

Research Article

Microscopic Comparison of the effect of Three Polishing Systems on a Nanofiller Composite Resin

Andrés A Barraza-Gómez^{1*}, Norma Cruz Fierro², A Nevárez-Rascón¹, José A Peña Flórez-Portillo¹, Grecia M Coco Carrillo¹

¹Research Department at the Faculty of Dentistry, Autonomous University of Chihuahua, Mexico

²Research Department at the Faculty of Dentistry, Autonomous University of Nuevo León, Mexico

Correspondence author: Andrés A Barraza-Gómez, Research Department at the Faculty of Dentistry, Autonomous University of Chihuahua, Mexico;
E-mail: estetica dental23@gmail.com

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Abstract

In restorative dentistry, selection of materials is decisive to obtain optimal aesthetic results, in the case of dental resins, the size characteristics and particle distribution of the different polishing systems, constitute a factor considerably influences the results.

Objective: The purpose of the present research work was to compare three systems employed to polishing composite resin, documenting the results at the microscopic level, to identifying which of them showed better results concerning the roughness.

Material and methods: Three polishing systems were evaluated: Soflex from 3M®, Optra Pol and Astrobrush from Ivoclar® Vivadent and Jiffy Hishine from Ultradent, employing the LSM 700 Confocal Microscopy System, also roughness was observed and registered on the surface of a nanofiller resin Tetric Evoceram Ivoclar® Vivadent inserted in stainless steel molds.

Results: The roughness mean observed were as follows: 13.95µm for Soflex of 3M®, 13.45µm for Optra Pol of Ivoclar® and 8.05µm for Jiffy Hishine Ultradent. All data recorded in Microsoft Excel 2010 IBM STATISTICS, determinated statistical differences between the groups of Ultradent®.

Conclusion: The lowest roughness corresponded to Ultradent with values of 8.01µm.

Keywords: Resin; Roughness; Polishing System

Introduction

Surface roughness represents a relevant aspect of restorative materials in dentistry since the function of the material in tooth rehabilitation, as well as the biological and aesthetic functional ones [1]. Roughness is an area of relevance in the clinical aspect as it influences the resistance

to wear, color change of the restorative material and the accumulation of dental plaque in places where the restorative material is not well polished on the other hand, employment [2,3]. The use of dental resins in restorative dentistry has an important application in the reconstruction of the dental structure, since by applying the material properly, it can return aesthetics and function to the dental organ [4]. Dental composite resins were introduced as a restorative material in the 1960s, these are compounds based on dimethacrylates and silane-coated inorganic fillers with high demand for treatments by patients, in which restorative material will be used to aesthetically match the natural organ [5,6]. In this regard, the success of the restorations depends on several aspects such as the treatment on the surface where the resin is going to be applied and the polishing elements and techniques [7,8]. The finish of resin restorations is transcendental as it confers characteristics aimed at imitating the natural surface of the enamel [9-11]. The application of aesthetic dental treatments, as well as the current trend of minimal intervention, has caused dental companies to improve their dental products, which depend to a high degree on the polishing and finishing systems used since this is a fundamental step for the success of the treatment [12-14]. Nowadays there is a wide variety of resin polishing systems and instruments to achieve a surface finish that resembles natural enamel as closely as possible, to name a few elements, the use of multi-sheet carbide cutters, diamond cutters, disc stones and strips with an abrasive finish, polishing pastes, soft or hard rubber cups and wheels with abrasives [9,15,16]. Regarding the average roughness of the surface of the tooth enamel,

corresponding to the approximate values of $0.64\mu\text{m}$ in the Roughness Index, therefore, this roughness index is a reference to follow since the central nervous system interprets irregularities in the oral cavity greater than $15\mu\text{m}$ as unpleasant. Therefore, in any polishing system, this value must be considered as a minimum concerning polishing systems, they give the restoration an ideal finish and anatomy through an adequate reduction of roughness with special instruments to achieve it [17-19].

The main purpose of this research work was to make a comparison of three polishing systems applied to a nanofill composite resin, documenting the results at the microscopic level, to identify at the microscopic level, which of them showed better results for the roughness identified and recorded.

Material and Methods

In order to compare three polishing systems applied to a resin composed of nanofillers and to identify microscopically their roughness values, 21 specimens of Tetric N Evoceram Ivoclar® Vivadent® composite nanohybrid resin of the following dimensions 8 mm in diameter by 5 mm in depth were studied, which were divided into 3 groups of 7 resin specimens, employing as a resin Tetric Evoceram Ivoclar® Vivadent (Table 1).

Polishing Systems	Composition	Process	Manufacturer
Sof-lex disc (three step)	Aluminum oxide	Medium grit disc 8690M - 20 s, fine grit disc 8690F - 20 s, superfine grit disc 8690SF - 20 s.	3M ESPEUSA
Jiffy HiShine	Aluminum oxide	White abrasive silicon carbide particles and aluminum oxide particles impregnated rubber cups ($1\mu\text{m}$).	Ultradent products. INC., South Jordan, UT, USA
Astropol-Ivoclar/Vivadent	Silicon rubber impregnated with diamond particles aluminum oxide and iron oxide	Silicon rubber.	AstropolIvoclar/Vivadent, Liechtenstein Germany
Astropol-Ivoclar/Vivadent	Silicon rubber impregnated with diamond particles.	Silicon rubber.	AstropolIvoclar/Vivadent, Liechtenstein Germany

Table 1: Polishing systems characteristics.

Specimen Preparation and Polishing

Resins were poured into stainless steel molds, in cavities of dimensions of 8 mm in diameter and 5 mm deep and were photopolymerized for 20 seconds each, using a VALO LED lamp from the Ultradent company, superimposing on the resin by means of Spedeex Coltene Whaledent / Coa silicone preforms to make a mask with a thickness of 1.5 mm to achieve an over-sealing on the stainless steel specimens and polishing on the resin [18,20,21], the resins were subjected to the 3 polishing systems, being the following: group 1 of 3M® with the system with the Soflex polisher, group 2 with Jiffy Hishine by Ultradent® and group 3, Ivoclar® with the Optra Pol system.

Microscopic Analysis

The samples were analyzed with the LSM 700 confocal microscopy system (Fig. 1) to identify the aspects related to roughness and for the surface contrast the JSM-6510LV Scanning Electron Microscope SEM was used at medium magnifications that generated reference micrographs at 500 x.

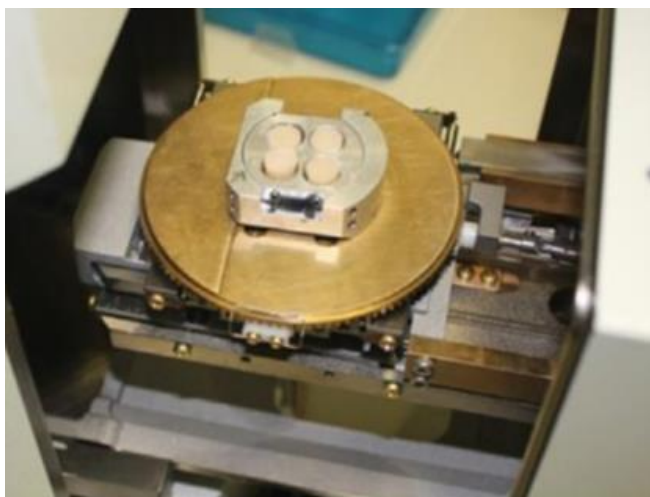


Figure 1: Samples mounted in the vacuum chamber of the confocal equipment for analysis.

Statistical Analysis

Data normality tests were applied for quantitative variables. bias, kurtosis and Shapiro Wilk, as well as a descriptive statistic in mean and standard deviation of the continuous variables, parametric inferential statistics, ANOVA test to compare the mean roughness between groups and Tukey's post hoc test to identify the differences between specific groups, establishing a value of statistical significance equal to or less than 0.05.

Results

Due to the SEM analysis at medium magnification, it was possible to observe the microstructural features on the surface in which the clear particles visible on the surface correspond to granular elements of the polishing material, while the dark areas correspond to small craters of the resins, also is possible to observe the scratch marks from polishing (Fig. 2).

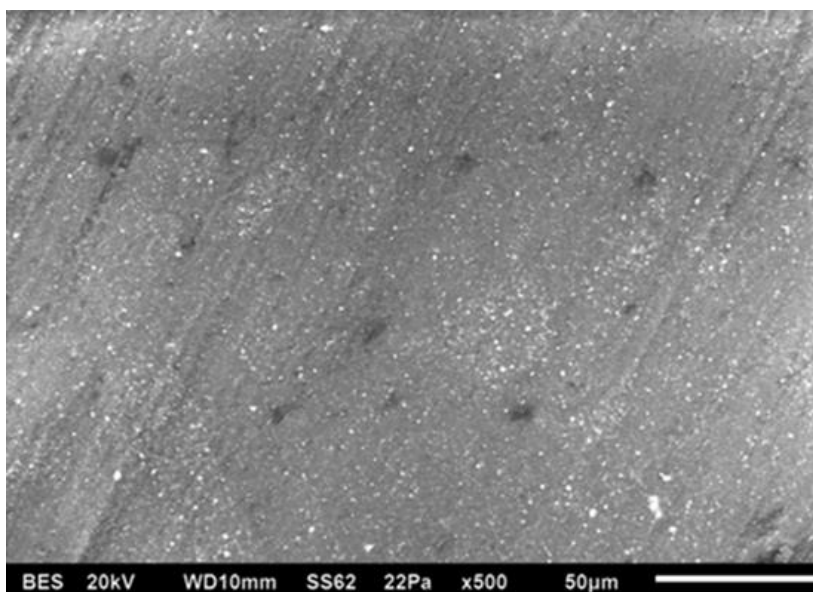


Figure 2: Representative specimen of polished® resin with the Optra Pol system.

On Table 2, statistically significant differences manifested between the different systems, showing that the polishing system determinate the degree of surface roughness.

Statistical	Group 1 Ivoclar Resin + Soflex 3M Polisher	Group 2 Ivoclar Resin + Ultradent Polisher	Group 3 Ivoclar Resin + Ivoclar Polisher
Stocking	13.95	8.01	13.45
Median	11.40	7.53	14.46
Standard deviation	5.87	1.29	2.86
Variance	34.46	1.66	8.17
Minimal	9.57	6.75	8.84
Maximum	26.79	9.53	16.78
Rank	17.23	2.78	7.94
n	7	7	7
IC95% LI	8.52	6.81	10.81
CI95% LS	19.38	9.20	16.10

Table 2: Comparative roughness values between the groups, expressed in μm to determine the Arithmetic Mean Roughness, where the minimum values are related to the most polished samples.

The significant differences between the different polishing treatments of the resins confirming that the polishing system used did influence the surface roughness, in this regard, the best results were linked to the lower roughness, these values corresponding to group 2, in which the Ultradent polishing system registered a mean of 8.01 microns of roughness, a median of 7.53 microns, a variance of 1.66 microns, with maximum values of 9.53 microns and a minimum of 6.75 microns, a range of 2.78 microns, this polishing system was superior with respect to the Ivoclar group which showed a mean of 13.45 microns, a median of 14.46 microns, with a standard deviation of 2.86 microns and a variance of 8.17 microns, with the minimum values varying from 8.84 microns to the maximum of 16.78 microns, with a range of 7.94 microns, the 3M Soflex group, on the other hand, showed results similar to the Ivoclar system with a mean of 13.95 microns, Median of 11.40 microns, obtaining the widest standard deviation of the 3 systems with 5.87 microns and a variance of 34.46 microns with minimum values of 9.57 microns which was the highest minimum value of the 3 polished systems as well as its maximum value which was 26.79 microns, obtaining a range of 17.23 microns, with these tables we can see that the best results were obtained by the Ultradent polishing group (Fig. 3, Table 3).

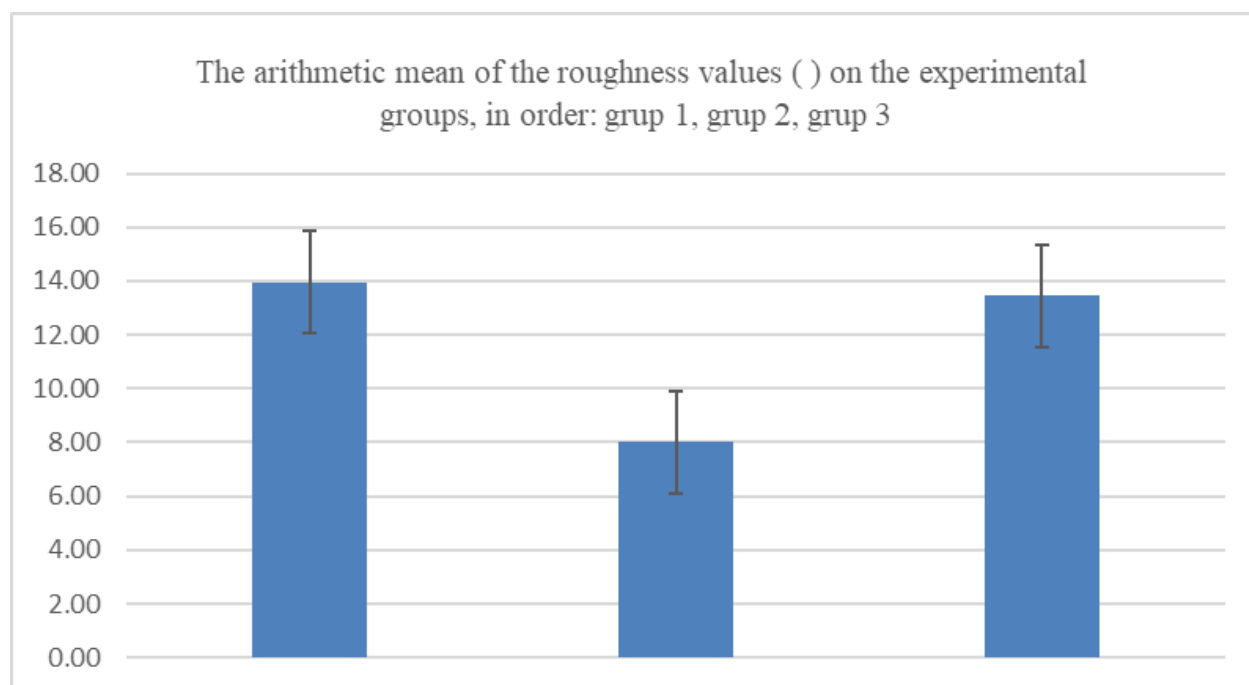


Figure 3: Comparative roughness values between the groups.

		Test T	Standard Error	Statistical Significance	Confidence Interval Lower Limit	Confidence Interval Upper Limit
Group 1	Group 2	5.95	2.05	0.025	0.70	11.19
	Group 3	0.50	2.05	0.968	-4.74	5.74
Group 2	Group 1	-5.95	2.05	0.025	-11.19	-0.70
	Group 3	-5.45	2.05	0.041	-10.69	-0.20
Group 3	Group 1	-0.50	2.05	0.968	-5.74	4.74
	Group 2	5.45	2.05	0.041	0.30	10.69

Table 3: Statistical results of Student's test t.

Discussion

The polishing of composite resins is a determining factor in the aesthetic and functional characteristics of composite resin restorations, also influencing their longevity, some studies have found that multi-step polishing systems are less effective than single-step ones, which was proven in the comparative study carried out with the Astropol Ivoclar® and Soflex 3M® systems, which obtained the best results, coinciding with the present study, where Ivoclar® showed the most appropriate values as a polishing system compared to the other polishing brands for composite resin [21-24]. On the other hand, Panna, et al., measured the roughness of three types of composite resin, which were: GC Sculpt, Filtek Z350 XT and Tetric N Ceram, also polishing them with paste impregnated with diamond particles, noting that the Tetric N Ceram resin obtained the best result in respect of the others due to its composition in its nanofiller, which is smaller, which is why it was decided to use this resin in the present study, concerning the polishing system, a comparative study between the Jiffy Hishine polishing systems of Ultradent Vs Soflex 3M® and Optra Pol Astrobrush of Ivoclar® confirmed that the Ultradent® system showed the best results in terms of the roughness coefficient [13,25]. The polishing of composite resins is one of the crucial procedures to achieve the proper surface characteristics of composite resins and the fine finish aimed at reducing surface roughness [26]. The texture of the surface is a critical point, so it is recommended to use multiple rotaries cutting instruments of fine and superfine diamond, as well as abrasive discs of aluminum oxide with diverse types of grains, so the use of different polishing systems will provide a good finish [27]. In most studies, it was conducted comparing one-, two- or more-step systems [28]. In particular, the comparison that was made in this study corresponded to a contrasted step to two two-step systems, the Jiffy Hishin one-step polishing system of the commercial house Ultradent®, the one that was linked to the lower values of roughness, compared to the others, in this regard Parasher, et al., in their study entitled comparative evaluation of the depth of cure and surface roughness of bulk-fill composites: An *in-vitro* study addresses a more complete perspective of the comparison using a complex methodology, which guides us for future studies in this line of research.

Conclusion

According to the results, it was possible to conclude that:

1. Statistically significant differences were found between the values linked to the systems, the results of this study show that the polishing system did affect the levels of surface roughness in the nano-filling resin used, which showed differences in the surface
2. Ultradent's Jiffy Hishin polishing system provided the lowest roughness values compared to the other systems, registering maximum values of 9.53 microns and averages of 8.01 microns, a median with the least variance
3. Regarding the comparison between groups, the 3M Soflex group showed results remarkably close to those of the Ivoclar system, with averages of 13.95 and 13.45 respectively and higher standard deviations, concerning the highest
4. Studies with a greater number of samples and complementary analyses such as micro and nano hardness, among others, are necessary to obtain clearer results that explain in detail the phenomenon of polishing in its interaction with the microstructure of composite resins, as well as the comparison of the most recent systems that have emerged

Conflict of Interests

The authors have no conflict of interest to declare.

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References

- Schmitt VL, Puppini-Rontani RM, Naufel FS, Nahsan FP, Alexandre Coelho Sinhoreti M, et al. Effect of the polishing procedures on color stability and surface roughness of composite resins. *International Scholarly Research Notices*. 2011;2011.
- Daud A, Adams AJ, Shawkat A, Gray G, Wilson NH, Lynch CD, et al. Effects of toothbrushing on surface characteristics of microhybrid and nanofilled resin composites following different finishing and polishing procedures. *J Dent*. 2020;99:103-376.
- Daud A, Gray G, Lynch CD, Wilson NH, Blum IR. A randomised controlled study on the use of finishing and polishing systems on different resin composites using 3D contact optical profilometry and scanning electron microscopy. *J Dent*. 2018;71:25-30.
- Fugolin APP, Pfeifer CS. New resins for dental composites. *J Dent Res*. 2017;96(10):1085-91.
- Garrofé AB, Picca M, Kaplan AE. Determination of microhardness of bulk-fill resins at different depths. *Acta Odontol Latinoam*. 2022;35(1):10-5.
- Demarco FF, Collares K, Coelho-de-Souza FH, Correa MB, Cenci MS, Moraes RR, et al. Previous composite restorations: A systematic review on long-term survival and reasons for failure. *Dent Mater*. 2015;31(10):1214-24.
- Dávila-Sánchez A, Gutierrez MF, Bermudez JP, Méndez-Bauer L, Pulido C, Kiratzc F, et al. Effects of dentine pretreatment solutions containing flavonoids on the resin polymer-dentine interface created using a modern universal adhesive. *Polymers*. 2021;13(7):1145.
- Dutra DA, Pereira GK, Kantorski KZ, Valandro LF, Zanatta FB. Does finishing and polishing of restorative materials affect bacterial adhesion and biofilm formation? A systematic review. *Oper Dent*. 2018;43(1):E37-e52.
- Ahmed MA, Jouhar R, Khurshid Z. Smart monochromatic composite: A literature review. *Int J Dent*. 2022;2022.
- Barreda GJ, Dzierewianko EA, Muñoz KA, Piccoli GI. Surface wear of resin composites used for Invisalign® attachments. *Acta Odontol Latinoam*. 2017;30(2):90-5.
- Amaya-Pajares SP, Koi K, Watanabe H, da Costa JB, Ferracane JL. Development and maintenance of surface gloss of dental composites after polishing and brushing: Review of the literature. *J Esthet Restor Dent*. 2022;34(1):15-41.
- Nagem Filho H, D'azevedo MT, Nagem HD, Marsola FP. Surface roughness of composite resins after finishing and polishing. *Braz Dent J*. 2003;14(1):37-41.
- Mangat P, Masarat F, Rathore GS. Quantitative and qualitative surface analysis of three resin composites after polishing - An *in-vitro* study. *J Conserv Dent*. 2022;25(4):448-51.
- Lainović T, Blažić DL, Vilotić M, Kakaš D. Effect of diamond paste finishing on AFM surface texture parameters and topography of dental nanocomposites polished by two different procedures. *Int J Innovative Research in Science, Engineering and Technol*. 2013;2(12):7353-9.
- Aydın N, Topçu FT, Karaoğlanoğlu S, Oktay EA, Erdemir U. Effect of finishing and polishing systems on the surface roughness and color change of composite resins. *J Clin Exp Dent*. 2021;13(5):e446-54.
- Botta AC, Duarte Jr S, Filho PI, Gheno SM. Effect of dental finishing instruments on the surface roughness of composite resins as elucidated by atomic force microscopy. *Microsc Microanal*. 2008;14(5):380-6.
- Joniot S, Salomon JP, Dejou J, Grégoire G. Use of two surface analyzers to evaluate the surface roughness of four esthetic restorative materials after polishing. *Oper Dent*. 2006;31(1):39-46.
- Monterubbiansi R, Tosco V, Orilisi G, Grandini S, Orsini G, Putignano A. Surface evaluations of a nanocomposite after different finishing and polishing systems for anterior and posterior restorations. *Microsc Res Tech*. 2021;84(12):2922-9.
- Reinhart D, Singh-Hüsken P, Zimmer S, Bizhang M. *In-vitro* influence of the use of an erythritol powder through air polishing on the surface roughness and abrasiveness of various restorative materials. *PLoS One*. 2022;17(7):e0270938.
- Tosco V, Monterubbiansi R, Orilisi G, Procaccini M, Grandini S, Putignano A, et al. Effect of four different finishing and polishing systems on resin composites: roughness surface and gloss retention evaluations. *Minerva Stomatol*. 2020;69(4):207-14.
- Jaramillo-Cartagena R, López-Galeano EJ, Latorre-Correa F, Agudelo-Suárez AA. Effect of polishing systems on the surface

- roughness of nano-hybrid and nano-filling composite resins: A systematic review. *Dentistry J.* 2021;9(8):95.
22. Dhananjaya KM, Vadavadagi SV, Almalki SA, Verma T, Arora S, Kumar NN. *In-vitro* analysis of different polishing systems on the color stability and surface roughness of nanocomposite resins. *J Contemp Dent Pract.* 2019;20(11):1335-8.
 23. St-Pierre L, Martel C, Crépeau H, Vargas MA. Influence of polishing systems on surface roughness of composite resins: polishability of composite resins. *Oper Dent.* 2019;44(3):E122-32.
 24. Osiewicz MA, Werner A, Roeters FJ, Kleverlaan CJ. Wear of bulk-fill resin composites. *Dent Mater.* 2022;38(3):549-53.
 25. Carrillo-Marcos A, Salazar-Correa G, Castro-Ramirez L, Ladera-Castañeda M, López-Gurreonero C, Cachay-Criado H, et al. The microhardness and surface roughness assessment of bulk-fill resin composites treated with and without the application of an oxygen-inhibited layer and a polishing system: an *in-vitro* study. *Polymers.* 2022;14(15):3053.
 26. Cayo-Rojas CF, Hernández-Caba KK, Aliaga-Mariñas AS, Ladera-Castañeda MI, Cervantes-Ganoza LA. Microleakage in class II restorations of two bulk fill resin composites and a conventional nanohybrid resin composite: An *in-vitro* study at 10,000 thermocycles. *BMC Oral Health.* 2021;21:1-8.
 27. Babina K, Polyakova M, Sokhova I, Doroshina V, Arakelyan M, Novozhilova N. The effect of finishing and polishing sequences on the surface roughness of three different nanocomposites and composite/enamel and composite/cementum interfaces. *Nanomaterials.* 2020;10(7):1339.
 28. Parasher A, Ginjupalli K, Somayaji K, Kabbinala P. Comparative evaluation of the depth of cure and surface roughness of bulk-fill composites: An *in-vitro* study. *Dental and Medical Problems.* 2020;57(1):39.

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