UNIVERSIDADE FEDERAL DE UBERLÂNDIA

FACULDADE DE ODONTOLOGIA

LUÍS FELIPE PREARO COMIN

EFEITO DA TRANSMISSÃO DE LUZ ATRAVÉS DE CERÂMICAS DE DISSILICATO DE LÍTIO CAD/CAM DE DIFERENTES TRANSLUCIDEZ COM DIFERENTES ESPESSURAS

2025

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EFEITO DA TRANSMISSÃO DE LUZ ATRAVÉS DE CERÂMICAS DE DISSILICATO DE LÍTIO CAD/CAM DE DIFERENTES TRANSLUCIDEZ COM DIFERENTES ESPESSURAS

Trabalho de Conclusão de Curso apresentado à Faculdade de Odontologia da Universidade Federal de Uberlândia como requisito parcial para obtenção do título de bacharel em Odontologia

Orientador: Prof°. Dr. Carlos José Soares

UNIVERSIDADE FEDERAL DE UBERLÂNDIA

Comissão Permanente de Supervisão dos Trabalhos de Conclusão de Curso da Graduação em Odontologia

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ATA DE DEFESA - GRADUAÇÃO

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Reuniu-se na Sala de Aula nº 31, Vila Digital, da Faculdade de Odontologia, Bloco 4L anexo A, último andar, Campus Umuarama, da Universidade Federal de Uberlândia, a Banca Examinadora, designada pelo Colegiado do Curso de Graduação em Odontologia, composta pelos professores doutores: **Priscilla Barbosa Ferreira Soares** (FOUFU); **Hugo Lemes Carlo** (FOUFU); e **Carlos José Soares** (FOUFU)- orientador do candidato.

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A seguir, o presidente da Banca concedeu a palavra, pela ordem, sucessivamente, aos examinadores, que passaram a arguir o candidato. Ultimada a arguição, que se desenvolveu dentro dos termos regimentais, a Banca Examinadora, em sessão secreta, atribuiu o resultado final, considerando o(a) candidato(a):

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RESUMO

Este estudo avaliou a influência do tipo, da opacidade e da espessura de cerâmicas de dissilicato de lítio para sistemas CAD/CAM sobre a transmissão de luz. Foram analisadas a potência radiante (mW), o fluxo radiante espectral (mW/nm) e o coeficiente de atenuação (mm-1), utilizando unidades de fotopolimerização com emissão monowave e multiwave. Cinco tipos de cerâmicas CAD/CAM na cor A2 foram testadas: DissiliKota, IPS e-max CAD, Mazic Claro CAD, Rosetta SM e T-Lithium, com dois níveis de translucidez: alta e baixa. A transmissão de luz foi avaliada com três unidades de fotopolimerização: Elipar DeepCure–L, Quazar e VALO Grand. A medição da potência e do espectro de luz transmitida foi realizada com um espectrômetro de fibra óptica e uma esfera integradora, com e sem a interposição das cerâmicas em quatro diferentes espessuras: 0,5 mm, 1,0 mm, 1,5 mm e 2,0 mm. O coeficiente de atenuação também foi determinado. Os dados de potência luminosa foram submetidos à análise de variância com três fatores e ao teste de Tukey, e o percentual de luz transmitida foi analisado por regressão exponencial (R^2), considerando nível de significância de 0,05 por cento. Os resultados mostraram que o tipo de cerâmica e o grau de translucidez influenciaram de forma significativa a transmissão de luz. Cerâmicas com baixa translucidez transmitiram menos luz em comparação às de alta translucidez. O coeficiente de atenuação variou conforme o tipo de cerâmica e a unidade de luz utilizada, sendo maior no espectro violeta. A espessura da cerâmica afetou significativamente a transmissão de luz $R^2>0.90$. Conclui-se que o tipo, a translucidez e a espessura da cerâmica de dissilicato de lítio CAD/CAM afetam significativamente a passagem de luz. À medida que a espessura aumenta, a quantidade de luz transmitida diminui de forma logarítmica, independentemente do tipo de cerâmica. A luz violeta sofre maior atenuação do que a luz azul quando se utilizam fontes de luz multiwave. As unidades Elipar DeepCure–L, Quazar e VALO Grand apresentaram comportamento semelhante em relação à transmissão de luz por todas as cerâmicas testadas.

Palavras-chave: Cerâmica; Lítio; Luz;

ABSTRACT

This study evaluated the effect of the type, opacity and thickness of the CAD/CAM lithium disilicate ceramics on the radiant power (mW), spectral radiant flux (mW/nm), the attenuation coefficient (mm^{-1}), when using different monowave and multiwave light curing units (LCUs). Five types of A2 CAD/CAM lithium disilicate ceramic were used (n = 3): DissiliKota (Kota Imports), IPS e-max CAD (Ivoclar Vivadent), Mazic Claro CAD (Vericom), Rosetta SM (OdontoMega), and T-Lithium (Talmax); in two translucencies: high (HT) and low translucency (LT) were tested for light transmission when using three LCUs: Elipar DeepCure–L (Solventum), Quazar (FGM) and VALO Grand (Ultradent). The power (mW) and spectral radiant power (mW/nm) were measured using a fiber optic spectrometer and integrating sphere with or without the 4 different thicknesses (0.5, 1.0, 1.5, 2.0 mm) of the CAD lithium disilicate ceramics. The attenuation coefficient was measured. Data of power light were subjected to 3-way ANOVA and Tukey HSD test, percentage of light transmitted was analyzed by exponential regression (R^2) ($\alpha = 0.05$). Light transmission through CAD/CAM lithium disilicate ceramics was significantly influenced by the type ($p<0.001$), and translucency ($p<0.001$). LT ceramics transmitted significantly lower light than HT ($p<0.001$). Attenuation coefficients varied among LCUs and ceramic types, with higher values in the violet spectrum. The thickness affected significantly the percentage of light transmitted $R^2>0.90$. CAD/CAM Lithium disilicate ceramic type, translucency, and thickness significantly affected the light transmission. As the ceramic thickness increased, there was a logarithmic decrease in light transmission, irrespective of the tested CAD/CAM lithium disilicate ceramic. Violet light was more attenuated than blue light for multiwave LCUs. Elipar DeepCure–L, Quazar, and VALO Grand exhibited similar light transmitted through all tested ceramics.

Keywords: Ceramics; Lithium; Light;

SUMÁRIO

OBJETIVO

O objetivo deste trabalho será apresentar o artigo intitulado “Efeito da transmissão de luz através de cerâmicas de dissilicato de lítio CAD/CAM de diferentes translucidezes com diferentes espessuras” a ser enviado para a Revista Journal Operative Dentistry.

Capítulo 1- Artigo Científico

Effect of light transmission through different translucency CAD/CAM lithium disilicate ceramics with different thickness

ABSTRACT

OBJECTIVE: This study evaluated the effect of the type, opacity and thickness of the CAD/CAM lithium disilicate ceramics on the radiant power (mW), energy (J/cm²), attenuation coefficient (mm^{-1}), using different monowave and multiwave light curing units (LCUs).

METHODOLOGY: Five types of A2 CAD/CAM lithium disilicate ceramic were used (n = 3): DissiliKota (Kota Imports), IPS e.max CAD (Ivoclar Vivadent), Mazic Claro CAD (Vericom), Rosetta SM (OdontoMega), and T-Lithium (Talmax); in two translucencies: high (HT) and low translucency (LT) were tested for light transmission using three LCUs: Elipar DeepCure–L (Solventum), Quazar (FGM) and VALO Grand (Ultradent). Radiant power (mW) and spectral radiant power (mW/nm) were measured using a fiber optic spectrometer and integrating sphere, both with or without the 4 different thicknesses (0.5, 1.0, 1.5, 2.0 mm) of the CAD lithium disilicate ceramics. The attenuation coefficient was then calculated. Data of energy (J/cm²) were subjected to three-way ANOVA and Tukey's HSD test, while the percentage of light transmitted was analyzed by exponential regression (R^2) ($\alpha = 0.05$).

RESULTS: Light transmission through CAD/CAM lithium disilicate ceramics was significantly influenced by the type ($p<0.001$), translucency ($p<0.001$), and LCU ($p<0.001$) . LT ceramics transmitted significantly lower light than HT ($p<0.001$). Attenuation coefficients varied among LCUs and ceramic types, with higher values observed in the violet spectrum. Thickness significantly affected the percentage of light transmitted ($R^2>0.90$).

CONCLUSION: CAD/CAM lithium disilicate ceramic type, translucency, and thickness significantly affected the light transmission. As the ceramic thickness increased, there was a logarithmic decrease in light transmission, irrespective of the tested CAD/CAM lithium disilicate ceramic. Violet light was more attenuated than blue light for multiwave LCUs.

Clinical implications: The light attenuation through LT and HT CAD lithium disilicate is material-dependent. Thickness greater than 1.5 mm significantly diminish light transmission, reducing the amount of energy delivered to the luting materials.

Key-words: Light curing unit, lithium disilicate glass ceramic, thickness, radiant power, irradiance.

INTRODUCTION

Different lithium disilicate glass-ceramics have been commercialized in CAD-CAM blocks.[1,2] Technical advancements in materials significantly influenced the commercial success of IPS e.max© CAD from Ivoclar Vivadent. Following the expiration of the lithium disilicate glass-ceramic patent in 2019, other manufacturers began introducing their own lithium disilicate glass-ceramic materials to the global market.[3,4] The success of these ceramics is primarily due to their ability to produce restorations in a single appointment, combined with their excellent fracture resistance and esthetic.[5]

The bonding process between the tooth, resin cement, and the ceramic restoration is a critical procedure for the success of the lithium disilicate glass-ceramic restoration.[6] Light-cured, dual-cure resin cements, flowable resin composites, heated regular past resin composite are indicated for cementing ceramic restorations, depending on the thickness of the restorative material.[7,8,9] The amount of the light at different spectra that passes through the ceramic and the exposure time are critical factors for determining the polymerization of various resinous materials.[10] Light curing units (LCUs) with a greater active tip area, power and emitted light in different wavelength can also affect the polymerization of resin cements with alternative photoinitiators.[11]

The most frequent photoinitiator in resin cements formulation is camphorquinone and tertiary amines, which are light activated by light at a wavelength of 470 nm.[12,13,14,15] Due to yellow color of the camphorquinone, some manufacturers have begun using a new generation of Norrish Type I photoinitiators, which are whiter and activated by violet light (390-410nm).[10,16,17,18,19] Multiwave LCUs have demonstrated superior outcomes in terms of degree of conversion, hardness, and depth of cure, particularly in resin composites containing TPO or Ivocerin.[20] However, their higher thermal emission and beam non-uniformity may present a clinical challenge.[20] The use of a thicker or more opaque restoration can reduce the light transmission through the material, especially violet light.[21] The bond to the tooth and the mechanical properties of the resin cement can also be compromised by significative light attenuation.[22,23]

The opacity and thickness are other factors that could influence the power and wavelength of light transmitted through the CAD/CAM lithium disilicate glass-ceramics.[11,24,25] Although these materials are all based on CAD/CAM lithium disilicate glass-ceramic, they can vary substantially in their crystalline intensities, which can affect translucency and, consequently, light transmission.[26]To the best of the authors' knowledge, no study has analyzed the light emitted by monowave and multiwave LCUs as it is transmitted through different types of CAD/CAM lithium disilicate glass-ceramics, varying in opacity and thickness. Therefore, the aim of this study was to evaluate the influence of the translucency and thickness of different CAD/CAM lithium disilicate glass-ceramics on light transmission when using monowave and multiwave LCUs. The null hypotheses were:

1) The CAD/CAM lithium disilicate glass-ceramics will not differ from precursor IPS e.max© CAD regarding the light transmission parameters.
2) The translucency and thickness of different CAD/CAM lithium disilicate glass-ceramics would not affect the transmission parameters of the light emitted in different wavelengths.
3) Monowave and multiwave LCUs would not have variability on the transmission parameters for different CAD/CAM lithium disilicate glass-ceramic type.

METHODS AND MATERIALS

Study design

The high translucency (HT) and low translucency (LT) of five CAD/CAM lithium disilicate glass-ceramics, DissiliKota (Kota Imports, Cotia, Brazil), Mazic Claro CAD (Vericom, Chuncheon-Si, Gangwon-Do, Korea), T-Lithium CAD (Talmax, Curitiba, Brazil), and Rosetta SM (Hass, Gangneung, Korea), were tested for light transmission in four different thicknesses (0.5, 1.0, 1.5, and 2.0 mm). Three light-curing units (LCUs) were used: one monowave unit, Elipar DeepCure–L (Solventum, St. Paul, MN, USA), and two multiwave units, VALO Grand (Ultradent, South Jordan, UT, USA) and Quazar (FGM, Joinville, SC, Brazil). The radiant power (mW), spectral radiant flux (mW/nm), and calculated irradiance (mW/cm^2) were measured both with and without the ceramics. The light attenuation coefficients were calculated for all combinations of ceramics and LCUs.

CAD-CAM glass ceramics preparation

The CAD/CAM ceramic blocks were glued to an acrylic plate with cyanoacrylate glue (Super Bonder; Loctite, Itapevi, Brazil). Using a precision saw (Isomet 1000; Buehler, Lake Bluff, USA) at 100 rpm under a 50 g load with copious water irrigation, the blocks were sectioned into 0.5, 1.0, 1.5, and 2.0 mm thicknesses. All CAD/CAM lithium disilicate glass-ceramics were then crystallized and glazed according to the manufacturer's instructions.

Total radiant power and emission spectrum

To determine the total radiant power (mW) and spectral radiant power (mW/nm) for the three LCUs, a fiber optic spectrometer (USB 4000; Ocean Insight, Orlando, USA) connected to a six-inch integrating sphere (Labsphere; North Sutton, USA) was used. The system was calibrated with an internal lamp (SCL 600; Labsphere).

Initially, the three LCUs were characterized using the full 12.5 mm aperture of the integrating sphere. Subsequently, measurements were taken with and without each of the four ceramic thicknesses (0.5, 1.0, 1.5, and 2.0 mm). For these measurements, the LCU tip was positioned at a 0-mm distance, touching the glazed ceramic surface through a 10 mm aperture in the integrating sphere. The tip diameters of the three LCUs were measured using a digital caliper (Mitutoyo, Tokyo, Japan), and the energy (J/cm^2) was then calculated.

Light attenuation coefficient

The light attenuation coefficients (AC) (mm^{-1}) were characterized for each LT and HT CAD/CAM lithium disilicate glass-ceramic and LCU were calculated according to the increased thickness. The AC characterizes how quickly incident light is attenuated when passing through a medium. A higher coefficient denotes greater light attenuation, while a lower value suggests minimal impact on light transmission. The attenuation coefficient (AC, mm^{-1}) was derived using the Beer-Lambert law: $I(z) = I_0 e^{(-\alpha z)}$, where I_0 represents the initial light intensity measured without the specimen, α is the attenuation coefficient, and z is the thickness of the specimen.

Statistical analysis

Energy (J/cm^2) data underwent analysis to assess normal distribution (Shapiro-Wilk test) and homoscedasticity (Levene test). Three-way ANOVA was used to examine interactions among study factors: CAD/CAM lithium disilicate ceramic type (5 levels), translucency (2 levels), and LCUs (3 levels). Post-hoc comparisons were conducted using Tukey's HSD test. All statistical tests maintained a significance level of $\alpha = 0.05$, and analyses were conducted using Sigma Plot 11.0 (Systat Software Inc, San Jose, USA). Exponential regression (R^2) was calculated to the mean values of the radiant power between the different translucencies (HT and LT). Descriptive analysis was performed on light attenuation coefficients (mm^{-1}), and calculated irradiance (mW/cm^2).

RESULT

The diameter of active tip is showed in Figure 1. Valo Grand has the lagger diameter of tip 11.8 mm, followed by Quazar 10.0 mm, and Elipar DeepCure–L 9.0 mm. The radiant power (mW) and the spectral radiant power (mW/nm) are shown in Figure 2. VALO Grand presented the higher radiant power values (1020 mW) than other LCUs, Elipar DeepCure–L and Quazar had similar radiant power around (840 mW). The Elipar DeepCure–L monowave LCU emitted had light peak at 450 nm and two multiwave LCUs Quazar emitted light peaks at 400nm and 452 nm, and VALO Grand at 395 nm, 444 nm and 464 nm. All tested LCUs had stable radiant power and spectral radiant flux during the 20 s exposure time. The calculated irradiance (mW/cm^2) emitted for Elipar DeepCure–L (1333 mW/cm^2) and Quazar (1070 mW/cm^2) emitted higher irradiance than Valo Grand (933 mW/cm^2). VALO Grand and Quazar confirmed to be a multiwave LCUs, emitting peak in the violet and blue spectrum.

The energy (J/cm^2) calculated using 40 s of exposure time transmitted through 0.5 mm and 2.0 mm of thicknesses from three LCUs (Elipar DeepCure–L, Quazar and VALO Grand), HT and LT translucency, and different types of CAD/CAM lithium disilicate ceramic are showing in Table 3 and Table 4 respectively. The 3-way ANOVA reported that the translucent, LCUs and ceramic types had significant effects on the energy (J/cm^2) transmitted through CAD/CAM lithium disilicate ceramic ($p<0.001$). In the general Elipar DeepCure–L presented higher energy than Quazar and VALO Grand ($p<0.001$). HT ceramics had higher energy values transmitted through the LT ceramics ($p<0.001$). In the general Rosetta and T-Lithium had the highest energy transmitted for both thicknesses 0.5 and 2.0 mm ($p<0.001$).

The percentage of light transmitted through all tested ceramics at different thicknesses is shown in Figure 6. For all LCUs, increasing the thickness resulted in an exponential reduction of the light transmission ($R^2 > 0.90$).

The attenuation coefficients of the light emitted for LCUs in all wavelengths with for all ceramics are shown in Figure 7. Violet light emitted by multiwave LCUs (Quazar and VALO Grand) had higher attenuation coefficient values than blue light. Different ceramics presented different attenuation coefficient (mm^{-1}HT ceramics had lower attenuation coefficient values than LT ceramics. IPS e-max CAD had the highest attenuation coefficient values for LT opacity and Rosetta the lowest for HT opacity.

DISCUSSION

The present study evaluated the influence of the opacity, thickness of the different types of CAD/CAM lithium disilicate ceramic on the light emitted by monowave and multiwave LCUs and transmitted through in different ceramic thicknesses. The versions of CAD/CAM lithium disilicate ceramics differed from the precursor IPS e.max CAD in all tested light transmission parameters. Therefore, the first null hypothesis was rejected. The translucency of different CAD/CAM lithium disilicate ceramics significantly influenced light transmission parameters at vary levels. The HT ceramics transmitted higher light than LT ceramics at all tested thickness and LCUs. Consequently, the second null hypothesis was rejected.

Understanding the radiant power and spectral behavior of light transmitted through lithium disilicate ceramics is crucial for selecting the appropriate resin cement. An adequate amount of energy, determined by the interaction between irradiance and exposure time in the correct spectrum, is essential to activate the photoinitiators.[27] The monowave LCU, Elipar DeepCure–L, showed a similar reduction in light transmission compared to the multiwave LCUs, Quazar and VALO Grand, as the ceramic thickness increased. However, the attenuation coefficient for these LCUs differed due to the presence of violet light emission, which was more attenuated than blue light. Consequently, the third null hypothesis was rejected. A recent systematic review demonstrated that multiwave LCUs offer superior polymerization outcomes, specifically in terms of degree of conversion, microhardness, and depth of cure, particularly when used with composites containing alternative photoinitiators like TPO and Ivocerin.[20] However, this same study reported that despite these improvements in mechanical properties, the level of evidence remains low. Clinical recommendations should therefore be made cautiously, as their higher thermal emission and beam non-uniformity may pose clinical challenges.[20]

When a LCU delivers energy through CAD/CAM lithium disilicate ceramics, the thickness of the material significantly influences the amount of radiant power that reaches the underlying luting materials. The transmitted irradiance through CAD/CAM lithium disilicate ceramics typically decreases from approximately 800 mW/cm^2 at 0.5 mm to 75 mW/cm^2 at 2.0 mm. Using 40 seconds of exposure time, an energy dose can reach 32 J/cm^2 for 0.5 mm but only 3 J/cm^2 for 2.0 mm ceramic thickness. This substantial reduction of the energy delivered as thickness increases highlights the clinical importance of selecting a luting material with a different activation process for cement restorations of different thicknesses.[12] For ceramic restorations with 0.5 or 1.0 mm thickness, light-cured cements, flowable resin composite, and heated regular paste resin composite can be properly polymerized. However, for thicker restorations, the use of dual-cure or self-cure resin cements is more adequate to ensure adequate mechanical performance and long-term stability.[12]Low translucency ceramics are frequently used to block out darker substrates, while high translucency (HT) is used when it is not necessary to modify the effect of the substrate color on the final restoration.[28] This study confirmed that the translucency of lithium disilicate ceramics significantly influences the radiant power transmitted.[29] This finding can be explained by the different crystalline intensities of each CAD/CAM lithium disilicate ceramic,[26] which affects translucency and, consequently, light transmission.

The transmitted energy through to LT CAD/CAM lithium disilicate ceramics can compromise the mechanical properties of light-curing resin cements.[22] Therefore, clinicians should consider extending the exposure time when light-activating resin cement under more opaque ceramic restorations. The difference on the light transmitted through HT and LT translucencies was not consistent across all tested CAD/CAM lithium disilicate ceramics. This inconsistency may be attributed to a lack of standardization in the production mechanisms used by different manufacturers for their LT and HT ceramics. Variations in their crystalline microstructure, sintering parameters, and chemical composition which are not standardized across manufacturers can cause these differences.[26] Higher light transmission can be correlated with a lower crystalline volume fraction and differences in grain orientation after sintering.[26] The sintering temperature and time can affect the formation of elongated lithium disilicate crystals, and ceramics with smaller, less densely packed crystals allow for greater light passage.[26]

Luting materials are subject to the ISO 4049:2019 guidelines,[30] which specifies a minimum depth of cure of 1.0 mm for opaque shades and 1.5 mm for non-opaque shades. The standard classifies light-curing resin cements in Group 2, meaning they require an external light source for polymerization. However, the standard provides no information on the minimum quantity of energy or the time necessary to light-activate these materials. This information is crucial, as the present study demonstrated that radiant power delivery is heterogeneous across different types of CAD/CAM lithium disilicate ceramics and LCUs. The percentage of total light transmitted was exponentially reduced by more than 40% of the total light emitted by all LCUs for 1.0 mm thicknesses and more than 20% for 2.0 mm thicknesses. In this context, to achieve a similar energy dose for a material with a thickness of 1.5 - 2.0 mm would be necessary to double the light activation time.

This study has limitations, single ceramic shade A2 was used for all CAD/CAM lithium disilicate ceramics. Additionally, was not verify the influence of these study factors present in this study on the mechanical properties, like degree of conversion, microhardness, and depth of cure, of the light cured luting materials. Therefore, further clinical studies are necessary to evaluating these factors and confirm the findings of this study.

The translucency and the thickness of the CAD/CAM lithium disilicate ceramics tested in this study suggests that the protocol of light activation can be adjusted when the clinicians are cementing thicker posterior and opaquer ceramic restorations. Increasing the time and making a localized light exposures, covering the entire extension of the restoration can improve the mechanical properties of the luting materials.[31] When used LCUs with diameter of active tip lower than the dimensions of the area to be light cured, is necessary to do perform multiple light exposures to cover all the area.[32,33,34] When increased the thickness from 1.5 - 2.0 mm, mainly for LT CAD/CAM lithium disilicate ceramic, adjusting exposure time for over 40 seconds and the preference for using dual cure resin cement can be necessary to delivery achieve an adequate luting procedure.

CONCLUSION

Within the limitations of this study, the following conclusions can be drawn:

1) The type, and shade of the CAD/CAM lithium disilicate ceramic affect significantly the radiant power (mW) transmitted through the CAD/CAM lithium disilicate ceramic.
2) The thickness reduce exponential the percentage of light transmitted.
3) Low translucency (LT) CAD/CAM lithium disilicate ceramic had more light attenuation than high translucency (HT), irrespective of LCU and ceramic tested.
4) The energy delivered above the CAD/CAM lithium disilicate ceramic with 0.5 mm thickness is sufficient for light activate light-cured luting material, but with 2.0 mm thickness the energy is not sufficient and dual-cured luting materials must be used.
5) When increased the ceramic thickness, violet light was more attenuated than the blue light the multiwave tested LCUs.

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Tables

Table 1. The specifications of A2 shade CAD-CAM lithium disilicate blocks tested.

Ceramic Type	**Shade / Opacity**	**Lot Number (HT/LT)**	**Manufacture**
DissiliKota	A2 / HT and LT	23041804 / 23033004	Kota Imports, Cotia, Brazil
IPS e.max CAD	A2 / HT and LT	YB442V / YB93CT	Ivoclar Vivadent, Schaan, Liechtenstein
Mazic Claro CAD	A2 / HT and LT	CL2701A2 / CH2N03A2	Vericom, Chuncheon-Si, Gangwon-Do, Korea
Rosetta SM	A2 / HT and LT	ABE06PF3001 / AAE06PI2501	Hass, Gangneung, Korea
T-Lithium	A2 / HT and LT	L8230204045-016 / L8230714089-051	Talmax, Curitiba, Brazil

Table 2. The specification of light-curing units (LCUs) tested.

Light Curing Units	Serial Number	Wavelength emission	Battery/ mains	Tip/light conductor	Manufacture
Elipar DeepCure–L	932125	Monowave	Battery	Optical fiber/ black	Solventum, St Paul, USA
Quazar	L23A1021R	Multiwave	Battery	Direct by LED	FGM, Joinville, Brazil
VALO Grand	C33856	Multiwave	Battery	Direct by LED	Ultradent, South Jordan, USA

Table 3. Means and standard deviations of the energy (J/cm^2) calculated when using 40 s of exposure time of the light emitted by 3 LCUs and transmitted through 5 lithium disilicate CAD ceramics at 0.5 mm thickness.

LCU	IPS e-max CAD		DissiliKota		Mazic Claro CAD		Rosetta SM		T-Lithium	
	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT
Elipar DeepCure–L	27.0 ± 1.5 Ca	22.7 ± 0.4 Ca*	29.9 ± 2.4 Ba	26.5 ± 1.0 Ba*	29.3 ± 1.3 Ba	25.9 ±0.3 Ba*	31.0 ±1.2 Aa	27.2 ±2.3 Aa*	32.1 ±1.7 Aa	27.9 ±0.6 Aa*
Quazar	20.7 ± 1.4 Cb	17.1 ± 0.5 Cb*	22.9 ± 1.7 Bb	20.3 ± 0.6 Bb*	22.4 ± 1.0 Bb	20.2 ±0.2 Bb*	24.2 ±1.3 Ab	21.1 ±1.8 Ab*	25.0 ±1.1 Ab	21.2 ±0.6 Ab*
VALO Grand	15.4 ± 1.2 Cc	12.7 ± 0.5 Cc*	16.5 ± 1.2 Bc	14.7 ± 0.4 Bc*	16.8 ± 1.0 Bc	14.7 ±0.1 Bc*	17.9 ±0.7 Ac	15.8 ± 1.1 A*	18.1 ±0.8 Ac	15.4 ±0.2 Ac*

Different letters and symbols indicate significant difference – uppercase letters are used for comparing lithium disilicate CAD ceramics with each translucency, lowercase letters are used for comparing LCU for each lithium disilicate CAD ceramics and translucency; * are used for comparing translucency HT and LT for each lithium disilicate CAD ceramic.

Table 4. Means and standard deviations of the energy (J/cm^2) calculated when using 40 s of exposure time of the light emitted by 3 LCUs and transmitted through 5 lithium disilicate CAD ceramics at 2.0 mm thickness.

LCU	IPS e-max CAD		DissiliKota		Mazic Claro CAD		Rosetta SM		T-Lithium	
	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT
Elipar Deep Cure–L	9.5 ± 0.1 Ba	5.4 ± 0.2 Ca*	9.2 ± 0.6 Ba	6.4 ± 0.5 Ba*	7.5 ± 0.2 Ca	6.4 ± 0.6 Ba	10.4 ± 0.3 Aa*	7.5 ± 0.3 Aa*	10.2 ± 0.7 Aa	7.1 ± 0.7 Aa*
Quazar	7.2 ± 0.2 Bb	3.9 ± 0.1 Cb*	6.8 ± 0.4 Bb*	4.8 ± 0.3 Bb*	4.9 ± 0.1 Cb	4.1± 0.4 Cb	8.1 ± 0.2 Ab*	5.7 ± 0.3 Ab*	7.8 ± 0.6 Ab	5.4 ± 0.5 Ab*
VALO Grand	5.5 ± 0.1 Bc	3.0 ± 0.1 Cc*	5.0 ± 0.3 Cb*	3.6 ± 0.2 Bc*	4.1 ± 0.1 Dc	3.5 ± 0.1 Bc	6.5 ± 0.2 Ac*	4.6 ± 0.2 Ac*	5.8 ± 0.4 Bc	3.8 ± 0.4 Bc*

Different letters and symbols indicate significant difference – uppercase letters are used for comparing lithium disilicate CAD ceramics with each translucency, lowercase letters are used for comparing LCU for each lithium disilicate CAD ceramics and translucency; * are used for comparing translucency HT and LT for each lithium disilicate CAD ceramic.

Figures

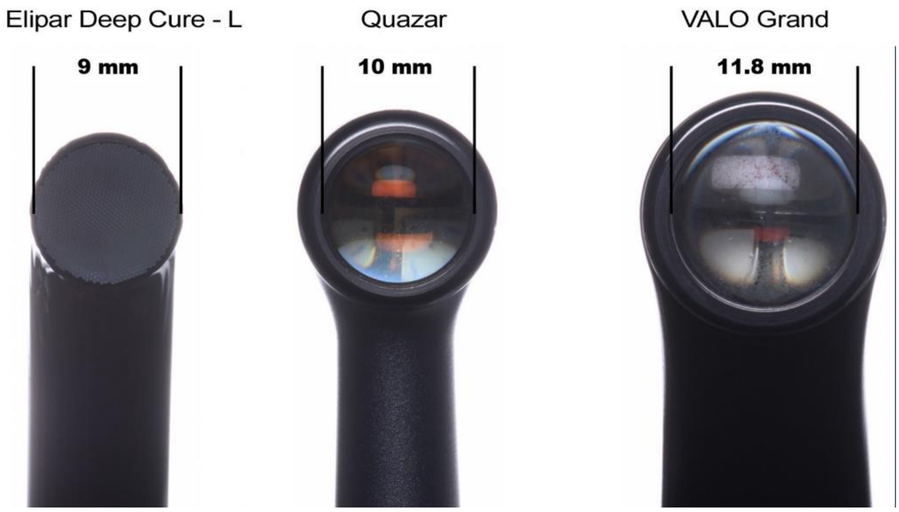

Figure 1. Internal diameter of the LCU tips tested.

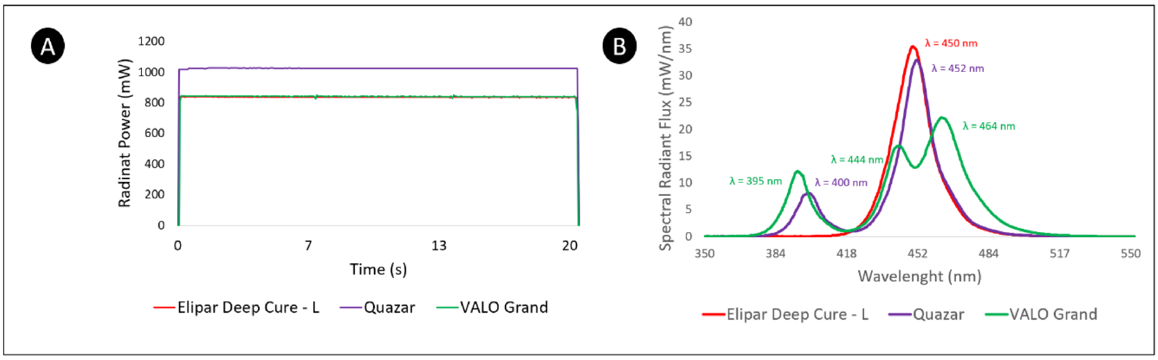

Figure 2. A; Radiant Power (mW); B: Spectral Radiant Flux (mW/nm) emitted by monowave and multiwave tested LCUs.

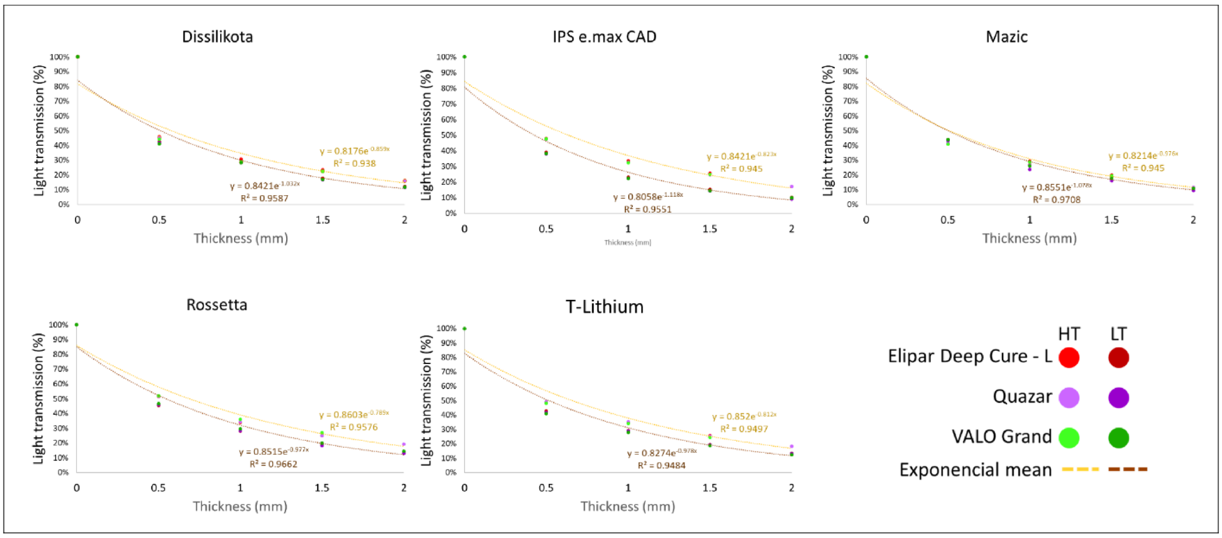

Figure 6. Attenuation (%) of the radiant power from the LCUs transmitted through five brands, two opacities and four thicknesses of CAD/CAM lithium disilicate ceramic.

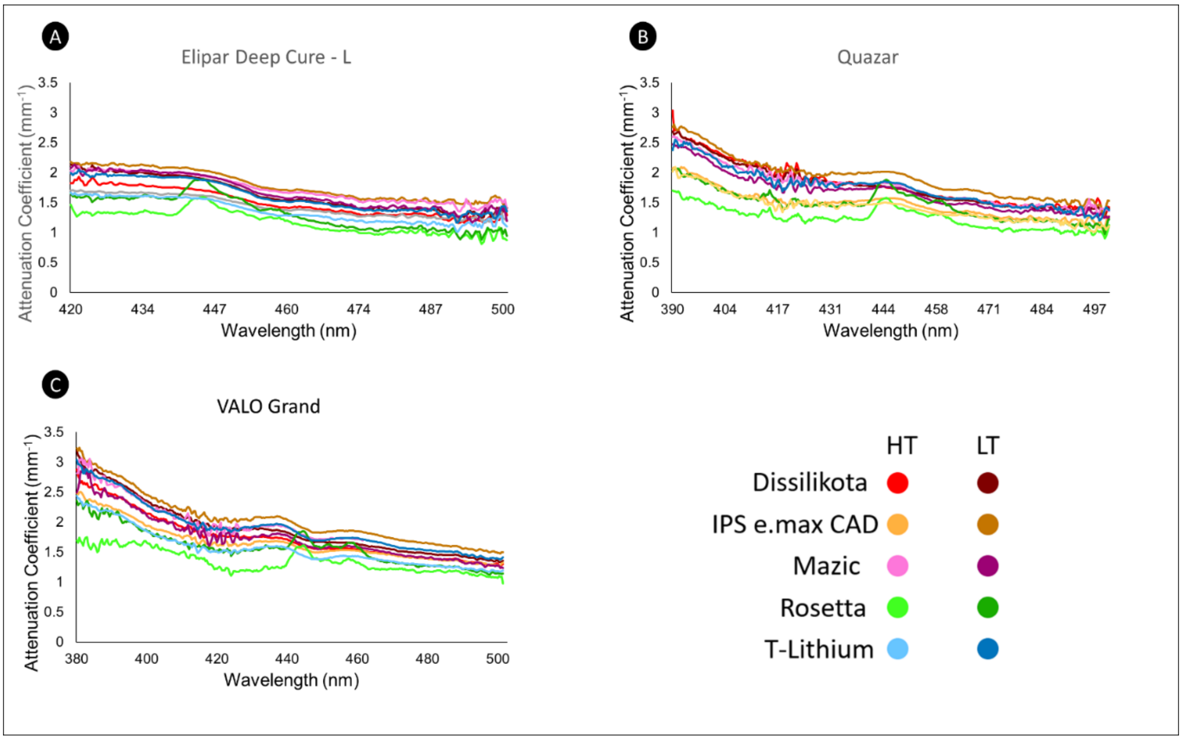

Figure 7. Light Attenuation Coefficients of the LCUs in relation to the different thicknesses of the different shades of the lithium disilicate CAD. Note the scale of the Elipar DeepCure–L, Quazar and VALO Grand start in 420, 390 and 380 nm due to difference or absence of violet led in these LCUs.

ANEXO – NORMAS DA REVISTA

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