Difference between post curing composite hardness with heating using dry sterilizer and radiation using light box

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ABSTRACT

Introduction: Composite resin has been used as a restoration material for quite a long time. Two different methods were expected to show result of which method that would be the most promising. Aim of study is to analyzed differences the hardness of one composite resin subjected to two post curing treatments. **Methods:** This study was a true experimental research (in vitro). The subjects were 30 specimens of the hybrid light cured resin composites made in a mold (6 mm diameter and 4 mm high). The hardness of all specimens were tested using Rebound Hardness Tester. Data were compared using ANOVA and post hoc analysis (for pairwise independent groups) using t-tests. **Results:** This study showed that post curing treatment by heat (for 10 min at 110 ^{o}C) showed higher hardness ($p<0.005$). **Conclusion:** There was difference of hardness between two methods of post curing. Moreover, post curing with dry heat sterilizer at 110^{o}C for 10 min was found to be the most promising post curing method.

Keywords: Hardness, resin composite, post curing.

PENDAHULUAN

Composite resin has been used as a restoration material for quite a long time. The former composite resin has poor mechanical properties and is not suitable for use in large cavities and receiving large masticatory force. Composite resin continues to evolve so that the type of composite resin is found to have good mechanical properties and the indication of its use is wider.[1,2]

Composite resin can be used for posterior tooth with broad cavities, usually on the teeth of post endodontic treatment. We as clinical practitioners should pay attention to the patient's desire to obtain an aesthetic final restoration after endodontic treatment. Generally, non-vital teeth are structurally weak, even after adequate endodontic treatment.

The selection of proper restoration is crucial in the follow-up of an endodontic treatment, because restoration failure will result in the failure of the endodontic treatment. Post-endodontic treatment requires an aesthetic and strong material in order to replace the structure of teeth especially in receiving chewing loads.[3]

Composite resin is an aesthetic restorative material and can have excellent mechanical properties. The weakness of the composite resin lies in its polymericity. The polymerization process should last until the entire monomer composition is depleted into a polymer. In fact, there are always remaining polymerized monomers that will lower the mechanical properties of the composite

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resin. The rapid development of composite resin manipulation techniques had produced an indirect techniques in the creation of composite restorations, especially for broad cavities. The advantage of composite resin selection as the main Indirect restoration material is that it allows the post-curing extra oral treatment to increase the degree of polymerization which will result in increased mechanical properties of the composite.[1,4,5,6] Another advantage of the indirect composite restoration among others is easier manipulation, can be done in a short time because there is no need of laboratory services and also relatively cheaper.[3,2]

In the manufacture of indirect composite resin, post curing is performed to improve the mechanical properties of these composite resin. Post curing techniques can be done in several methods, namely heating, heating with pressure, and additional radiation.[1] Heating will increase the conversion rate of monomer-monomer, thereby increasing the hardness of composite resin.[1,4,5,6]

Additional radiation will optimize light penetration and increase the degree of polymerization.[7,8] The additional radiation used in the study was done in a self-made light box. The Light box is made of cube-shaped glass, aiming to enhance the polymerization process, due to the more evenly beam reflection effect, and will eventually increase the hardness of the composite resin.[9]

Based on these things, the authors feel interested in doing research to see the difference in the hardness of composite resin on post curing by heating using dry sterilizers and additional rays using the light box.Aim of study is to analyzed differences the hardness of one composite resin subjected to two post curing treatments.

METHOD

The type of research used is experimental. Hybrid type composite resin restoration material, with an average filler size of 0.6 μm, with a smallest filler of 0.01 μm.

Samples were taken from the composite resin population randomly. Specimens are made using a cylindrical stainless steel mold with a diameter of 6 mm and a height of 4 mm. Samples were made as much as 30 pieces, with 10 pieces using post-curing technique by heating using dry sterilizers, 10 pieces for the technique group of post curing with radiation using the light box, and 10 pieces for the control group without doing post curing.

Research begins with preparing sample prints. Insert the composite layer (± 2 mm) into the mold. Press and flatten with cement stopper. Radiate the composite resin with LCU LED for 20 sec. Then proceed with the second layer until the mold is filled, place mylar strips on top, press with fiber and place load on the mold. Once pressed, the fiber is opened, the excessed composite is removed, then reexposed for 20 Seconds. Composite is then released from the mold.

The specimens are divided randomly into 3 groups, i.e. group A, B and C, each consisting of 10 specimens. Group A is a control group, no post curing is done. In group B do post curing by heating using dry sterilizer with a temperature of 110 ¤C for 10 minutes.[1,11] Group C is done by post curing with radiation using a light box for 10 minutes.[11]

The hardness test is carried out using a rebound hardness tester. The specimen surface is marked with a test point on the top and bottom surfaces. The specimen is placed on a test table, then a hitter is dropped on a 10-inch stainless steel rod with a rounded tip (spherical) that will bounce onto the specimen. The bounce scale will be visible on the “dial”.

The higher the reflection, the higher the hardness of the material is tested. In this research, the preparation of samples (specimens) was conducted in Conservative Dentistry Laboratory of the Faculty of Dentistry University Padjadjaran. The hardness test was conducted in the Geomechenics Laboratory of tekMIRA Rock mechanics.

RESULTS

Hardness testing was conducted on 20 composite resin specimens after post curing with 2 different techniques and on 10 control specimens. Each specimen is tested at 5 test points on the top surface. 5 data on each specimen is taken on average, then obtained the data as seen in table 1.

The Data in table 1 is analyzed using the one factor ANOVA as seen in table 2. Table 2

Tabel 2. Hardness of Composite resin Using Three Different Methods (unit SR)

Control	Heating	Radiation
82.4	87.4	86.6
82.2	89.2	86.4
84.6	88.0	86.4
84.4	91.0	86.4
84.4	90.4	86.4
84.4	89.2	86.0
84.6	90.6	86.4
84.4	91.0	86.6
83.6	90.8	86.4
84.8	90.6	86.4

Tabel 2. Variance Analysis on the Mean Strength of the Resin Using Three Different Methods

One factor ANOVA

Mean	n	Std. Dev	
83.9800	10	0.940	Control
89.8200	10	1.301	Heating
86.4000	10	0.163	Radiation
86.7333	30	2.597	Total

ANOVA table

Source	SS	df	MS	F	p-value
Treatment	172.195	2	86.0973	99.21	3.62E-13
Error	23.432	27	0.8679		
Total	195.627	29			

Post hoc analysis (2-tail p-values for pairwise independent groups t-tests)

		Control	Radiation	Heating
		83.9800	86.4000	89.8200
Control	83.9800			
Radiation	86.4000	2.37E-07		
Heating	89.8200	9.92E-10	1.58E-07	

shows the results of one factor ANOVA analysis for the testing of resin hardness similarities after obtaining a different treatment. The test result with ANOVA gives F count = 99.21 while F table = 3.35 for α = 95% or P-value < of 5% which is of the mean statistics, it means the average hardness of the resin because of the heat-giving (8 9.82 SR) treatment, compared with the average hardness of the resin by the radiation (86.40 SR) and also differs from the hardness of the resin with no treatment (control) of 83.98 SR.

After test of ANOVA, conducted a test range with T test (see POSTHOC Analysis) which provides meaningful testing results. The third average hardness produced, one with the other is mutually different. The test result implies that the hypothesis is acceptable.

DISCUSSION

In table 1, there are research findings showing the difference between hardness between the three test groups. The value of composite resin hardness in the control group, the test group with heating, and the test group with the radiation of the light boxes are different from each other. This corresponds to some previous studies proving that post curing can increase the degree of composite polymerization, which is examined through a hardness test.[4,6,11]

The hardness test in this study used a rebound hardness tester tool which is a testing of hardness. The reflection height of the specimen surface shows the hardness of the material. The

Hardness control group value (without treatment) is 83.98 SR, a post curing group with heating is 89.82 SR, and a post curing group with a light box is 86.40 SR. Analysis test results in table 2 indicate a discrepancy in hardness In the three test groups. In the above results it is seen that the hardness of the post-curing group by radiation of the light box is smaller than the post-curing group with heating.

Polymerization of composite resin always leaves residue monomers that are not polymerized perfectly. At room temperature, the conversion rate of composite resin in polymerization is always imperfect, which ranges from 48-60%.[6,12] It is influenced by light penetration which is likely not up to perfect to all filler particles and composite resin matrices. By using restoration of an indirect composite resin, additional polymerization (post curing) can be done to increase the degree of polymerization, which will then enhance the mechanical properties of these composite restorations.[13]

Heating at 110 ¤C for 10 minutes increases the degree of conversion of the remaining monomers and then further polymerization will occur which increases the hardness of the composite resin overall.[1,4,6,19] The energy generated on the heating will increase the amplitude of the composite matrix chain, so that free radicals and methacrylate groups will join and form covalent bonds, then increase the degree of conversion.[10,14,15] Increased hardness will occur as the conversion rate increase.[1,6] In this study it was seen that the hardness of composite resin was significantly increased, marking that the above theory proved to be true.

Radiation in the light box is aimed at improving the penetration of the rays in all directions through the reflection of the evenly beam from the mirror surface inside the light box. It is not known clearly whether in early polymerization in addition to the unpolymerized monomer there is also the remaining photoinitiator. Without a photoinitiator, the rays given to the composite resin will not give any influence. Increasing the value of the test group hardness with the illumination of the study showed that the polymerization process continues, marking that in addition to the remaining monomers, there are also photoinitiators that have not been accelerated by Light due to uneven penetration of rays.

The results of the analysis showed a significant difference between the three test groups ($P < 0,005$). The hardness of composite resin that does not go through the post process is significantly lower curing ($p < 0,005$) than the composite resin that is post curing by illumination in the light box, and the 2 groups are significantly lower than post curing by heating on dry sterilizers ($P < 0,005$).

In the study, there was also a surface inspection of the specimen, to see if the degree of polymerization increased from increased hardness occurred evenly. The average result of hardness testing on Rebound scale for group A (control) shows the number 83.24, group B (heating) 87.58 and group C (light box) 86.46. If compared between top and bottom surface hardness in each group, it appears that in the post curing group with the light box shows almost the same results. The average upper surface hardness is 86.40, while on the lower surface of 86.46. This proves that the rays in the light box are scattered evenly because of the reflection of the mirror inside the light box.

The results of this study showed that the post curing method with heating is the best (? A < ? B > ? C). These results indicate that the hypothesis was accepted. However, further research is required regarding the mechanical properties of the composite overall with similar treatment. In addition, as the conversion rate or the degree of polymerization of a composite increases, the likelihood of shrinkage (polymerization shrinkage) also increases. In the Indirect restoration, this deficiency can be overcome by the use of resin cement at the time of insertion. But resin cement also has limited strength, where if the thickness is too large, it can crack during mastication and cause the cement to dissolve, then leak occurs. It is therefore necessary to further research on the shrinkage after the post-curing method.

CONCLUSION

There was difference of hardness between two methods of post curing. Moreover, post curing with dry heat sterilizer at 110°C for 10 min was found to be the most promising post curing method.

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