AL-AZHAR
Dental Journal
For Girls

The Official Publication
of The Faculty of Dental
Medicine For Girls,
Al-Azhar University
Cairo, Egypt.

Print ISSN 2537-0308 • Online ISSN 2537-0316

ADJ-for Girls, Vol. 6, No. 3, July (2019) — PP. 285:290

Evaluation of Marginal Accuracy and Color Stability of Lithium Disilicate Laminate Veneer Compared to Hybrid Ceramic Veneer

Eman M El-Malah [1*], Sahar A Abd El-Aziz [2], Suad M Hassan [3]

Codex : 36/1907

azhardentj@azhar.edu.eg

http://adjg.journals.ekb.eg

DOI: 10.21608/adjg.2019.6942.1066

ABSTRACT

Purpose: The purpose of the current study was to evaluate marginal accuracy and color stability of lithium disilicate laminate veneer compared to hybrid ceramic veneer. **Materials and Methods:** Forty maxillary teeth were collected and prepared (but joint preparation) to receive a laminate veneer. They were equally sub grouped (n= 20) to receive 2 types of laminate veneers (IPS E-max CAD and vita enamic). The veneer was milled from the blocks in a CEREC 3 Machine. All veneers were cemented with resin cement. All samples had been subjected to 20000 thermal cycles which are equivalent twenty years of clinical use. Marginal gap were measured by using universal serial bus (USB) Digital microscope. Colors were measured using a reflective spectrophotometer. Marginal gap and color were measured pre and post thermo cycles. Data were tabulated and statistically analyzed. **Results:** For the marginal gap, the two tested materials demonstrated an acceptable value. Regarding the color stability there was color change for both groups after thermal cycling with higher mean values for Vita Enamic than E-max and that was statistically insignificant. **Conclusion:** The E-max veneers recorded less marginal accuracy and more color stability than Vita Enamic and they did not affected by thermo cycling.

KEYWORDS

Emax, hybrid ceramic, reinforced ceramics, colors stability, veneer.

INTRODUCTION

The veneer is a layer of cosmetic materials placed on a tooth, to improve the aesthetic or to protect the tooth's surface. A dentist can use one veneer on a single tooth that have been fractured or changed on color, or on multiple teeth to create a "Hollywood" smile, close diastema,

- Paper extracted from master thesis entitled "Evaluation of Marginal Accuracy and Color Stability of Lithium

1. Dentist at Administration Medical University of Al-Azhar. email: dent.emohamady@gmail.com
2. Professor of Crown and Bridge Faculty of Dental Medicine for Girls Al-Azhar University.
3. Lecturer of Crown and Bridge Faculty of Dental Medicine for Girls Al-Azhar University.

fill the black triangles between teeth due to gum recession, and produce a uniform color, shape, and alignment. The porcelain veneer may need minimal to no preparation on the tooth surface[1].

There are two types of materials used for fabrication of veneers: composite and porcelain. A composite veneer may be placed directly, or indirectly, while porcelain veneer placed only indirect[2].

The ceramic systems have important esthetic qualities and great fracture resistance, once they are reinforced with leucite and lithium disilicate. A significant improvement in clinical performance was observed by lithium disilicate glass ceramic machinable restorations including high flexural strength and very appealing translucency[3]. Introduction of the IPS E-max, the translucency was further improved due to development of its crystalline volume and refractive index[4].

Vita enamic is the first hybrid dental ceramic with a dual-network structure (86% by wt.) ceramic is strengthened by (14% by wt.) acrylate polymer network. It has less brittleness than pure ceramic and has better abrasion than composite. The success and longevity of any restoration are related to three main criteria; strength, fit and esthetics[5].

Inaccurate margin create spaces between the margin of restoration and the prepared tooth surface. As these spaces increases and part of luting cements are soluble, plaque accumulation at this defective area followed by gingival inflammation, caries, and pulpal problems. Disturbance in the marginal accuracy can create stress concentrations that reduce the strength of the restoration and cause its fracture[6]. Some authors said that the margin of the restoration is considered clinically accepted when the marginal gaps and cement thicknesses is $< 120\ \mu$m. Different methods and testing techniques have been used to evaluate the marginal adaptation including direct microscope, cross sectional views, light bodied impression replica, laser videography using light bodied impression replica, profilometry and X ray micro-tomography which viewed 2D and 3D imaging of the space between the tooth/model die and restoration[7].

Color stability of a restoration is important as the mechanical properties of the material. Color changes by time reduce the longevity and quality of restorations. Prolonged exposure to staining solutions may discolor composite resins, CAD/CAM processed composite resins, and ceramic materials[8].

Color measurement devices, Colorimeter is a device designed to measure color by a mechanism of using filter to simulate the human eye on a fixed set of illuminant and observer conditions. The results of colorimeter were less accurate leading to commercial failure of this system. But, it is portable, cheap, and simple with a small reading. The Spectrophotometer is a device used to measure the color in numbers, which makes color selection easier and reliable[9]. Johnston WM established $\Delta E=3.7$.[10]

MATERIALS AND METHODS

In this study a total of forty caries-free human maxillary central incisors were extracted for periodontal reasons were selected. All samples were prepared to receive ceramic laminate veneer which fabricated from IPS E-max CAD and Vita Enamic. Group 1: Twenty teeth for IPS E-max CAD. Group 2: Twenty teeth for Vita Enamic.

Sample preparation:

All samples were prepared for a butt-joint preparation type with labial depth 0.5 mm, 0.3mm cervical and 2 mm incisal reduction. To standardize the amount of reduction; silicon index was made. This index was used as template to evaluate the amount of tooth reduction. A three wheel depth cutter diamond stone (Brassler, savannah, GA LVS, USA) guided the reduction. Any sharp angles were removed to prevent stress concentration.

Scanning of the preparations:

All prepared teeth were scanned by using in-lab software version 3.8. A CAD/CAM milling

machine had been used to mill the ceramic blocks. The veneers were seated and cemented with resin cement (CHOICETM 2 veneer resin cement), applying loading device with a fixed pressure of 250g for 1 min. on the prepared teeth. All samples were subjected to 20,000 thermal cycle equivalents to 20 years of oral service. The low-temperature point was 5°C. The high temperature point was 55°C.

Marginal gap measurements:

Each specimen was photographed using universal serial bus (USB) Digital microscope with a built-in camera (Scope Capture Digital Microscope, Guangdong, China). connected with an IBM compatible personal computer using a fixed magnification of 90X. Shots of the margins were taken for each specimen. Four equidistant landmarks along the cervical and incisal circumference for each surface of the specimen (Mesial, labial, distal, and incisal) were done. Each selected point was measured and repeated five times. The measures were done before and after thermo cycling of all specimens. The data were collected, tabulated and statistical analysis.

Color measurement:

Color of samples was measured using a reflective spectrophotometer (Model RM200QC, X-Rite, Neu-Isenburg, Germany). A white the background was selected and measurements were done according to the CIE L*a*b* color space relative to the CIE standard illuminant D 65. The change in color (ΔE) values was evaluated through calculation of the difference in color measurements of all samples pre and post thermo cycling by using the formula:

$$\Delta E\ (L^*a^*b^*) = [(L^*1 - L^*2)2 + (a^*1 - a^*2)2 + (b^*1 - b^*2)2]1/2$$

RESULTS

Explored data had been checked, distributed and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Student t-test and ANOVA were used to study the effect of veneers materials and thermal aging on mean values. When ANOVA test is significant; Tukey's post-hoc test was used for pair-wise comparisons. The significance level was at $P \leq 0.05$ and 95% Confidence interval.

Marginal gap measurement

Total effect of material type on marginal gap

Regardless to thermo cycling, totally it was found that Vita Enamic material group recorded lower gap mean values than E-max material group mean value. This was statistically significant ($p<0.05$) as demonstrated by two-way ANOVA (table 1).

Total effect of thermo cycling on marginal gap

Irrespective of material type, totally thermo cycling demonstrate effect on marginal gap mean values significantly ($p < 0.05$) by two-way ANOVA, where the marginal gap before thermo cycling recorded lower mean value than after thermo cycling (table 1).

Table (1) *Marginal gap reading (Mean values± SDs).*

Variable		Thermo cycling						Statistics
		Before			After			P value
		Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	
Material	E-max	67.81±14.22	47.93	101.59	86.51 ±22.37	59.95	119.90	<0.0001*
	Vita Enamic	38.07±6.16	18.70	33.90	57.48±16.19	33.08	73.97	<0.0001*
Statistics	P value	0.020*			0.0157*			

**significant (p< 0.05)* *ns; non-significant (p>0.05)*

Color measurement

Color change results (Mean±SD) for both groups after thermal cycling are summarized in (table 2). It was found that Vita Enamic material group recorded higher mean values (**D**E 2.11±2.01) than E-max material group mean value (**D**E 1.06±2.37). This was statistically insignificant ($p > 0.05$) as verified by unpaired t-test table (2).

Table (2) *Color change results (Mean±SD) for both groups after thermal cycling.*

Group \ Variables		Color change			
		DL	Da	Db	DE
Material	E-max	0.28±1.86	0.18±1.3	0.59±4.32	1.06±2.37
	Vita Enamic	0.59±2.2	0.39±1.88	1.53±2.58	2.11±2.01
Statistics	P value	0.8465ns	0.0202*	0.4688ns	0.0612ns

** significant (p< 0.05)*

ns; non-significant (p>0.05

DISCUSSION

Several improvements in material mechanical and esthetic properties have been attempted. IPS e-max CAD is a lithium disilicate glass ceramic. It was chosen due to its spcial combination of strength and aesthetic properties as natural tooth color, excellent translucency and brightness [11]. Vita enamic is a hybrid dental ceramic witch has a dual-network structure. It is less brittle than pure ceramic and has good abrasion resistant than composite. Enamic has high degree of elasticity and high strength after adhesive bonding. Moreover, It has properties almost identical to those of natural teeth including excellent light conductivity [5].

Marginal accuracy and color stability are important factors that affecting the success of fixed prosthetic restoration. In the present study, human central incisor teeth were selected for specimen fabrication to mimic the clinical cementation condition (etching and bonding), modulus of elasticity and strength represent the clinical condition better than would plastic or animal teeth[12-14].

The preparation design for laminate veneers selected in this study is the butt-joint preparation design that provides the preservation of the peripheral enamel layer on the tooth margins, which is effective in reduce micro leakage at the palatal surface, and withstand shear stresses. This design able to eliminate the prismatic and the inter prismatic mineral crystals that will improve enamel etching and enhance tooth-ceramic bonding [15].

These present study examined the effect of marginal accuracy and color stability of the laminate veneers before and after thermo cycling on two CAD/CAM ceramic materials by using one preparation design. Thermal cycling procedure is a method to simulate intraoral conditions. It is performed as clinical trials are costly and time consuming [16].

For marginal gap consideration, acceptable value had been demonstrated for the two tested materials. The acceptable clinical marginal opening is between 40 and 120 um. There was significant difference between the two materials regardless of thermo cycling with a higher mean value for E-max. After thermo cycling the E-max and Vita enamic recorded a significant increase in the marginal gap compared to the pre- thermo cycling values with a significant difference between them [17].

Our results come in the same side with a study evaluated the marginal gap of laminate veneers (butt-joint design) fabricated from Lava Ultimate, IPS e-max CAD, IPS empress CAD on a prepared epoxy resin die and cemented with resin cement. Marginal gap of all specimens were measured and recorded pre and post the artificially accelerated aging process. IPS e-max and IPS empress showed a significant statistically difference in the marginal gap due to the effect of aging with a higher mean marginal gap value than the pre-aged group [18].

This may be due to differences in the structural composition of the 2 materials. The milling bur type that used and particle size of fillers may affect restoration accuracy. Other causes such as the intrinsic properties of the CAD-CAM system, the choice of the rotary instrument in the milling machine and its speed, technique of fabrication, type of preparation design, thickness of spacer, scanning method and its accuracy, the software system and the type of restorative material [19,20].

Spectrophotometer was used to evaluate color stability. This device carries the disadvantage of being less accurate when measuring on curved surfaces when compared to the more recently invented spectroradiometer. It was however more superior to the colorimeter and was the technology available in hand [21].

Regarding the color stability in this study it was found that there was color change for both groups after thermal cycling recorded that Vita Enamic material group is higher mean values than E-max material group and that was statistically insignificant.

Our results come with a study that evaluated color stability of Vita Enamic, Lava Ultimate, e-max CAD and Filtek supreme which have been thermo cycled in coffee for 5000 cycles. They found that after exposure to hot and cold coffee, the color instability of the Vita Enamic had been perceived but was clinically acceptable. Thermo cycling inside coffee caused no perceivable color change for the E-max CAD materials at any thickness value [22,23].

Not only the filler/resin ratio is better in Vita Enamic but also the type of the resin that may contribute to the color change, as some resin monomers can be classified as stain resistant and others as non-stain resistant. UDMA is a hydrophobic monomer rendering it more stain resistant whereas TGDMA exhibits a degree of water absorption thus allows penetration of the hydrophilic colorant into the resin matrix. The color change of Vita enamic could attributed to their composition where the pores of the structured sintered ceramic matrix were filled with a polymer material rendering it a hybrid material which has dual network structure [24].

CONCLUSIONS

The following could be concluded within the limitations of this study:

1. Regardless to thermo cycling, E-max veneers recorded less marginal accuracy than Vita Enamic.
2. After thermo cycling the E-Max and Vita Enamic recorded a significant increase in the marginal gap compared to before thermo cycling.
3. E-max veneers recorded color stability better than Vita Enamic veneers after thermo cycling.

REFERENCES

1. Serdar C, Mine D, Berran O. The effect of various preparation designs in the survival of porcelain laminate veneers. J Adhes Dent. 2009; 11: 405-11.
2. Marco M, Gresnigt, Warner K, Mutlu O. Randomized clinical trial of indirect resin composite and ceramic veneers: Up to 3- year follow–up. J Adhes Dent 2012; 15: 181-90.
3. Topcu F, Sahinkesen G, Yamanel K. Influence of different drinks on the colour stability of dental resin composites. J Dent 2009; 3: 50-56.
4. Baratieri L, Guimaraes J. Ceramic laminates. In: Baratieri LN. Clinical solutions; fundamentals and techniques. Florianopolis: Point 2008;11: 214-71.
5. Coldea A, Swain M, Thiel N. Mechanical properties of polymer-infiltrated-ceramic-network materials. J Dent Mater 2013; 29:419-26.
6. Balkaya MC, Cinar A, Pamuk S. Influence of firing cycles on the margin distortion of 3 all-ceramic crown systems. J Prosthet Dent. 2005;93:346–55.
7. Contrepois M, Soenen A, Bartala M, Laviole O. Marginal adaptation of ceramic crowns: A systematic review. J Prosthet Dent. 2013;110:447-54.
8. Oliveira-Junior OB, Buso L, Fujiy FH, Lombardo GHL, Campos F, Sarmento HR, et al. Influence of polishing procedures on the surface roughness of dental ceramics made by different techniques. J Gen Dent. 2013;61:4–8.

9. Corciolani G and Vichi A. Repeatability of color reading with a clinical and a laboratory spectrophotometer. J Int Dent South Africa. 2006;8:62–70.

10. Ragain JC , Johnston WM. Accuracy of Kubelka-Munk reflectance theory applied to human dentin and enamel. J Dent Res. 2001;80:449–52.

11. Da Costa DC, Coutinho M, De Sousa AS, Ennes JP. A meta-analysis of the most indicated preparation design for porcelain laminate veneers. J Adhes Dent. 2013; 15:215–20.

12. Flinn BD, Degroot DA, Mancl LA, Raigrodski AJ. Accelerated aging characteristics of three yttria-stabilized tetragonal zirconia polycrystalline dental materials. J Prosthet Dent. 2012;108:223–30.

13. Abdul Khaliq A and Al-Rawi I. Fracture strength of laminate veneers using different restorative materials and techniques. (Acomparative in vitro study). J Bagh Coll Dent. 2014; 26:1-8.

14. Raigrodski AJ. Contemporary materials and technologies for all-ceramic fixed partial dentures: A review of the literature. J Prosthet Dent. 2004;92:557–62.

15. Joyston-Bechal A, Kidd E, Joyston-Bechal S. Essentials of dental caries: the disease and its management. 2nd ed. Oxford: Oxford University Press. 1998;66-78.

16. Boyle JJ, Naylor WP, Blackman RB. Marginal accuracy of metal ceramic restorations with porcelain facial margins. J Prosthet Dent.1993;69:19-27.

17. Hamza TA, Al-Baili MA, Abdel-Aziz MH. Effect of artificially accelerated aging on margin fit and color stability of laminate veneers. J Stomat Dis Sci. 2018;2: 1-8.

18. Reich S, Uhlen S, Gozdowski S, Lohbauer U. Measurement of cement thickness under lithium disilicate crowns using an impression material technique. J Clin Oral Investig. 2011;15:521-6.

19. Shim JS, Lee JS, Lee JY, Choi YJ, Shin SW, Ryu JJ. Effect of software version and parameter settings on the marginal and internal adaptation of crowns fabricated with the CAD/CAM system. J Appl Oral Sci. 2015;23:515-22.

20. Bolt RA, Bosch JJ, Coops JC. Influence of window size in small-window colour measurement, particularly of teeth. J Phys Med Biol. 1994;39:1133–42.

21. Stawarczy kB, Egli R, Roos M, O¨zcan M, Ha¨mmerle CHF . The impact of invitro aging on the mechanical and optical properties of indirect veneering composite resins. J Prosthet Dent. 2011;106,386–98.

22. Vita Enamic, Vita Zahnfabrik, Germany. Technical product brochure. www.vita-zahnfabrik.com.

23. Silva Leite M, Silva F, Meireles S, Duarte R, Andrade A. The effect of drinks on color stability and surface roughness of nanocomposites. Europ J Dent 2014; 8: 330-36.