DENTINO
JURNAL KEDOKTERAN GIGI
Vol III. No 1. Maret 2018

THE COMPARISON OF THE STORAGE TEMPERATURE ON DIAMETRAL TENSILE STRENGHT VALUE OF BULK-FILL RESIN COMPOSITE

Niketa Khairina[1], Dewi Puspitasari[2], Sherli Diana[3]
[1]Faculty of Dentistry of LambungMangkurat University
[2]Division of Material Science of Faculty of Dentistry of LambungMangkurat University
[3]Division of Conservation of Faculty of Dentistry of LambungMangkurat University

ABSTRACT
Background*: The decrease and increase of bulk-fill composite resin storage temperature are infunction to extend the expiration period and obtain lower viscosity, making it easier for application of composite resin. Temperature is one that affects the polymerization process. Different polymerization qualities will affect the physical and mechanical properties of the composite resin, one of which is the diametral tensile strength.* ***Purpose****: To analyze the difference of tensile strength value of diametral bulk-fill composite resin stored at low temperature (5˚C), room temperature (25˚C) and high temperature (35˚C).* ***Method****: 33 specimens with 6 mm diameterand 3 mm thicknesswere divided into three treatment groups consisted oflow temperature storage group (5˚C), room temperature group (25˚C)and high temperature group (35˚C). The diametral tensile strength wasmeasured by Universal Testing Machine and analyzed by One Way Anova and Post Bonfond Bonferroni test.* ***Result****: The mean diametral tensile strength of bulk-fill composite resin with storage temperature 5˚C (35,85 MPa), 25˚C (42,72 MPa) and 35˚C (45,73 MPa). One Way Anova Test obtained p value = 0,001 (p>0,05) and continued with Post Hoc Bonferroni, so it can be concludedthat there was significant difference in the value of diametral tensile strength of bulk-fill composite resin with 25˚C and 35˚C storage temperature compared with 5˚C, and there was no significant difference in diametraltensile strengthof bulk-fill composite resin by comparing the temperature treatment of 25˚C with 35˚C.* ***Conclusion****: The diametral tensile strength value of the bulk-fill composite resin are increased as the storage temperature increase..*

Keywords: *bulk-fill composite resin, temperature, diametral tensile strength.*

Correspondence: Niketa Khairina, Program StudiKedokteran Gigi FakultasKedokteran Gigi UniversitasLambungMangkurat, Jalan veteran 128B, Banjarmasin, Kalsel, email: niketa.khairina77@gmail.com.

INTRODUCTION

Nowadays, resin composites are widely used for direct restoration of both anterior and posterior teeth. It is because of their excellent characteristics, such as mechanical and physical properties, manipulative qualities, and biological compatibility.[1] Composite resins are commonly used for diastema closure, tooth lengthening, masking tooth discolorations and restoring the tooth structure destroyed by caries, abrasion or trauma.[2] This is due to the aesthetic properties of the composite resin that resemble the original tooth color.[1]

Resin composites have been developed throughout years, recently, there are new innovation called bulk-fill resin composites. Bulk-fill resin composites have excellent characteristics, such as mechanical, physical and optical properties, so it becomes the choice for direct restoration in one application stage.[1] It has been introduced to the market in an attempt to simplify and expedite the restoration process. Differences in rheological properties and application techniques, bulk-fill resin composites are further classified in low-viscosity (flowable) and high-viscosity (sculptable) material type.[3]Bulk-fill resin composites perform low polymerization shrinkage therefore microleakage and stress are decreased by exhibiting some elasticity. They have low viscosity, thus allow for easy adaptation to the cavity wall. These materials also demonstrated an improving depth of cure for at least 4 mm, which can be accomplished by their translucency and high conductivity to the light transmission.[1]

Chaves et al (2015) has been reported that clinicians tend to store the restorative materials at low temperatures (refrigerator), especially the resin composites, in order to "prolong" their shelf life. Composite resin storage in the refrigerator ranges from 2-5ºC. These cooled restorative materials are used immediately after being removed from the refrigerator. In addition, their manipulative properties are modified, considering that some of the composites are too sticky and tend to flow less at lower temperatures.[4]The composite resins store in refrigerator has transformation sorption and solubility.[4,5]

Castro et al (2013) in research also stated that pre-heating resin composites can improve the mechanical properties of composite resins and attain the low viscosity, thus having better marginal adaptation to cavity walls. Chaves et al (2015) used a temperature of 37-40ºC using an oven to determine the mechanical properties of composite resins in high temperature storage.The oven represents a composite resin storage like in a dentist room without air conditioning. Indonesia is a tropical country which has average temperature around 35ºC, which is why this study use 35ºC temperature in of the treatment group.[6]

The pre-heating composite resin before application has not changed polymerizationshrinkagerate, but the low viscosity composite resin causes relaxation of the polymer chains which can reduce stress compared to the composite resins stored at room temperature.[3]Room temperature may affect energy activation at polymerization process. Polymerization qualities will affect the mechanical properties of composite resins.[7]

The restoration of the composite resin in the posterior tooth in the oral cavity may experience compressive force in vertical direction and tensile force in horizontal direction simultaneously. The restoration of the composite resin will break or crack, if the restoration material does not have the strength to withstand the pressure during mastication on the posterior tooth. One of the tests to determine the strength of the restorative material is the diametral tensile strength test. Diametral tensile strength is one way of measuring the ability of a material, especially one that is fragile when receiving an indirect load. The slab of the material is compressed diametrically in the test machine until it fracture in two separate parts. The test of diametral tensile strength difference is to know one of the mechanical properties of the composite resin used as one of the restoration materials whose strength accepts the chewing power in the oral cavity and meets the aesthetic as a restorative material.[8,9,10]

Based on the backgroundabove, it can be takenas a problem wherethis research is generally aimed to analyze the difference of tensile strength value of diametral bulk-fill composite resin stored in order to obtain whether there is difference of tensile strength value of diametral bulk-fill composite type resin stored at low temperature (5˚C), room temperature (25˚C) and high temperature (35˚C).

MATERIALS AND METHODS

This research is a pure experimental study with posttest only control group design. In this experimental study, 33 specimens ofresin composite materials divided in 3 groups (n=11) were prepared. Bulk-fill composite resins Tetric N-Ceram (Ivoclar, Vivadent) were used (Table 1) with 6 mm diameter mold and 3 mm thickness based on ADA No.27 specification and has a flat, non-porous and smooth surface.In group I: bulk-fill composite resins were stored in refrigerator or low temperature storage (5ºC); Group II: bulk-fill composite resins stored in room temperature(25ºC); Group III: bulk-fill composite resins are stored in an oven or high temperature storage (35ºC).

Table 1. Characteristics of composite resins used in the study (manufacturers' data)

Composite Resin	Brand (Manufacture)	Shade	Composition
Bulk-fill composite resin	Tetric N-Ceram (IvoclarVivadentSchaan Liechtenstein)	IV B	*DMA:19-21% weight* *Inorganic filler: 75-77% weight* *Barium glass* *Prepolymer* *Ytterbium trifluoride* *Mixed oxide* *Catalysts, stabilizers and pigments: <1% weight*

Composite syringes were wrapped with ziplock plastic and placed in the refrigerator, incubator and oven for at least 24 hourswith temperature5˚C, 25˚C and 35˚C. Then the bulk-fill composite resin was removed from the storage room and continued by making the samples of 11 samples for each group. Preparation of bulk-fill composite resin plate using ADA specification No. 27 with a diameter of 6 mm with a thickness of 3 mm. Application of bulk-fill composite resins on the mold wascarried out as soon as possible to maintain the temperature of the bulk-fill composite resin after being removed from storage space.The composite resin wasthen shined for 20 seconds using a light curing unit of LED type with a distance of 1 mm and a 90º angle. After setting, composite resin wereremoved from the mold carefully to obtain an undamaged composite resin and ready for testing. The composite resin wasimmersed in a saline and stored in an incubator at 37ºC for 24 hours to condition like condition in the oral cavity. Furthermore, the bulk-fill composite resin was tested for diametral tensile strength using the Universal Testing Machine (Tokyo Testing

Machine MFG CO. LTD) loaded with 250 kgF and cross head speed 0.5 mm / min.

Samples of bulk-fill composite resin ready for testing were placed on universal testing machine compression plate and applied pressure with 250 kgF load and cross head speed 0.5 mm / min until the sample broke. The value that occuredwhen a bulk-fill composite resin broken for the first time would appear on the Universal Testing Machine screen and recorded as a diametral tensile strength value of bulk-fill composite resin sample.

RESULT

Table 2 shows the mean DTS values of bulk-fill composite resins after 24 hours of storage in refrigerator, incubator and oven.

Table 2. Table mean and standard deviation of DTS values of the bulk-fill composite resins distributed according to different group of the temperature storage

Group	Mean ± SD
temperature 5ºC	35,85 ± 5,79
temperature 25ºC	42,72 ± 6,92
temperature 35ºC	45,73 ± 4,45

The result of normality test in bulk-fill composite resin group p value = 0,500 in group A (5ºC), p = 0,076 in group B (25ºC) and p = 0,784 in group C (35ºC) with p> 0,05 wasnormally distributed and continued with homogenity test of p = 0,485 (p> 0,05) showedhomogeneous data variant. All data wasnormally distributed and homogeneous, so the parametric test of One Way Anova wasfollowed.

The results of One Way Anova statistical test showed the value of 0.001 (p <0.05) which showed that there was a significant difference in storage temperature group to the value of tensile strength of diametral bulk-fill composite resin. Further tests were performed using Post Hoc Bonferroni test which showed significant differences between treatment groups. The results of the Bonferroni test can be seen in table 3.

Table 3. Comparison among DTS values of bulk-fill composite resin at different of storage temperatures using the Bonferroni test

	p value		
	Temp 5ºC	Temp 25ºC	Temp 35ºC
Temp 5ºC	-	0,028*	0,001*
Temp 25ºC	0,028*	-	0,699
Temp 35ºC	0,001*	0,699	-

Notes: *P-value of >0.05 was statistically different significant

Based on Table 3, the results of the Post Hoc Bonferroni test show that there wasa significant difference (p <0.05) in the storage temperature group 5ºC compared to the 25ºC temperature. Significant differences were also obtained in the storage temperature group 5ºC compared to 35ºC and there was no significant difference in the 25ºC storage temperature group compared with the 35ºC temperature

DISCUSSION

The result of the diametral tensile strength test against the storage temperature of the bulk-fill composite resin shows that enhancementthe storage temperature of bulk-fill composite resin can increasethe value of the diametral tensile strength. These results are consistent with Calheiros et al (2014) who found thatthe increase temperatures will decrease the viscosity of nanohybrid composite resins and increase the movement of free radicals that can lead to increased polymerization rates and high degree of conversion.

Storage of bulk-fill type composite resin at low temperature (refrigerator) obtained a value of diametral tensile strength which is lower than those treated in room temperature. The Incident occur because the low temperature will increase the viscosity of the composite resin that affects the movement of molecules during the polymerization process.[3] At low temperature storage, the vibrations of the atomic molecules will decrease as the storage temperature drops and the distance between molecules of atoms gets closer. When the temperature reaches absolute zero, the atom will stop moving. The decreased atomic motion will increase the viscosity of the material. If this continues to occur, there will be a change of form in the material

Viscosity changes alsoobtained by storing the bulk-fill composite resin at high temperature (oven). The high temperature given on the composite resin will decrease the viscosity. The monomer movement of the composite resin also occur at high temperatures. The amplitude of atomic or molecular vibrations and free radicals will increase, followed by the increase ofthe average distance between atoms and internal energy. The effect that occurs indicates a phenomenon called thermal expansion.[3,8] Tauböck et al (2017) found that when temperatures are increased, the viscosity of the bulk-fill composite resin will decrease and affect the movement of molecules as a result of energy high heat, and facilitate the movement of segments of the polymer chains that can delay the polymerization process to the next stage. Adequate polymerization will increase the degree of conversion of composite resins. High degree of conversion will improve physical properties and mechanical properties, color stability and biocompatibility of composite resins.[12]

Bulk-fill composite resins stored at refrigerator have the lowest diametral tensile strength compared with bulk-fill composite resins stored at room temperature and high temperature (oven) and show significant differences. Calheiros et al (2014) found that nanohybrid composite resins stored at low temperatures will lower the conversion rate and slow the polymerization rate, so it takes a longer time during the curing process to obtain a degree of conversion similar to storage at room temperature. Decreased conversion degrees at low temperatures will also decrease the value of the diametral tensile strength of the composite resin, whereas the increase in temperature before polymerization decreases the viscosity followed by increasing the monomer change to the polymer.[13]

The diametral tensile strength value of bulk-fill composite resin stored at high temperature (oven) is higher than the room temperature, but statistically has no significant difference. The research by Sharafeddin et al (2015) states that there is no significant effect on nanohybridcomposite resins and microfiller that are affected by elevated room temperature and temperature.[14] This is influenced by the time of application and temperature when removing the composite resin from tube. The temperature of the heated composite resin will be affected by the external temperature and the length of time required for the application process which make the viscosity of the composite resin back to its original state similar to that of the composite resin stored at room temperature.[15]

This research has several things to consider such as temperature and time of application that are difficult to control. It was also become a trouble on Prasanna et al (2007) research when composite resins were applied clinically to the oral cavity. The temperature of composite resin will be return to room temperature and affect the time required when removing the composite resin from the tube, applying to the cavity, contouring and polymerization process. The heated composite resins will quickly regain their original temperature and reduce the benefits of the heating change to original temperature.[15]

The conclusion that can be drawn from the conducted research is there is difference of tensile strength value of diametral bulk-fill composite resin stored at low temperature (5˚C), room temperature (25˚C) and high temperature (35˚C). The diametral tensile strength value of the bulk-fill composite resin increases with the rising of temperature in bulk-fill composite resin.

REFERENCES

1. Jaturanont P, Niyomdee T, Noranarttrakun K, KlaywonChompussornAnuwatmetee D, Kanchanauppatum W, Keawsri S, Phithaksakulwech S. 2016. Evaluation Surface Roughness Of A Bulk-Fill And A Conventional Resin Composite After Finishing And Polishing With Different Polishing Systems. *Rsu National Research Conference*. 29: 26-34.
2. Davari A, Daneshkazami A, Behniafar B, Sheshman M. 2014. Effect Of Pre-Heating On Microtensile Bond Strength Of Composite. *Journal Of Dentistry, Tehran University Of Medical Sciences.* 11(5): 569-575.
3. Tauböck TT, Tarle Z, Marovic D, Attin T. *2015*. Pre-Heating Of High-Viscosity Bulk-Fill Resin Composites: Effects On Shrinkage Force And Monomer Conversion. *Journal Of Dentistry.7(14): 1-23.*
4. Chaves FO , Farias NCD, Medeiros LMDM, Alonso RCB, DiHipólito V, D'alpino PHP. 2015. Mechanical Properties Of Composites As Functions Of The Syringe Storage Temperature And Energy Dose. *Journal Appliance Oral Science.* 23(2): 120-128.
5. Castro FLAD, Campos BB, Bruno KF, Reges RV. 2013. Temperature And Curing Time Affect Composite Sorption And Solubility. *J Appl Oral Sci*. 21(2): 157-162.
6. Aienna, Adyatma S, Arisanty D. 2016. KenyamananTermalRuangKelas di Sekolah Tingkat SMA Banjarmasin Timur. *JurnalPendidikanGeografi*. 7(2): 1-12
7. Didron PP, Chrzanowski W, Ellakwa A. 2013. Effect Of Temperatures On Polymerization Stress And Microleakage Of Class V Composite Restorations. *Open Journal Of Composite Materials*. 3: 107-112.
8. Anusavice KJ. 2004. *Phillips' Science Of Dental Materials Ed 10*(Terj. Johan Arief Budiman Dan Susi Purwoko). EGC PenerbitBukuKedokteran. Jakarta. Hlm. 16-17, 31-66, 227-247.
9. Esterina H. 2012.PerbedaanKekuatan Tarik Diametra Resin KompositNanofillerDan Resin KompositNanoceramic. *Conservative Dental Journal*2(1).
10. Alves PB, Brandt WC, Neves A, Cunha LG, Silva-Concilio LR. 2013. Mechanical Properties Of Direct And Indirect Composites After Storage For 24 Hours And 10 Months. *European Journal Of Dentistry*. 7: 117-122.
11. Alkhudhairy FI. 2017. The Effect of Curing Intensity on Mechanical Properties of Different Bulk-Fill Composite Resins. *Clinical, Cosmetic and Investigational Dentistry*. 9: 1–6.
12. AlShaafiMaan M. 2017. Factors Affecting Polimerization of Resin-Based Composites: Literature Review. *The Saudia Dental Jurnal*. 29: 48-58.
13. Calheiros FC, Daronch M, Rueggeberg FA, Braga RR. 2014. Effect of Temperature on Composite Polymerization Stress and

Degree Conversion. *Dental Material*. 30(6): 613-618.
14. Sharafeddin F, Motamedi M, Fattah Z. 2015. Effect of Preheating and Precooling on the Flexural Strength and Modulus of Elasticity of Nanohybrid and Silorane-based Composite. *J Dent Shiraz Univ Med Sci.* 16(3 Suppl): 224-229.
15. Prassanna N, Reddy YP, Kavitha S, Narayanan LL. 2007. Degree of Conversion and Residual Stress of Preheated and Room-Temperature Composites. Indian *Journal of Dental Research.* 18(4): 173-176.