ORIGINAL ARTICLE

Evaluation of light-curing units tips used in the clinic of a dental school

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https://doi.org/10.14436/2447-911x.17.2.156-167.oar

Submitted: June 21, 2019

Revised and accepted: February 14, 2020

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How to cite: Miranda DA, de-Oliveira PM, Ganimi NF, Marques LACR, Aguiar FHB. Evaluation of light-curing units tips used in the clinic of a dental school. J Clin Dent Res. 2020 May-Aug;17(2):156-67.

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» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

ABSTRACT

Introduction: *Composite resins are operator-dependent materials and hence LED-dependent. There are many types of LEDs available on the market, so knowledge of emitted irradiance and equipment components is critical to maintaining the quality of adhesive restorations. The light-conducting tip, depending on the curing light, may be transparent or dark and may change the radiance of the device when in contact with impurities, when cracked and / or fractured.* ***Objective:*** *To evaluate the curing tips used in the clinic of a dental school, as well as to measure the irradiance emitted before and after their replacement.* ***Method:*** *20 light curing units were analyzed by a calibrated evaluator who verified the presence of fractures (yes or no), debris (yes or no) of resinous materials remnants and reflection capacity (cracks). The irradiance of each device was measured before and after the tip change.* ***Results:*** *After analyzing the data, the paired t test was applied, comparing the irradiance after changing the tip with the initial irradiance. The analyzes were performed with a significance level of 5%. There was a significant increase in irradiance ($p < 0.05$) after replacing all tips of the devices. It can still be observed that 30% of the tips had debris, 30% cracks, 30% fractures and 10% had debris and cracks. Conclusion: The presence of debris, cracks and fractures caused the irradiance emitted by the devices to decrease drastically and their replacement made the devices could be safely used again.*

Keywords:

Polymerization. Luminescent Measurements. Curing Lights, Dental.

INTRODUCTION

Composite resin is a material that allows the performance of imperceptible procedures by reproducing the characteristics of dental structures in relation to color, shape, texture and function, providing more natural restorations. However, one of the greatest concerns of dental professionals is to obtain an aesthetic restoration, without losing the quality of the restorative material. Insufficient polymerization is related to clinical failures such as the occurrence of microleakage, marginal discoloration and increased abrasion, since the properties of the composite resin decrease with poor polymerization.[1-4]

The dental market has tended to modernize and facilitate the polymerization stage, with reduced times. However, in the case of photopolymerizing devices, two of the main elements that need to be considered are irradiance and its ability to collimate the beam.[3,4] The photoactivation process of resinous materials begins when the blue light falls on the photosensitive agent (photoinitiator), usually the camphorquinone, which absorbs light in the visible spectrum with maximum absorption at 468nm. The light that triggers the photoactivation process is externalized from the photopolymerizer by means of light-conducting tips that can be made of optical fiber or polymer. The polymer light-conducting tip can change the light spread when in contact with impurities. Such a characteristic can be understood by the way in which light is transmitted through the medium. The light that penetrates the polymer is refracted at an angle proportional to the ratio of the refractive index of the air to the transmission medium. If any surface, such as lips and cheeks, comes into contact with the polymer tip, there will be a decrease in the luminous energy that would be transmitted to the composite resin with subsequent loss of its physical and mechanical properties.[5,6]

Most commercially sold LED devices consist of wired or wireless equipment, with a portable charger, a vision shield and a light conductor (tip). The tips, in most devices,

are attached to the equipment and are easily susceptible to damage to its structure, such as residual resin / adhesive on the tip, the tips may be broken, scratched or with small cracks, causing the light reaching the material to be polymerized is less intense.[7-10] The turbo tip would be a good indication for the devices. The problem is that, although the energy is concentrated at the tip, in greater distances its power density decreases quickly, due to the little collimation of the light beam.[11] One type of light transmission that must be viewed with caution is the plastic and / or acrylic tip. With a refractive index of around 1.5, this type of tip promotes weak light conduction and has the potential to deflect light from the intended target, causing a significant reduction in the amount of light reaching the photopolymerizable material. However, devices with this type are sold at a more affordable price and, therefore, used in a school clinic, without however being subject to constant maintenance.

Thus, the periodic maintenance of photopolymerizing devices must be extremely important in order to check for any defects that may compromise the light intensity and the quality of the adhesive restorations. It is important to note that the measurement of the devices when performed by radiometers can generate inaccurate data, since there are large discrepancies in measurements of light emission with these devices. Thus, these devices cannot be used as the only way to assess the quality of the photopolymerizers. The clinical evaluation of the quality of the restorations and the quality of the tips associated with the measurement with radiometers helps to monitor the light emission from the devices over time.[12] Thus, the objective of this in vitro work was to evaluate the quality of the tips of the photopolymerizing devices used in the clinic of a dental school, as well as to compare the irradiance emitted by the devices in the current conditions and in conditions of replacement of the luminous tip.

MATHERALS AND METHODS

Experimental Design

For this in vitro study, 20 LED light curing devices - model DB 686 (Dabi Atlante, Ribeirão Preto, SP, Brazil) were used, with transparent tip and the response variable was the qualitative analysis of the tips - fractured, cracked, with debris and / or association of definitions. Quantitative analysis was performed by measuring irradiance before and after tip replacement. The null hypothesis tested in this study was that there would be no difference in the irradiance of the tips evaluated initially and after their replacement.

Evaluation of the quality of fiber optic tips and measurement of irradiance

The tested devices were in use at the Dentistry Clinic of the Faculty of Medical and Health Sciences of Juiz de Fora / SUPREMA. Each device was analyzed individually by a calibrated evaluator who analyzed the presence of fractures (yes or no), debris (yes or no) from remaining resinous materials and the ability to reflect (cracks). For the evaluation of the light reflection (presence of cracks), a printed text, in good quality, was selected and, over it, each tip was passed in such a way that if the words were clear at the end of the fiber tip, the evaluator attested the good performance (quality) of the optical fiber; if the words in the text presented with any distortion in the eyes of the evaluator, the presence of cracks in the tip was configured. The evaluator could still verify more than one change in the quality of the analyzed tip.

For the evaluation of irradiance, the Ecel RD-7 digital radiometer (Ecel, Ribeirão Preto, SP, Brazil) was used, according to the protocol established in previous studies.[13-16] The light-curing device was activated for 20 seconds, in constant intensity mode, on the radiometer sensor and, afterwards, 3 readings were performed for 20 seconds, to ensure the repetition of the reading and an interval of ten seconds was left between each measurement. . The result was the arithmetic mean expressed in mW / cm^2.

Statistical analysis

After the descriptive and exploratory analysis of the data, the paired t test was applied, comparing the irradiance after the tip change with the initial irradiance. The analyzes were performed using the R Core Team program, with a significance level of 5%.

RESULTS

It is observed in Table 1 and Figure 1 that there was a significant increase in irradiance ($p < 0.05$) after replacing all the tips of the devices. In Figure 2, it can be seen that 30% of the tips had debris, 30% cracks, 30% fractures and 10% had debris and cracks.

Table 1: Mean, standard deviation, median, minimum and maximum irradiance values of the light curing tips used in the clinic of a dental school

	TIME	
	INITIAL	AFTER REPLACEMENT
Mean	280.75	402.10
standard deviation	17.61	7.92
median	283.00	400.00
Minimum value	245.00	389.00
maximum value	310.00	420.00

p<0.0001

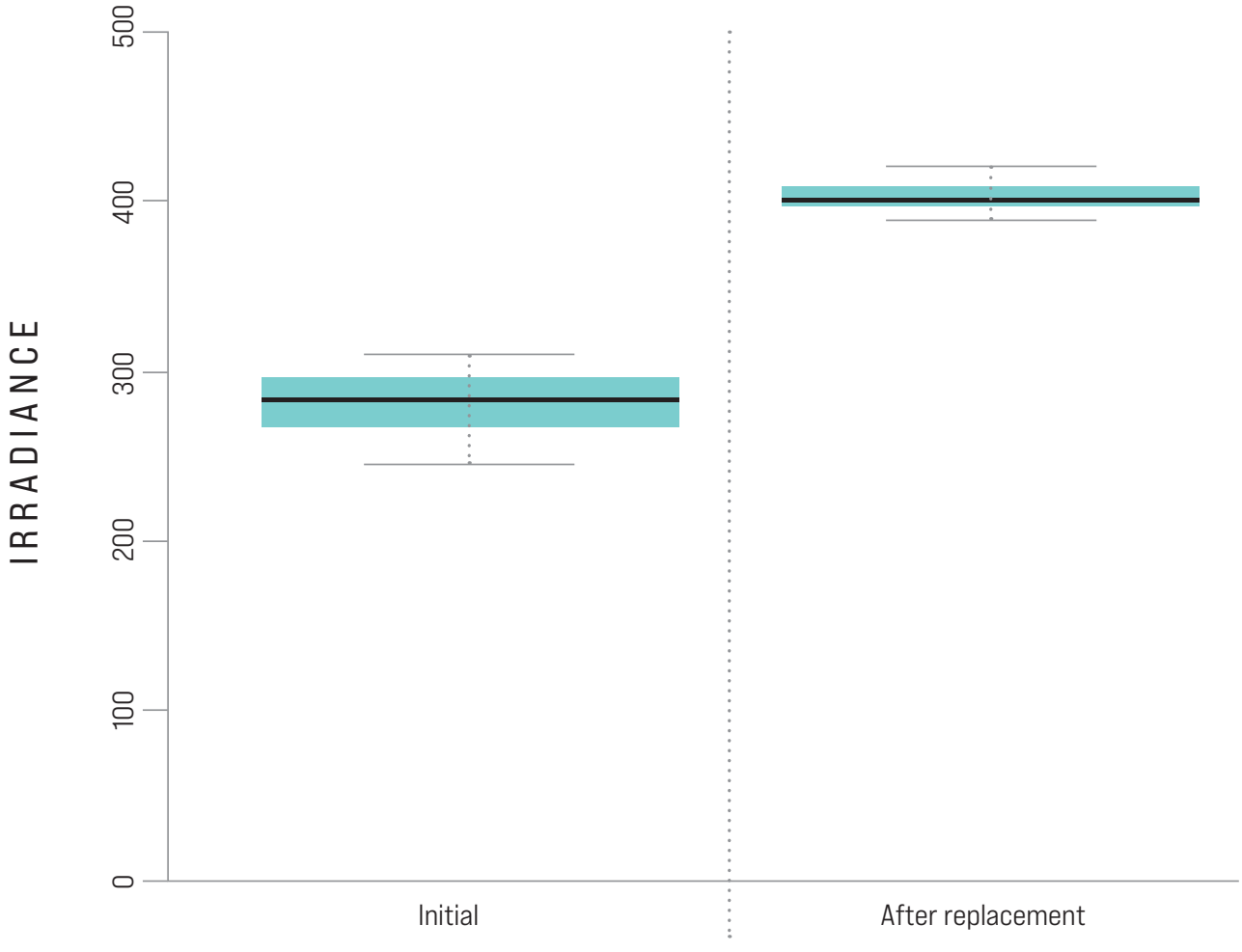

Figure 1: Box plot of the irradiance of the light curing tips used in the clinic of a dental school in the initial times and after the exchange.

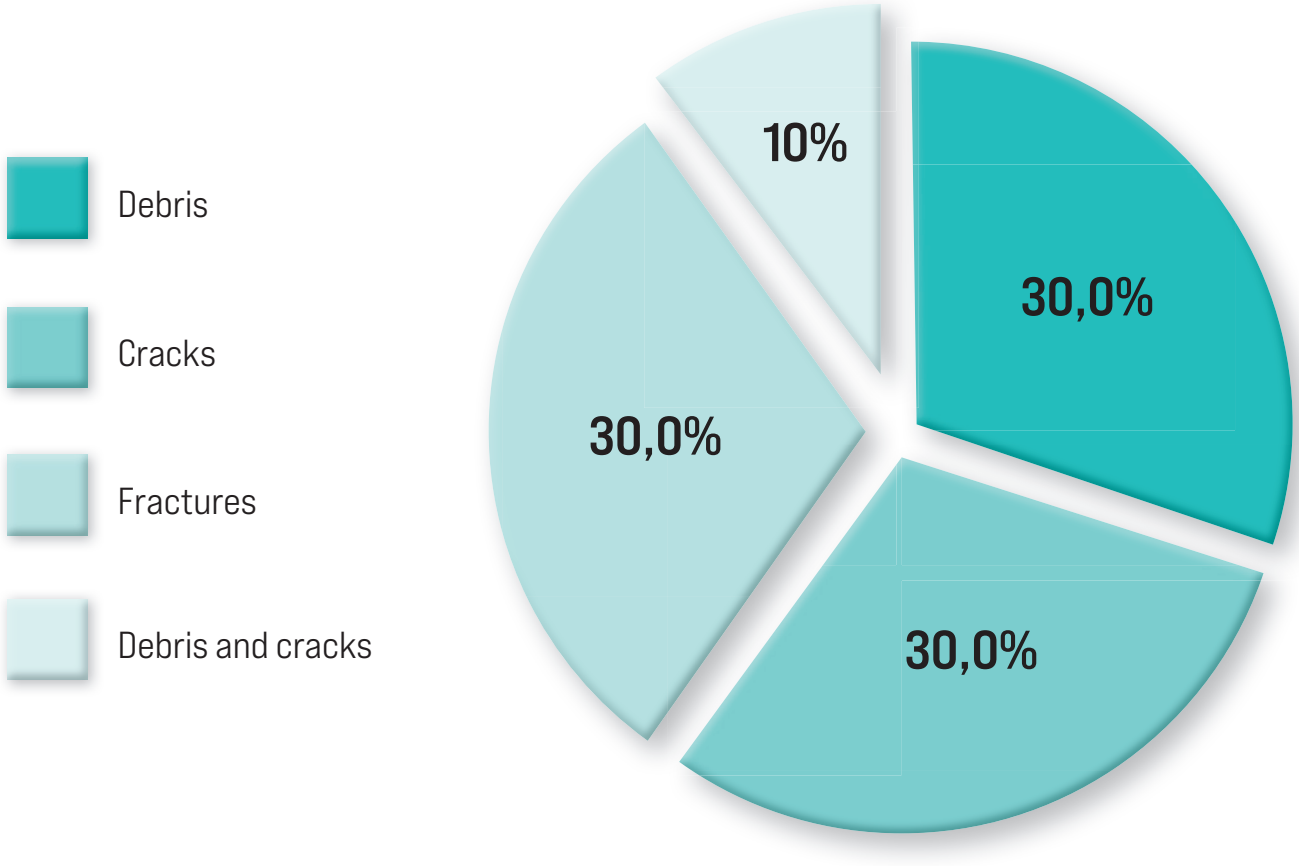

Figure 2: Frequency distribution of the qualification of the photopolymerizer tips used in the clinic of a dental school.

DISCUSSION

The light-curing device has become one of the most used tools in daily practice. Several materials currently available depend on the action of the photopolymerizer to become effective or polymerize, although the rate of polymerization has been improved still remains insufficient, being considered one of the causes of clinical failure. These devices are of fundamental importance in the routine of the dental clinic, and it is essential that professionals have full knowledge about the operation, optimization of use and maintenance of these devices.[11]

According to the results found in this study, all 20 devices used in the clinic of the Faculty of Dentistry had some kind of deterioration of the tip, be it with the presence of debris, fractured, cracked and / or with debris and cracked, simultaneously.[11,12] The evaluation in table 1 shows that the devices initially presented a significant variation in the irradiance values, since the standard deviation was 17.61, that is, the difference between the maximum (310 mW/cm^2) and minimum (245 mW)/cm^2) were of great amplitude (Fig 1). When the tips were replaced, the standard deviation dropped dramatically, causing a statistically significant difference ($p < 0.0001$). This shows that these devices were operating below the expected standard and, only after replacing them, did the irradiance meet the minimum values suggested by the literature.[12] These data are in agreement with the study by Miranda et al,[13] which justifies that the presence of restorative materials in the light tip is able to reduce the irradiance emitted by the device, causing a possible underpolymerization of restorative materials. Underpolymerization can cause color change, greater porosity, decreased adhesion to dental tissue, greater wear, deterioration of its mechanical and physical properties, in addition to insufficient polymerization of the deeper layers which also contributes to microleakage, increasing the index of post sensitivity-operative and restoration failures.[7]

In order to be successful during an adhesive restorative procedure, in relation to

the complete and satisfactory conversion of monomers to polymers, it is necessary that, among other factors, a minimum irradiance of the photopolymerizing device around 300 to 400 mW/cm^2 is observed.[12-14] The results obtained in this study revealed worrying data, since only 4 (four) of the 20 (twenty) devices tested (20%) had the minimum necessary irradiance. In the general context, the average of the devices was 280.75mW/cm^2. As all the evaluated devices presented some kind of abnormality in the quality of the tip, in a way, this data was expected, however, not with such low values, since they were possibly not operating in the expected way. However, all the devices tested in this study never underwent maintenance and were only evaluated by the technician when the number of emergencies, mainly breaks in restorations and even total loss of adhesion of the restorations to the substrate was noticed. The lack of maintenance can be explained, since these devices have been in use for more than 2 years, however, due to continuous use and, on a large scale, this certainly contributed to a degradation of the photopolymerizers in a short period.

Also according to the data in Figure 2 (only 2 devices - 10%) presented tips with the presence of debris / cracks. According to Miyazaki et al.[9], this type of modality can reduce the emission of light intensity by 46.2%. In this study it was found that with the replacement of the tips, the irradiance increased by 43.22%, leaving the devices in ideal conditions for use. According to Balbi et al[7], the evaluation of the light curing tips revealed that 13.33% had a fracture and 86.66%, debris, differing considerably from the results found in this study. According to Figure 2, 30% of the tips were fractured and 30% were with debris. The difference in results can be justified by the biosafety protocol implemented by the Dentistry clinic, in which plastic film that is smooth, transparent and well adhered to the light tips of the photopolymerizing devices is used. However, when this measure was adopted, the devices had been in use for at least 2 years.

It is important to remember that fractures, cracks and debris in the tips of the devices can cause a reduction of 46.2% in the emission of light intensity.[12,16] In this

study, after replacing all tips, the average irradiance was 402.1mW / cm^2, which means a real increase of around 69.82%. Thus, after replacing the tips, the devices could be used with greater safety in the dental clinic, ensuring better results in the adhesive procedures, provided that a minimum photo-activation time of 40 seconds is used, so that a 16J of power.[17]

Following the observations of some studies, the devices with light intensity below 200 mW/cm^2 should be sent for maintenance, because in addition to the tips, other factors such as the quality of the batteries can affect the quality of the light to be emitted. Studies on this topic[18,19] have found that some brands of curing light may not be able to maintain the same emission power after 100 cycles, others not even after 50 cycles. Therefore, one of the ways to maximize restorative procedures in the clinic of the Faculty of Dentistry was the implementation of a periodic maintenance program for the photopolymerizing devices, carrying out monthly measurements of the intensity of the light emitted, with the aid of radiometers and, based on the needs observed , the tips, batteries and even the devices will be replaced. The maintenance of light curing devices is as important as any other care to avoid failures in aesthetic restoration with composite resin.[20]

CONCLUSION

According to the results obtained in this study, it can be stated that:

1. The tips of the photopolymerizers may present with the presence of debris, cracks and fractures, drastically reducing the irradiance emitted by the devices.
2. After changing the tips, the devices had a minimum acceptable light intensity for polymerization of resinous materials.
3. Periodic maintenance of the devices is essential.

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