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Comparative evaluation of depth of cure in dental composites after using LED light curing unit of two different intensities

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Abstract

In the last few decades' restorative dentistry has undergone an exponential evolution. This evolution allowed the development of restorative composite materials with excellent physical properties, chemical properties, and better clinical performance. Recently, light curing dental composites are extensively used in restorative dentistry. It is a piece of dental equipment that was introduced to restorative dentistry. It initiated photo polymerization reaction of composites resins. It is used on different dental materials that are curable by light. The light falls under the visible blue light spectrum. This light has a range of wavelengths and different between each type of device. There are four basic types of dental curing light sources: tungsten halogen, light-emitting diodes (LED), plasma arcs, and lasers. The two most common are halogen and LEDs. LED curing lights impact and develop the photo polymerization of composites

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resins. At this research we will study the comparative evaluation of depth of cure in dental composites after using LED light curing unit of two different intensities.

Keywords: dentistry, LED light, composites resins, Polymerization, curing light

Introduction

The light-activated resin composites in restorative dentistry have been grown dramatically in recent years. There are different types of photo-polymerization methods which have advantages and disadvantages based on its technology, mechanism of light, and self-curing technology (Melikechi & Pradhan, 2001). It depends on the photons and wavelength, in case of using these light curing materials, the dentist should make sure that enough photons reach the entire composite (Yap, Soh, Han, Siow, & others, 2004). The major disadvantages of QTH unit are heat generation, limited lifetime of the bulb and degradation of reflector and filter overtime. The light emitting diode (LED) which uses doped gallium nitride semiconductors when subjected to electric current emits blue light (Fleming & Maillet, 1999). Compared to QTH, LED units have narrower wavelength spectrum and require no filter. New generation high intensity LED light curing units have the advantage of reduced curing time similar to laser units. Also this technique has a moderate costs, short time of curing, ability to polymerize composite materials and produce a high depth of cure (Wiggins, Hartung, Althoff, Wastian, & Mitra, 2004) . At this study we will discuss the light-emitting diodes (LED) and compared the depth of cure resin composite using two LED light curing units of different intensities and curing time. We will use a materials and devices such as Composite restoration material, LED light cure (low intensity), LED light cure (high intensity),

Vicker’s hardness testing machine to perform this study at College of Dentistry, King Khalid University.

The study problem

The aim of this study is to evaluate the depth of polymerization of composite restoration using LED light curing unit of two different intensities. This research will answer the following questions:

1- What is the light-emitting diode (LED) technique?

2- How does LED initiate photo polymerization reaction of composites resins?

3- What are the advantages and disadvantages of LED?

4- What is the degree of polymerization of the composite restorations by using LED?

5- What are the degrees of two different intensities LED for two different times cure the dental composites?

What distinguishes this study from previous studies?

This study is In Vitro in pure laboratory where 40 Composite blocks were prepared and half of the specimens were cured with low intensity LED light cure for 20 seconds and the other half were cured with high intensity LED light cure for 3 seconds, the surface hardness of the specimens is then measured using Vicker's hardness to determine the degree of polymerization. It is a clinical study and will be fulfilled only in presence of human beings. This study has approval from ethical committee at College of Dentistry, King Khalid University.

The study content

1.0 The visible light curing of the resin composite

Visible light that is used for curing resin-based composites allows the dentist to initiate the polymerization for each layer. The main polymerization

types are (halogen bulbs, plasma arc lamps, argon ion lasers, and light emitting diodes) The LED is most established today. The curing protocols are based on improving the photo polymerization (Tsai, Meyers, & Walsh, 2004). The curing depth is depending on the distance of the resin composite to the light source. The power of LED in curing of the resin composite may be 20 seconds when is a low intensity LED. The latest generation LED units (high intensity LED) providing light intensities of up to 2,000 m W/cm2 that may be cure the resin composite in duration less than 20 seconds (Melikechi & Pradhan, 2001).

2.0 The advantages of LED in the polymerization

The mechanism of LED in the polymerization of the resin composite depends on the junctions of doped semiconductors (p-n junctions) where electrons and holes are recombining and generating blue light (Alto, Vieira, Guimarães, Poskus, & Silva, 2006). There is a small polymer lens that collimates the blue light (Leonard, Charlton, Roberts, & Cohen, 2002). This blue light has the highest photo polymerization effect. LED advantages compared to others techniques are less energy consuming, don't require external cooling, has a long lifetime without loss of its intensity(Tsai et al., 2004).

3.0 The degree of polymerization of the composite restorations by using LED

LED curing units are most effect in hybrid composite resin polymerization and don't cause any thermal change in pulp tissue. The degree of polymerization depends on the source of light, its intensity, its density, its wavelength, and the duration of exposure (Emami, Söderholm, & Berglund, 2003). So LED degree of polymerization is different by its intensity, where the degree will be differ between the high intensity LED and the low intensity LED if the duration of exposure is the same. But you can use the high intensity LED for short duration and give the same degree of polymerization of the low intensity LED when is used for 20 seconds (Rahiotis, Patsouri, Silikas, & Kakaboura, 2010).

4.0 Comparing between the degrees of polymerization of two different LED intensities

To compare between the degrees of polymerization of two different LED intensities, we prepared 40 Composite blocks, 20 composite blocks will be cured with LED light cure (low intensity) for 20 seconds, the others 20 composite blocks will be cured with LED light cure (high intensity) for 3 seconds, and using Vicker's hardness testing machine to measure the degree of polymerization and get the results. All these materials and instruments are available at anywhere in KSA. Cylindrical specimens of a composite cured with the two different light curing units were prepared with a stainless steel mould of 6 mm diameter and 8 mm thickness. The moulds were filled with composite after application of separating media in the inner surface of mould. A glass slides were placed over the composite and pressure was applied to extrude the excess material. Composites were irradiated through the polyester strip (50 μm). For the group A low intensity LED light is used for photo initiation and applied for 20 seconds. Group B high intensity LED light curing used and curing was done for 3 seconds for each specimen. Measurement of depth of cure was carried out by scraping technique. Immediately, after curing, cylindrical composite blocks extracted from the mould and the uncured material was gently removed by surgical blade. The height of cured material was measured in center of the block with a digital micro meter.

The results of the study

The results of polymerization of 40 Composite blocks that were prepared and half of the specimens were cured with low intensity LED light cure for 20 seconds and the other half were cured with high intensity LED light cure for 3 seconds.

Table (1) depth of light cure in group A

4.28	4.74	4.28
4.09	4.01	4.77
4.46	4.06	4.17
4.04	4.01	4.04
4.81	4.82	4.39
4.03	4.41	4.79
4.09	4.29	4.33
4.55	4.26	4.82
4.84	4.42	4.63
4.01	4.04	4.77

Mean value for group A is 4.36233

Table (2) depth of light cure in group B

3.64	4.06	4.10
4.13	4.36	3.96
4.31	4.52	4.30
4.11	4.06	4.54
4.19	4.36	4.36
4.15	4.41	4.26
4.12	4.10	4.46
4.26	4.35	4.36
4.06	4.46	4.20
4.21	4.20	4.09

Mean value for group B is 4.23933

Student's t-test revealed that there is no statistically significant difference in depth of cure of composite between the two groups (P value -0.10087).

The degree of polymerization of the composite restorations using LED light curing units of two different intensities for two different times is same.

The suggestions

Dental technology continues to evolve; new methods of performing certain dental procedures will continue to replace those once thought as pinnacle. LED units of high intensities require very less time for curing which helps to prevent contamination of composite during restoration.

The conclusion

The degree of polymerization of LED depends on the source of light, its intensity, its density, its wavelength, and the duration of exposure. The degree of polymerization of the composite restorations using LED light curing units of two different intensities for two different times is same. There is no statistically significant difference in depth of cure of composites photo polymerized by the two LED units of different intensities.

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