COLOR STABILITY OF DIFFERENT NANO-HYBRID COMPOSITE MATERIALS ON A DIRECT ANTERIOR VENEER RESTORATION

Tran Thuy Duong[1], Tran Thien Long, Novelya[2], Wilvia[3*]

[1] Undergraduate Dental Program, Faculty of Dentistry, Universitas Prima Indonesia
[2] Department of Dental Sciences, Faculty of Dentistry, Universitas Prima Indonesia
[3] Department of Dental Material, Faculty of Dentistry, Universitas Prima Indonesia

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***Corresponding author:**
Wilvia

E-mail address:
wilviadrg@unprimdn.ac.id

*The growth of direct veneer solutions has led to new inventions in nanocomposite materials. However, the major concern of composite material is its discoloration characteristic, which cannot be tolerated in veneer restorations. The aim of this in-vitro experiment was to compare the color stability (ΔE) of nanohybrid composite materials: flowable nanocomposite (G genial Universal Flo from GC Japan) with prefabricated composite resin veneer (Componeer from Coltene: Altstätten, Switzerland). Thirty-four samples of GUF (A2) and PCRV (bleach shade) were prepared. Samples were immersed in instant coffee for 24 hours in four weeks, and were measured between weeks. GUF was pre-treated with photosynthesis using LED Halogen light (light intensity 1200-2000mw/ cm3) for 40 seconds. Then polishing and finishing GUF samples used aluminum oxide discs (Sof-Lex; 3M ESPE). Both samples were analyzed for their color changes using CIE L*a*b* system with a spectrophotometer (CM-5, Konica Minolta, Osaka, Japan). The results of the Independent T-test statistically showed a significant difference ($p<0.05$) from the average value of color stability in every week between Componeer and GUF The one-way ANOVA statistical test showed a significant difference ($p<0.05$) from the average value of color stability of both PRCV Componeer and GUF groups between weeks 1, 2, 3, and 4. After four weeks, GUF group veneer system revealed a better performance in color stability ($\Delta E = 5{,}331 \pm 0{,}707$) in comparison to prefabricated veneer groups ($\Delta E = 16{,}408 \pm 2{,}183$) with p value<0.05. In summary, GUF has less discoloration in comparison to PRCV Componeer.*

1. Introduction

Ceramic material is widely used in veneer restoration because of its characteristics in wear resistance, biocompatibility, color stability, and natural light transmission[1]. Apart from its advantages, fabricating veneer using ceramic materials has several drawbacks i.e., time-consuming and multiple visits, difficulties in repairing, and also high cost[2]. As a consequence, the resin-based composite veneer has been developed to fill in the voids in terms of economic efficiency and less chair time needed[3]. Resin composite veneer can easily achieve compatible adaptation to veneer's luting agent without any chemical aid as porcelain restoration[4]. A study of 147 direct nano-resin laminate veneer were conducted by Demirci et al (2015). It showed a high survival rate of resin composite veneer of Filtek Supreme XT (3M ESPE) used Scotchbond Multi-Purpose Plus (3M ESPE) bond was 92.8% and Ceram X duo used XP Bond (Densply DeTrey) bond was 93% after 4 years in placement[5] .

One of the innovative nano-hybrid composite restoration materials introduced to the market is G-Aenial Universal Flo (GUF) by GC Japan. Based on the manufacturer's guide, G-Aenial Universal Composite contains methacrylate monomer 31% with UDMA, Bis-MEPP, and 69% nanohybrid filler particles. Terry (2017) stated that G-Aenial Universal Flo Composite is trusted for its strength, aesthetic, and color stability[6,7]. Other study claimed that GUF was an innovative silane treatment which enhances hydrolytic stability and filler-matrix integrity[8].

Another innovative material is a prefabricated Composite resin veneer (PCRV) Componeer from Coltene Altstätten, Switzerland. Componeer is proven as fine as other Hand-layered veneer (HLV) material requiring less hand-skill, such as: Tetric N-Ceram[9]. Albuquerque et al. (2019) found that the prefabricated veneer Brilliant New Generation and Brilliant Everglow from Coltene performed better than Filtek Supreme XTE (FXT) (3M ESPE)[10].

Other study suggested the monomers and the inorganic content's refractive index of the composite has optimized the degree of the conversion leading to higher color stability[9].

Veneer discoloration is recognized as one of the major reasons for people to change their resin composite veneer restorations[11]. There are two main causes for discoloration i.e., intrinsic and extrinsic factors. Intrinsic factors were affected by physicochemical characteristics such as resin matrix, deep of cure, shade, degree of conversion, photoinitiator, water absorption, filler particle size, and degree of polymerization. Extrinsic factors including staining beverage, and alteration on the surface. Coffee has the most influenced in color changing of all composite materials [11, 12, 13]. This study aimed to compare the color stability of nano-hybrid flowable composite materials (G-Aenial Universal Flo / GUF) with prefabricated composite resin veneer Componeer (PCRV) after being stained by coffee for four weeks. Four weeks immersing continuously is similar to 2.5 years of clinical lifetime respectively as 24 hours staining in-vitro equals to one-month clinically[14].

2. Research Method

This post-test only in-vitro experimental study was designed to compare the color stability of two nanohybrid types: a flowable composite and a prefabricated veneer composite after one month introduced to colored substances. The research was held at Ho Chi Minh city from October to November 2021. In this study, all samples must be identical with the dimensions of 10 mm diameter x 1 mm thickness. Samples that were distorted, incorrect dimension, formed voids and contaminated were all discarded from this study[15,16].

Materials and Methods

2.1 G-Aenial Universal Flo (GUF) Preparation

G-Aenial Universal Flo (GUF) Shade A2 from GC Japan was used in this study. Seven-teen samples were made utilizing a plastic plate. To create a smooth surface and get rid of excessive composite, the composite is pressed using glass slides covered with mylar strips. All samples are light-cured with a LED halogen light (light wavelength 420-480 nm, light intensity 1200-2000mw/ cm3) for 40 seconds. The light curing's intensity is recorded by using a handheld radiometer prior to each curing to ensure the polymerization degree of all sample is the same. All direct veneer material samples (GUF) were finished and polished with aluminum oxide discs (Sof-Lex; 3M ESPE) and ultrasonically cleaned in distilled water for 10 minutes[17]. Thickness control used digital caliper accurate to 0.1mm (Digimatic CD- 15DCX; Mitutoyo, Kawasaki, Japan). For the optimal conversion, the samples were stored in diluted water at 37°C in shaded container for 24 hours before immersing in coffee solution.

2.2 Prefabricated Composite Resin Veneer (PCRV) Componeer Preparation

Seven-teen PRCV Componeer samples were prepared based on manufactures' guidelines, no polishing required since it was prefabricated. A digital caliper (Digimatic CD- 15DCX; Mitutoyo, Kawasaki, Japan) was used to control the samples' thickness of 0.1mm.

2.3 Coffee Preparation

The coffee used in this research is instant black coffee G7 from the Trung Nguyen brand. One pack of the instant coffee consists of 2-gram of

black coffee powder with < 5% moist and >1% caffeine. One pack of the coffee powder was poured into a bowl of 60ml hot water (80°C – 100°C) and stirred it until the coffee is completely dissolved in the water. Allowed the coffee to cool down until it reached 37°C. Immersed the samples into the solution.

2.4 Evaluation of Color Stability

All samples were measured using spectrophotometer (Spectrophotometer CM2600D, Konica Minolta, Osaka, Japan) according to the CIE L∗ a∗ b∗ (Commission Internationale de l'Eclairage, L∗, a∗, b∗) system. The color differences (ΔE) and color coordinates (ΔL∗, Δa∗, and Δb∗) between baseline week 0 (T0) and week 4 (T4) were measured and calculated using formula.

Data Analysis Method

The independent T-test, One-way ANOVA analysis, and the Least Square Differences (LSD) statistical test were conducted to compare the data collected in this study.

3. Result and Discussion

3.1. Study Result

This study showed a steady decreased in color stability for both GUF and PRCV Componeer groups after soaked in coffee solutions for 4 weeks. The discoloration seen in PRCV group were double the GUF group in week 1, and rose to three-fold starting from week 2 to week 4. The results of the Independent T-test statistically showed a significant difference ($p<0.05$) from the average value of color stability in every week between Componeer and GUF.

PRCV Componeer's color changed drastically in the first week, and increased one-fold from week 1 to week 2, from 7,607 ± 0,379 to 13,935 ± 1,800. Afterward, the color stability decreased slightly. The one-way ANOVA statistical test showed a significant difference ($p<0.05$) from the average value of color stability of PRCV Componeer between weeks 1, 2, 3, and 4.

Meanwhile, the color changes in GUF group was also noticed starting from week 1 to week 4. There was also a significant difference ($p<0.05$) from the average value of color stability of GUF between weeks 1, 2, 3, and 4.

Table 1. Color Stability Difference Between GUF and Componeer in week 1, 2, 3 and 4

	Color Stability ($\bar{X}$ ± SD)		**p-value**
	GUF	**PRCV Componeer**	
Week 0	0	0	
Week 1	3,201 ± 0,868	7,607 ± 0,379	
Week 2	4,583 ± 1,371	13,935 ± 1,800	0,000*
Week 3	5,010 ± 1,456	15,475 ± 1,965	
Week 4	5,331 ± 0,707	16,408 ± 2,183	

*Independent T-test, * significant p<0,05*

The results of the Least Square Differences (LSD) statistical test demonstrated a significant difference ($p<0.05$) from the average value of color stability of Componeer between week 1 compared to week 2, 3, and 4. However, there was no significant difference in the discoloration of Componeer in week 3 compared to week 4 ($p<0.05$).

As for the GUF group, Least Square Differences (LSD) statistical test indicated a significant difference ($p<0.05$) from the average value of color stability of GUF between week 1 compare week 2, 3, and 4. Based on the test, there was no significant difference ($p<0.05$) from the average value of color stability of GUF between week 2 compare to week 3 and 4.

3.2. Discussion

As an indirect veneer restoration, esthetic is one of the most concerns. Therefore, color stability has become a golden standard for an aesthetic material to be trusted in clinical uses. Nanohybrid technology has been developed to replace conventional composite because of its improved features: less shrinkage, balanced strength, and aesthetic[18]. This study evaluates the color stability of the new methacrylate-based nanohybrid composite materials G Aenial Universal Flo (GUF) and Prefabricated Composite Resin Veneer (PRCV) Componeer. Componeer prefabricated veneer was made especially for direct veneer technique. The PRCV fabrication process, including polymerization and polishing, is in the factory to ensure controlled quality and homogenity[3]. Also, the prefabricated forms bring aesthetic appearance and easily handled by practitioners[4]. In contrast, GUF materials requires lots of handling to form the anatomy, polishing and finishing of the final veneer restoration. Since the result affected by lots of factors, there is no guarantee that GUF color stability is surpassed.

PRCV Componeer is made of 80% inorganic material. Many reports ruled out higher inorganic contents create less discoloration on resin because resin matrix has high water absorption[19]. Nonetheless, its particle size (0.02 to 2.5μm) is larger than GUF (16nm – 200nm) which only accounted for 69% of the inorganic property. Aside from particle size, Arregui (2015) found that TEDGMA causes discoloration for its hydrophilic characteristic, and TEDGMA combining with Bis-GMA leads to the worst effect on color stability[12]. While Componeer has the combination of both TEDGMA and Bis-GMA (G-Aenial Universal

Injectable from Technical Manual, ver 1.0, 2018) (Componeer brochure). Besides, polishing smaller particles can create a smoother surface in respectively to large particles composite[20]. Hence, these explained the results in this study, in which Componeer has lower color stability compared to GUF.

4. Conclusion

Within the limitations of this experiment, the study concludes that properties of G aenial Universal Flo (GUF) surpassed PRCV Componeer material as direct veneer restoration. Despite the results obtained, the outcome of the materials in clinical placements also depends a lot on the luting agent system and handlings such as tooth preparation, polishing and finishing of materials. So far, there was no clinical trials study on GUF nor PRCV Componeer. Thus, further clinical studies with longer follow-up are suggested to be conducted in corporation with studies in a laboratory to evaluate the mechanical and optical properties of these direct veneer materials.

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