Compressive strength differences between hybrid composites using post curing light box with LED and dry heating, in vitro

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ABSTRACT

Hybrid type of composite resins is used as dental restorative materials in a wide cavity directly or indirectly. The mechanical properties of the composite resin would increase post curing. The purpose of this study was to determine the differences between the compressive strength of hybrid type composite resin post-curing using LED light box and dry heating. This type of research was a quasi-experimental in vitro with the sample size of 30 samples which were divided into two groups. Each sample was tested using a Universal Testing Machine (Lloyd) at a speed of 1 mm/minute to test the compressive strength. Compressive strength values were recorded when the sample broke. The average value of compressive strength of the two treatment groups were statistically calculated using t-test. The results of this study showed that a hybrid composite resin with post curing using a light box with LED was at 194.138 Mpa which was lower than using the dry heat of 227.339 Mpa. It showed the statistically significant difference. The conclusion of this study was that the compressive strength of post-cured hybrid composites using a light box with LED was significantly lower than the post-curing using dry heat.

Key words: Compressive strength, composite resin, post curing

ABSTRAK

Resin komposit tipe hybrid *sering digunakan sebagai bahan restorasi gigi pada kavitas yang luas, secara direk maupun indirek. Sifat mekanis resin komposit akan meningkat jika dilakukan* post curing. *Tujuan penelitian ini adalah untuk mengetahui perbedaan* compressive strength *antara resin komposit tipe* hybrid post curing *menggunakan* light box *dengan LED dan pemanasan kering. Jenis penelitian ini adalah eksperimental semu secara in vitro dengan jumlah sampel 30 buah yang dibagi menjadi dua kelompok. Tiap sampel diuji menggunakan* universal testing machine *(LLOYD) pada kecepatan 1 mm/ menit untuk menguji* compressive strength. *Nilai* compressive strength *dicatat saat sampel pecah. Nilai rata-rata* compressive strength *kedua kelompok perlakuan dihitung secara statistik menggunakan uji t-test. Hasil penelitian ini memperlihatkan resin komposit* hybrid *dengan* post curing *menggunakan* light box *dengan LED sebesar 194,138 MPa lebih rendah daripada dengan pemanasan kering sebesar 227,339 MPa yang secara statistik menunjukkan perbedaan yang signifikan. Simpulan dari penelitian ini adalah* compressive strength *pada komposit* hybrid post curing *menggunakan* light box *dengan LED lebih rendah secara nyata dibandingkan* post curing *menggunakan pemanasan kering.*

***Kata kunci:** Compressive strength, resin komposit, post curing*

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INTRODUCTION

Composite resin has been introduced in the field of dentistry as restorative materials to minimize the shortcomings of previous restoration materials. Composite resin is widely used and become one of esthetic restorative materials that most widely used. Composite resin is used as restorative material due to its good strength, excellent esthetic, reasonably priced, and it is able to adhere to tooth structure, and its easy handling. Composite resin is widely used as a restorative material, lutting agents, direct and indirect restorations, metal facings and core hitches for post-endodontic treatment.[1-4]

Composite resin consists essentially of three main ingredients, the organic polymer matrix, inorganic filler and coupling agent. Matrix and filler are binded by the coupling agent. Organic matrix is a monomer, which is a free radical polymerization initiation system. Monomer system is at the core of the composite resin system.[3-5] Composite weakness lies in the polymerization process, ideally all monomers transformed into polymers, but in fact not all of the monomer is converted into polymer, conventional radiation produces approximately 50-75% degree of conversion. Residual monomers which are not converted will affect the degree of conversion and lower the mechanical properties of the composite, including compressive strength, increase water solubility and resorption, and low color stability. Decrease in mechanical properties of the composites resulted in several drawbacks, including marginal leakage, fragile edges of fillings, secondary caries, and tooth sensitivity effects.[3,5-9]

The development manipulation technique generates the indirect composite resin in producing the composite resin restorations, especially for extensive restoration. In the indirect composite resin restorations, post curing treatment can be given extra orally to increase the degree of conversion and mechanical properties and produce better esthetic restoration.[7]

Polymerization can be improved by post curing to improve the mechanical properties of resin composites. Post curing techniques can be done in several heating methods, i.e. heating with pressure (autoclave) and additional irradiation.[10] According to Lombardo et al.[10], the temperatures above 60°C can improve the mechanical properties of composites. Another study conducted by Wendt[10] on dry heat as an additional method of polymerization of the resin composite concluded that dry heating at 125°C for 2.5, 7.5 and 15 minutes improve mechanical properties such as hardness and color stability of resin composites.[10]

Widyasari[11] and Rizany[12] conducted a study of post curing light box using a cube-shaped glass mirror that reflects light equally in all directions. Research proved that the post curing with light box was capable to enhance the process of polymerization and monomer conversion as well as increase the speed thus improves the mechanical properties of composite resin, such as compressive strength and flexural strength. Additional heating is done by dry heating, while the additional radiation was done in LED light box with a glass cube.[10-12]

Based on the above matters the author was interested to do research to see the difference between the compressive strength of hybrid composites post-cured using a light box with LED and dry heating.

METHODS

The type of study used was a quasi-experimental. The study population was a composite resin restorative materials that have a hybrid filler with filler size on average 0.6 μm; with the smallest filler of 0.01 μm.[13] Samples were taken randomly, 15 pieces of hybrid type cylindrical composite resins with 3 mm in diameter and 6 mm in height. Thirty samples were made and divided into two groups; 15 pieces were post-cured hybrid type composite resin using light box with LED; and 15 pieces were post-cured hybrid type composite resin with dry heating. The average value of compressive strength of the two treatment groups were statistically calculated using t-test.

The research was carried out using tools and materials; molds for resin composites with a diameter of 3 mm and 6 mm height cylinder made of stainless steel; instruments for composite resins, LED, light curing unit, light box of cube-shaped glass mirror that was made with size of 3x3x3 cm, dry heat (dry sterilizer), compressive strength testing machine (Lloyd Instruments LRX plus), the long slide, hybrid type composite resin.

The research was followed: (1) Prepared a composite mold (cylindrical shape; height 6 mm, diameter 3 mm); (2) Inserted composite layer (2 mm) into the mold. Pressed and smoothed using cement stopper. Cured composites with LED curing light for 20 seconds, then continued the next layer up to 3x6 mm or until the mold was full, then the composite was released from the mold[13]; (3) Measured the sample with a long sash. Checked the surface of the sample. It must be in contact with the field test equipment; (4) Samples were divided into 2 groups: Group A and B, each consisted of 15 samples. Samples in Group A then received post curing using a LED light box for 10 minutes. Samples in Group B received post curing using dry heat in the temperature of 110°C for 10 minutes; (5) Testing and calculation of the value of compressive strength were then performed; (6) Place the sample on the test table Universal Testing Machine (Lloyd) under a compressive load to the contact with the sample, so that the center of the engine load was in the vertical direction of the middle surface of the sample; (7) Activated the test machine, and then provided a continuous load with a speed of 1 mm/min, to formed a cracks or fractures in the sample. Value of compressive strength had been viewed on computer screens, and data was automatically stored directly in the computer.

RESULTS

The average value of compressive strength testing of composite samples is obtained through a hybrid using a universal testing machine (LLOYD). The test results are recorded and recorded directly into a computer and do the calculation the average value of compressive strength. Test results are presented in Table 1:

Based on Table 1, it is shown that the average compressive strength of hybrid composites using a light box with LED was 194.138 MPa and the average compressive strength of hybrid composites using dry heat was 227.339 MPa. These results showed the average compressive strength of hybrid composites using the light box with LED was lower than the average compressive strength using dry heat.

The average differences between the compressive strength of hybrid composites post-cured with LED light box and dry heating, used the statistical test of t-test indicated a significant result. It meant that the average compressive strength of hybrid composites post-cured using a light box with LED results were lower than the average compressive strength of hybrid composites post-cured using dry heat. Figure 1 shows the average value of compressive strength using LED light box was lower than average value of compressive strength using dry heat.

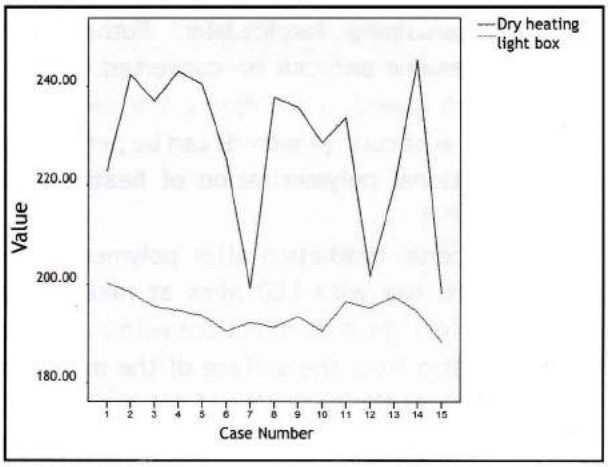

Figure 1. The line diagram of compressive strength value of post-curing using a light box

DISCUSSION

Table 1 showed the results of research on hybrid composite compressive strength of each group. Value of compressive strength of hybrid composites showed significant difference between the test group using LED light box and the test group using dry heat. These results indicated that the compressive strength of hybrid composites with LED light box was lower than the dry heat.

Table 1. Rating average compressive strength in hybrid composites post curing using box with LED light and dry heating

No	Compressive strength light box (Mpa)	Compressive strength dry heat (Mpa)
Average (mean)	194.38	227.339
deviation standar	3.232	16.257
N	**15**	**15**

In the polymerization process ideally all monomers transformed into polymers, but in fact not all of the monomer is converted into polymer, the irradiation by means of conventional produce approximately 50-75% degree of conversion. Residual monomers which are not converted will affect the degree of conversion and lower compressive strength.[10] The studies carried out previously proved that post-curing can improve the degree of polymerization of the composite by examination through test compressive strength. Research conducted by Shah et al.[14] stated that there is a direct relationship between the degree of conversion of composite compressive strength, the greater the degree of conversion, the higher value of compressive strength.

Polymerization process is still ongoing and there has not been converted monomer, a polymer and the remaining fotoinisiator. Fotoinisiator monomer residue and can be converted by post curing which aimed at increasing the degree of conversion. Post curing methods can be performed by an additional polymerization of heating and irradiation.[10,14]

Additional irradiation after polymerization using a light box with LED aims at maximizing penetration of light in all directions with a uniform light reflection from the surface of the mirror in the light box. At the beginning of polymerization, the fotoinisiator is accelerated by the beam due to uneven penetration of light.

Post curing with heating produces energy that can increase the vibration amplitude of the composite matrix so that the chain increases the degree of conversion and mechanical properties of composites. Post curing uses dry heat causes the compressive strength value higher because it can increase the degree of conversion. Heating produce additional energy to increase the cross chain, so the compressive strength is better.[10,14,15]

These results indicate that the average compressive strength of post-curing using a light box with LED was lower than post-curing using dry heat. It is due to the heat that is the energy source that can activate free radicals from the monomer molecule and reinitiate the polymerization process. These results indicate that the hypothesis is accepted.

In this study, additional heating at a temperature of 110 ^{0}C for 10 minutes was performed, however, if the heating temperature is above the glass transition temperature of the matrix which is 100-120 ^{0}C, the mechanical properties of composite resin would be affected, especially for the type of resin-based dimethacrylate.[10,14,15]

CONCLUSION

The conclusion of this study is that the compressive strength of post-cured hybrid composites using a light box with LED is significantly lower than the post-curing using dry heat.

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