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Original Article

Dentistry Section

Evaluation of Bulk Fill Composite Roughness Polished with Spiral Rubber Discs: An In-vitro Study

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ABSTRACT

Introduction: Restorations with high surface roughness directly influences restorative procedure longevity. When used correctly, polishing systems optimises the quality, aesthetics and longevity of composite resins.

Aim: To evaluate the influence of three two-step polishing systems of spiral rubber discs on surface roughness of three different bulks fill composite resins.

Materials and Methods: This in-vitro study was conducted from May 2021 to January 2022, at the Universidade Estadual de Pernambuco, School of Dentistry, Recife, Pernambuco, Brazil. Total 20 specimens of each resin {three Bulk Fill resins: Filtek One Bulk Fill (3M-ESPE), Aura Ultra Universal Restorative Bulk Fill (SDI) and Opus Bulk Fill (FGM)} were randomly divided into four groups (n=5 each). The three groups include test polishing systems {Sof-Lex Diamond Polishing System (3M/ESPE, Saint Paul, Minnesota, USA), Decamp Plus Twist Spiral EVE (Odontomega, Ribera Prato, SP, Brazil), Spiral Swivel (Jota, Ruth, Kanton St. Gallen, Switzerland)} and one control group include no polishing system. To assess surface roughness, before and after polishing, specimens were evaluated on a digital rugosimeter. Data was subjected to the Shapiro-Wilk test to assess normality, followed by Analysis of Variance (ANOVA) to compare the mean between the different types of resins and types of polishers.

Results: For the composite resins studied, significant differences were observed only when polished with Sof-lex Spiral (p-value=0.013). All polishing system caused a significant improvement in the roughness of composite resins compared to the control group. The mean roughness reduction comparison test between the types of polisher was significant (p-value <0.001), there was a significantly greater reduction in the roughness of EVE Decamp Plus Twist Spiral and Swivel Spiral polish system, compared to polish system from Sof-Lex Diamond Polishing System and control group. No statistically significant differences were found between EVE Diacomp Plus Spiral and Spiral Swivel polishing system.

Conclusion: The spiral rubber polishers evaluated were effective in reducing the roughness of bulk fill composites. However, EVE Decamp Plus Spiral and Spiral Swivel polishers showed better results than Sof-Lex Spiral.

Keywords: Composite resins, Dental aesthetic, Dental polishing

INTRODUCTION

Bulk fill composite resins are materials able to restore teeth in single increments upto 5 mm in depth [1]. This modality of composite resins have good clinical longevity, chemical and mechanical properties [2], being classified into low viscosity or high viscosity, depending on the load present in the resin matrix [3]. However, regardless of the restorative material used, restorations with high surface roughness directly influence restorative procedure longevity [4]. Therefore, polishing systems have been developed in order to smoothing the restoration and consequently, avoid plaque accumulation, gingival inflammation, recurrent caries, surface staining, and discomfort [5,6].

Although polishing procedure in posterior composite restorations is difficult due to anatomical characteristics required to posterior teeth [7,8], this step should not be neglected, as a perfectly polished surface of composite resin leads to improved mechanical properties such as microhardness and better aesthetic appearance [4,6,9].

Finishing and polishing procedures influence the quality, aesthetics and longevity of composite resins, whereas the finishing step is defined as contouring or reducing the restoration to obtain the ideal anatomy, the polishing step promotes the smoothing of roughness and reduction of surface scratches created by the instruments used in finishing [10]. However, the finishing and polishing steps provides not only a good aesthetic result, but also marginal integrity and, consequently, good soft tissue health [11].

Recently, spiral rubber discs have been developed and used by dentists. These materials are able to polish posterior teeth restorations without harming the anatomy produced during the restorative procedure [12]. However, there are few studies about the effectiveness of these polishers in bulk fill composite resins surface roughness [13,14]. Thus, the aim of this study was to evaluate the influence of three two-step polishing systems of spiral rubber discs on surface roughness of three different bulk fill composite resins. The objective of study was to evaluate the surface roughness in three bulk fill resins: Filtek One Bulk Fill (3M-ESPE), Aura Ultra Universal Restorative Bulk Fill (SDI) and Opus Bulk Fill (FGM) submitted to three two-step polishing systems of spiral rubber discs: Sof-Lex Spiral (3M-ESPE), EVE Decamp plus Spiral (Odontomega) and Swivel Spiral (Jota).

The null hypotheses of this study were: (I) there is no difference in the surface roughness caused by the different polishers tested, (II) there is no difference in the surface roughness of the different composite resins tested.

MATERIALS AND METHODS

This in-vitro study was conducted from May 2021 to January 2022, at multiuser materials research laboratory at the Universidade Estadual de Pernambuco, School of Dentistry, Recife, Pernambuco, Brazil.

Sample size calculation: The sample was calculated based on previous studies [13,14]. Based on a mean and standard deviation found (±0.2), a significance level of 5% and a test power of 80%,

a minimum size required per group was three. Two more samples were added considering possible losses, so five samples per group were taken for this study. The sample size was calculated using the website calculoamostral.bauru.usp.br (University of São Paulo, Bauru, São Paulo, Brazil).

Bulk fill: Three composite bulk fill resins-

- Filtek One Bulk Fill, (3M/ESPE, Saint Paul, Minnesota, USA),
- Aura Ultra Universal Restorative (SDI, Bayswater, Westminster, Australia),
- Opus Bulk Fill (FGM, Joinville, SC, Brazil)

Spiral rubber discs: Three sets of spiral rubber discs selected for this study-

- Sof-Lex Diamond Polishing System (3M/ESPE, Saint Paul, Minnesota, USA),
- Decamp Plus Twist Spiral EVE (Odontomega, Ribera Prato, SP, Brazil)
- Spiral Swivel (Jota, Ruth, Kanton St. Gallen, Switzerland)

The manufacturers and the protocols of tested polishing systems are presented in [Table/Fig-1]. Samples with bubbles, cracks or scratches were excluded.

Material	Manufacturer	Protocols
Sof-Lex Diamond Polishing System	3M/ESPE, Saint Paul, Minnesota, USA	Polishing was performed with water irrigation, low speed and light pressure, It was performed two polishing stages: **Spiral 1:** A beige pre-polisher spiral was used to smooth and remove scratches in restorations that develop during contouring. **Spiral 2:** A pink diamond-embedded spiral was used to aid in achieving high polish.
EVE Decamp Plus Twist Spiral	Odontomega, Ribeirão Preto, São Paulo, Brazil	Polishing was performed with water irrigation, low speed and light pressure, It was performed two polishing stages: **Pink-Medium Grain:** Pre-Polishing-DT-DCP14m, DT-DCP10m **Gray-Fine Grain:** Final Brightness-DT-DCP14f, DT-DCP10f
Swivel Spiral	Jota, Rüthi, Kanton St. Gallen, Switzerland	Polishing was performed with water irrigation, low speed and light pressure, with counter clockwise rotation. **Step 1:** Pre-polishing: Polisher 9150 (red). **Step 2:** High Gloss Polish: Polisher 9837 (grey).

[Table/Fig-1]: Protocols and manufacturers of the polishing systems used in the study.

Preparation of Specimens

Twenty cylindrical specimens of each resin was obtained using a stainless steel split matrix with 4 mm in diameter and 2 mm thickness. On a glass slide, the metallic matrix was placed and filled with each composite resin. Another glass slide was placed over the resin and pressed to obtain a plane, smooth and polished surface. After this, light curing was performed for 20 seconds (800 mW/cm^2; VALO, Ultra dent, Salt Lake City, UT, EUA) according to Dias MF et al., [15].

After making the samples, they were evaluated under a stereomicroscope (40X magnification) and after these steps, the specimens were randomly divided into four subgroups (three tests, one for each spiral disc tested and 1 control, without treatment) (n=5). In order to facilitate the specimens reading, the resin blocks were fixed in acrylic resin. Subsequently, the specimens surface were sanded with #400 and #600 water sandpaper for 1 minute (each) in a polisher (Aropol 2VPU, Aortic, Coria, Brazil) to simulate the roughness of the composite resin caused during the finishing of the restoration. After that, all specimens were stored in distilled water at 37°C for 24 hours. Then, specimen's surface roughness was assessed before and after polishing procedure, which was performed by a single operator, according to the manufacturer's instructions.

Roughness Evaluation

Before performing the polishing procedures with spiral discs, all specimens were submitted to surface roughness reading (Portable Rugosimeter SJ-310-4MN, Mitutoyo, Kawasaki, Japan), in three different directions (vertical, horizontal and transversal). The surface of each sample was analysed at a length of 1.25 mm, at a speed of 0.5 mm/sec, three times, and thus obtained the mean surface roughness in Ra (µm).

Polishing Procedure

To carry out the polishing of the specimens, the spiral discs were coupled to a micromotor with 1,200 rpm for 3 minutes in contact with the sample (X-Smart Plus, Dentsply, Mailer), the polishing time was defined based on the manufacturer's recommendations. The order of use of polishers was followed by the instructions of each manufacturer [Table/Fig-1]. In the control group, no polishing was performed. After finishing the polishing of all specimens, they underwent to a new roughness evaluation cycle in the digital rugosimeter, following the same protocols detailed above.

STATISTICAL ANALYSIS

The data obtained was carried out using Statistical Package for Social Sciences (SPSS) software version 23.0 (Inc. Chicago, IL, USA). To assess normality, the data were subjected to the Shapiro-Wilk test, followed by Analysis of Variance (ANOVA) to compare the mean between the different types of resins and types of polishers. In the comparisons that the ANOVA test showed statistical significance, a two-by-two comparison was made using the Tukey's test. All analysis used a 5% significance level.

RESULTS

Mean values and standard deviation of the initial roughness according to the type of resin and polisher are presented in [Table/Fig-2]. It was verified that, on average, the level of roughness caused by the water sandpaper in the polishing tool was similar among the composite resins. This indicates homogeneity of the specimens distributed among the different types of polishers and resins at the beginning of the analysis.

Polishing system	Resins			p-value (ANOVA)
	Filtek 3M (Mean±SD)	AURA (Mean±SD)	FGM (Mean±SD)	
Control	1.30±0.23	1.25±0.05	1.12±0.08	0.162
Sof-Lex Diamond polishing system	1.13±0.15	1.11±0.09	1.17±0.08	0.710
EVE Diacomp Plus Twist Spiral	1.15±0.07	1.17±0.07	1.10±0.08	0.298
Swivel Spiral	1.21±0.14	1.20±0.11	1.08±0.09	0.215
p-value (ANOVA)	0.330	0.398	0.132	-

[Table/Fig-2]: Mean and standard deviation of the initial roughness according to the type of resin and type of polish system.
p-value <0.05 was considered as statistically significant

[Table/Fig-3] showed the mean and standard deviation of the variation in roughness after polishing, according to the type of resin and polishing system. It was demonstrated that for Filtek One Bulk Fill resin (3M-ESPE) there was a lower value of surface roughness reduction when using Sof-Lex Diamond Polishing system when compared to Swivel Spiral, followed by EVE Decamp Plus Twist Spiral polisher (p-value <0.001). However, all polishing systems significantly reduced the roughness of composite resins when compared to control group.

For Aura resin (SDI) there was a higher roughness reduction value when the Swivel Spiral polish system was used, followed by the

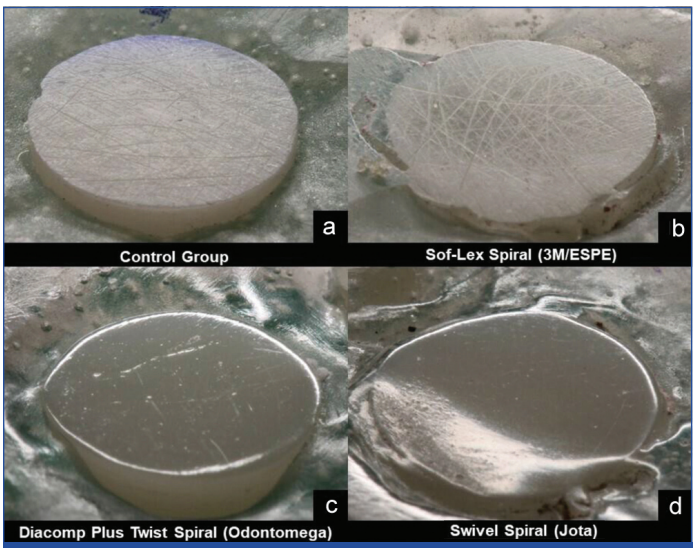
Polishing system	Resin roughness reduction (µm)			p-value (ANOVA)
	Filtek 3M (Mean±SD)	AURA (Mean±SD)	FGM (Mean±SD)	
Control	-0.158[a]±0,096	-0.125[a]±0.051	-0.075[a]±0.053	0.204
Sof-Lex Diamond polishing system	-0.493[b]±0,131	-0.478[b]±0.122	-0.738[b]±0.134	0.013*
EVE Diacomp Plus Twist Spiral	-0.955[c]±0,0912	-0.972[c]±0.105	-0.908[b,c]±0.102	0.589
Swivel Spiral	-1.019[c]±0,118	-1.022[c]±0.107	-0.956[c]±0.066	0.513
p-value (ANOVA)	<0.001	<0.001	<0.001	-

[Table/Fig-3]: Mean and standard deviation of the variation in roughness reduction after polishing according to the type of polisher and composite resin.
*Statistical differences (Tukey's Test)
[a]The control group differs significantly (p-value <0.05) from the other groups
[b]The Sof-Lex Spiral 3M polisher differs significantly (p-value <0.05) from other polishers
[c]The polisher EVE and swivel spiral have the same performance (p-value >0.05)

EVE Decamp plus Twist Spiral polish system, Sof-Lex Diamond Polishing System compared to the control group. Also, the mean roughness reduction comparison test between the types of polisher was significant (p-value <0.001), there was a significantly greater reduction in the roughness of EVE Decamp Plus Twist Spiral and Swivel Spiral polish system, compared to polish system from Sof-Lex Diamond Polishing System and control group.

In FGM resin, there was a higher value of roughness reduction when the Swivel Spiral polisher was used, followed by EVE Decamp Plus Twist Spiral polisher, and Sof-Lex Diamond Polishing System compared to the control group. The comparison test of the mean roughness reduction between the types of polisher was significant (p-value <0.001).

When comparing the resins, for EVE Decamp Plus Twist Spiral and Swivel Spiral polishers there was no significant difference in the level of roughness reduction between Filtek One Bulk Fill (3M-ESPE), Aura Ultra Universal Restorative (SDI) and Opus Bulk Fill (FGM) resins (p-value=0.589 and p-value=0.513; respectively). For Sof-Lex Diamond Polishing system there was a significantly greater reduction in roughness when used in Opus Bulk Fill (FGM) resin when compared to 3M-ESPE and Aura (p-value=0.013) [Table/Fig-3,4].



[Table/Fig-4]: The roughness/smoothness obtained in resins composite with the different spiral rubber discs tested. (a) In the control group, no polishing was performed, the surface roughness can be observed. (b) In the Sof-lex Spiral (3M-ESPE) group there is a decrease in roughness when compared to the control group, but a surface roughness is still noticeable. (c) In the Decamp Plus Twist Spiral (Odontomega) and (d) Swivel Spiral (Jota) groups there is a smoothness and surface shine obtained from the use of polishers.

DISCUSSION

The first null hypothesis was rejected since a statistically significant difference was observed between the tested polishing systems. The Sof-Lex Spiral (3M-ESPE) promoted less reduction in the surface roughness of the three bulk fill composite resins studied when compared to the Spiral Swivel (Jota) and Decamp plus Twist Spiral (Odontomega) polishers. The second null hypothesis was also rejected since statistically significant differences were observed between the polishing ability of the different bulk fill restorative materials researched.

The aesthetic of composite resin restorations can be influenced by finishing and polishing steps, colour stability, as well as the material of choice used [16,17]. These composites, when in an acidic environment (low pH), can change their surface structure, losing the smoothness of the surface obtained with polishers, resulting in a rougher surface [18]. However, when polishing is performed correctly, the surface roughness is considerably reduced, as seen in this comparative in-vitro study.

In the present study, the resins showed similarity in the initial surface roughness, as well as, in general, responded in a similar way to the polishers. It was also observed that the surface roughness is influenced not only by the type of resin, but also by the polishing procedure used. According to St-Pierre L et al., the quality of the polished surface depends on the flexibility of the instrument, its shape and hardness. When these materials are used in posterior teeth, the spiral rubber discs through their anatomical shape, guarantee to polish the scars and fissures with greater ease [19].

Restorations in composite resin without adequate polishing present roughness, being more susceptible to greater adhesion of bacterial plaque and greater presence of biofilm. These materials, regardless of the brand, tend to have a lower bacterial adhesion by *S. Mutans* compared to those that have not obtained any surface treatment, such as when going through the finishing step with diamond tips [20]. According to Satou J et al., these factors can lead to the failure of the restorative procedure, in addition to facilitating the installation of periodontal diseases and secondary caries [21]. In another study, Endo T et al., showed that not performing this step can lead to a decrease in longevity when compared to restorations that underwent finishing and polishing [6].

In a study by Bansal K et al., it was found that the use of Sof-Lex (3M/ESPE) spiral disc polisher provided a better surface smoothness when compare to others polishing systems. This finding differs from the present study, in which was observed that the Spiral Swivel (Jota) polisher had a greater reduction in roughness compared to the 3M polisher. This lower roughness reduction of Sof-lex spiral polishing system could be attributed to its greater spiral flexibility compared to EVE Decamp Plus (Odontomega) and Swivel (Jota) spirals [22].

Some researchers in the literature report the importance of using a polishing paste [23,24]. However, in this study, this hypothesis was discarded, as according to the manufacturers, the spirals discs have diamonds in their composition, dispensing with the use of diamond paste for polishing.

There is a variety of polishing materials available in the market, such as sanding discs, abrasive rubber tips, diamond pastes and spiral discs made of rubber impregnated with diamonds [8]. This last method is presented as a clinically attractive option for being a single step and having greater simplicity in its use. Alves LMM et al., performed the test with these four types of polishers and according to the results; they all promoted an acceptable level of smoothness [25]. In this study, three polishing systems commonly used in dental clinics were evaluated, however there are only a few studies in which evaluated EVE Decamp plus polishing systems performance [26,27]. From that, it is important to analyse each situation, since not all polishers are able to satisfactorily polish an occlusal surface, for example.

Composite resins are classified in different ways, but an important classification is the size and percentage of their inorganic filler added to the organic matrix. This can significantly influence surface roughness [28]. It is well-established that resin compounds with smaller particle sizes facilitate higher gloss and lower surface

Author's/Year of study	Sample size	Place of study	Polishing materials	Parameters assessed	Conclusion
Bansal K et al., (2019) [22]	10	Punjab, India	Sof-Lex polishing system, Shofu composite polishing system	Composite restoration and enamel surface roughness	Finishing and polishing of composite restoration can achieve a surface roughness similar to that of enamel.
Paolone G et al., (2020) [13]	15	Milan, Italy	Sof-Lex Spiral Wheels, HiLuster PLUS,Astropol, Opti1Step (OS)	Roughness and gloss of full-body bulk-fill materials	The tested combinations of bulk-fill and polishing systems provided clinically acceptable results with regard to roughness, while the outcome was poor for gloss. Multistep finishing/polishing systems were able to produce smoother surfaces on full-body bulk-fill materials compared to simplified ones.
Lassila L et al., (2020) [14]	3	Turku, Finland	Laboratory polishing with different silicon paper grits, Sof-Lex spiral and Jiffy Polisher	Surface roughness, surface gloss and surface hardness	The tested chairside polishing protocols presented lower surface gloss and higher surface roughness values than the laboratory polishing protocols.
Rigo LC et al., (2018) [30]	18	Rio Grande do Sul, Brazil	Sof-Lex and Astropol	Surface roughness	Sof-Lex created rougher surfaces for bulk fill composites. It was concluded that surface roughness was related to material composition rather than the polishing system.
Present study, 2022	5 in each group	Recife, Brazil	Sof-lex Spiral, EVE Diacomp Plus Spiral and Spiral Swivel	Surface roughness	The spiral rubber polishers evaluated were effective in reducing the roughness of bulk fill composites. However, EVE Diacomp Plus Spiral and Spiral Swivel polishers showed better results than Sof-Lex Spiral.

[Table/Fig-5]: Characteristics of similar studies.

roughness values after sequential polishing protocols [25,29,30]. In the case of the present study, it was known that bulk fill resins have larger particles and in smaller amounts to provide a translucency that allows a light curing in larger increments [17]. However, according to results obtained in [Table/Fig-3], Sof-Lex Diamond Polishing System presented statistical significance when all composite resins were compared, this data may be influenced by the particle size of resins, which is different although all composite resins were bulk fill. Thus, greater attention should be given to the choice of correct polishing system to be used in this class of restorative material. Similar studies have been tabulated in [Table/Fig-5] [13,14,22,30].

Thus, with the results obtained in this study, it can be concluded that when polisher system is chosen and performed correctly, the surface roughness of the restorative material is enhanced, reducing the surface grooves and consequently minimising the chances of biofilm accumulation on its surface.

Limitation(s)

This study had limitation of difficulty in reproducing the clinical characteristics that could affect the results found such as contact with saliva and acidic drinks as well as habits that could change the roughness of materials such as brushing, use of abrasive agents and occlusal contacts.

CONCLUSION(S)

The Spiral Swivel (Jota) and Decamp Plus Twist Spiral (EVE) polish system were more effective in reducing the surface roughness of bulk fill composite resins when compared to Sof-Lex Spiral (3M-ESPE). The bulk fill composite resins investigated performed similarly to be polished with the different spiral polishers studied. However, further studies are necessary in order to assess the long-term roughness of these materials.

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- iThenticate Software: May 26, 2022 (9%)

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