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Research Article

Effect of One-Step Polishing Systems and Bleaching on Gloss after Staining of Resin Composites

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Abstract

Aim: To evaluate the effects of two one-step polishing systems (OneGloss and PoGo) on gloss of two nanocomposite resin composites (Clearfil Majesty Esthetic and Filtek Z350 XT) before and after exposure to a staining solution. In addition, the effects of one office-bleaching agent (Ultradent Opalescence Boost PF 40%) on gloss of the resin composites after staining was evaluated.

Materials and Methods: Forty cylindrical specimens were prepared from each resin composite against Mylar strip (Mylar) and were tested for gloss (T1). The specimens were randomly assigned to four groups of 10 each. Each specimen was finished using a tungsten carbide finishing bur (Finish) and was measured for gloss (T2). Then, specimens were polished (Polish 1) with OneGloss or PoGo and was measured for gloss (T3). All specimens were stained (Stained) in coffee solution for 4 days and was measured for gloss (T4). Specimens were polished (Polish 2) with OneGloss or PoGo and then bleached (Bleach) with Ultradent Opalescence Boost PF 40% for 40 minutes and was measured for gloss, T5 and T6, respectively.

Results: There was a statistically significant differences ($P < 0.05$) between the two resin composites for gloss after Mylar strip. Also, after Polish 2, a statistically significant difference for gloss for both polishing systems OneGloss or PoGo on both resin composites was evident, with PoGo producing a higher gloss value. At Mylar strip and after Finish, there was no statistically significant difference in the two resin composites. Conclusion: PoGo polishing was less susceptible to staining and produced the highest gloss. Staining reduces the gloss for both resin composites. Re-polishing and bleaching do not increase gloss for either resin composite.

Clinical Significance: The use of PoGo polishing system made nanocomposite resins less susceptible to staining and produced the highest gloss. Re-polishing and bleaching do not increase gloss for either resin composites.

Keywords: *Finishing/Polishing; Gloss; Nanofilled Resin Composite; In vitro; Esthetics*

Introduction

Various resin composites restorative materials are available for direct restoration of children teeth [1,2]. The surface properties of restorative materials play important role in the clinical success [3]. Some studies revealed that surfaces of restoration maybe affected by finishing and polishing [4,5]. Finishing is performed to create an anatomical shape and remove excess restorative material while polishing is performed to increase the shine of restoration and yield a natural look resembling enamel [4,5]. Most recent restorative materials have been introduced to the dental profession to meet demands for better esthetics [6]. The physical properties of different restorative materials such as gloss are influenced by exposure to the oral environment [3]. Gloss is an important property and is used primarily as a measure of surface shine [7]. The gloss of a surface may be defined as its degree of approach to a mirror surface. A perfect mirror surface is said to have maximum gloss [8]. Gloss is measured in Gloss Units (GU) and is measured using a glossmeter. A glossmeter measures the specular reflection of a specimen [7,8]. The light intensity is registered over a small range of the reflection angle (60°). Gloss and polishability as a whole is material dependent i.e. it depends on the material/manufacturer as to how well the material can be polished to a smooth surface [9].

The foundation of esthetically pleasing smile concept is the unrecognizable esthetically pleasing dental restoration. Today's resin composites provide the dental practitioner a number of choices for a restorative method and material and offer more control over the final result than in the past [10,11]. Resin composites are increasingly used for direct restoration of teeth due to their favorable physical, optimal esthetics, and mechanical properties, and availability of efficient bonding systems [10,11]. Nanotechnology is known as the production and manipulation of materials and structures in the range of about 0.1 - 100 nm by various physical and chemical methods [12]. One of the latest resin composite technology is the nanofilled composite, which features a large amount of very small filler than the traditional microfilled composites and is designed to provide good mechanical properties, high translucency, high polish and maximum esthetics [12-14], allowing it to be used as both posterior and anterior restorations, thus replacing the microhybrid and microfill resin composites.

For resin composites different finishing and polishing procedures are routinely employed such as diamond points, carbide burs, abrasive disks, polishing pastes, as well as one-step polishing systems such as PoGo and OneGloss by which contouring, finishing, and polishing can be completed using a single instrument in minimal time [5,15,16]. PoGo is a one-step diamond micropolisher and OneGloss is an aluminum oxide finisher and polisher, which provide ideal finish for all types of resin composites [5,16]. Generally, resin composites with smaller size filler particles provides better surface finish than one containing larger filler particles [17]. Highly polished surfaces can be achieved by reducing inorganic particle size [18]. One-step polishing systems such as PoGo (DENTSPLY/Caulk, Milford, DE, USA) and OneGloss (Shofu INC, Japan) were introduced by which contouring, finishing, and polishing can be completed using a single instrument in minimal time [16]. PoGo is a one-step diamond micropolisher and OneGloss is an aluminum oxide finisher and polisher, which provide ideal finish for all types of composite and cemented restorations [5,16].

To our knowledge, limited studies have evaluated the maintenance of surface gloss of nanocomposite resin restorative materials after different polishing, staining, and re-polishing or bleaching. Therefore, the aims of the present *in vitro* study were to evaluate the effects of two one-step polishing systems (PoGo and OneGloss) on gloss of two nanocomposite resin restorative materials (Clearfil Majesty Esthetic and Filtek Z350 XT) before and after exposure to a staining solution. In addition, the effect of one office-bleaching agent (Ultradent Opalescence Boost PF 40%) on gloss of the two nanocomposite resins after exposure to staining was evaluated. The null hypothesis tested was there is no difference in the gloss among the resin composites after different polishing, staining and re-polishing or bleaching.

Materials and Methods

In this *in vitro* study, 40 cylindrical specimens (8 mm diameter, 2 mm thickness) were prepared from each nanocomposite resin Clearfil Majesty Esthetic (Kuraray Medical Co, Tokyo, Japan) and Filtek Z350 XT (3M ESPE, St. Paul, USA) material (shade A3) according to the instructions of the manufacturers using cylindrical metal molds. Each material was placed into the cylindrical metal molds and covered with a Mylar matrix strip (Mylar Uni-Strip, L.D., Caulk Co., Milford, DE, USA) and pressed using glass slide (Shandon Polysine Slides, Thermo Scientific, Kalamazoo, MI, USA) in order to flatten the surface. The specimens were polymerized according to the instructions of the manufacturers using a LED curing light (Elipar S10, 3M ESPE, Seefeld, Germany) on each side and no further trimming, finishing or polishing was carried out. The bottom surface of each specimens was marked to avoid it is exposure to the applied tested instruments and materials. Specimens were stored in distilled water for 72 hours at room temperature (25°C). Specimens were thermocycled 1500 times cycles (SD

Mechatronik GmbH Dental Research Equipment, W. Germany) in baths at 5°C and 55°C, with 5 seconds transfer time and 30 seconds dwell times. The specimens prepared from each material were randomly allocated to four groups with 10 specimens each. All specimens were measured for gloss (Testing Phase One - T1). The gloss (surface reflectance) of each specimen was recorded (Mylar Step) with a small area glossmeter (Rhopoint Novo-Curve Gloss meter, Rhopoint Instruments, Leonards on Sea, East Sussex, UK) in gloss units (GU) which correlates light reflectance to the visual sensation of gloss. Measurements were made at the center of each specimen's surface. The specimens were moved over the glossmeter for 30 seconds recording the highest value obtained.

Each specimen in all groups was finished (Finishing Step) using a tungsten carbide finishing bur # 7206 (SS White Burs Inc., Lakewood, New Jersey, USA) for 15 seconds in a rotary motion to simulate initial finishing of the restorative material. A single investigator polished all specimens. One tungsten carbide finishing bur was used for each specimen. All specimens were measured for gloss (T2). Specimens were stored in distilled water for 24 hours at room temperature (25°C).

Each group was subjected to different surface treatment of the entire surface. Surface treatments include OneGloss (Shofu INC, Japan) or PoGo (DENTSPLY/Caulk, Milford, DE, USA) polishing system (Polish 1 Step) for 30 seconds (A new polishing disc was used for each specimen surface treatment). The same investigator polished all specimens. All specimens were measured for gloss (T3). Specimens were stored in distilled water for 24 hours at room temperature (25°C).

All specimens were immersed in staining coffee solution for 4 days and kept in an incubator (Stained Step). The coffee solution was prepared using 11g powder (NESCAFE Classic Nestlé Brazil, Araras, Brazil) to 500 mL water. The solution was changed after 2 days. The initial pH value of the solution was measured using 3540 conductivity/pH meter (JENWAY-Barloworld Scientific, CM6 3LB, Essex, England) and recorded as 4.943, and the second pH value of the solution was recorded as 4.993. The disks were placed in a container with testing side facing up exposed to the staining solution. Then the specimens were cleaned ultrasonically (Eurosonic energy; Euronda SpA, Vicenza, Italy) in distilled water for 30 min and dried with air spray before testing according to modification of the methods described by Um and Ruyter (1991) [19]. All specimens were measured for gloss (T4). Specimens were stored in distilled water for 24 hours at room temperature (25°C).

Each group was subjected to different surface treatment similar to T3 above (Polish 2 Step) and then the surface was bleached (Bleach Step) using Ultradent Opalescence Boost PF 40% (Ultradent Opalescence Boost PF 40%) for 40 minutes. All specimens were polished and bleached by the same investigator. All specimens were measured for gloss after polishing (T5) and bleaching (T6).

Statistical analysis

Means and standard deviations were recorded for surface gloss. The results were analyzed using one-way and two-way repeated measures analysis of variance (ANOVA) and Fisher's least significant difference (LSD) test. The gloss recorded between different groups, within each group, and experimental conditions were evaluated. Correlations between staining and staining improvements as related to gloss was evaluated. All statistical analyses were set at a significance level of $P < 0.05$. The statistical analysis was performed with SPSS Version 20.0 (SPSS Inc. Released 2007. SPSS for Windows, Chicago, SPSS Inc., Ill).

Results

Table 1 show the comparisons of the means and standard deviation of gloss between the two resin composites during different steps. The statistical analysis showed significant differences ($P < 0.05$) between the two resin composites for gloss after Mylar. Also, after Polish 2 and Bleach, a statistically significant difference for gloss ($P < 0.05$) for both polishing systems PoGo and OneGloss on both resin composites was evident. Mean gloss with PoGo produced a higher gloss value.

	Clearfil Majesty Esthetic		Filtek Z350 XT	
Mylar	75.8 ± 15.9^{a}		92.5 ± 9.5^{A}	
Finish	9.9 ± 3.8		10.2 ± 3.1	
	OneGloss	**PoGo**	**OneGloss**	**PoGo**
Polish 1	47.3 ± 9.8	58.9 ± 9.5	53.4 ± 9.3	57.4 ± 6.2
Stained	37.7 ± 11.9	49.9 ± 9.4	36.7 ± 7.4	54.1 ± 4.7
Polish 2	34.4 ± 6.4^{b}	48.8 ± 4.3^{c}	46.8 ± 5.5^{B}	61.2 ± 4.6^{C}
Bleach	38.7 ± 5.8	49.6 ± 5.7	40.9 ± 6.4	48.6 ± 7.1

Table 1: *Means and standard deviation of gloss at the different steps. Comparison between Clearfil majesty esthetic and filtek Z350 XT*.*
**: Horizontal comparisons means with corresponding superscript letter show a statistical significance - P-value < 0.05.*

Table 2 show vertical comparisons of gloss for Clearfil Majesty Esthetic. There was a statistically significant difference for gloss at Mylar and Finish (P < 0.05). In addition, a statistically significant difference for gloss between Finish and Polish 1 (P < 0.05) was evident for both OneGloss and PoGo (P < 0.05) polished resin composites. In addition, there was a statistically significant difference for both OneGloss and PoGo from Polish 1 to Stained (P < 0.05) specimens. However, there was no statistically significant difference for either OneGloss or PoGo between Stained and Polish 2 and Bleached specimens. When comparing Polish 1 and Polish 2 and Polish 1 with Bleached specimens, a significant difference was found for both OneGloss and PoGo from Polish 1 to Polish 2 and Bleached specimens (P < 0.05). A reduction in gloss between Stained and Polish 2 was noted, but this reduction was not significant.

	Clearfil Majesty Esthetic	
Mylar	75.8 ± 15.9^{A}	
Finish	9.9 ± 3.8^{a,b,c}	
	OneGloss	**PoGo**
Polish 1	47.3 ± 9.8^{B,D,F,G}	58.9 ± 9.5^{C,E,H,I}
Stained	37.7 ± 11.9^{d}	49.9 ± 9.4^{e}
Polish 2	34.4 ± 6.4^{f}	48.8 ± 4.3^{h}
Bleach	38.7 ± 5.8^{g}	49.6 ± 5.7^{i}

Table 2: *Means and standard deviation of vertical comparisons of gloss at the different steps for Clearfil majesty esthetic*.*
**Vertical comparisons means with corresponding superscript letter show a statistical significance - P-value < 0.05.*

Table 3 show horizontal comparisons of gloss for Clearfil Majesty Esthetic. Comparing the two polishing systems at testing phases Polish 1, Stained, Polish 2 and after Bleach showed a significant difference (P < 0.05) in gloss with PoGo one step polishing system producing a higher gloss surface.

	Clearfil Majesty Esthetic	
Mylar	75.8 ± 15.9	
Finish	9.9 ± 3.8	
	OneGloss	**PoGo**
Polish 1	47.3 ± 9.8^{a}	58.9 ± 9.5^{A}
Stained	37.7 ± 11.9^{b}	49.9 ± 9.4^{B}
Polish 2	34.4 ± 6.4^{c}	48.8 ± 4.3^{C}
Bleach	38.7 ± 5.8^{d}	49.6 ± 5.7^{D}

Table 3: *Means and standard deviation of horizontal comparisons of gloss at the different steps for clearfil majesty esthetic*.*
**: Horizontal comparisons means with corresponding superscript letter show a statistical significance - P-value < 0.05.*

Table 4 show vertical comparisons of gloss for Filtek Z350 XT. The results show a statistically significant difference for gloss at Mylar and Finish. A statistically significant difference for gloss between Finish and Polish 1 ($P < 0.05$) was found for both OneGloss and PoGo. Unlike Clearfil Majesty Esthetic, there was only a significant difference ($P < 0.05$) when comparing Polish 1 to Stained for OneGloss. When comparisons are made between Stained and Polish 2, for either OneGloss or PoGo respectively, there was no statistical difference between the two one step polishing systems. Comparing OneGloss and PoGo at Polish 1 and Polish 2 showed no statistically significant difference between the two polishing systems. However, a statistical difference was found between OneGloss and PoGo at Polish 1 with Bleached ($P < 0.05$).

	Filtek Z350 XT	
Mylar	92.5 ± 9.5^{A}	
Finish	$10.2 \pm 3.1^{a,b,c}$	
	OneGloss	**PoGo**
Polish 1	$53.4 \pm 9.3^{B,D,E}$	57.4 ± 6.2^{F}
Stained	36.7 ± 7.4^{d}	54.1 ± 4.7
Polish 2	46.8 ± 5.5	61.2 ± 4.6
Bleach	40.9 ± 6.4^{e}	48.6 ± 7.1^{F}

Table 4: *Means and standard deviation of vertical comparisons of gloss at the different steps for Filtek Z350 XT*.*
**Vertical comparisons means with corresponding superscript letter show a statistical significance - P-value < 0.05.*

Table 5 show horizontal comparisons of gloss for Filtek Z350 XT restorative materials. Comparing between the two polishing systems at testing phases Stained, Polish 2, and Bleached showed a statistically significant difference ($P < 0.05$) with PoGo producing a higher gloss.

	Filtek Z350 XT	
Mylar	92.5 ± 9.5	
Finish	10.2 ± 3.1	
	OneGloss	**PoGo**
Polish 1	53.4 ± 9.3	57.4 ± 6.2
Stained	36.7 ± 7.4^{a}	54.1 ± 4.7^{a}
Polish 2	46.8 ± 5.5^{c}	61.2 ± 4.6^{c}
Bleach	40.9 ± 6.4^{d}	48.6 ± 7.1^{d}

Table 5: *Means and standard deviation of horizontal comparisons of gloss at the different steps for Filtek Z350 XT*.*
**: Horizontal comparisons means with corresponding superscript letter show a statistical significance - P-value < 0.05.*

Discussion

The tested null hypothesis in this investigation was rejected, as there were some differences of surface gloss of the two resin composites under the different testing steps. In the present *in vitro* study, the surface gloss was analyzed because it has been demonstrated that physical properties of different restorative materials such as surface gloss is influenced by exposure to the oral environment [3]. One of the clinical significance of the surface gloss property is its degree of surface shine [7], which influences the failure or success of esthetic restorations. In this study, the Glossmeter has been specifically chosen because it has the ability to measure surface gloss of a restricted area [20]. In the present study, gloss values (GU) changed as the resin composites materials progressed from Mylar to various stages of finishing, polishing, staining, re-polishing and bleaching of the materials. A gloss value of < 10 GU is considered to be low in gloss, 10 - 70 GU is considered semi-gloss, and > 70 GU is considered high gloss [21-23]. There are three main geometries for gloss measurements: 20°, 60° and 85° [21-23]. The choice of which will be used actually depends on GU value obtained at 60°: if values recorded are under 10 GU, an 85° geometry should be used, for 10 - 70 GU a range of 60° is most suitable, while if gloss of more than 70 GU at 60°, a 20° geometry would be the most appropriate [21-23]. For reference, a totally non-reflective surface will have 0 GU and a perfect mirror will read 1000 GU at 60° [24,25]. Since the majority of the values obtained for the polished resin composites were in the 10 - 70 GU range, and because this geometry has been used in previous studies, a 60° geometry was chosen for this study. Standardizing of the experiment conditions further justifies the usage of the same 60° geometry for all the specimens and all the phases of testing the materials. Difference in surface gloss of tested restorative materials in this study may be due to their surface gloss, which is influenced by reflective capacity. Light reflectance is generally influenced by several factors such as surface properties, type of illumination, and position of the observer [26]. During the course of this study, when comparing the two resin composites, Filtek Z350 XT had higher gloss values. At Mylar step, both resin composites materials were considered to be categorized as high gloss with a mean gloss values of 92.5 GU for Filtek Z350 XT and 75.8 GU for Clearfil Majesty Esthetic, with Filtek Z350 XT having the higher gloss. All other measured gloss values for various stages of testing were in the category of semi-gloss with the exception of gloss values after Finish, which was considered low gloss category. This indicates that a significant amount of gloss was lost by finishing with the tungsten carbide bur and that after polishing with OneGloss (an aluminum oxide finisher and polisher) and PoGo (one-step diamond micropolisher) a significant amount of gloss returned to both resin composites, however, not to the levels of baseline.

Between initial polishing (Polish 1) with OneGloss or PoGo and staining the samples, a significant difference was observed with gloss decreasing to lower values for both resin composites with the exception of the Filtek Z350 XT group polished by PoGo, in which no change was observed between tests. This finding is consistent with previous studies reporting that polishing systems are resin composite material dependent [9,27,28]. After Staining of the resin composites and Polish 2/Bleached (re-polished with OneGloss or PoGo or Bleached the resin composites that had been initially polished with OneGloss or PoGo), there was no significant difference is gloss for either resin composites type re-polished with either type of polishing system or after bleaching. This data suggests that after staining the samples with coffee, re-polishing or bleaching of the resin will have no effect on gloss of the material. This is in contrast to the study by Bowles., *et al*. [29] that concluded surface reflectance showed significant changes in microfilled and hybrid resin composites after application of highly concentrated tooth whiteners with 30 - 35% hydrogen. The authors contributed these changes in surface reflectance to more subtle changes in the surface and perhaps in the immediate subsurface. However, differences in results of the two studies may be due to different types of resin composites materials used or different concentrations and time of bleaching application. A significant difference in gloss value was found between Polish 1 and Polish 2 for both polishing systems and Bleached for the Clearfil Majesty Esthetic resin composite, but only a significant difference between Polish 1 and Bleached for the Filtek Z350 XT resin composite. This again suggests that the effectiveness of the finishing/polishing systems was material dependent, which was also seen by Yap., *et al* [28]. When comparing the two polishing systems to one another a significant difference for both resin composites can be seen at all testing phases (with the exception of after Finishing) with PoGo producing the highest gloss value. This is consistent with Paravina., *et al*. [27] that PoGo produces highly glossed surfaces compared to other polishing systems.

The results of this investigation should consider the limitations of the study, including it is *in vitro* setting. *In vitro* studies lack reproduction of oral environment, such as saliva, oral mastication and antagonist occlusion, and other factors, which affect the surface of the restorative materials. In addition, the clinical condition in the mouth is not easy to mimic in the laboratory setting [30]. Nevertheless, *in vitro* studies can provide isolated data of some variables with no interference from other factors. Thermocycling was performed in this study to simulate some aspects of the oral environment. Another limitation of this study was the use of two resin-composites only. It would be beneficial if more and different restorative materials/systems are tested. In addition, restorative material surface was flat which do not mimic clinical situation. However, despite these limitations, the research does describe a number of positive links between *in vitro* effect and clinical effect.

Conclusion

Under the experimental conditions and the methodology of this *in vitro* study, the following conclusions can be made:

1. PoGo polishing was less susceptible to staining.
2. PoGo polishing system produced the highest gloss. Staining reduces the gloss for both materials.
3. Filtek Z350 XT showed the highest gloss at all stages of testing with the exception of after finishing.
4. Re-polishing and bleaching do not increase gloss for either resin composites.
5. Repolishing and bleaching only affects Clearfil Majesty Esthetic that had been polished and re-polished with OneGloss or polished by OneGloss and then bleached.
6. Regardless of the materials, Mylar produced the highest gloss values. Polishing systems are resin composite material dependent.

Clinical Significance

This study stresses that regardless of the materials, Mylar produced the highest gloss values and polishing systems are resin composite material dependent. The use of PoGo polishing system made nanocomposite resins less susceptible to staining and produced the highest gloss. Repolishing and bleaching only affects Clearfil Majesty Esthetic that had been polished and re-polished with OneGloss or polished by OneGloss and then bleached.

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