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Comparison of two Radiometers in the Validation of the Irradiance Emitted in the Light Curing Apparatus of the Faculty of Medical Sciences and Health of Juiz De Fora /SUPREMA

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Abstract

Introduction: For better clinical execution, the performance of LED light curing agents is gaining space in dentistry. For a better efficiency of the photopolymerizers, the intensity of the light through the radiometers must be validated with the constant periodical maintenance so that the emission of light is within the standards of irradiance established by the manufacturers. ***Objective:*** To compare the irradiance measured by two Ecel RD-7 and SDI radiometers, respectively. ***Method:*** 8 Bluephase-based photopolymerizers were used when the batteries were fully charged. For each apparatus were measured three readings and then averaged. ***Results:*** The exploratory analysis of the data indicated homoscedasticity, that is, there is a significant difference between the variances of the two devices. ***Conclusion:*** The Ecel RD-7 radiometer with rechargeable battery presented better results than the SDI radiometer.

Keywords: Photopolymerization; Light; Irradiation.

1. Introduction

Currently in dentistry restorative materials have peculiar characteristics such as restoring form, function and, above all, aesthetics to the dental element. Due to the technological advancement of companies of dental materials, it is observed that the composite resin is widely used in aesthetic restorations. For better application of these materials, the different brands of light curing devices are highlighted in the emission of radiance according to the variation of their intensities. Therefore, for clinical practice, light-curing devices are essential in the work environment of dental surgeons.[1,2]

Light curing devices are instruments that emit high intensity blue light, being found in two types on the market: rigid fiber optic and flexible fiber2. The mechanism of these devices starts from the ideal emitted wavelength, being able to vary from 410 to 500 nm3. The photopolymerization process is related to camphorquinone which is characterized as a photoinitiator frequently found in most photopolymerizable dental materials.[3] When exposed to light, in the presence of initiators such as amines, the formation of free radicals occurs which, in turn, initiate the polymerization process by the conversion of monomers into polymers.[3]

For better clinical performance, halogen lamp light curing is being replaced by LEDs. LED is the acronym in English for Light Emitting Diode. It is composed of a blue light which is determined by the chemical combination of two different semiconductors that establishes the wavelength of emission, characterizing more closely as the spectral distribution. The result of this composition is a lower energy consumption and low heat production. It is concluded that the main advantage for this substitution is the production of visible light through quantum mechanical effects instead of the heating of metallic filaments.[3]

The loss of light intensity is evident in several studies and in clinical practice. The procedures associated with high chances of clinical failure are directly related to the polymer formed by a particular light source. The factors responsible for the success of a restoration in composite resin can be classified in sufficient emission of light intensity, correct wavelength emitted, adequate exposure time and type of tip. However, factors such as type, color

and opacity of the composite resin, thickness of the increment, composite temperature, distance from the tip of the light to the surface of the restorative material and the time after radiation influence the polymerization and degree of conversion of the composite resins.[4,5,6]

At present there are specific radiometers for each type of light curing device, whether it comes from halogen light or LED light.[7,8] Some light-curing devices have radiometers attached at their base that verify the maximum intensity the device emits, but not exactly its value. This facilitates daily dental procedures for dental surgeons as they instantly reproduce if the device is in perfect condition for use.[3,4]

Thus, the radiance of photopolymerizers generated by the photoactivation apparatus are very important parameters to achieve maximum conversion of monomers into polymers.[9,10] The purpose of this study were evaluated the ability of the radiometer to measure the intensity of light waves at the point of exit of the light-curing of the photopolymerizer in LED.

2. Methods

2.1 Experimental Design

The present study was of experimental quantitative character, whose non-probabilistic sample was composed of 10 photopolymerizers of the Bluephase brand, with only 8 being in a legitimate state of operation. The criterion used for evaluation was its complete charge, battery quality and light tip quality.

The factors under study were third-generation light-curing devices at one level (n = 10) - Bluephase LED device with dark tip. The response variable was the values of irradiance emitted after the use of a radiometer, in two levels: brand Ecel RD-7 and mark SDI.

2.2 Reading of Apparatus Irradiance

Before measuring with the radiometer, each light-curing device of the brand Bluephase tested was fired once for 20 seconds in High mode. Then the light-curing tip was placed in contact with the photosensitive surface of the radiometer, so that the tip was centered on the photosensitive cell and perpendicular to it. At this time, the photopolymerizer was activated and, after 20 seconds of activation, the observed intensity was recorded.

For reading, the Ecel RD-7 and SDI Radiometers were used, which were calibrated every 4 readings (figures 2 and 3). After removing the devices from the loader bases, the light bulb of each device was placed directly on the radiometer sensor and, after 20 seconds, with a flashing light, the devices emitted the value of the irradiance generated for each photopolymerizer.

3. Results

3.1 Statistical analysis

After the data collection, the irradiance values of each device were tabulated and, afterwards, a mean of the values found for the devices tested was made. The mean results of the model of the apparatus in question are shown in grafic 1. The exploratory analysis of the data indicated homoscedasticity, that is, that there is no significant difference between the variances of the two devices.

Thus, Student's t-test was applied for homogeneous variances for the comparison between the devices, regarding radiance values. The analyzes were performed in the R * program considering the level of significance of 5%.

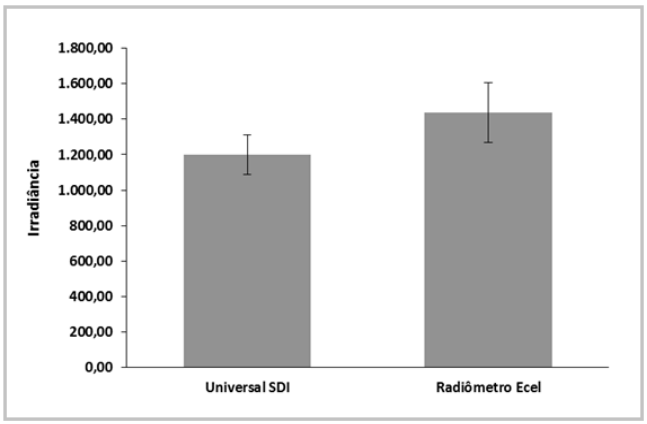
*R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.URL https://www.R-project.org/

3.2 Irradiance

Table 1: Mean and standard deviation of radiance depending on the device

	Appliance	
	Universal SDI	**Radiometer Ecel RD-7**
Mean	1200,70	1436,60
Standart	112,56	169,18

p=0,0017



Graphic 1: Mean and standard deviation of irradiance according to the apparatus.

4. Discussion

Dentistry gains strength through the use of restorative materials, which have a number of physical, chemical and biological requirements and the ability of these materials to restore shape, function and aesthetics to the dental element.[11,12] According to the literature, a suitable polymerization should have a radiance of around 400 mW / cm² (milliwatts per square centimeter), with a time of 20s (seconds), with a minimum acceptable value of 300 mW / cm².[13]

It is important to note that periodic maintenance should be carried out on the photopolymerizers every six months and that they should be replaced whenever necessary, according to the manufacturers.[3] Success in a restorative procedure is directly related to the performance of the photopolymerizer. Periodic maintenance as well as part of the components, cleaning and light intensity are of paramount importance, since frequency and use are responsible for the wear of the appliance.[13] Biosafety for the protection of patients and professionals is aimed at avoiding cross-infection, therefore, it is necessary to disinfect the photopolymerizers.[15]

Thus, to ensure that appliances perform their light intensity over time, it is critical that academics and clinicians be aware of the care to avoid problems caused by residual monomers. The aid of a

radiometer is essential to ensure adequate polymerization of composite resins.[12,13]

The quality of the battery of the photopolymerizers may be another factor that may lead to a difference in values.[16,17] Even if a voltmeter was not used, the devices were tested from the moment they showed constant charged battery lights and consequently the acquisition time of these influenced the potential of the batteries used.[18,19] It is important to note that the life time of a replaceable battery is approximately 1200 photopolymerizations with a duration of 10 seconds each, and may resemble a watch battery.[20,21,22]

The last factor that may interfere with the results is the measurement of the light point, since the closer it is to the tip of the photopolymerizer, the less light is dissipated and thus, the more reliable is the result obtained by the radiometer.[18,23]

Regarding light intensity values, it is recommended that devices with an intensity of less than 200 mW / cm² be routed for maintenance, as the composite resin will not be adequately polymerized. Devices with light intensity between 201 and 399 mW / cm² are acceptable, but require additional polymerization time. Light intensities of 300 mW / cm² are sufficient when the appropriate exposure time is used. And devices with light intensity greater than 400mW / cm² can be used with the exposure time of 20 seconds for increments of 2mm of composite resin1.

5. Conclusion

From the results found in this study we can conclude that:

- Light curing devices used in the Dentistry Clinic of the Faculty of Medical Sciences and Health of Juiz de Fora / SUPREMA are suitable for dental use.
- Even if they are suitable for use, it is recommended that the apparatus be periodically maintained.
- The Ecel RD-7 radiometer with rechargeable battery presented better results than the SDI radiometer.

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