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(RESEARCH ARTICLE)

Photopolymerization devises light intensity relation with physical translucid barriers use

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Abstract

Nowadays, the use of halogen or light emission diode (LED) devices in dental attention is constant for almost any oral treatment. The need of providing an adequate light intensity for a correct photopolymerization of the resinous materials is critical. Likewise, it is important to consider the biosecurity norms for avoiding cross-contamination by residues likely to be accumulated at the top of the light guide in contact with oral cavity fluids. Therefore, the use of translucid barriers at the top of the light guide is imperative to protect the health of the patient while providing a correct polymerization of the resinous materials. The present study analyzes the effect of using four translucid barriers in the light intensity of three dental lamps commercially available. The tested barriers are two of commercial availability, and two conventional plastic wraps. Results indicate a significant reduction of light intensity without affecting the requirements for a correct photopolymerization with any barrier. Differences among barriers points out a conventional plastic wrap as more suitable than commercially available barriers, considering only light intensity provided.

Keywords: Light intensity; Sleeves; Light curing; Barriers

1. Introduction

Up to date, the use of resinous materials has increased drastically in general dentistry consult due to the aesthetic and functional advantages of these materials. Restorations with composed resins needs the light emitted by photo polymerization devices as physical means to be activated [1], [2].This is given due to the presence of traditional photo-initiators in its composition such as canforquinone [3] or other alternatives as Lucirin TPO or Ivoceri, among others [1].

The halogen and light-emitting diode (LED) lamps are common types of light devices, with LED as the most used due to its narrow wavelength with lower heat generation and no necessity for ventilation, representing lower costs. LED devices are classified into three generations according to their radiation. The first generation presents a range from 100 to 280 $mW*cm^{-2}$, requiring long time exposures (around 60 seconds). The second-generation produce a wavelength between 410 and 470 nanometers, presenting difficulties for the activation of alternative photo indicators. Finally, the third generation LED devices surged due to these limitations, presenting a better functioning thanks to the wavelengths between 380 to 500 nm, a combination of blue and violet light that allows the activations of both traditional and alternative photo indicators [4]–[9].

The correct photopolymerization of these materials depends on several factors related to the lamp and its use, such as light intensity ($mW*cm^{-2}$), exposure time, heat produced by the device, distance, and angle between the light and the resinous material. In the same way, we found biomaterial dependent factors as tone of resinous material, type of fill,

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quantity of photo indicator in the material, and its thickness [3]. Rueggeberg et al., [10] and Martin et al., [11] described that the minimum intensity needed for the activation of a compound resin with a thickness of 2 mm must be 400 mW*cm-^{2} with an exposure time of 60 seconds. The decrease in light intensity alters the mechanical properties of the material, allowing the creation of marginal micro filtrations. The low depth of photopolymerization entails to the degradation of the material with massive fractures, discoloration of the restoration, and post-operatory sensibility [12].

The presence of dental materials residues at the active extreme of the light guide of the lamp prevents the correct light supply, reducing the emitted intensity [13]. The presence of these residues in contact with oral fluids represents a risk factor of cross-contamination. The Center for Diseases Control (CDC) has categorized the photopolymerization elements as semi-critic due to its frequent relation with oral tissues and indicates that it has to be submitted to disinfection biosecurity norms [14]–[17]. There exist four recommended ways to obtain a suitable biosecurity with the use of photo activators devices:

Cold disinfection with ethanol solution at 70% or glutaraldehyde at 2% [18], [19]. The contact between the light guide and the disinfectant solution has to be a minimum of ten minutes to guarantee the viricide and sporicidal action. However, the glutaraldehyde solutions can reduce the light transmission or damage the fibers of the light guide [10].

The use of autoclavable fibers sterilized with distillate water at 134 °C for 20 minutes. In the same way, the autoclave use can reduce the light transmission capacity by 50% after three autoclave cycles due to the accumulation of mineral residues on the top of the guide light [18]–[20].

Use of plastic fibers pre-sterilized [18], [19].

Use of disposable translucid physical barriers [18]–[20].

This last option is recommended to avoid the cross-contamination and the dispose of materials waste at the top of the optic fiber. The used barriers can be of different materials as low-density polyethylene (LDP) or polypropylene (PP), which compounds different conventional plastic wrappings [14], [18]–[22]. Therefore, the main goal of this article is to analyze the relation of light intensity with the use of different translucid barriers in photo curating lamps.

2. Material and methods

The present research is of type exploratory – descriptive, in which the variability of light intensity from three photopolymerization devices were compared with the use of four translucid barriers. The light devices analyzed were: Bluephase N (Ivoclar-Vivadent, Schaan, Liechtenstein) (BN), Elipar DeepCure-L (3M ESPE, St Paul, Minnesota, USA) (EDC), and Maxima RU12000 (Henry Schein INC, Melville, New York, USA) (MRU). The selected barriers were two of commercial availability: Pent Type Curing Light Sleeve 123 (PremiumPlus, Brooklin, New York, USA) (PTCLS) and Plasdent Light Guide Sleeves PS 4500 (Perio Support, Novi, Michigan, USA) (PLGS); and two conventional plastic wraps: Strech (Consultplast, Cuenca, Ecuador) (S) and Plastic Wrap (Diafano, Cuenca, Ecuador) (PW). The light intensity was assessed with a dental radiometer Bluephase meter II (Ivoclar-Vivadent). Measures were done after established the diameter of the light guide for each device through the configuration of the dental radiometer and the integrated stencil in its back.

Before measures, each light guide top was disinfected with methyl alcohol at 70% and removed any kind of residue present in it, also, a maximum battery charge was considered with a continuous light output.

Techniques of descriptive and analytic statistics were used to determine the distribution of light intensity among the replicates and test groups. Also, a one-way analysis of variance (one-way ANOVA) and post-hoc Tukey test was developed to determine differences among lamps and test groups. All tests were developed in the software R and its interface R-Studio with a significance of 5%.

3. Results

3.1. Light intensity distributions

The registered values of light intensity presented a no normal distribution for each analysis group. The lamps presented intensities that differ significantly among the brands selected for this study. However, all lamps presented light intensities above the recommended value for the photo-curate process. Table 1 indicates the distribution of light

intensity values obtained for each analysis group, as well as the significance recorded from the Shapiro-Wilk normality test.

Table 1 Light intensity values distribution and normality test significance.

Group	Lamp	P	Minimum	Q1	Median	Mean	Q3	Maximum
Control	1	8,54E-06	750	750	750	753	750	770
	2	4,67E-06	1170	1180	1180	1178	1180	1180
	3	0,01228	1470	1472	1480	1478	1480	1490
PTCLS	1	0,03586	700	710	710	711	717,5	720
	2	0,01541	1020	1020	1030	1027	1030	1040
	3	0,001426	1430	1430	1430	1436	1440	1450
PLGS	1	0,01541	710	710	720	717	720	730
	2	4,71E-05	1090	1092	1100	1097	1100	1100
	3	0,03586	1420	1422	1430	1429	1430	1440
S	1	0,0001687	710	710	710	714	720	720
	2	0,02195	1070	1080	1080	1080	1080	1090
	3	0,004219	1430	1432	1445	1442	1450	1450
PW	1	0,00128	720	720	735	731	740	740
	2	4,71E-05	1100	1100	1100	1103	1108	1110
	3	0,00601	1450	1450	1460	1460	1470	1470

Lamp: Bluephase N (1), Elipar DeepCure (2), Máxima RU12000 (3).
Groups: Control, Pent Type Curing Light Sleeve 123 (PTCLS), Plasdent Light Guide Sleeves PS 4500 (PLGS), Strech (S), and Plastic Wrap (PW).

3.2. Differences between groups and lamps

Significant differences of light intensity among all cover groups were determined. The Tukey post-hoc analysis allowed to determine to which group can be attributed such differences. Control groups were registered with values about 750, 1180, and 1480 mW*cm^{-2} for lamps one, two, and three, respectively as observed in Figures one to three. This group represent the main significant differences compared to each barrier group ($p<0.05$) as indicated in table two to four.

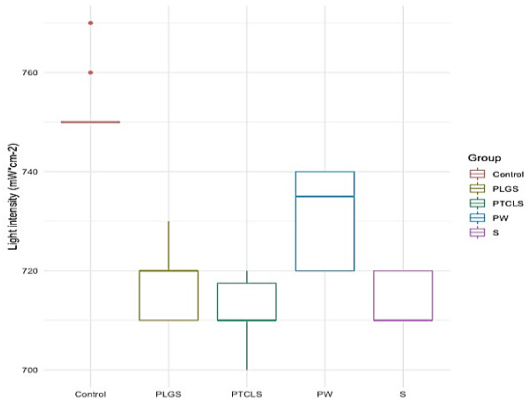

Figure 1 Groups boxplot distribution for lamp 1

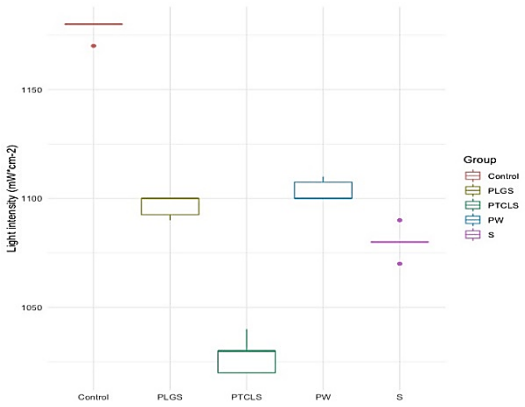

Figure 2 Groups boxplot distribution for lamp 2

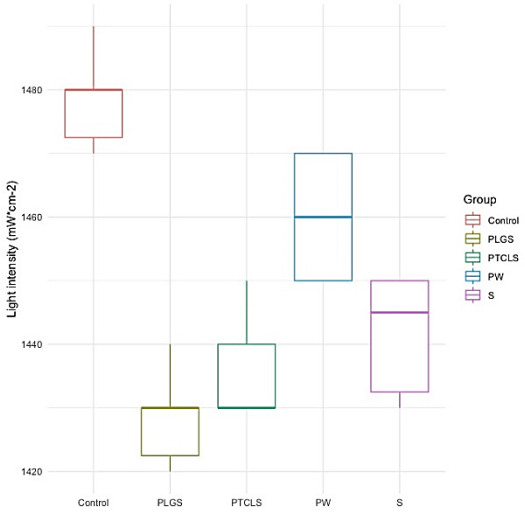

Figure 3 Groups boxplot distribution for lamp 3

Table 2 Post-Hoc group comparison for lamp one**.**

Groups	**Differences**	**Lower**	**Upper**	***P***
PTCLS – Control	-41	-51.6654	-30.33547	0.0000
PLGS – Control	-49	-59.6654	-38.33457	0.0000
S – Control	-35	-45.6654	-24.33457	0.0000
PW – Control	-17	-27.6654	-6.33457	0.0004
PLGS – PTCLS	-8	-18.6654	2.66543	0.2250
S – PTCLS	6	-4.6654	16.66543	0.5061
PW – PTCLS	24	13.3345	34.66543	0.0000
S – PLGS	14	3.3345	24.66543	0.0046
PW – PLGS	32	21. 3345	42.66543	0.0000
PW – S	18	7.3345	28.66543	0.0001

Table 3 Post-Hoc group comparison for lamp two.

Groups	Differences	Lower	Upper	*P*
PTCLS – Control	-154	-160.6165	-147.3834	0.0000
PLGS – Control	-81	-87.6165	-74.38	0.0000
S – Control	-98	-104.6165	-91.3834	0.0000
PW – Control	-75	-81.6165	-68.3834	0.0000
PLGS – PTCLS	73	66.3834	79.6165	0.0000
S – PTCLS	56	49.3834	62.6165	0.0000
PW – PTCLS	79	72.3834	85.6165	0.0000
S – PLGS	-17	-23.6165	-10.3834	0.0000
PW – PLGS	6	-0.6165	12.6165	0.0920
PW – S	23	16.3834	29.6165	0.0000

Table 4 Post-Hoc group comparison for lamp three.

Groups	Differences	Lower	Upper	*P*
PTCLS – Control	-42	-51.3571	-32.6428	0.0000
PLGS – Control	-36	-45.3571	-26.6428	0.0000
S – Control	-39	-48.3571	-29.6428	0.0000
PW – Control	-22	-31.3571	-12.6428	0.0000
PLGS – PTCLS	6	-3.3571	15.3571	0.3739
S – PTCLS	3	-6.3571	12.3571	0.8911
PW – PTCLS	20	10.6428	29.3571	0.0000
S – PLGS	-3	-12.3571	6.3571	0.8911
PW – PLGS	14	4.6428	23.3571	0.0009
PW – S	17	7.6428	26.3571	0.0000

Groups PTCLS, PLGS, and S for lamp one presented the lower values with PW as the higher, representing the next main significant differences. Similar results were obtained for lamp two, where the barrier group PTCLS showed the lower light intensity with a median about 1020 $mW*cm^{-2}$ and the barrier group PW with the higher (1100 $mW*cm^{-2}$). Finally, the lower values for lamp three were presented in groups PTLCS and PLGS (1430 $mW*cm^{-2}$), while PW presented the higher (1460 $mW*cm^{-2}$).

4. Discussion

Nowadays the importance of accomplishing with adequate biosecurity norms is critical for dental attention in general. The correct management of the photopolymerization devices avoids adverse effects related to cross-contamination as well as the level of preventive or restore treatments.

In the present study, significant differences in light intensity were observed in three photocuration lamps when comparing the application of physical protection barriers. Al-Marzok [20] found similar results when evaluating the relationship of two translucid barriers use with the hardness of its curated resin. Cellophane wrap presented the lower

light intensity decrease in comparison to commercial disposable plastic. However, the study does not indicate significant differences in Knoop hardness values for both analyzed groups.

Khode [18] compared the light intensity reduction in several protection barriers with the microhardness of the resin. They point out that all the barriers effectively decrease the intensity and only one barrier of commercial availability and fragments of latex globes decreased the microhardness.

Likewise, Ajaj [21] compared both the effect of using infection control barriers and time exposure with the light intensity emitted. While a significant decrease in light intensity was observed, it does not differ with exposure times.

In another study, it has been demonstrated that the use of barriers and wrapping plastic reduced the light intensity significantly but without impact on the dental curation or negative effects at the clinical level [23].

Rueggeberg [1] indicates that most of the wrapping plastic barriers are not standardized and interfere with light intensity up to 40%, while recommends to not allocate the cover unions over the light guide, which will reduce even more the light output.

In contrast, McAndrew [24] has not found differences between the use of commercial covers and wrapping plastic, while using globes or matt barriers can present reductions in the light intensity.

5. Conclusion

The use of translucid physical barriers over the light guide reduces significantly the light intensity emitted by the devices analyzed in this research. However, nowadays, its use is remarkably important to prevent any kind of cross-contamination between the device and the oral tissues. When using these barriers, it is recommended to monitoring continuously the light intensity to avoid the use of devices with critical intensities (< 400 mW*cm-2) that can affect the curate of the restoring material.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Rueggeberg F. A., Giannini M., Arrais C. A. G., and Price R. B. T., "Light curing in dentistry and clinical implications: a literature review," *Braz. Oral Res.*, vol. 31, no. suppl 1, pp. 64–91, Aug. 2017, doi: 10.1590/1807-3107bor-2017.vol31.0061.

[2] Alqabbaa L., Alsenani M., Alsaif N., Alsaif R., and Binalrimal S., "Light intensity output of visible light communication units and clinicians' knowledge and attitude among Riyadh private clinics," *J. Conserv. Dent.*, vol. 21, no. 6, p. 667, 2018, doi: 10.4103/JCD.JCD_252_18.

[3] Alonso R. C. B., Brandt W. C., Souza-Junior E. J. C., Puppin-Rontani R. M., and Sinhoreti M. A. C., "Photoinitiator concentration and modulated photoactivation: influence on polymerization characteristics of experimental composites," *Appl. Adhes. Sci.*, vol. 2, no. 1, pp. 1–11, 2014, doi: 10.1186/2196-4351-2-10.

[4] Cadenaro M., Maravic, T., Comba, A., Mazzoni, A., Fanfoni, L., Hilton, T., Ferracane, J., & Breschi, L., "The role of polymerization in adhesive dentistry," *Dent. Mater.*, vol. 35, no. 1, pp. e1–e22, 2019, doi: 10.1016/j.dental.2018.11.012.

[5] Harlow J. E., Sullivan B., Shortall A. C., Labrie D., and Price R. B., "Characterizing the output settings of dental

curing lights," *J. Dent.*, vol. 44, pp. 20–26, Jan. 2016, doi: 10.1016/j.jdent.2015.10.019.

[6] Magalhães Filho T. R., Weig K. M., Costa M. F., Werneck M. M., Barthem R. B., and Costa Neto C. A., "Effect of LED-LCU light irradiance distribution on mechanical properties of resin based materials," *Mater. Sci. Eng. C*, vol. 63, pp. 301–307, 2016, doi: 10.1016/j.msec.2016.02.060.

[7] Mouhat M., Mercer J., Stangvaltaite L., and Örtengren U., "Light-curing units used in dentistry: factors associated with heat development—potential risk for patients," *Clin. Oral Investig.*, vol. 21, no. 5, pp. 1687–1696, 2017, doi: 10.1007/s00784-016-1962-5.

[8] Price R. B., Ferracane J. L., and Shortall A. C., "Light-Curing Units: A Review of What We Need to Know," *J. Dent. Res.*, vol. 94, no. 9, pp. 1179–1186, Sep. 2015, doi: 10.1177/0022034515594786.

[9] Price R. B. T., "Light Curing in Dentistry," *Dent. Clin. North Am.*, vol. 61, no. 4, pp. 751–778, Oct. 2017, doi: 10.1016/j.cden.2017.06.008.

[10] Rueggeberg F. A., Caughman W. F., and Comer R. W., "The effect of autoclaving on energy transmission through light-curing tips," *J. Am. Dent. Assoc.*, vol. 127, no. 8, pp. 1183–1187, 1996, doi: 10.14219/jada.archive.1996.0409.

[11] Martin F. E., "A survey of the efficiency of visible light curing units," *J. Dent.*, vol. 26, no. 3, pp. 239–243, 1998, doi: 10.1016/S0300-5712(97)00004-3.

[12] Elhejazi A. A., "The effects of temperature and light intensity on the polymerization shrinkage of light-cured composite filling materials," *J. Contemp. Dent. Pract.*, vol. 7, no. 3, p. 12—21, Jul. 2006, [Online]. Available: http://europepmc.org/abstract/MED/16820803.

[13] Ernst, C.-P., Price, R. B., Callaway, A., Masek, A., Schwarm, H., Rullmann, I., Willershausen, B., & Ehlers, V. , "Visible Light Curing Devices - Irradiance and Use in 302 German Dental Offices.," *J. Adhes. Dent.*, vol. 20, no. 1, pp. 41–55, 2018, doi: 10.3290/j.jad.a39881.

[14] Sword, R. J., Do, U. N., Chang, J. H., & Rueggeberg, F. A., "Effect of Curing Light Barriers and Light Types on Radiant Exposure and Composite Conversion," *J. Esthet. Restor. Dent.*, vol. 28, no. 1, pp. 29–42, Jan. 2016, doi: 10.1111/jerd.12173.

[15] Hwang, I. N., Hong, S. O., Lee, B. N., Hwang, Y. C., Oh, W. M., & Chang, H. S., "Effect of a multi-layer infection control barrier on the micro-hardness of a composite resin," *J. Appl. Oral Sci.*, vol. 20, no. 5, pp. 576–580, 2012, doi: 10.1590/S1678-77572012000500014.

[16] Caughman, G. B., Caughman, W. F., Napier, N., & Schuster, G. S., "Disinfection of visible-light-curing devices.," *Oper. Dent.*, vol. 14, no. 1, pp. 2–7, 1989.

[17] Center for Diseases Control, "Recommendations from the Guidelines for Infection Control in Dental Health-Care Settings — 2003," *Centers Dis. Control Prev.*, p. 17, 2003, [Online]. Available: http://www.cdc.gov/mmwr/PDF/%0Ahttps://www.cdc.gov/oralhealth/infectioncontrol/pdf/recommendations-excerpt.pdf.

[18] Khode, R., Shenoi, P., Kubde, R., Makade, C., Wadekar, K., & Khode, P., "Evaluation of effect of different disposable infection control barriers on light intensity of light-curing unit and microhardness of composite - An in vitro study," *J. Conserv. Dent.*, vol. 20, no. 3, p. 180, 2017, doi: 10.4103/JCD.JCD_171_16.

[19] Celerino de Moraes Porto, I., Ramos de Brito, A., & Parolia, A., "Effect of cross infection control barriers used on the light-curing device tips on the cure depth of a resin composite," *J. Conserv. Dent.*, vol. 16, no. 3, p. 224, 2013, doi: 10.4103/0972-0707.111319.

[20] Al-Marzok, M., "The effect of wrapping of light-cure tips on the cure of composite resin," *Eur. J. Gen. Dent.*, vol. 1, no. 3, p. 183, 2012, doi: 10.4103/2278-9626.105384.

[21] Ajaj, R., Nassar, H., & Hasanain, F., "Infection control barrier and curing time as factors affecting the irradiance of light-cure units," *J. Int. Soc. Prev. Community Dent.*, vol. 8, no. 6, p. 523, 2018, doi:

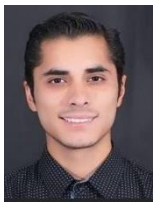
10.4103/jispcd.JISPCD_226_18.

[22] Scott, B. A., Felix, C. A., & Price, R. B. T., "Effect of disposable infection control barriers on light output from dental curing lights," *J. Can. Dent. Assoc. (Tor).*, vol. 70, no. 2, pp. 105–110, 2004.

[23] Hodson, N. A., Dunne, S. M., & Pankhurst, C. L., "The Effect of Infection-Control Barriers on the Light Intensity of Light-Cure Units and Depth of Cure of Composite," *Prim. Dent. Care*, vol. 12, no. 2, pp. 61–67, Apr. 2005, doi: 10.1308/1355761053695149.

[24] McAndrew, R., Lynch, C. D., Pavli, M., Bannon, A., & Milward, P., "The effect of disposable infection control barriers and physical damage on the power output of light curing units and light curing tips," *Br. Dent. J.*, vol. 210, no. 8, pp. 1–4, 2011, doi: 10.1038/sj.bdj.2011.312.

Author's short biography



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