EC DENTAL SCIENCE
Research Article

Comparison between Led and Halogen Photoinitiator Systems on Setting Time for Different Thickness of Resin-Based Composite for Various Seconds

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Received: July 28, 2018; **Published:** September 12, 2018

Abstract

Objectives: The aim of the study is to examine the hardness of the top and bottom layer of the cured restoration by LED and halogen light cure systems by using three different resin composite.

Methods: Composite resin (Filtek Z 250, 3M, USA), (Filtek Z 350, 3M, USA) and (Tetric N-ceram bulk-fill, Ivoclar vivadent, Lichtenstein) was used as test material and cured by (LED, 3M ESPE Elipar S10, USA) and (Halogen, Lions dental supply Omega 750 II, USA). A custom made bronze mold was used to prepare samples for 2 mm, 4 mm, 5 mm and 6 mm with LED light source and halogen cured for 20 and 40 seconds. Hardness was measured using Vickers hardness device. Data was used using ibm spss 20. 4 way anova repeated measurement and dependent " t" test to analyze the data.

Results: Significant differences were found in hardness of samples cured by LED light sources and also in The curing performance of the tested QTH was not as well as the LED light.

Conclusions: LED light cure produced greater hardness than Halogen. 40 seconds showed better hardness than 20 seconds and Tetric N-ceram showed better hardness values than Z350 and Z250.

Keywords: *Hardness; Bulk Fill; Vickers Hardness Test; Nano Filled; Halogen*

Introduction

A light cure is a dental equipment, it has a function that polymerize resin based composite [1]. Also it can polymerize any dental materials that are curable by light. Each light cure equipment has its own wavelengths depending on the type of the device is being used. Tungsten halogen, laser, light-emitting diode (LED) and plasma arc curing (PAC) are the most basic types of dental curing light. LED and halogen are the most frequent used in dental clinics.

Tungsten halogen curing light (QTH)

Halogen light cure is the most light cure equipment that been used in dental clinics [2]. It has a thin tungsten filament that function as a resistor of an electric current flows through it [2]. Electromagnetic radiation is emitting in the form is a visible light by the heated resistor [2]. The temperature is almost 3000 kelvin. an intensity of 400 - 600 mW/cm^2 provided by the blue light that been emitted from the device [3]. Halogen light cure system has many drawbacks. One of these is the filament generate a very high temperature which means it has to contain a ventilating fan Containing a ventilating fan makes the device large and it will generate a very noisy sound that will make the clinics uncomfortable for the patients [2].

Light-emitting diodes [LEDs] curing light

In 1995 light emitting diodes were first suggested in the literature [4]. Gallium nitride-based semiconductor is used to emit a blue light from the LED device. LED light cure has many advantages, it is lightweight because it does not contain a ventilating fan. When comparing LED with halogen light cure, LED does not require a ventilating fan because it generate heat much less. LED has a rechargeable battery which makes the device portable and comfortable to use.

Aim of the study

This study aimed at examining the hardness of the top and bottom layer of the cured restoration by using three different resin composite (Table 1), four different thicknesses and two light cure system (Table 2). Curing time will be 20 seconds and 40 seconds. It was aimed to know the ratio of the bottom layer of the cured restoration with the top layer. By knowing the ratio, we can determine the depth of cure of both LED and HALOGEN light cure based on the thicknesses, restorations and curing time.

Materials and Methods

Materials

Three types of resin composite materials were used. The chemical composition and manufacturers' information about the materials are listed in table 1.

Type	Composition	Manufacturer
Conventional composite [5]	bis-GMA UDMA TEGDMA bis-EMA(6)	3M Filtek Z350 XT, USA
Nano fill composite [6]	Bis-GMA TEGDMA Bis-EMA(6) UDMA	3M Filtek Z250 XT, USA
Bulk fill composite [7]	Bis-GMA UDMA	Ivoclar vivadent Tetric N-ceram, Lichtenstein

Table 1

- bis-GMA (Bisphenol A diglycidyl ether dimethacrylate).
- UDMA (urethane dimethacrylate).
- TEGDMA (tri-ethylene glycol dimethacrylate).
- bis-EMA(6) (Bisphenol A polyetheylene glycol diether dimethacrylate).

Two light cure systems as shown in table 2.

Type	Manufacturer
LED	3M ESPE Elipar S10, USA
Halogen	Lions dental supply Omega 750 II , USA

Table 2

Methods

Preparation of samples

Sample size will be 720, using three different types of resin based composite (conventional composite, Nano-fill composite, Tetric N-ceram bulk fill composite) Each specimen will be placed in custom-made bronze molds then cured by two different types of light-cure system (LED and Halogen) for two exposure times of 20 seconds and 40 seconds in four different thicknesses (2 mm, 4 mm, 5 mm and 6 mm) The sample will be stored after curing in water for 24 hours.

Depth of cure

Hardness is defined as the resistance of a material to indentation or penetration. Based on top and bottom hardness measurements, we will calculate the ratio of bottom/top hardness, and give a minimum value for this ratio. These calculations will be done using vickers hardness device. In order to consider the bottom surface as adequately cured, values of 0.80 and 0.85 have often been used [8].

Statistical analysis

Descriptive statistics (mean, Standard deviation, graph) using ibm spss 20. 4-way anova repeated measurement and dependent" t" test will be used to analyze the data.

Results

It was suggested if the bottom layer is 80% or more cured when comparing it with the top layer it was called 'Well cured'. If it was less than 80% it is called 'Partially cured'. And for the sample that the bottom layer which wasn't cured or it was soft we called 'Not cure'.

Z350, 2 mm, 20 seconds that been cured by LED showed significance difference than that cured with the HALOGEN. While Z350, 4 mm, 20 seconds cured by LED showed insignificance difference than that cured with the HALOGEN. Also in Z350, 5 mm and 6 mm, 20 seconds cured by LED showed insignificance difference than that cured with the HALOGEN.

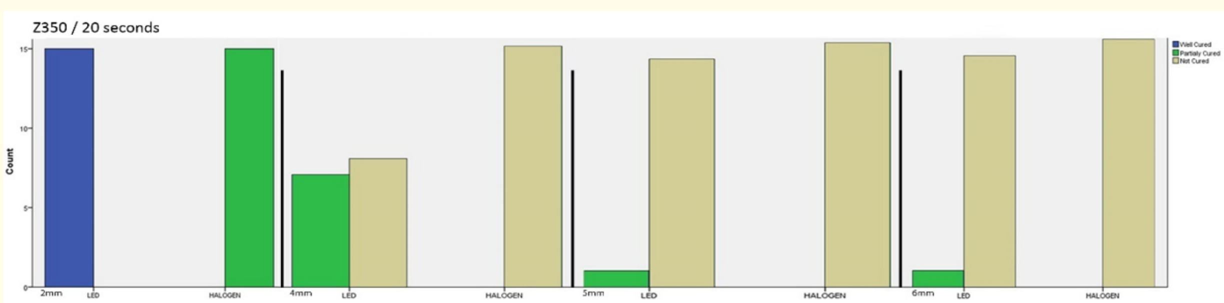

Figure 1

For the Z350, 2 mm, 40 seconds cured with LED and HALOGEN showed all the samples are the same (well cured, No P-Value). Z350, 4 mm, 40 seconds cured by LED showed significance difference than that cured with HALOGEN. Z350, 5 mm, 40 second cured by LED showed significance difference than that cured with the HALOGEN. Z350, 6 mm, 40 seconds cured by LED showed insignificance difference than that cured with the HALOGEN.

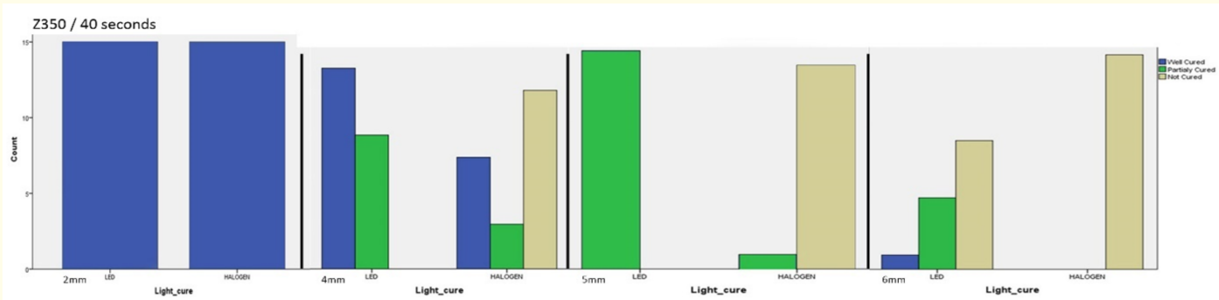

Figure 2

Z250, 2 mm, 20 second cured by LED showed significance difference than that cured with the HALOGEN ones. While Z250, 4 mm, 20 seconds cured by LED showed insignificance difference than that cured with the HALOGEN. And Z250, 5 mm and 6 mm, 20 seconds cured by LED showed insignificance difference than that cured with HALOGEN.

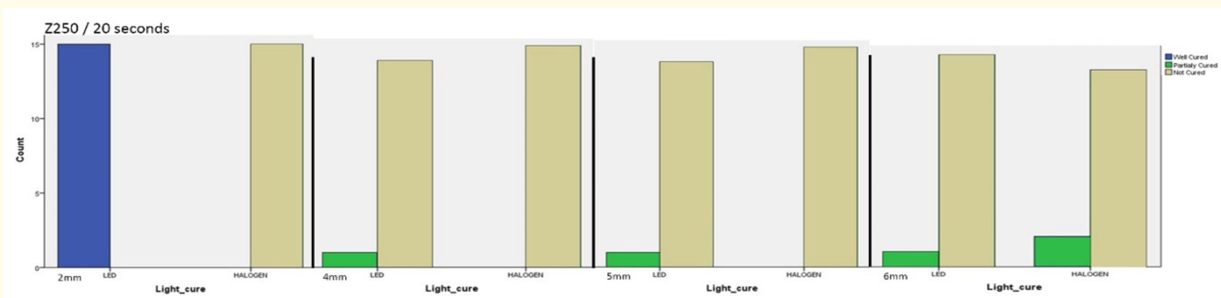

Figure 3

Z250, 2 mm, 40 seconds cured by LED showed significance difference than that cured with the HALOGEN. Z250, 4 mm, 40 seconds cured by LED showed insignificance difference than that cured with the HALOGEN light cure Also Z250, 5 mm and 6 mm, 40 seconds cured with LED showed insignificance difference than that cured with the HALOGEN light cure.

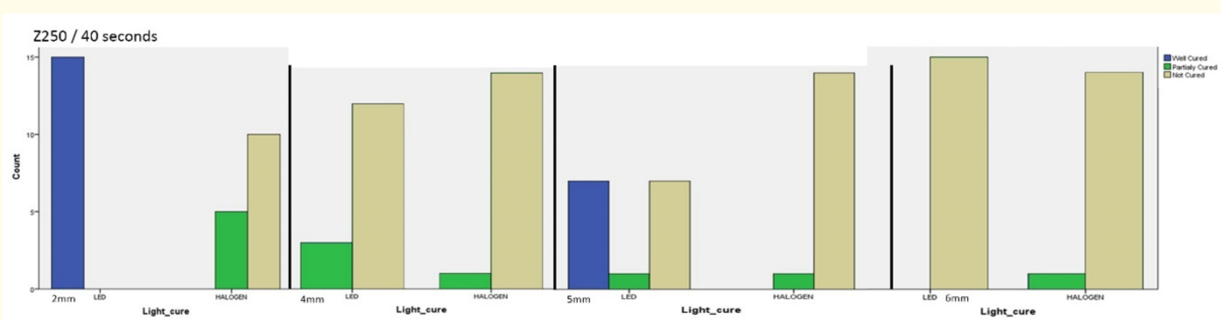

Figure 4

For Tetric N-ceram, 2 mm, 20 seconds cured with LED and HALOGEN showed all the samples are the same (well cured, NO-P Value). Tetric N-ceram, 4 mm, 20 seconds cured with LED significance difference than that cured with the HALOGEN. Tetric N-ceram, 5 mm, 20 seconds cured by LED showed significance difference than that cured with the HALOGEN light cure. Tetric N-ceram, 6 mm, 20 seconds cured with the LED showed insignificance difference

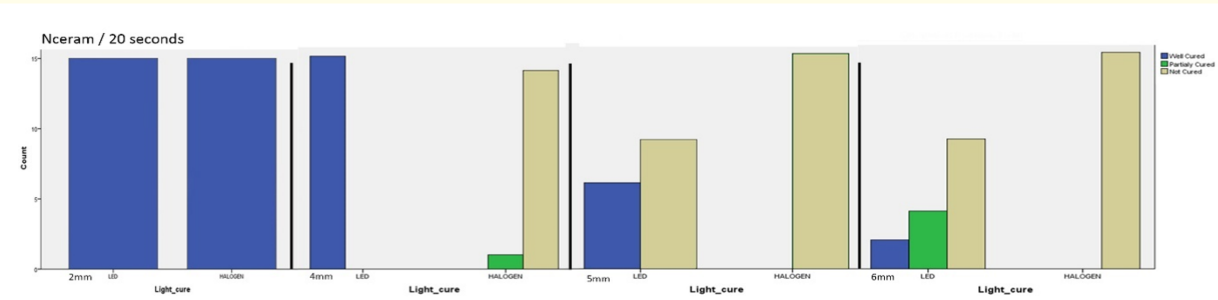

Figure 5

Tetric N-ceram, 2 mm, 40 seconds cured with LED and HALOGEN showed all of the samples are the same (well cured, NO-P value). Tetric N-ceram, 4 mm, 40 seconds cured with LED showed significance difference than that cured with the HALOGEN. Tetric N-ceram, 5 mm, 40 seconds cured with LED showed significance difference than that cured with the HALOGEN. Tetric N-ceram, 6 mm, 40 seconds cured by LED showed significance difference than that cured with HALOGEN.

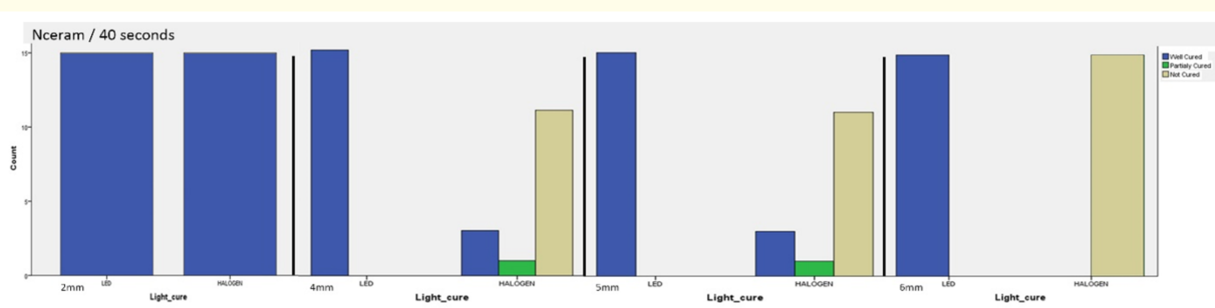

Figure 6

Composite	Thickness	Exposure Time	Asymp. Sig (2-sided)	Exact Sig. (2-sided)
Z350	2 mm	20 seconds	-	.000
		40 seconds	NO P-value	NO P-value
	4 mm	20 seconds	-	.006
		40 seconds	0.004	-
	5 mm	20 seconds	-	1.000
		40 seconds	-	.000
	6 mm	20 seconds	-	1.000
		40 seconds	0.024	-
Z250	2 mm	20 seconds	-	.000
		40 seconds	0.000	-
	4 mm	20 seconds	-	1.000
		40 seconds	-	.598
	5 mm	20 seconds	-	1.000
		40 seconds	0.009	-
	6 mm	20 seconds	-	1.000
		40 seconds	0.309	-
Tetric N-ceram	2 mm	20 seconds	NO P-value	NO P-value
		40 seconds	NO P-value	NO P-value
	4 mm	20 seconds	0.000	-
		40 seconds	0.000	-
	5 mm	20 seconds	-	.017
		40 seconds	0.000	-
	6 mm	20 seconds	0.024	-
		40 seconds	-	.000

Discussion

The curing performance of halogen light cure system was compared with LED light cure system with the goal of determining whether halogen and LED are capable of curing composites completely with exposure time of 20 and 40 seconds. Increments of 2, 4, 5 and 6 mm thickness. Successful polymerization is the key of obtaining the optimal physical functioning of resin composite materials [9]. Z350 composite With both light curing systems for 20 and 40 seconds, we can see that 2 mm thickness has better hardness than 4 mm, while 4 mm is better than 5 and 6 mm only with LED light curing system. For 40 seconds, Z250 composite with both light curing systems for 20 seconds, better hardness was seen with 2 mm thickness in LED, while surprisingly, with halogen curing system 6 mm showed 2 specimens out of 15 were partially cured and better hardness than 2, 4 and 5 mm. For the same composite but for exposure time of 40 seconds, 2 mm showed better hardness than 4 mm, yet with LED, 5 mm was cured better than 4 and 6 mm. Lastly with Tetric N-ceram composite with both curing systems for 20 second, 2 mm showed better hardness than 4 mm and 4 mm thickness was better than 5 and 6 mm in LED while with halogen 4 and 5 mm showed same hardness value. LED for 40 seconds showed the best result for all thicknesses using Tetric N-ceram composite. So, it can be seen that the greater well cure observed for the samples cured with the LED, the camphorquinone photoinitiator need 470 nm peak be activated in an optimum wavelength which can be achieved by the narrow spectral range of the LED [10,11]. Also, its High intensity of up to 1200 mW/cm^2 provided a fast cure. The trans-mission coefficient is influenced by the wavelength of the light, the refractive indices of the resin and fillers, and the nature and amount of the filler particles [12]. In accordance with Atmadja and Bryant [13] and Prati., *et al.* [14] recommended increasing the light curing time when the cavity is deep. When the light curing time increased the higher hardness value it showed in the results of the study. All of the samples showed higher hardness values in the top surface when comparing it with the bottom surfaces. the ratio between the bottom and top hardness for all experimental groups was much lower than considered ideal (0.8 or greater) in halogen curing system when compared to LED curing systems with respect to hardness and depth of cure. The hardness values and depth of cure was significantly higher in LED light cure. This result representing a lower amount of energy [15] and a shorter period of time for light to penetrate deeper into the material, since part of the light necessary for polymerization is absorbed and scattered by the resin composite that has already been polymerized [16]. Another related factor may be that, although much emitted light can satisfy the camphorquinone (CQ) absorption curve and initiate a polymerization reaction, the highest probability of light absorption corresponds with the peak at 465 nm. While the output of the halogen curing light has a broad spectrum, so 80% of the energy from the halogen lamp is outside the useful curing range [2,17-19]. In general, larger hardness values are indicators of more extensive polymerization [20]. The bottom surface has been shown to be problematic with regard to the degree of polymerization because the thicker the resin composite increment was, the less the polymerization happened [13,14].

Conclusions

- Hardness values produced were greater with the LED light than with the Halogen light cure system.
- Tetric N-ceram composite showed better hardness values than Z350 and Z250.
- Exposure time of 40 seconds showed better hardness values than 20 seconds.
- Curing Tetric N-ceram composite for 40 seconds can cure up to 6 mm thickness using LED light cure system.

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Volume 17 Issue 10 October 2018