

Evaluation of the Irradiance Emitted by Different Modes of Photoactivation with and without the use of Luminous Tip

Diogo de Azevedo Miranda, Jordana Alves Sotto-Maior, Marcela Freitas de Oliveira, Soraia Luziléia de Oliveira

Department of Dentistry, Faculty of Medical Sciences and Health, Juiz De Fora, Brazil

ABSTRACT

Introduction: The process of photoactivation of the resinous materials begins when the blue light penetrates the photosensitive agent (photoinitiator). To attenuate the generation of stresses during the polymerization process, some studies have used different photoactivation approaches, such as low intensity in continuous light, high intensity in continuous light, photoactivation in steps (Soft-Start), and high intensity in high light. **Goals:** The objective of the study was to compare the irradiance emitted by a single device in relation to the methods of photoactivation with and without the use of the transparent tip. **Methods:** The study was the photopolymerizer from the Dental Clinic of FCMS/SUPREMA, in one level ($n = 8$) - DABI ATLANTE DB 686 device and two photoactivation modes: Soft-start and high, with and without the use of the tip. The response variable was the values of irradiance emitted after the tests with the two types of photoactivation with and without the use of tip, through the measurement with radiometer Hilux light emitting diode MAX. **Results:** Mean values of irradiance were significantly higher when high photoactivation mode was used ($P < 0.05$) and when no tip was used ($P < 0.05$). **Conclusion:** From the results found in this study, it can be concluded that the high method presented higher values of irradiance when compared to the soft-start method.

Key words: Irradiation, light, polymerization

INTRODUCTION

At present, the dentistry is based on the adhesive principles, since the great majority of its procedures depends on this property, which is achieved mainly by the resinous materials, whether in the form of adhesive systems, resin cement, flow resins, conventional or compactable composite resins, and basically changing the concentration of charges between them.^[1,2]

The process of photoactivation of the resinous materials begins when the blue light penetrates the photosensitive agent (photoinitiator), usually the camphorquinone, which absorbs light in the visible spectrum with maximum absorption at 468 nm. To promote the beginning of this reaction, different light sources are available in the market, such as halogen

lamp, argon laser, plasma arc light, and light emitting diode (LEDs).^[3,4]

The blue light that triggers this whole photoactivation process is exteriorized from the photoactivating apparatus by means of light-conducting tips which may be fiber optic or polymer.^[5] Fiber optic tips prevent light scattering by providing suitable photoactivation of the resin materials. The polymer tips that were recently introduced in the dental market have advantages in terms of cost and versatility of use.^[6,7]

To attenuate the generation of stresses during the polymerization process, some studies have used different photoactivation approaches, such as low intensity in continuous light, high intensity in continuous light, photoactivation in steps (Soft-Start), and high intensity in high light. The main objective of these methods is to prolong the pregel phase of the dental

Address for correspondence:

Dr. Diogo de Azevedo Miranda, Rua Sampaio 330/602, Granbery, Juiz de Fora, Minas Gerais 36010-360, Brazil

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composites, allowing longer time for the monomer flow and, consequently, the tensions generated by the polymerization contraction.^[8,9]

The action of the soft-start method consists in prolonging the pregel phase of the dental composites, allowing a longer flow time of the monomers. This technique will promote better marginal adaptation of the restoration, due to the relaxation of the tensions occurred in the composite during the initial polymerization phase. However, in this case, the rate of exposure to light is decreased, which may interfere with the degree of polymerization of the composite and, consequently, affect the hardness of the material.^[10]

Mehl *et al.* (1997) evaluated the mechanical properties of composite resins when activated by the “soft-start” method, which consists of initial activations with reduced power density, finishing the polymerization with total power density.^[11]

Unlike the high method, where monomers are transformed into polymers uniformly and thus, they create more resistant polymer chains.^[10,12]

It is important to emphasize that the composites are influenced not only by the quality of photoactivating light but also by the type of material used, including resin cement composition and inorganic material content, which is responsible for the longevity of the material in the buccal cavity.^[13,14]

Due to the introduction of different types of composite resin and different polymerization techniques, this study aimed to compare the irradiance emitted by a single device in relation to the photoactivation methods with and without the use of the transparent tip.

METHODS

Experimental design

The DABI ATLANTE DB 686 device and two photoactivation modes: Soft-start [Figure 1] and high [Figure 2], with and without the use of the nozzle tip. The response variable was the values of irradiance emitted after the tests with the two types of photoactivation with and without nozzle use, through the measurement with Hilux LED MAX radiometer [Figure 3].

Reading the irradiance of the devices

The present *in vitro* study was of experimental quantitative character, whose sample, and not probabilistic. All photoactivating devices came from the FCMS/SUPREMA Dental Clinic and included in this study all devices that had tips without any type of groove, breakage, or any type of adhered resinous material.

To read the irradiance was used the radiometer provided by the company SDI, which was calibrated every 4 readings. The

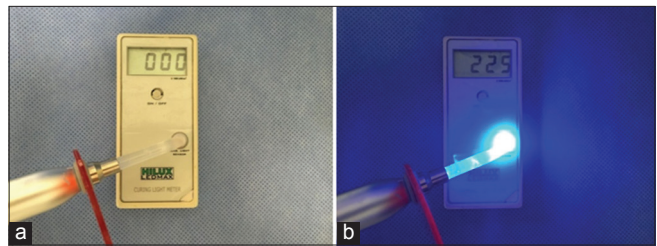


Figure 1: Irradiance emitted by the DABI ATLANTE DB 686 photopolymerizer with the use of the tip

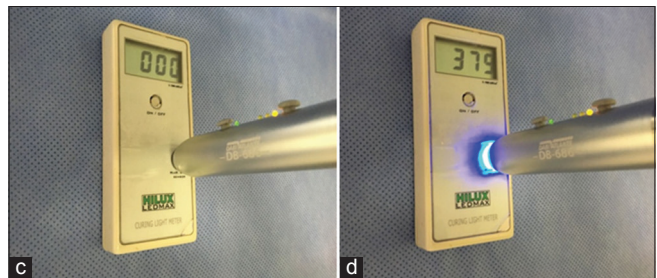


Figure 2: Irradiance emitted by the DABI ATLANTE DB 686 photopolymerizer without the use of the tip



Figure 3: Hilux light emitting diode MAX radiometer

first reading [Figure 1] was performed with the transparent tip directly against the radiometer sensor and after 20 s of flashing the device emitted the irradiance value generated for each tested photoactivation mode. The second reading [Figure 2] was performed without the transparent tip, with the handpiece directly against the radiometer sensor and after 20 s of flashing the device emitted the irradiance value generated for each tested photoactivation mode.

RESULTS

Methodology of statistical analysis

After the exploratory analysis of the data, a variance analysis (ANOVA) was applied, considering in the statistical model that the measurements were performed in the same apparatus.

The analyzes were done through program R15, considering the level of significance of 5%.^[15]

Results

Table 1 and Figure 4 show the results of the irradiance analysis as a function of the photoactivation mode and the tip. It was observed that the averages of irradiance were significantly higher when high photoactivation mode was used ($P < 0.05$) and when no tip was used ($P < 0.05$).

DISCUSSION

Considering the results of this study, it can be noted that when the apparatus was used without the transparent tip, the irradiance values were significantly higher, regardless of the photoactivation mode tested. This is in agreement with the literature when the quality of the emitted light is of fundamental importance for the clinical success of restorative procedures performed with the resin materials.^[16] The intensity of the light multiplied by the exposure time results in the total energy or energy density, which should be approximately J/cm².^[17] If the light curing unit has a light intensity of <400 mW/cm², the ideal properties of the resins will not be reached and in this way, the material tends to fail more easily.^[17] The reduction of the light intensity is imperceptible to the human eye, as well as the polymerization

efficiency of the composite resins, since the most superficial layer is polymerized, so it is up to the operator to have knowledge about the perfect functioning of the apparatus to request the technical service periodically.^[18]

According to Poulos *et al.* (2002), the degradation suffered by the components of the photopolymerizer in a short time generates reduction of light intensity and some criteria must be taken into account with regard to interference in the value of light emitted by each such as: Type of tip used (dark, transparent), residues found at the tips of the appliances, charging of the appliance (partial, total), the time of acquisition, and operation of these.^[19]

Some LCUs have the pre-programmed photoactivation mode or can be performed with conventional device by increasing the distance between the guide light tip of the irradiated material, so the approach of the tip gradually increases the irradiance.^[20] Miranda *et al.* (2018) have reported that devices with built-in tips tend to emit a more continuous light regardless of the mode of photoactivation tested. This is because the light is less likely to disperse to the irradiated surface.

As for the polymerization techniques, it is known that the soft-start mode has been developed in an attempt to reduce the voltage caused by the polymerization contraction,^[21] and can generate polymers with different structures.^[22] When compared to the continuous (conventional) technique, the late pulse technique showed a decrease in contraction tension, allowing the material to flow between the wrists and to relax the tension.^[23] However, some studies disagree, believing that there is no difference in the generation of tension.^[24]

Benefits of the soft-start method in reducing polymerization shrinkage stress and marginal gap have been widely discussed. Several articles attest to the potential value of soft-start polymerization techniques.^[25-28] The late pulse, ramp, and step. These studies justify the use of these techniques. However, other authors claim not to observe great advantage in their use and contend the possibility of reducing the mechanical properties of the resinous composite.^[29,24]

Although some articles demonstrate that the soft-start mode is more effective, and others that there is no difference, the present study contradicts, thus showing that the high mode excelled in presenting a significant difference.

CONCLUSION

From the results found in this study, it can be concluded that:

- The high method presented higher values of irradiance when compared to the soft-start method.
- Although the device used recommends the use of the coupled tip, the irradiance values were significantly lower when compared to the use of the tip.

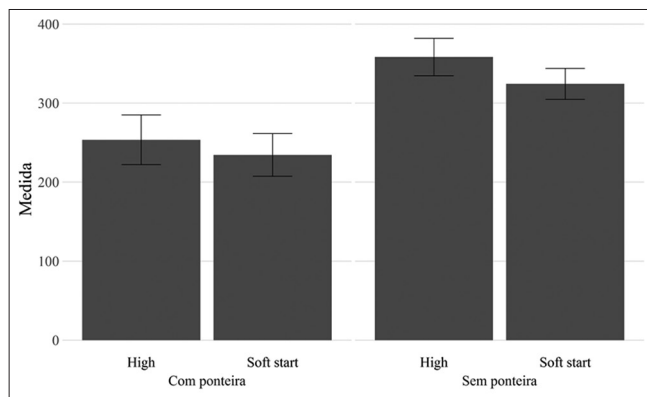


Figure 4: Average (standard deviation) of the irradiance as a function of the photoactivation mode and the tip

Table 1: Mean (standard deviation) of the irradiance as a function of the photoactivation mode and the tip

Tip	Photoactivation mode	
	High	Soft-start
With	253,50 (31,41)	234,38 (26,97)
Without	358,25 (23,72)	324,250 (19,54)
	A	B

Distinguished letters (upper and lower case) indicate significant differences ($P \leq 0.05$). Result of analysis of variance (ANOVA): Pointer: $P < 0.0001$, photoactivation: $P = 0.0012$, pointer x photoactivation: $P = 0.3079$

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