International Journal of Scientific Research in Dental and Medical Sciences

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The Effect of Four Disc-shaped Polishing Systems on the Surface Roughness and Micro-hardness of Clearfil AP-X Esthetics Composite Resin

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ARTICLE INFO

Article history:
Received 28 December 2021
Received in revised form 15 February 2022
Accepted 27 February 2022
Available online 03 March 2022

Keywords:
Composite resins
Dental polishing
Hardness tests

ABSTRACT

Background and aim: Polishing techniques are important in preserving the beauty and success of composite restorations. This study evaluated the surface roughness and micro-hardness of CLEARFIL AP-X Esthetics composite polished by different polishing systems.

Material and methods: A total of 50disc-shaped CLEARFIL AP-X Esthetics composite were prepared. Composite discs were divided into five groups. The first group was not polished, and other groups were polished by four types of polishing discs and were classified as follows: group 2: polished by Sof-lex disc, group 3: Optidisc, group 4: Dental finishing disc, group 5: Praxis polishing disc. All the specimens were stored in distilled water at 37 ° C for 24 hours, and after that, the surface roughness of composite samples was measured by a profilometer. After profilometry, the microhardness of samples was measured by the Vickers test. The data were analyzed using a one-way ANOVA test.

Results: The results indicated that the Sof-lex group had the lowest surface roughness with an average of 0.078±0.017, comparable with the control group(0.069±0.011). Statistical analysis demonstrated that surface roughness between different polishing systems was statistically significant ($p<0.001$). In addition, Praxis polishing disk with an average of 405.13±3.278 had the greatest micro-hardness than the control group (287.17±2.302), and an average of micro-hardness between different kinds of disc-shaped polishing systems was statistically significant ($p<0.001$).

Conclusions: Our results demonstrated that the Sof-Lex polishing system was more successful than other polishing systems in the finishing and polishing CLEARFIL AP-X Esthetics composite.

1. Introduction

Composite resins are one of the most common restorative materials. In recent years, clinical use of composite resins has interestingly extended due to the increasing demands of beauty, advances in composite technology, and ease of adhesion.[1] Regardless of the shape and status of the cavity, surface smoothness is clinically important. The level of surface roughness as one of the most important features affecting the quality of composite materials has increasingly been noted. In fact, on the one hand, surface smoothness enhances the beauty and the capacity to reduce plaque retention, discoloration level, tissue inflammation, and recurrent decay and, in total, can play an important role in patient comfort.[2, 3] Several factors determine resin composites' surface roughness, such as filler material content, size, shape, the distance between particles, the type of bond, and the efficiency of filler matrix bonds.[4] Recently, surface roughness has been improved by reducing the particle size and increasing the filler loading. In addition, several properties of polishing systems such as hardness, shape, size, or abrasive components and flexibility of solid matrix (where the material is embedded in it) also have key roles in the creation of surface smoothness.[5]

In this regard, many efforts have been conducted in order to the polishing system provide the most surface smoothness for available composites in the

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http://doi.org/10.30485/IJSRDMS.2022.331297.1257

market.[6] Polishing techniques are important in preserving the beauty and long-term success of composite restorations. Moreover, the surface roughness and microhardness are directly related to poor polishing that can lead to too much color levels, increasing the amount of wear and accumulation of plaques.[7, 8] In this regard, different polishing systems in various sizes and shapes have been introduced by various manufacturers, including various forms of rotary abrasive brushes, manual strips, siloxane rubber, and diamond polishers which the efficiency of them has also been studied on different composite materials.[9, 10] One of the composites recently entered the market is CLEARFIL AP-X Esthetics composite(Kuraray Noritake Dental Inc, Japan) belonged to nano-hybrid generation composites and presented by the manufacturer particularly for esthetic demands.[11] It is available in different shades and effects for providing good esthetic results. Due to other features of this composite, such as filler content of 78%, the flexural strength of 118MPa, 1.9% shrinkage, the polishing ability of 57, and excellent Polishing and handling, it will be considered in the near future.[12] Therefore, this study aimed to evaluate the surface roughness and micro-hardness of CLEARFIL AP-X Esthetics composite polished with different polishing systems.

2. Material and methods

The study proposal was approved by the ethics committee of the College of the Babol University of Medical Sciences informed written consent was obtained from all the participants before samples collection.

In this experimental study, CLEARFIL AP-X Esthetics composite (Kuraray, Japan) with A1 shade and four types of the polishing disc consists of Praxis polishing disc(TDV, USA), Sof-Lex (3m -ESPE, USA), Dental finishing disc (Tor Vm, Russia) and Opti disc (Kerr, USA) were used. A polyethylene mold prepared 50 pieces of the disc-shaped composite with a diameter of 10 mm and a thickness of 2 mm. Resin composites were placed carefully into the generator, and a transparent mylar strip was placed in the lower and upper levels to reduce the oxygen inhibitor layer. A glass slab(1.1mm thick) was applied to the mylar strip, and pressure was applied to remove excess resin. After removing the glass layer, the composite was cured by the LED waves (VALO LED, Ultradent, USA) with the intensity of 710-840mW\cm2 for twenty seconds. The specimens were removed from the mold, and the edges were rounded by 1000 grit silicon carbide paper. According to the polishing system used, these composite discs were divided into five groups(n=10). The first group was not polished and was considered as a control group. Other groups were polished by low-speed handpiece using four types of polishing discs on one side and were classified as follows: group 2: polished by Sof-Lex disc, group 3: polished by Opti disc, group 4 polished by dental finishing disc, group 5: polished by Praxis polishing disc.

The time of polishing with each disk was standardized at 30 s.the pressure exerted on the composite surface was intermittent and controlled by the operator. According to the manufacturer's recommendation, the disks were used in a low-speed contra-angle handpiece and underwater cooling. After using each disk, the specimens were rinsed with water spray for 15 s to remove debris. After the polishing process, the specimens were stored in distilled water at 37 ° C for 24 hours. A calibrated, mechanical 2-D profilometer (Tr200, time, USA) was used to measure the Ra for each specimen with a cutoff value of 0.25 mm and a tracing length of 2mm. Three measurements in the center of each sample at crossing directions were performed. After profilometry, the microhardness of samples was measured by the Vickers test (Vickers, Buehler, Germany). Three points on each sample were evaluated, and the average micro-hardness of these three points was considered hardness.

Statistical analysis

The data were analyzed using the one-way ANOVA test (SPSS version 20), and a significance level of 0.05 was considered for both the surface roughness and microhardness tests.

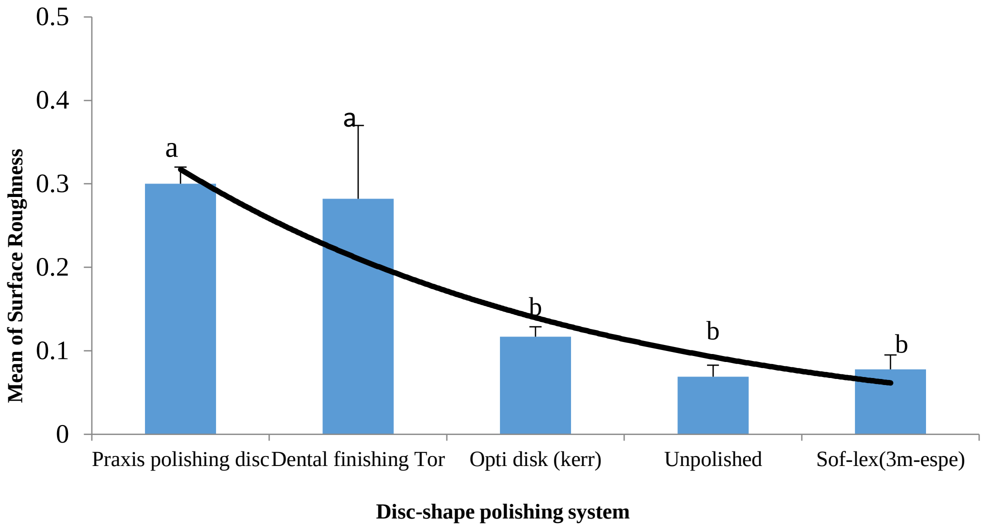
3. Results

Determination and comparison of the surface roughness of nanohybrid composite obtained results of comparing the average surface roughness of nanohybrid composite according to four disc-shaped polishing systems and non-polished group were shown in Table 1.

Table 1. Determination and comparison of the surface roughness of nanohybrid composite according to disc-shaped polishing systems.

Significance level	Test statistics	Confidence interval 95%	Deviation from the mean	Average	Polished disc-shaped
<0.001	54.635	0.102-0.462	0.088	0.282	Dental finishing disk tor
		0.092-0.141	0.012	0.117	Opti disk (kerr)
		0.043-0.113	0.017	0.078	Sof-lex(3m-espe)
		0.047-0.092	0.011	0.069	Unpolished
		0.259-0. 342	0.020	0.300	Praxis polishing disk

Our results indicated that the control group (without Polishing) had the lowest surface roughness (highest polishing level) with an average of 0.069±0.011, and after that Sof-lex group (3m-Espe)had the lowest surface roughness with an average of 0.078±0.017. Statistical analysis using the Kruskal-Wallis test demonstrated that surface roughness between disc-shaped polishing systems was statistically significant ($p<0.001$). As shown in Fig. 1, the control group (without Polishing) had significantly less surface roughness than other groups ($p<0.001$).



*Different letters show significant differences.

Fig. 1. Bar graph of the average surface roughness of nanohybrid composite according to disc-shaped polishing systems.

In addition, among the various systems, the average surface roughness of the praxis polishing disk was considerably higher than the Opti disk (Kerr) and Sof-lex (3m-espe) ($p< 0.05$) but had no significant difference with the Dental finishing disk ($p>0.05$). On the other hand, the Dental finishing disk compared to Optidisk (Kerr) and Sof-lex (3m-espe) had more surface roughness ($p<0.05$). Moreover, the two groups, Opti disk (Kerr) and Sof-lex (3m-espe) were not significantly different from each other in terms of surface roughness ($p>0.05$).

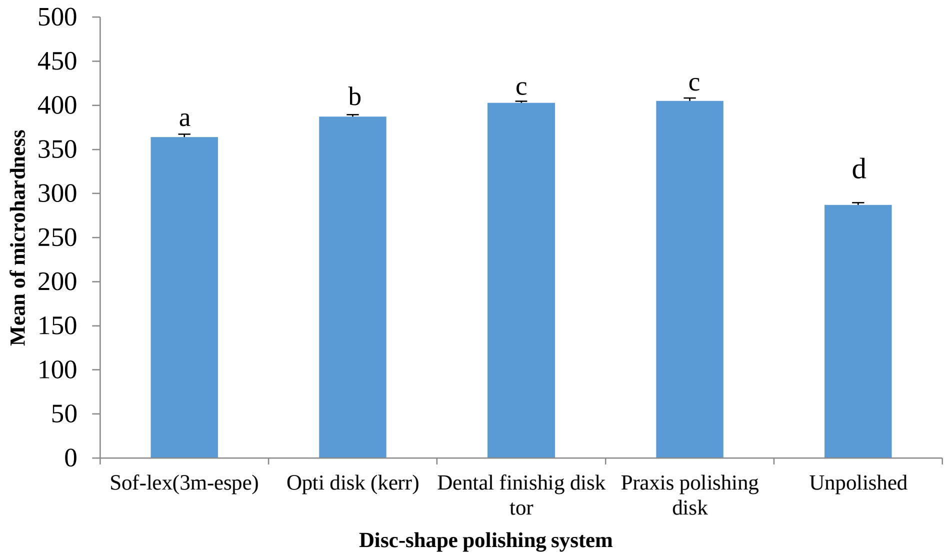
Determination and comparison of nanohybrid composite micro-hardness

The comparison results of the nanohybrid composite micro-hardness polished by four disc-shaped polishing systems and the non-polished group are shown in Table 2.

Table 2. Determination and comparison of the surface micro-hardness of a nanohybrid composite according to disc-shaped polishing systems.

Significance level	Test statistics	Confidence interval 95%	Deviation from the mean	Average	Polished disc-shaped
<0.001	114.745	357.41-370.85	3.285	364.13	Sof-lex(3m-espe)
		382.65-392.01	2.289	387.33	Opti disk (Kerr)
		399.10-406.50	1.808	402.80	Dental finishing disk tor
		398.41-411.86	3.287	405.13	Praxis polishing disk
		282.46-291.87	2.302	287.17	Unpolished

According to this table, the control group (without Polishing) had the lowest micro-hardness with an average of 287.17±2.302 and Praxis polishing disk with an average of 405.13±3.278 had the greatest micro-hardness; that average of micro-hardness between different kinds of disc-shaped polishing systems was statistically significant using Kruskal-Wallis test ($p<0.001$). As shown in Fig. 2, the control group (without Polishing) had the lowest micro-hardness than other groups ($p<0.001$) significantly.



*Different letters show significant differences

Fig. 2. Bar graph of the average micro-hardness of a nanohybrid composite according to disc-shaped polishing systems.

In addition, among the various systems, the average micro-hardness of the Praxis polishing disk was considerably higher than the Opti disc (Kerr) and Sof-lex (3m-espe) ($p< 0.05$) but had no significant difference with the Dental finishing disc ($p>0.05$). On the other hand, the Dental finishing disc group compared to the Optidisc group (Kerr) and Sof-lex group (3m-espe) had more micro-hardness ($p<0.05$). Moreover, composite micro-hardness in the Optidisc group (Kerr) was higher than Sof-lex (3m-espe) ($p<0.001$).

4. Discussion

The present study evaluated the effect of four disc-shaped polishing systems on surface roughness and microhardness of Clearfill Ap-x2 composites. The result showed that the control group(the sample was polymerized with mylar strip)had the least surface roughness. This result is following prior investigations. For instance, Kumari Rv[13] reported that the polishing system considerably creates a rougher surface than the mylar strip. Polyester stripes make the smoothest surface in resin composites the most desirable esthetically. Paying attention to anatomical limitations and occlusion adjustment, the polishing process of the composite surface is necessary, which results in degradation of the soft shallow upper surface of composites and exposing the deeper lines. Polishing systems, especially those used in the esthetic zone, should create a soft surface like the mylar strip. The roughness of abrading agents, the geometry of instruments, and the methods of utilizing them greatly impact the final softness. As Barakah[14] reported in 2014, surface roughness is primarily dependent on the contents and polishing process, and this system resulted in diverse polishing systems such as one-step and multi-step, which have already been studied widely. Some studies, such as Roudrigues 2015,[15] reported better outcomes for multi-step systems. We investigated various multi-step disc-shaped systems in the present study. The sof-lex discs made the most smoothness in accordance with Hassan AM 2015[16] and Barbosa 2015.[17] In this present study, the softness gained by sof lex disc was very close to the mylar strip, which showed no meaningful difference. The same result is also reported in the Gonulol study.[18] Barbosa[17] evaluated eight polishing systems on several composites and concluded that the softest surface is created using sof lex discs. This predominance may be due to the superior quality of the discs and efficient adhesiveness abrading particles to the disc base. The fillers are pushed down to the bottom layers by the pressure of the mylar strip, so the superficial layer contains less filler, which is the reason for less hardness. Following removing this low-filler layer, the beneath layer with a high degree of conversion and filler is exposed, and this issue explains the high hardness measure in Praxis and Dental finishing disk Tor groups. The lower amount of hardness in Sof-lex and Optidisc could be due to the deeper resection of composite by the discs and exposure of lower layers with less degree of conversion. Similarly, Nithya K et al. 2020[19] evaluated three polishing systems on five composites and concluded that the Sof-Lex Spiral group exhibited higher mean microhardness, less surface roughness, and higher gloss. This different result about microhardness with our study may be due to different materials and polishing systems. Despite our result, Canto FMT et al. 2020[20] evaluated three polishing systems (Soflex 4 steps, Sof-lex Spiral 2 steps, and PoGo (single step)) and concluded that no difference was observed between polishing groups in roughness and microhardness. This may be explained because the Z250 resin they use in their study is a micro-hybrid resin, and larger particles offer less protection on the resin matrix from a finishing and polishing process.

5. Conclusions

Our results demonstrated that after the control group Sof-Lex polishing system group had the least microhardness and was more successful than other polishing systems in the finishing and polishing procedures of disc-shaped CLEARFIL AP-X Esthetics composite. On the other hand, the group of Praxis polishing disks had the greatest micro-hardness, and the control group (without polishing) had the lowest micro-hardness than other groups significantly.

Conflict of Interest

The authors declared that there is no conflict of interest.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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How to Cite this Article: Nezhadnasrollah F, Fotovat F, Yousefi H, Fatahi M, Rasoolinia M. The Effect of Four Disc-shaped Polishing Systems on the Surface Roughness and Micro-hardness of Clearfil AP-X Esthetics Composite Resin. International Journal of Scientific Research in Dental and Medical Sciences, 2022;4(1):16-20. http://doi.org/10.30485/IJSRDMS.2022.331297.1257.