) and fiber optics [11].

The aim of this study was to compare the color stability between two different ceramic veneering materials, Enamic® and Zirconia veneers.

Materials and methods

This in vitro study was done in the specialty clinics at the Faculty of dentistry, Beirut Arab University (BAU), Beirut, Lebanon.

Twenty-four square-shaped specimens were cut using a disc into a thickness of 0.8 mm. The samples were divided into six groups, each consisted of 4 specimens:

- Group 1: 4 specimens from Zirconia were placed in coffee.
- Group 2: 4 specimens from Zirconia were placed in Perio Lacer mouthwash (Chlorhexidine digluconate 0.2%).
- Group 3: 4 specimens from Zirconia were placed in Pepsi® beverage.
- Group 4: 4 specimens from Enamic® were placed in coffee beverage.
- Group 5: 4 specimens from Enamic® were placed in Perio Lacer mouthwash.
- Group 6: 4 specimens from Enamic® were placed in Pepsi® beverage.

The blocks were sent to BAU laboratories. Two of the most popular CAD/CAM ceramics were chosen in this study. Using a precision saw machine, 0.8 mm-thick specimens of 10 mm diameters were prepared with high-translucent CAD/CAM blocks by slicing them with a water-cooled diamond disk at low speed (150 rpm). The 0M1

Material	Enamic®	Zirconia
Code	HC	Zirconia
Composition	Hybrid ceramic	Oxide ceramic
Filler Type	Silica and alumina	Zirconia and yttrium
Particle % weight	86	95
Translucency/shade	0M1	0M1

Table 1: Characteristics of the hybrid ceramic (HC) and Zirconia materials selected for the study.

Solutions	ΔL		Δa	
	Enamic®	Zirconia	Enamic®	Zirconia
Perio Lacer	1.19±0.31	-0.20 ± 0.87	2.23±0.09	0.68 ± 0.09
Pepsi®	1.82±0.31	0.04±0.005	1.89±0.24	0.045±0.005
Coffee	2.17±0.32	0.04±0.005	3.35±0.40	0.045±0.005
Baseline	0.00± 0.10	0.00 ± 0.12	0.00 ± 0.15	0.0± 0.14

Table 2: Mean and standard deviation of the baseline and final "L and a" values.

color for Enamic® specimens was chosen according to the Vita Easy shade guide (Vita Zahnfabrik, Germany). The selected hybrid ceramic (HC) and Zirconia materials are listed in Table 1.

Color measurements

Before color measurements were taken, all of the specimens were cleaned in de-ionised water for ten minutes in an ultrasonic cleaner and then dried with compressed air. The baseline color measurements were performed with a clinical spectrophotometer (Vita Easy Shade, Vita Zahnfabrik, Germany) using CIE $L^*a^*b^*$ and were recorded before treatment with the staining solution. The device was kept perpendicular to the surfaces to guarantee similar conditions for all of the samples. Before each measurement, we calibrated the spectrophotometer according to the manufacturer's recommendations. All measurements were performed under a D65 light source on white, black and neutral grey surfaces.

After repeating the color measurements three times for each of the specimens, the mean values of L^* , a^* and b^*

were calculated. In the CIE $L^*a^*b^*$ system color differences (ΔE^*) formula, L^* represents lightness, a^* represents the chromaticity coordinate for red-green and b^* represents the chromaticity coordinate for yellow-blue for color differences (ΔE^*) formula [12]: $\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$

After shade was taken, 12 zirconia and 12 Enamic® specimens were divided into 6 groups. Each group contained 4 specimens. In the coffee groups (groups 1 and 4), each specimen was immersed in 150ml of water and coffee for 48 hours and stirred every 8±1 hours. In the Pepsi® groups (groups 3 and 6); each specimen was immersed in 10ml of Pepsi® for 48 hours and stirred every 8±1 hours [13]. In the Perio Lacer mouthwash (groups 2 and 5), each specimen was immersed in 10 ml of 0.2% Chlorhexidine (CHX) mouthwash at a pH of 5.1 and 37 °C for 2 min, once per day. The solution was replaced every day for 7 days [14].

After every immersion in the different solutions, the specimens were cleaned with an air-water spray vigorously to ensure that they are clear from any remnants of the solution. At

the end, the specimens have undergone shade measurement using Vita Easy Shade.

Data were described using median mean and standard deviation (SD) measures. Kruskal-Wallis H test and Mann-Whitney U test were used for comparisons of different solutions and materials. SPSS version 18.0 (SPSS Inc., Chicago IL, USA) was used for statistical analysis. A $p < 0.05$ was considered statistically significant.

Results

After immersion of the specimens in Perio Lacer mouthwash, coffee, and Pepsi® we observed a significant difference in Δa and ΔL between Enamic® and Zirconia (both $p < 0.001$) (Table 2).

Zirconia showed no difference in color in both coffee and Pepsi® but it showed a slight, statistically insignificant difference in color after immersion in Perio Lacer mouthwash.

Regarding Enamic®, there was an obvious change in the color of the specimens when placed in coffee, Pepsi®, and Perio Lacer mouthwash with the

Solutions	ΔE	
	Enamic®	Zirconia
Perio Lacer	1.97±0.31	0.82 ± 0.08
Pepsi®	1.82±0.31	0.03±0.04
Coffee	3.17±0.32	0.04±0.05

Table 3: Descriptive statistics of the color difference values (ΔE^*ab) of the two groups immersed in different solutions.

Solution	Enamic® 0M1	Zirconia 0M1
Perio lacer	1R1.5	1M1.5
Pepsi®	1M1.5	0M1
Coffee	1M2	0M1

Table 4: Color changes after immersion in different solutions.

most color change being seen in the Perio Lacer mouthwash group.

There was a significant difference between the ΔE values of the two materials following immersion in Perio Lacer mouthwash, coffee, and Pepsi® (both $p < 0.001$). In all the solutions, we observed a significantly greater mean ΔE in Enamic® compared to Zirconia (both $p < 0.001$).

There was a statistically significant difference in the mean ΔE of Enamic® between the three solutions ($p < 0.001$). The mean ΔE values were highest in coffee, followed by Perio Lacer mouthwash, and Pepsi®.

There was a statistically significant difference in the mean ΔE of Zirconia between the three solutions ($p < 0.001$). The mean ΔE values were highest in Perio Lacer mouthwash. There was no change in color in samples that were immersed in coffee and Pepsi® (Chart1).

Discussion

Based on the results of this study, the null hypothesis that there is no difference between Enamic® and

Zirconia veneers regarding color stability was rejected.

The current study assessed the effect of three types of solutions on color stability of two different ceramic materials. For many years, the tooth shade guide was used to determine tooth color. Although inaccurate and subjective, this method was easy to use. Later, scientific methods have been introduced that overcame deficiencies with the visual guide.

A spectrophotometer is an instrument that detects color changes. The spectrophotometry data can be translated into quantitative values. The advantages of the spectrophotometer include "accuracy, ability to analyze the principal components of a series of spectra, and the ability to convert data to various color measuring systems". However the instrument is expensive and mostly used by researchers [12].

Color perception is related to many factors, such as individual differences in color perception, the surface texture of the material, illumination conditions and instrumental differences in color matching. In this study, the color difference in translucent ceramics was accepted as $\Delta E^* = 2.7$, which has been

reported as an average threshold value in a previous study [15]. There has been no clear agreement about the accepted ΔE^* limit until the present day. In this study, the ΔE^* values of HC materials stored in the coffee solution were higher than the accepted threshold ΔE^* value [12].

Vita Enamic® was reported in the literature to be the best choice for anterior and posterior restorations that closely matched neutral tooth color [16]. In Enamic®, the ceramic-network material is infiltrated with urethane dimethacrylates (UDMA) and triethylene glycol dimethacrylate (TEGDMA) mixture [17]. Because TEGDMA has higher water absorption, staining agents penetrate more easily the resin matrix. Therefore, the stainability of Enamic® may be due to the TEGDMA content [18].

Monolithic zirconia provides high esthetic results as well as high fracture resistance even at a minimum thickness. There is no disadvantage in using a polished zirconia antagonist to the enamel and feldspathic porcelain [5]. Generally, in full ceramic veneers, light transmission and translucency depend on the "crystal content, its

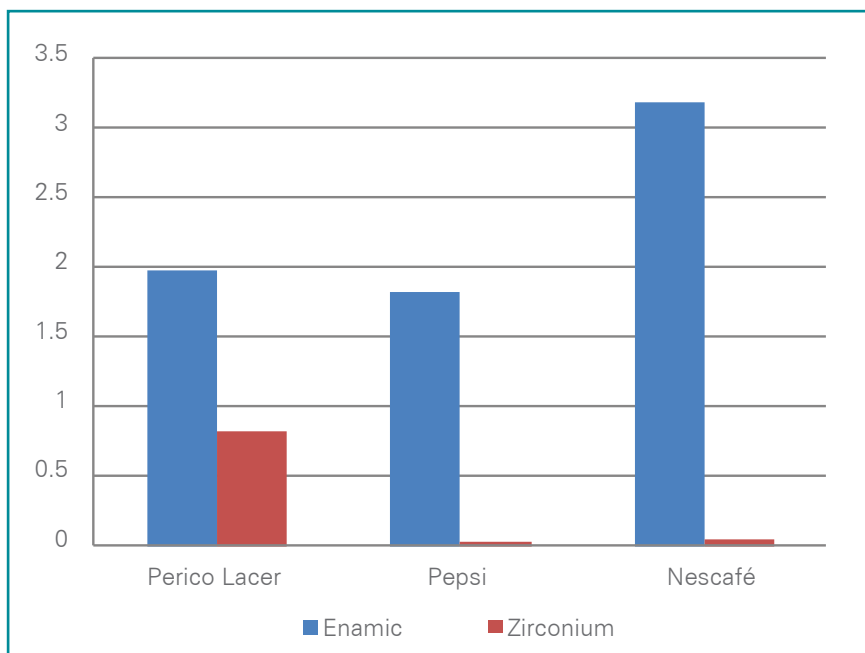


Chart 1: Representation of ΔE values.

chemical nature, particles size, and the thickness of the core” [19]. In the current study, we used the same thickness of materials in each group. The high physical properties in the zirconia groups may have had influenced relative color stability of the material compared to hybrid ceramics. However both materials included grain and small particles which might reduce surface roughness and susceptibility to discoloration. In addition, the crystalline structure of zirconia might decrease color changes compared to the Enamic® groups which contained resin [17].

Mouthwashes are commercially available in two forms, alcohol-free or alcohol-based in which the alcohol mainly acts as the solvent [20]. In the present study we did not observe any correlation between pH and alcohol-based solutions in terms of discoloration. This finding is similar to that reported by another study that examined discolorations of resin composite [21].

In a previous study that investigated the effects of coffee and Coca Cola® on the color stability of resins and ceramics, the authors reported

that color change of porcelain was not noticeable ($\Delta E^*=1.2$ to 1.4) [22]. Similarly, glazed ceramic material’s color change after immersion in coffee was found to be less than composite resin’s color change [23].

Coffee has been the most frequently used staining solution in color studies followed by Pepsi® and CHX.

Among the limitations of the current study, this is an in vitro study that did not reflect clinical situations, since salivary pellicle and consumption of different foods and beverages might influence the color change susceptibility [24]. Further researches should compare the color stability of ceramics with different types of solutions under clinical conditions.

Our results revealed that CHX-composed mouthwash increased the staining ability of the two main groups. A number of researchers [25, 26] have stated that the ability of mouthwash solutions to change the color of restorative materials depends on the type of restorative materials and the capability of resin matrixes to absorb water. One study [27] reported that the stain susceptibility of zirconia was less than that of CAD/CAM hybrid ceramics.

Conclusion

The present study showed that both monolithic Zirconia and Enamic® underwent color changes after immersion in Perio Lacer mouthwashes. However, these changes were not visually perceptible in Zirconia specimens. The Enamic® specimens immersed in coffee and Pepsi® underwent color changes as well, unlike Zirconia specimens that showed no clinical color change.

Therefore, treatment planning and restorations materials should be chosen adequately, taking into consideration the patient dental hygiene, diet and habits.

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