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COMPARISON USAGE TIME OF LED *Light Curing Unit* TO NANOFILLER COMPOSIT RESIN TOWARDS ITS COMPRESSIVE STRENGTH

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ABSTRACT

Background: *A perfect polymerization is very important for good restoration. Good restoration is affected by some factors. One of it is LED Light Curing Unit's usage time. LED Light Curing Unit's usage in which more than five years ideal lifetime causes decreasing light intensity and compressive strength of composite resins.* ***Purpose:*** *To analyze the compressive strength value of nanofilled composite resins that polymerized with a new (never been used) and used LED Light Curing Unit's.* ***Methods:*** *Laboratory experimental method (true experimental) with post-test only with control group design. First group with 16 samples as positive control polymerisez with new and (never been used) LED Light Curing Unit. The second group with 16 samples polymerized with LED Light Curing Unit that has been used more than five years. Sample were molded with 4mm diameter and 8mm thick. The compressive strength value is measured with Universal Testing Machine.* ***Results:*** *Independent T-Test showed p=0,000 (p<0,05), that means there was significant differences on compressive strength's value of nanofilled composite resins that polymerised based on Light Curing Unit's usage time. Compressive strength value of nanofilled composite resins polymerised by LED Light Curing Unit that has been used more than five years was lower than new and never been used LED Light Curing Unit. Used LED Light Curing Unit has decreasing light intensity outcome, so the photons that achieve the restoration is reduced and cause imperfect polymerization.* ***Conclusion:*** *Compressive strength value of nanofilled composite resins polymerised by LED Light Curing Unit that has been used more than five years was lower than nanofilled composite resins polymerised by new and never been used LED Light Curing Unit.*

Keywords*: LED Light Curing Unit's usage time, compressive strength, LED Light Curing Unit, nanofilled composite resins*

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INTRODUCTION

Tooth caries is tooth demineralization process caused by long terms of accumulated plaque.[1] The main cause of tooth caries is cariogenic food (substrate), microorganisms, tooth (host) and time.[2] Treatment of dental caries is called restoration.[1] Materials fillings in Dentistry is metal, polymer, ceramic, glass ionomer and composite resin.[1,3]

The use of composite resins for dental fillings is growing due to its good aesthetics, easy to apply, and filling materials technology. Composite resin consist of an organic polymer matrix, inorganic fillers, a binding agent, initiator-accelerator material, and materials inhibitor.[4,5] Filler particles are added to the organic phase with the aim at improving physical and mechanical properties of the organic matrix, so the newest types of composite resins have been developed with a

modified filler. Classification of composite resin according to filler particles are divided into makrofiller, mikrofiller, hybrid, mikrohybrid, and nanofiller.[4,5,6]

Nanofiller composite resin as the material has equivalent mechanical strength compared to the hybrid type of composite resin and good poles quality compared with the mikrofiller composite resin.[7] Nanofiller composite resin fillings are materials witha very small-sized filler.[4] The amount of filler particle contained in the composite resin is directly proportional to one of mechanical properties of the composite resin compressive strength. The higher totality of filler particles, the stronger the compressive strength value.[7]

The compressive strength is one of the mechanical properties of the composite resin.[5] The compressive strength is the amount of maximum resistance of a material to resist fracture due to mastication load pressure, it can be determined by applying a compressive load on a cylinder or square cross-sectional area.[8] The compressive strength generated should have the same mechanical properties such as the original tooth structure.[9]

The properties of composite resin fillings materials such as the compressive strength is affected by the polymerization process.The polymerization process has a complex relations with the fillings material properties.[8] This is influenced by composition of the composite resin, light transmission into the material, the activator-initiator, the light source used, the wavelength of light, photo activation method and composite resin colour.[8] The intensity of light produced by Light Curing Unit influenced by the type of Light Curing Unit used, irradiation distance, long exposure, usage times and cleanliness of the tip.[10]

Most widely used Light Curing Unit type is Light Emitting Diode (LED).[11] The advantage of using LEDs is it requires a lower energy than other type of Light Curing Unit, it does not require external cooling section, small unit, wireless mode, and generate less heat.[5] The wavelength generated by LED is between 450-490 nm so it meets the photo-initiator composite irradiation criteria which is 400-500 nm.[12,13] Periodically testing for LED needs to be done to ensure a perfect polymerization process. Ray source will surely become damaged over time. LED's life expectancy is approximately 1000 hours or 5 years of use and the intensity of light produced will be deteriorated.[14,15]

The output power of the bulb LED will be deteriorated due to aging of the bulb LED so the effectiveness of the curing process will decrease.[14] All these light sources will be damaged over time.[14] Ray source intensity varies over time depending on the quality and the age of the lamp.[16] Different light intensities affects the composite nano particles degree of conversion. Use LED light source to polymerize the composite nano-particles with 800 light intensity within 20 seconds to get the maximum degree of conversion.[17]

Based on the background above, the research is done to compare usage time of LED Light Curing Unit against the nanofiller composite resin compressive strength. The purpose of this study is to analyze the value of the compressive strength of nanofiller composite resin polymerization with Light Curing Unit usage times.

MATERIALS AND METHODS

The method used in this research is the true laboratory experimental with post-testonly control group design.Research goal is to analyze the compressive strength of nanofiller composite resin polymerized with a new (never been used) LED with LED which has been used more than five years.

Research sample was taken using simple random sampling consist of two groups. The first group as the positive control group is nanofiller composite resin polymerized with new (never been used) LED. The second group is nanofiller composite resin polymerized with LED which has been used more than 5 years. Based on the Federer formula, at least 16 samples required from each group, so minimal amount of total sample for this study are 32 samples.

The tools used in this study were a mold sample with diameter of 4mm and 8mm in height according to ISO 4049 specification for polymer-based restorations, new LED with DentamericaLitex® 696 brand, LED Light Curing Unit over the age of 5 years with DentamericaLitex® 696 brand, filling instrument was used to apply and flatten the nanofiller composite resin into the mold, mylar strip was used as a tool for leveling the mold resin composite, tweezers was used to hold the samples that have been hardened, gloves and masks were used as sterilization for researchers, Universal Testing Machine was used to measure the compressive strength of the composite resin of nanofiller,Curing Light Meters were used to measure the intensity of light produced by Light Curing Unit, plastic box

where the specimens stored, the incubator was used to adjust the sample with the physiological conditions in the oral cavity before being treated.

The materials used in this study was a nanofiller composite resin branded 3M ™ ESPE ™Filtek ™ Z350XT, vaseline was used so that the composite resin would not stick to the mold of artificial saliva.The procedure of the research wass to measure the light intensity of LED Light Curing Unit using a curing light meters. LED Light Curing Unit tip was directed to the light curing meters, when the results came out on the screen, then it was recorded as the amount of light intensity in units of mW / ($mW/cm^{2)}$. The sample data was prepared in accordance with ISO 4049 with diameter of 4mm and 8mm height. The samples were divided into two groups.They were made by using acrylic mold (split mold) cylindrical with diameter of 4mm and 8mm high, smeared with vaseline and mylar strip as a pad.

Mold was placed on a glass plate. Nanofiller composite resin was applied with the horizontal incremental technique into the mold by using filling instrument with thickness of ± 2mm, then polymerized at the bottom and the top of each layer, this process was repeated 4 times until the mold was full. Each individual sample group was polymerized with LED Light Curing Unit that had the same brand and the same wavelength, but with different time of use. Polymerization of the first group as positive control used a new (never been used) LED Light Curing Unit and the second group used LED Light Curing Unit over 5 years of use, the tip of LED was directed to the middle for 20 seconds, the tip should be placed as close as possible with the surface of the resin, the irradiation angle is 90º.

Once hardened, the composite resin was removed from the mold, nanofiller composite resin samples was ready. The Samples were incubated with artificial saliva in an incubator for 24 hours at temperature of 37ºC. Nanofiller composite resin samples incubated for 24 hours, then it was tested by using a press test equipment (Universal Testing Machine) with press speed 1,0mm/min. The sample was pressed to observe the cracks and fractures. The number appeared on the press test equipment monitor screen was recorded as the value of maximum force. Finally, the value of the compressive strength was calculated following Karina's formula. According to Karina (2014):[7]

$$CS = \frac{F \times 9.807}{A}$$

Information :

F = maximum force value recorded at screen, written with kilogram-force (kgf) unit

9.087 = value of gravity

A = cross-sectional area specimens ($A = \pi r^2$) written with mm^2 unit

CS = the value of the compressive strength, written by megapascals (MPa) unit

RESULTS

The research results on comparative usage time of LED Light Curing Unit against the nanofiller composite resin compressive strength based on measurements with Universal Testing Machine with the compressive strength of 1mm/min. The results of the compressive strength value measurement of each group are shown in Table 1.

Table 1. The average value of the compressive strength of the nanofiller composite resin based on LED Light Curing Unit usage times

Group	Mean	±	Standard Deviation
New LED	345,57	±	16,53
LED >5 years	243,44	±	13,56

Table 1 shows that the average value of nanofiller composite resin polymerized with a new (never been used) LED Light Curing Unit (the first group) compressive strength is 345.57 ± 16.53 MPa and nanofiller composite resin polymerized with LED Light Curing Unit that has been used more than five years (the second group) compressive strength is 243.44 ± 13.56 MPa. It shows the average value of the compressive strength of the first group was higher than the second group.

The data of nanofiller composite resin compressive strength found then was tested for normality using the Shapiro-Wilk test and was tested for homogeneity using Levene's Test, the results showed all data were normally distributed and homogeneous. Next, parametric tests used Independent T-Test. It was conducted and got the results the value of $p = 0.000$ ($p < 0.05$), which means that there are significant differences in the value of the compressive strength of the nanofiller

composite resin polymerized with a new (never been used) LED Light Curing Unit compared with nanofiller composite resin polymerized with LED Light Curing Unit that has been used more than five years.

DISCUSSION

Nanofiller composite resin as a fillings material can be activated by polymerization using a light source.[14] Polymerization of a good fillings requires a perfect polymerization.[18] Perfect polymerization is depend on various intrinsic conditions, curing techniques and Light Curing Unit output effectiveness.[19] Tools used to monitor the quality of the Light Curing Unit is the Light Intensity Meters.[14] Perfect polymerization process affects the mechanical properties of composite resin, one of them is the compressive strength.[18]

Critical control point of polymerization is the intensity of the beam.[18,20] Light intensity is associated with the amount of light produced by the Light Curing Unit per unit area.[19] Intensity of the light varies from 400mW/cm^2 to 1600mW/cm^2.[19] Light intensity of Light Curing Unit affects the number of photons in achieving restoration.[18] Factors that may affect beam intensity is the distance of the tip to the fillings, light curing unit usage times, damage of the curing light, the type of filter and the tip.[19] The light of Light Curing Unit reduction may be caused by a low battery or anode and cathode combination wich is being weak, so the part or instrument of Light Curing Unit must be replaced. when the ideal limit is reached, the intensity of the light generated is not eligible for perfect polymerization.[19,20]

Light Curing Unit type most widely used is LED.[11] Ideal limit usage for LED is five years of clinical use.[14.15] LED usage times affects the ability of graded light produced and causes the beam intensity low.[14] Degradation of the LED rated lower than QTH, because LED using semiconductor gallium nitrate that generates minimal heat as light emission source.[14.20]

LED's semiconductor will produce light when it is connected to the circuit. LED circuit in the form of diodes consist of combinations of anode and cathode in the junction which form photons (light) in the form of blue light.[20] Blue light is paralleled by small lenses in front of the junction from the anode and cathode, then it passed through the tip Light Curing Unit to reach restoration.[20] The conclusion which can be drawn from the result of this research is the value of the compressive strength nanofiller composite resin polymerized with LED has been used more than five years is lower than nanofiller composite resin polymerized with a new (never been used) LED Light Curing Unit.

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