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In Vitro Effects of Sof-Lex, Eve, and Astropol Polishing Systems on Composite Resin Surface Roughness after Aging

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ABSTRACT

Objectives: Surface roughness is one of the important properties of composite restorations. Different polishing systems are used to provide an appropriate composite restoration surface. The aim of this study was to evaluate the effects of Sof-Lex, Eve, and Astropol polishing systems on composite resin surface roughness after aging.

Materials and Methods: In this in vitro study, 36 composite discs (8×2mm) were fabricated. The specimens were randomly divided into three groups (N=12) for polishing with (I) Sof-Lex (3M ESPE), (II) Eve (Ernst Vetter GmbH), and (III) Astropol (Ivoclar/Vivadent) polishing systems. The specimens were then subjected to thermocycling. Surface roughness of the specimens was measured before and after polishing, and after thermocycling by a contact profilometer. Repeated Measures ANOVA was used to analyze the data ($\alpha=0.05$).

Results: Although Astropol showed slightly higher surface roughness in comparison to Sof-Lex and Eve, the level of surface roughness before and after polishing and after aging was not significantly different among the three polishing systems ($P=0.704$).

Conclusion: Within the limitations of this in vitro study, Sof-Lex, Eve, and Astropol showed similar acceptable results with regard to composite resin surface roughness.

Keywords: Composite Resins; Dental Polishing; Surface Properties

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INTRODUCTION

Composite resins are among the extensively used restorative dental materials due to their optimal esthetics, adhesion capacity, longevity, and thermal insulation [1-3]. The success of esthetic restorations depends on the color stability and mechanical properties of the materials used. Discoloration and alteration in optical properties of composite restorations are among the common problems and challenges encountered after composite restorations [4-6]. Free surface roughness has a significant impact on the durability and color of tooth-colored restorations in the oral cavity [7]. A rough surface has disadvantages such as enhanced plaque accumulation, tooth decay, and decreased resistance to staining, among others [8]. Superior esthetic outcomes and patient satisfaction are among the reasons behind the use of tooth-colored restorative materials [9]. Alteration in esthetic properties of composite resins over time, especially discoloration caused by the rough surface of restorations, can result in patient dissatisfaction after treatment, and can lead to restoration replacement and damage to the remaining tooth structure, and cause dental pulp injury [10]. Therefore, finding a way to improve the characteristics of composite resins and their durability in the long-term is essential and a research priority.

Nowadays, different methods are used to improve composite properties. Polishing of composite restorations is among the suggested techniques to decrease their surface roughness [11]. Silicone discs, tungsten carbide burs, rubber cups, abrasive strips, and polishing pastes are used for this purpose, and are available in one-step and multistep polishing systems [12-16]. However, there is still controversy regarding the efficacy of different types of polishing systems. A previous study discussed that despite reduction of surface roughness by using one-step polishing systems, their efficacy depends on the type of composite as well [17]. Another study reported that the multistep systems decreased the surface roughness, and yielded a smoother surface [18].

Considering the existing controversy and shortcomings of previous studies [10,13], this study aimed to assess the effect of Sof-Lex, Eve, and Astropol polishing systems on the surface roughness of a nanohybrid composite after aging. The null hypothesis of the study was that Sof-Lex, Eve, and Astropol polishing systems would have no significant difference in terms of their effect on surface roughness of a nanohybrid composite before and after the aging process.

MATERIALS AND METHODS

This study was approved by the Research Ethics Committee of Islamic Azad University (approval code: IR.IAU.DENTAL.REC.1399.155).

In this in-vitro study, Estelite Sigma Quick® supra-nano filled composite resin (Tokuyama, Tokyo, Japan) was used to fabricate 36 composite discs. The discs had 8mm diameter and 2mm height, and were fabricated using a cylindrical stainless-steel mold. First, the mold was placed on a glass slab, and composite was packed into it. Then, a Mylar strip was placed over the composite discs to achieve a smooth surface after light-curing. All specimens were cured for 60 seconds by a halogen curing unit (Optilux, Kerr, Orange, CA, USA) with a light intensity of 800mW/cm^2. The tip of the light curing device was placed perpendicular to the Mylar strip over the composite discs in contact with the glass slab. The specimens were incubated for 20 hours at 37°C with a relative humidity of 97%±3%.

The surface roughness of the specimens was initially measured before polishing (baseline) by a contact profilometer (T8000; Hom md work. Jenoptk, Germany). A diamond stylus scanned the surface of the specimens at a speed of 0.5mm/s with 4mN force.

The specimens were then randomly divided into three groups (N=12) based on the type of polishing system: (I) Sof-Lex (3M ESPE, St Paul, MN, USA), (II) Eve (Ernst Vetter GmbH, Pforzheim, Germany), and (III) Astropol (Ivoclar/Vivadent, Liechtenstein, Germany) polishing system. The specimens were polished in each group according to the manufacturer's instructions (Table 1).

In the first group (Sof-Lex), the polishing disc was used with gentle pressure for 30 seconds. In the second group (Eve), medium and soft radial bristle disc brushes were used each for 15 seconds with rotational movement with 3000-8000rpm. In the third group (Astropol), wet polishing was performed with rotational movement and continuous pressure for 10 seconds at 10,000rpm. After the polishing process, the surface roughness of the specimens was measured for the second time. The specimens were then subjected to 5000 thermal cycles for aging in a thermocycler (TC300; Vafae factory, Tehran, Iran), which included immersion in water baths between 5° and 55°C for 20 seconds with 20 seconds of transfer time. The surface roughness of the specimens was measured again after thermocycling. Thus, the mean surface roughness values (Ra) and maximum surface roughness (Rmax) were measured in each group before polishing, after polishing, and after aging.

Table 1. Properties of the three polishing systems used in this study

Polishing system	Type and steps	Composition	Application
Sof-Lex	Aluminum oxide discs. Four steps	Medium (29µm) Fine (14µm) Superfine (5µm)	Each step 30 seconds, gentle pressure of the polishing discs.
Eve	Spiral wheels of flexible aluminum oxide. Two steps	Polish in two groups of pink radial bristle disc brush (medium) for pre-polish and cream color radial bristle disc brush (fine) for high shine polish.	Each step 15 seconds with 3000-8000rpm.
Astropol	Rubber polishers impregnated with silicon carbide aluminum oxide, titanium oxide and iron oxide. Three steps	Caoutchouc, silicon carbide, aluminum oxide, titanium oxide and iron oxide. (Coarse: gray [45mm], fine: green [1mm])	The polishing procedure was started with gray followed by green and finally the pink rubber cup, each for 15 seconds.

To analyze the difference in level of surface roughness, repeated measures ANOVA was applied considering the type of polisher as the between-subject factor. Values less than 0.05 were considered statistically significant.

RESULTS

In the present study, the level of surface roughness of nanocomposite discs polished with three polishing systems of Sof-Lex, Eve and Astropol was measured before polishing, after polishing and after aging by thermocycling. The mean and standard deviation of surface roughness of the groups are shown in Figure 1and Table 2.

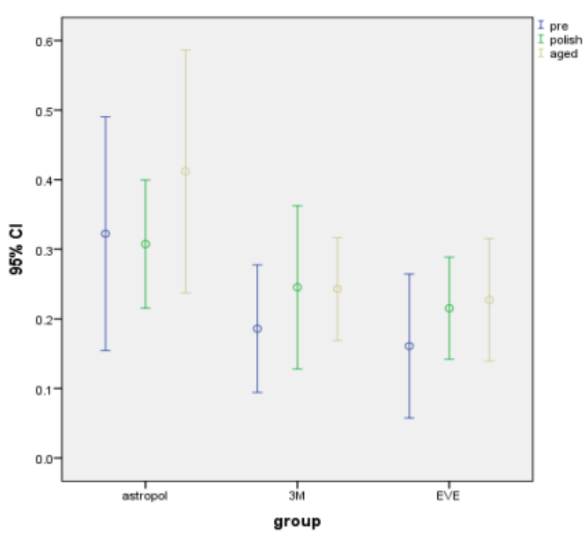

Fig 1. Mean and standard deviation of surface roughness of the specimens using the three polishing systems.

According to repeated measures ANOVA, there was no significant difference among the three polishing systems in level of surface roughness before polishing, after polishing, and after aging (P=0.704).

Table 2. Mean and standard deviation of surface roughness of the specimens in the three groups of polishing systems (N=12)

Time	PS	Mean	SD	Min	Max
Baseline	Astropol	0.32	0.26	0.05	0.73
	Sof-Lex	0.18	0.14	0.04	0.47
	EVE	0.16	0.16	0.04	0.64
	Total	0.22	0.2	0.04	0.73
After polishing	Astropol	0.3	0.14	0.07	0.52
	Sof-Lex	0.24	0.18	0.06	0.74
	EVE	0.21	0.11	0.08	0.42
	Total	0.25	0.15	0.06	0.74
After aging	Astropol	0.41	0.27	0.11	1.04
	Sof-Lex	0.24	0.11	0.08	0.47
	EVE	0.22	0.13	0.06	0.52
	Total	0.29	0.2	0.06	1.04

PS: polishing system; SD: standard deviation; Min: minimum; Max: maximum

DISCUSSION

Surface roughness of restorations can affect both esthetics and biological properties, and can enhance discoloration, abrasion, and plaque accumulation, followed by secondary caries. Evidence shows that surface roughness can also affect gingival health because restorations with a rough surface enhance plaque accumulation and decrease the efficiency of oral hygiene practice [19].

It is important to know which finishing and polishing systems provide optimal surface quality for successful composite resin restorations in clinical practice. Surface roughness of composite resins can change depending on the polishing process, and structure, type, flexibility, hardness, and grain size of materials used in this process [20].

The aim of this in vitro study was to assess the effect of three composite polishing systems namely Sof-Lex, Eve, and Astropol on surface roughness before and after polishing and after aging. The results of the present study showed that the level of surface roughness after the polishing and aging process was not significantly different among the three systems of Sof-Lex, Eve, and Astropol, and the performance of all three was the same. Thus, the null hypothesis of the study was accepted. The lowest surface roughness was related to Sof-Lex polishing system which was similar to the findings of some previous studies [20-22].

Nemati Anaraki et al. [23] indicated that among three different Eve polishing systems, the flexible aluminum oxide discs yielded the lowest surface roughness compared to Rubber Polisher Teco and Intensive twisted rubber polisher in microhybrid composites.

Aging of composite resins is often the result of mechanical mechanisms of physical degradation such as attrition, abrasion, and fatigue. It may also be due to chemical degradation mechanisms such as temperature-related decomposition or enzymatic, hydrolytic, and acidic processes. Thermo-cycling is a common method to simulate hydrothermal aging [24]. In the present study, the temperature of water baths changed between 5°C and 55°C for the aging process of composite resin specimens. Gale and Darvell [25] showed that usually 10,000 thermal cycles are equivalent to one year of clinical service, and each 20 to 50 cycles are equivalent to one day of clinical service. In the present study, 5000 thermal cycles were considered, which are approximately equivalent to 6 months of clinical service.

Since the maximum water sorption of composite resins occurs during the first 20 hours [26], the specimens were stored in distilled water at 37°C for 24 hours before the study. In addition, this process simulated the first day of intraoral restorations [27].

There are several methods for assessment of surface roughness, such as surface contact profilometry, atomic force microscopy, and laser spectrometry. Evidence shows that in many cases, there is a positive relationship between the abovementioned three methods [28]. Surface roughness is often assessed by measuring the Ra value using profilometry [29]. In the present study, a contact profilometer was used to assess the surface roughness.

The surface roughness values obtained in the present study ranged from 0.161µm to 0.461µm. Although there is no accepted threshold for assessment of surface roughness, Bollen et al. [30] reported that surface roughness levels more than 0.2µm may increase plaque accumulation, risk of caries, and periodontal inflammation. In the current study, Sof-Lex and Eve polishing systems yielded roughness values lower or slightly higher than 0.2µm, but the level of surface roughness created by Astropol was higher than 0.2µm. The Astropol system can be less effective due to the use of abrasive silicon carbide particles. It has been suggested that silicon carbide abrasive particles may not be as effective as aluminum oxide particles and diamond abrasives for use in finishing and polishing systems of composite resins [19]. On the other hand, patients may feel some levels of roughness by their tongue when the surface roughness value exceeds 0.5µm [21]. In the present study, the surface roughness values were lower than 0.5µm in all three polishing systems, which were consistent with the results of Hassan et al, [27] and Nemati Anaraki et al [23].

In a recent systematic review [31] on different polishing systems, aluminum oxide was one of the most important components used to achieve a smooth surface. Multistep polishing systems such as Astropol and Sof-Lex discs were the most effective. However, the Eve polishing system was not included in the review, but was evaluated in the present study.

It appears that since nanocomposites contain nanoparticles of the same size [27], Sof-Lex system (aluminum oxide discs), spiral wheels of Eve (flexible aluminum oxide discs), and Astropol system (silicon carbide) yielded equal level of surface roughness in this type of composite.

CONCLUSION

Based on the results of the present in vitro study and considering its limitations, it appears that Sof-Lex, Eve, and Astropol had similar acceptable performance with regard to composite resin surface roughness.

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CONFLICT OF INTEREST STATEMENT

None declared.

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