UNIVERSIDADE FEDERAL DE UBERLÂNDIA
FACULDADE DE ODONTOLOGIA

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# INFLUENCE OF FINISHING AND POLISHING PROTOCOLS AND LIGHT CURING UNITS ON THE SURFACE ROUGHNESS AND GLOSS OF A COMPOSITE RESIN.

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# INFLUENCE OF FINISHING AND POLISHING PROTOCOLS AND LIGHT CURING UNITS ON THE SURFACE ROUGHNESS AND GLOSS OF A COMPOSITE RESIN.

Trabalho de conclusão de curso apresentado a Faculdade de Odontologia da UFU, como requisito parcial para obtenção do título de Graduado em Odontologia

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## RESUMO

Para que as restaurações obtenham um resultado favorável, é importante realizar adequada fotoativação e o correto acabamento e polimento da superfície da resina. Dessa forma, o objetivo desta pesquisa é analisar a influência da fotoativação e do acabamento e polimento nas propriedades das resinas compostas. Para isso foi avaliada rugosidade e brilho das amostras confeccionadas com a resina nanohíbrida Amaris (VOCO Cuxhaven, Hamburg, Germany) que foi fotoativada com diferentes aparelhos diodo emissores de luz (LED): Valo (Ultradent, Salt Lake City, Utah, EUA), Valo Grand (Ultradent, Salt Lake City, Utah, EUA), Bluephase (Ivoclar, Schaan, Liechtenstein), Elipar (3M ESPE, St Paul, MN, USA), Emitter (Schuster, Hyannis, MA, EUA) e Radii Xpert (SDI Bayswater, Vistoria, Australia); e polidas com três sistemas diferentes: Sof-Lex Diamond Polishing System (3M ESPE, St Paul, MN, USA), Jiffy Polisher (Ultradent, Salt Lake City, Utah, EUA) e Opti1Step (Kerr, Orange, CA, EUA). Os resultados obtidos não mostraram significante diferença tanto na rugosidade quanto no brilho das amostras quando comparando os diferentes tipos de LED. Entretanto, ao analisar os dados obtidos dos diferentes sistemas de polimento, pôde se observar maior rugosidade e menor brilho do sistema Jiffy. Contudo, apesar da relação entre estas propriedades, não se pode associá-las diretamente ou esperar que seus resultados sejam semelhante para todas as marcas, pois o brilho se trata de um fenômeno ótico e a rugosidade uma propriedade física do material. Além disso, nota-se maior variação do brilho das amostras obtidas a partir do polidor Opti1Step. Isto acontece uma vez que as partículas que promovem o polimento do material se encontram distribuídas de maneira não uniforme, promovendo resultados diferentes ao longo de seu uso. Diante disso, é possível perceber a influência da execução destas etapas na confecção das restaurações e em suas propriedades que estão relacionadas com a sua longevidade.



**Palavras-chave:** resina composta; acabamento e polimento; diodo emissor de luz.

## ABSTRACT

The aim of this study was to evaluate different Light Cure Unit (LCU) and polishing protocols on surface roughness and gloss of a composite resin. Roughness and gloss of samples (n=8) of nanohybrid composite resin (E1, VOCO Cuxhaven, Hamburg, Germany) were evaluated and lightcured with different light-emitting diode (LED) devices: Valo (Ultradent, Salt Lake City, Utah, USA), Valo Grand (Ultradent, Salt Lake City, Utah, USA), Bluephase 20i (Ivoclar, Schaan, Liechtenstein), Elipar DeepCure-L (3M ESPE, St Paul, MN, USA), Emitter D (Schuster, Hyannis, MA, USA) and Radii Xpert (SDI Bayswater, Survey, Australia); and polished with three different systems: Sof-Lex Diamond Polishing System (3M ESPE, St Paul, MN, USA), Jiffy Original Composite System (Ultradent, Salt Lake City, Utah, USA) and Opti1Step (Kerr, Orange, CA, USA). There was no difference for the different LEDs for roughness (P=0.935) and gloss (P=0.012). For the superficial roughness test Sof-Lex and Opti1Step were similar between themselves and significantly superior to Jiffy. For the gloss test Sof-Lex and Opti1Step presented superior results than Jiffy. The LCU did not influence the roughness and gloss of the composite resin, while the polishing protocol showed influence on the result.



**Key words:** Composite resin, finishing and polishing, Light Emitted Diode, Light Cure Unit

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**Abstract**

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**Clinical relevance:** Composite resin restorations are routinely done in dental practice. The influence of the light cure unit on the finishing and polishing of composite resins is not well established.

**Key words:** Composite resin, finishing and polishing, Light Emitted Diode, Light Cure Unit

## Introduction

Over the years, several studies were done to evaluate the longevity of composite resin restorations over time.[1-3] The survival rates varies between 93% (91% - 95%) in four years to 86% (82% - 89%) in twelve years.[4] The most common reasons of failures noticed are caries,[5] bruxing patients,[6] fractured or lost restoration, fractured tooth, and endodontic complications.[4]

Some of the failure risks can be prevented during the restorative procedure.[5] Low strength and susceptibility to degradation can be caused by an insufficient radiant exposure taking to short composite longevity.[7] A properly cure technique must be applied paying attention to the exposure time to the LED [7] and distance between the light tip of the curing lamp and the restorative material trying to set it 0 mm.[5] The total irradiance that concern the material depends on the tip of light distance and time.[8] Thus, if the irradiance is increased also the degree of cure enhances and the physical and mechanical properties of RBCs will improve.[9]

As essential as a satisfactory light curing, an adequate finishing and polishing is required to bring out a good result and to prevent future problems such as secondary caries and discoloration.[10] While finishing is done to achieve desired anatomy and a gross contouring of RBCs, polishing reduces roughness and removes scores created during finishing.[11] To perform this step it is commonly used a diversity of instruments such as tungsten carbide and fine-grained diamond burs, stones, rubber burs, and abrasive latex in finishing procedures.[12] Abrasive impregnated (with diamond) rubber cups and points, aluminum oxide-coated abrasive disks, abrasive strips, and polishing pastes are then used for the polishing process.[13]

The process of polishing can step in some of physical properties such as gloss and roughness. Gloss definition brings that it is an optical phenomenon related to the reflection of material surface when light rays hit the surface in same angle.[14, 15]

Therefore, the relationship between LCU and finishing and polishing is uncertain. It is known that there is no better LCU or finishing and polishing protocol defined yet. Thus, the aim of this study was to evaluate different LCU and polishing protocols on surface roughness and gloss of a composite resin.

The null hypotheses were that different LCU do not influence the surface roughness and gloss of the composite resin and and polishing protocols do not influence the surface roughness and gloss of the composite resin.

## Materials and methods

*Specimens preparation*

As the dental restorative material of interest, it was selected the nanohybrid Amaris (E1, VOCO Cuxhaven, Hamburg, Germany). The specimens were sorted in distilled water. They were made in a light-free room and all specimens were done in a metallic mold. Its dimensions were 2-mm deep and had a 4-mm diameter. The material was placed into the matrix with a resin spatula. Below the mold there was a glass plate and above its polyester strip (AllPrime, Brasília, Brazil). The polyester strip was placed to well press the material in the matrix and to avoid direct contact between resin and the light cure source once it was leaning against the tape. About all the light emitting diode (LED), it was setted up static by holding it with both hands on top middle of the sample and cured for 20 seconds. In the research was used six different light curing units. The *n* was 8. The details about them are on table 1.

Table 1 – Information provided by manufacturers about their light curing units (LCU)

| LCU | Manufacturers | Irradiance ($mW/cm^2$) | External tip diameter (mm) | Emission spectrum (nm) |
|---|---|---|---|---|
| Valo | Ultradent, Salt Lake City, Utah, EUA | 1000 | 10 | 395–480 |
| Valo Grand | Ultradent, Salt Lake City, Utah, EUA | 1000 | 12 | 395–480 |
| Bluephase 20i | Ivoclar, Schaan, Liechtenstein | 1200 | 10 | 385–515 |
| Elipar DeepCure-L | 3M ESPE, St Paul, MN, USA | 1470 | 10 | 430–480 |
| Emitter D | Schuster, Hyannis, MA, EUA | 1250 | 8.2 | 420-480 |
| Radii Xpert | SDI Bayswater, Vistoria, Australia | 1500 (+ 5 %, - 15 %) | 8 | 440-480 |

After light-curing, the specimens were removed from the mold, excess material was removed. The finishing and polishing were done with an electric micro motor Beltec LB-100 (Beltec, Araraquara – São Paulo, Brasil) with 10.000 rpm. For the finishing it was selected OptiDisc (Kerr, Orange, CA, EUA) in different grit levels available: course finish and fine polish. Both were used for 1 minute on the surface. Thereafter three different polishers protocols were done: Sof-Lex Diamond Polishing System (pre-polishing/beige and polising/pink) (3M ESPE, St Paul, MN, USA), Jiffy Original Composite System (yellow and white) (Ultradent, Salt Lake City, Utah, EUA) and Opti1Step (Kerr, Orange, CA, EUA). A device was used to standardize the force during polishing. The polishing was done for 60 seconds each step of their systems and always with irrigation.

*Surface Roughness Measurement*

The surface roughness (Ra) values were measured by Surface Roughness Tester (SJ-310, Mitutoyo, Kawasaki, Japan) obtained from the top surfaces of the specimens at three different locations. Roughness values (Ra) were measured for each specimen operating with a 2 μm diamond stylus and to record roughness measurements it moves at a constant speed of 0.5 mm / sec and a force of 0.7 mN.

*Surface Gloss Analysis*

The evaluation of surface gloss was performed with a gloss meter (CS300, CHN Spec, Hangzhou City,China). After the equipment calibration, all samples were measured at a 60-degree incidence angle.

The gloss measurements are known as gloss units (GU), which determines that a surface that does not reflect brightness has zero GU and a glass surface with a refractive index of 1567 has 100 GU.[16]

*Statistical Analysis*

For the statistical evaluation of the results of gloss and surface roughness were analyzed by two-way ANOVA with post-hoc Tukey's test for multiple

comparisons. SigmaPlot software (SigmaPlot 12.0, Systat Software, San, Jose, CA, USA) was used to conduct the tests, with a significance level set at 95%.

## Results

The results for roughness and gloss are presented in Tables 2 and 3, respectively. For roughness ($p$=0.012) and gloss ($p$=0.935) testing, the LCU showed no statistical difference.

For roughness test, the polishing protocol ($p$≤0.001) showed statistical difference. Opti1Step and Sof-Lex Diamond Polishing System groups (0,160 and 0,164 Ra) presented similar results and are significantly better than Jiffy Original Composite System group (0,224 Ra) (Table 2).

In the gloss test, there was significantly difference in the polishing protocol ($p$≤0.001). Opti1step and Sof-Lex Diamond Polishing System (34.34 and 31.47 GU) presented similar results and are significantly superior compared to Jiffy Original Composite System (20.93 GU) (Table 3).

**Table 2-** Mean ± standard deviation for surface roughness (Ra) of composite resin with different LEDs (n = 8)

| | **Valo** | **Grand Valo** | **Elipar DeepCure-L** | **Radii Xpert** | **Bluephase 20i** | **Emitter D** | *Mean* |
|---|---|---|---|---|---|---|---|
| **Opti1step** | 0.193 ± 0.062 | 0.122 ± 0.038 | 0.123 ± 0.039 | 0.145 ± 0.044 | 0.178 ± 0.060 | 0.202 ± 0.045 | 0.160 ± 0.048 **A** |
| **Jiffy Original Composite System** | 0.225 ± 0.069 | 0.207 ± 0.078 | 0.219 ± 0.043 | 0.245 ± 0.056 | 0.197 ± 0.034 | 0.248 ± 0.064 | 0.224 ± 0.057 **B** |
| **Sof-Lex Diamond Polishing System** | 0.136 ± 0.031 | 0.168 ± 0.034 | 0.185 ± 0.031 | 0.216 ± 0.030 | 0.119 ± 0.028 | 0.162 ± 0.045 | 0.164 ± 0.038 **A** |

**Table 3-** Mean ± standard deviation for gloss (GU) of composite resin with different LEDs (n = 8)

| | **Valo** | **Grand Valo** | **Elipar DeepCure-L** | **Radii Xpert** | **Bluephase** | **Emitter D** | *Mean* |
|---|---|---|---|---|---|---|---|
| **Opti1step** | 31.58 ± 8.23 | 37.21 ± 8.3 | 30.82 ±8.85 | 36.62 ± 9.48 | 36.10 ± 6.43 | 33.75 ± 9.51 | 34.34 ± 8.46 **A** |
| **Jiffy Original Composite System** | 22.1 ±3.1 | 20.3 ± 5.6 | 21.0 ± 6.2 | 19.8 ± 5.4 | 19.5 ± 4.2 | 22.9 ± 8 | 20.93± 5.4 **B** |
| **Sof-Lex Diamond Polishing System** | 31.76 ±10.71 | 29.97 ± 5.35 | 31.6 ± 10.29 | 31.01 ± 7.74 | 30.61 ± 9.90 | 33.90 ± 5.62 | 31.47± 8.26 **A** |

## Discussion

The null hypothesis that different LCU and polish systems would not influence on surface roughness and gloss of composite resin was reject. Different polishers influence the roughness and gloss.

Finish and polish procedures are directly related to the aesthetics of restorations and to their longevity.[17-19] These steps can influence on the mechanical and physical properties of composite resin surface such as minimizing wear, reducing roughness and increase gloss.[20-22] Although it is observed that surface roughness and gloss can be negative correlated during the finishing and polishing, but the relation is not proportional.[23]

Different LCU can polymerize the same composite resin and generate different degree of conversion (DC).[24] The DC is directly enhanced with the physical and chemical properties of the composite resin.[25] In the present study the roughness and gloss of the composite resin was not influenced by the LCU once that there were no significant difference between the obtained results.

Some studies showed the Amaris roughness about 0.16 Ra [26] to 0.23 Ra.[27] In this present study, the results were similar but varies according to the polishing protocol used. Sof-Lex Diamond Polishing System and Opti1Step performed significantly similar on tests however both were significantly better than Jiffy Original Composite System. The first two had results that are resembling to the ones obtained on literature [26,27] (between 0.123 and 0.216) and Jiffy Original Composite System showed a little higher than the others staying between 0.197 and 0.248 Ra. It can be explained by the type of abrasive particle bringing up a higher value than other polishers for this composite resin.

There are also differences on results obtained by gloss test. They were between 19.5 and 37.21 GU. The Sof-Lex Diamond Polishing Syste presented great results and it is likely due to the wheel of this polisher that has 2 parallel rows of 15 individually radiating elastomeric “bristles” uniformly impregnated with abrasives that can nearly every surface of a restoration.[28] Also, there are studies showing that flexible aluminum oxide discs create a smooth and glossy surface.[18, 29, 30] Applied to this composite resin surface the Opti1Step produced a glossy outside that is significantly better than Jiffy Original Composite System one and

similar to the one obtained with Sof-Lex Diamond Polishing System. This result can be explained by the shape, particles hardness, disposition and type of particle and matrix type that these particles are in it.[18]

Polishing improve surface gloss and decrease roughness constantly during the procedure.[23] However, this correlation is no always that way, it also depends on composite resin properties such as particles sizes.[31] So, there is a variation along polishing procedures results that can bring up different roughness surface, gloss and other properties according to the composite resin that is used and the polisher that is played. By this way, a same polisher could deliver a different result depending on the composite resin that it is used.

This study has limitations. It is a laboratory study made on controlled situations what can be tough to be transported to clinical situations. An example is the capability to access all restored faces to equally polish all regions. Another limitation is the way that light curing was done by the intimacy contact with composite resin and without any movement and distancing of the LED tip. This is not something that always possible to do on patients due to mouth opening limitation, cavity depth or the LED tip shape.

## Conclusion

The Light Cure Units did not affect the roughness and gloss of composite resin.

Opti1Step and Sof-Lex Original Composite System polishers showed lower roughness and higher gloss.

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