DENTINO
JURNAL KEDOKTERAN GIGI
Vol II. No 2. September 2017

THE EFFECT OF THERMOCYCLING TEST ON THE SURFACE HARDNESS VALUE OF BULK FILL RESIN COMPOSITE

Dewi Puspitasari, Amina Khairima, Sherli Diana
Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin

ABSTRACK

Background: *Bulk fill typed composite resin can be applied at once into the tooth cavity of approximately 4 mm. The surface hardness of composite resin can be affected by temperature. Variation temperature in oral cavity due to the consumption of cold and hot food or beverages. Thermocycling tests are used to simulate aging of restorative materials in oral cavity by exposing material to repeated cycles of cold(4 ^{o}C) and hot(60°C) temperatures.* ***Purpose:*** *To analyze thermocycling test effect with 1500 and 3000 cycles to the surface hardness value bulk fill composite resin.* ***Methods:*** *This study is true experimental post test only with control group design. This study used 27 samples of bulk fill composite resin divided into 3 groups, first group is control group that did not do thermocycling test, second group is group of thermocycling 1500 cycles and third group of thermocycling 3000 cycles.* ***Results****: Mean value of composite resin surface hardness control group 46.529 ± 1.331 MPa, group thermocycling 1500 cycles 44.100 ± 1.039 MPa, and group thermocycling 3000 cycles 42.251 ± 1.470 MPa. The data were tested using One Way ANOVA and post Hoc Bonferroni with p <0.05, there were significant differences in all treatment group.* ***Conclusion:*** *Thermocycling test with 1500 and 3000 cycles (equal with clinically used 6 month and 1 year) in resin composites may decrease surface hardness value*

Keywords: *bulk fill composite resin, surface hardness, thermocycling test*

Correspondence: Dewi Puspitasari, Faculty of Dentistry, University of Lambung Mangkurat, Jalan Veteran No 12B, Banjarmasin, Indonesia, email: dewident@gmail.com

INTRODUCTION

Resin composites is a dental restorative material that is widely used in dentistry due to good esthetic and strength.[1] The material was introduced by Bowen in 1962 and undergoes advancement in technology to improve the properties.[2] Each type of resin composites basically consist of four main components such as resin matrix, filler particles, silane coupling agents and initiators.[3]

The advantages of resin composites as restorative materials are good resistance, low water absorption, able to bind with tooth surface by using adhesive system, more resembles the color of nature teeth and easy to be manipulated. A good bond between resin composites and remaining tooth structure may prevent damage and protect the tooth from excessive temperature change.[4]

One of resin composites disadvantage is polymerization shrinkage. Polymerization shrinkage can be overcomed by applying a resin composites technique incrementally. Incremental techniques take longer time in the restoration process due to resin compositess application layer by layer. Layered techniques may cause empty space and gaps in the restoration resulting in a failure of restoration.[3]

In 2009 a new type of resin composite was developed and called bulk-fill typed Resin

composites. This type of resin composite can be applied at once to a tooth cavity with a depth of approximately 4 mm. Bulk fill type resin composites using nanohybrid type filler. Nanohybrid is one of type hybrid resin composites that contains nano-sized filler particles. By addition of fillers and more initiators in this type resin composite may improve the physical properties of resin composites.[5]

Resin composites that had been applied to dental cavities undergo a dynamic and complex process involving changes in temperature, food, beverages, saliva and biofilms. This process occured over a long period of time, as the aging of resin composites develops over time. The aging process is characterized by the presence of degradation in resin composites. Research on the aging process of resin composites was carried out by simulating the conditions in the oral cavity through several in vitro tests, one of it is the thermocycling test.[6,7]

Thermocycling test has been commonly used in dental research since 1952. Conventional thermocycling tests are used to simulate aging of restorative materials in oral cavity by exposing material to repeated cycles of cold and hot temperatures in the waterbath alternately, in an effort to multiply and repeating the thermal changes occurring in the oral cavities.[8]

The thermocycling test is an in vitro process that represent conditions between the restorative material and tooth for the same temperature limit as it is experienced in the oral cavity. Thermocycling tests can produce potential negative effects because of the different coefficients of thermal expansion between the teeth and the restoration.[7]

The mechanism of action of thermocycling test may occured in two ways. First, high-temperature water (heat) will accelerate hydrolysis and increase water absorption as well as interfere with the polymerized resin composites bond. Second, the thermal expansion coefficient of the restorative material is higher than that of the dental network resulting in repeated expansion pressures on the surface of the restoration..[7]

International Standards Organization (ISO) 11450 (1994) states that the standard thermocycling test is carried out with a 500-cycle cycle at 5-55 ° C with a dwell time of 30 seconds. Research of Stewardson et al (2010) stated that thermocycling 500 cycles is equal with with the number of cycles that are expected to occur within about 2 months in the oral cavity.[8]

The varying temperatures in the oral cavity due to the consumption of cold and hot foods or drinks may resulting stress on the surface of the restoration causing micro leakage and destruction of the restoration. A constant temperature between 4° C to 60° C may resulting stress which can damage the properties of restorative materials such as cohesive, pressure, shear strength, hardness and roughness. The surface hardness may be related to the degradation of the restoration, since resin composites is directly related to the quality of the polymerization, the crosslinking density of Resin composites material and the filler material.[9]

Surface hardness is used as a tool of measuring the restoration material to determine the material's ability to withstand the force. The hardness of resin composites may affect abrasion grade while food mastication and tooth brushing.10 Hence, this research has been performed to find out the effect of thermocycling test with 1500 cycles and 3000 cycles on the surface hardness value of bulk fill typed resin composite.[10]

MATERIALS AND METHODS

Twenty seven samples were randomly divided into three groups, that were treated with thermocycling test 1500 cycles, thermocycling test 3000 cycles and as control. The sample were made by using a mold with diameter of 5 mm and thickness of 4 mm, the resin composite material in the research are bulk fill type resin composite Tetric N Ceram Bulk Fill Ivoclar Vivadent. Resin composite was applied at once into mould with depth of 4 mm and irradiated for 20 seconds. After polymerization was complete, samples were removed from the mould then stored in a beaker with saline solution placed in an incubator at 37 ° C for 24 hours. After 24 hours, the treatment group samples were carried out for thermocycling test with temperature 5ºC (cold) for 30 seconds and temperature 55ºC (heat) for 30 seconds and dwell time 15 seconds the treatments were repeated for 1500 cycles and 300 cycles.All samples of control group, treatment 1500 cycles and treatment 3000 cycles were subjected to surface hardness test using Micro Vickers Hardness Tester (ZwickRoell (Zhμ)®Micro hardness tester, Germany). All samples are given indentations with a 200 gf load and dwell time of 15 seconds. statistical data test were carried out using One Way ANOVA and

continued with Post Hoc Bonferron with significance value p <0.05

RESULT

The mean of surface hardness value of bulk fill Resin composites on thermocycling test can be seen in Table 1. The highest mean surface hardness of composite bulk fill resin composites in the control group and lowest in thermocycling treatment group of 3000 cycles. There was significant difference in all treatment groups with p <0.05..

Tabel 1. Surface Hardness Value and Standard Deviation (SD) of Bulk Fill type Resin composites Type

Groups	Mean ± Standard Deviation (MPa)
Control	46,529 ± 1,331[a]
thermocycling 1500 cycle	44,100 ± 1,039[b]
thermocycling 3000 cycle	42,251 ± 1,470[c]

*Value with different superscript letters shows significant difference at p < 0.05

DISCUSSION

In the present study, the hardness value of the bulk fill resin composites in the control group had a higher surface hardness value compared to the thermocycling 1500 cycles treatment group that equal to duration of resin composites within the oral cavity for 6 months, thermocycling 3000 cycles that equal tot the duration of resin composites in the oral cavity for 1 year has the lowest surface hardness value. This study is consistent with the research of Oliveira et al (2010) and Tuncer et al (2013) showing that there is a decrease in the hardness of the surface of resin composites by thermocycling test.[9,11] The result may be explained by the water absorption, water molecules acting into polymeric structure and result in plasticizing. In the study, the surface hardness of bulk fill resin composite in the thermocyling test 1500 cycles treatment group has a higher value than the thermocyling test group of 3000 cycles. The more extreme heat-cold temperature cycles that exposed to the bulk fill-type resin composites so the less the surface hardness will be. The sample of thermocycling tests undergoes temperature fluctuations that produce thermal stress similar to fatigue or stress due to application of cycle load from the cumulative effect of shrinkage and expansion. Furthermore, microgap may be formed in the resin matrix and interface of fillers-matrix may broke down due to the high temperature variations. High temperature rise causes water absorption, solubility and diffusion coefficient to increase.[12]

Exposure to water may cause hydrolytic degradation of the filler-silane layer or matrix expansion resulting in a decrease in the hardness of the surface of resin composites.[13,14] The negative effect of water on resin composites occurs with two different mechanisms. The first mechanism is the water molecules role in altering the material properties of the elastic state to the plastic state which will increase the volume of Resin composites matrix so that the material properties decrease. The second mechanism is the breakdown of resin composites component in water.[12]

Thermocycling test is a simulation of the oral cavity temperature that fluctuates every day. The extreme cold temperature of the oral cavity is 5ºC, while the extreme temperature of heat in the oral cavity is 55ºC. The extreme temperature is the lowest and highest temperature acceptable by the oral cavity itself. The fluctuating temperature of the oral cavity may affect the degradation of the adaptation quality of a restorative material.[15]

The decrease in the hardness of the surface of Resin composites caused by the degradation process of Resin composites material may occur over time. This is supported by the statement of Roeters (2005) that Resin compositess clinically can last for 5-10 years, but these restoration materials may undergo changes in physical and mechanical properties after one year of use.[16]

The bulk fill Resin composites has a monomer component of Bis-GMA, UDMA, an inorganic filler comprising barium glass, ytterbium trifluoride, mixed oxide and propolymer. The presence of particle filler material in the resin matrix may increase the strength of the bulk fill Resin composites, in addition to decrease polymerization shrinkage, decrease expansion, and contraction due to temperature and decrease water absorption. Ytterbium trifluoride contained in a bulk fill Resin composites has the ability to release fluoride and a high degree of raadioopacity.[16]

The hardness of the surface of resin composites is affected by the organic matrix (monomer) and the inorganic filler, it is also depends on the density and structure of polymer and conversion of degree after polymerization. It is known that the presence of aromatic groups in BisGMA and BisEMA

monomers form polymeric structure with higher rigidity. The higher the number of particles, the hardness of the surface of the material also increases. Hardness is also used as an indirect method to measure the conversion rate of resin, the higher the conversion rate the higher the hardness value is.[9,17]

CONCLUSION

Based on the result of the present study, it can be concluded thermocycling test with 1500 and 3000 rounds (comparable with clinical usage of bulkfill resin composite type for 6 months and 1 year) may decrease the value of surface hardness.

REFERENCE

1. Putriyanti F, Herda E, dan Soufyan A. Pengaruh saliva buatan terhadap diametral tensil strength micro fine hybrid resin komposit yang direndam dalam minuman isotonik. Jurnal PDGI 2012; 61 (1): 43.
2. Aprilia, Rochyani L, dan Rahardiarto E. Pengaruh minuman kopi terhadap perubahan warna pada resin komposit. Indonesian Journal of Dentistry 2007; 14 (3): 164.
3. Raharjo G. Pengaruh jenis Fiber sebagai penguat restorasi resin komposit bulk fill terhadap resistensi fraktur gigi premolar pasca Perawatan Saluran Akar. Tesis. Universitas Gajah Mada. 2014: 2-8.
4. Susanto AA. Pengaruh ketebalan bahan dan lamanya waktu penyinaran terhadap kekerasan permukaan resin komposit sinar. Journal of Dentistry 2005; 38 (1): 32.
5. Kwong, Wilson . How to complete Bulk fill restoration. Dental Products Report. 2013; 12 (1): 7-8.
6. Rinastiti M. Pengaruh penuaan terhadap densitas ikatan silang resin komposit packable bulk fill, Sonic active bulk fill dan packable konvensional. Tesis. Universitas Gajah Mada. 2014: 1.
7. Risanti I. Efek klorheksidin terhadap pengurangan degradasi kekuatan ikat geser resin komposit-dentin. Tesis. Universitas Indonesia. November 2012: 16-17.
8. Morresi AL, D'Amario M, Capogreco M, et al. Thermal Cycling for restorative materials: Does a standardized protocol exist in laboratory testing? A literature review. Journal of The Mechanical Behavior of Bioedical Materials 2014; 29: 297-302.
9. Oliveira JCD, Aiello G, Mendes B, et al. Effect of Storage in Water and Thermocycling on Hardness and Roughness of Resin Materials for Temporary Restorations. Material Research 2010; 13(3): 355-358.
10. Sitanggang P, Tambunan E, dan Wuisan J. Uji Kekerasan Komposit Terhadap Rendamam Buah Jeruk Nipis (Citurs Aurantifola). Jurnal e-Gigi (eG) 2015; 3 (1): 230.
11. Tuncer S, Demirci M, Tiryaki M, et al. The Effect of a Modelling Resin and Thermocycling On The Surface Hardness, Roughness, and Color Of Different Resin Composites. Journal of Esthetic and Restorative Dentistry 2013; 25(6): 408-409.
12. Karimzadeh A, Ayatollahi MR, and Shirazi HA. Mechanical Properties Of A Dental Nano-Composite In Moist Media Determined By Nano-Scale Measurement. International Journal Of Materials, Mechanics And Manufacturing 2014. 2(1): 67-70.
13. Pereira SMB, Castilho AA, Marocho SMS, et al. Thermocycling effect on microhardness of laboratory composite resins. Braz J Oral Sci 2007; 6(22):1372-1375.
14. Tabatabaei MH, Sadrai S, Bassir SH, et al. Effect Of Food Stimulated Liquids And Thermocycling On The Monomer Elution From A Nanofilled Composite. The Open Dentistry Journal 2013. 7: 62-66.
15. Sari GGP, Nahzi MYI dan Widodo. Kebocoran Mikro Akibat Efek Suhu Terhadap Pengerutan Komposit Nanohybrid. Jurnal Dentino 2016; 1 (2): 108-112.
16. Todd JC and Wanner M. Scientific Documentation Tetric EvoCeram Bulk fill. 2013: 23.
17. Abed YA and Sabry HA, Alrobeigy NA. Degree of Conversion and Surface Hardness of Bulk-Fill Composite Versus Incremental-Fill Composite. Tanta Dental Journal 2015; 12: 74-75.