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# BASE SURFACE TEMPERATURE OF BULK FILL RESIN COMPOSITE WITH DIFFERENT THICKNESS

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***ABSTRACT***
***Background****: The material thickness is one factor that influences the polymerization of resin composites. Bulk fill resin composite is an efficient dental resin composite restoration material because it can be cured to a thickness of up to 4-5 mm. The thickness of the material can also affect the temperature rise, while maintaining the temperature is very important because a significant increase can damage the pulp.* ***Purpose:*** *This research aimed to analyze the base surface temperature of bulk fill resin composite with different thicknesses.* ***Methods:*** *Thirty bulk fill resin composite samples with a diameter of 5 mm were divided into three groups with different thicknesses, namely group I (3 mm), group II (4 mm), and group III (5 mm). Each group of samples was cured using an LED Light Curing Unit for 20 seconds, and carried out simultaneously with the measurement of the base surface temperature using a type-K digital thermocouple. Data analyzed using One Way ANOVA and LSD post hoc tests.* ***Results****: The mean and standard deviation of the base surface temperature of bulk fill resin composite in groups I, II, and III, respectively, is 37.56 ± 1.06ºC, group II 36.89 ± 1.23ºC, and group III 36.00 ± 1.2 ºC. It showed significantly different between the* groups (p<0,05). ***Conclusion:*** *The thicker the bulk fill resin composite, the lower the base surface temperature.*

***Keywords:*** *base surface temperature, bulk fill resin composite, thickness.*
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## INTRODUCTION

Bulk fill resin composite is one of the many innovations in composite resins that are happening in line with the swift advancement of technology. Because bulk fill resin composite can be polymerized to a thickness of 4-5 mm, it can be applied simultaneously into cavities without increments, saving processing time compared to conventional composite resin.

Bulk fill resin composite can be polymerized so thickly because it contains a complex composition of matrix (such as TEGDMA, BisGMA, UDMA, AUDMA, BisEMA, DDDMA, AFM), filler (such as addition of Ytterbium trifluoride (YbF3) agglomerate nanoparticles, non-agglomerated/non-aggregated silica nanoparticles, zirconia nanoparticles, etc.) and photoinitiator (such as camphorquinone with addition of acyl phosphine oxide, dibenzoyl germanium derivatives, or Lucirin TPO (2,4,6-trimethylbenzoyl-diphenylphosphine oxide), or MAPO (mono acyl phosphine oxide).[1,2] The use of a complete combination of matrix, filler and photoinitiator aims to improve mechanical properties.[1-5]

The thickness of the resin composite material is one of the factors that influences polymerization.[6,7] Meanwhile polymerization can affect the base surface temperature. Not only thickness, composite shade can also affect the base surface temperature.[8] Controlling changes in temperature is crucial because large increases have the potential to induce irreversible pulp inflammation and even necrosis. The pulp may become permanently harmed by temperatures between 42-42.5°C.[9] In previous studies reported that the temperature of conventional resin composites increased to more than 42.5°C related to curing time, thickness, and shade.[8,10,11]

Conventional resin composites usually only have a depth of cure 2 mm, in contrast to bulk fill resins composites which have a depth of cure above that. This study aimed to analyze the base surface temperature of bulk fill resin composite with different thicknesses.

## METHODS

The first step was making a mold model using a wax baseplate with a diameter of 5 mm and different thicknesses, namely 3 mm, 4 mm and 5 mm.

Stainless steel pipettes were used to form molds. The wax baseplate that had been perforated was placed into the cuvette with a cast stone. Baseplate wax was placed into the plaster mix until its top surface was parallel to the top surface of the surrounding plaster mix, then waited until it dried and hardened. After hardening, the top surface of the cast and mold was smeared with vaseline. The upper cuvette was installed, then glued to the lower cuvette until it was tight (metal to metal contact). The stone gypsum was stirred again, then the stone gypsum was put into the top cuvette until there was a little excess. Next, the cuvette was closed and locked until the plaster hardened. After that, the cuvette was immersed in boiling water for 15-20 minutes. The cuvette was removed from the boiling water, then waited until it cooled. The cuvette was opened and doused with hot water to clean the remaining wax. Doughs made from elastomeric molding materials were prepared. The elastomer used was an addition silicone (hydrophilic vinyl polysiloxane) type elastomer with a putty consistency (Perfit, Huge, China), then placed into the mold that had been formed and pressed until the excess elastomer comes out of the cuvette. Once hardened, the elastomer mold was removed from the gypsum negative mold.

The second step was making the elastomeric master cast support and thermocouple cable support. The elastomer dough was made in the form of a block and shaped according to the part of the elastomer master cast mold or cable. Then fixed it and waited until it hardened. After hardening, the elastomer mold or thermocouple cable was removed from the support that had been formed.

The final step was making samples and measuring the base surface temperature. A total of 30 bulk fill resin composite samples (IVB shade Tetric N Ceram® *bulk-fill*, Ivoclar Vivadent, Liechtenstein) with a diameter of 5 mm[2,8,12,13] were divided into three groups with different thicknesses, namely group I (3 mm), group II (4 mm), and group III (5 mm). The bulk fill resin composite was taken using a plastic instrument and placed into an elastomer master cast. The bulk fill resin composite was leveled and compacted by covering the top with a cellophane strip and placing a glass slab on top for 2 minutes. The glass slab and the cellophane strip were removed, then the excess bulk fill resin composite was cleaned. The cellophane strip was placed back on the top surface of the bulk fill resin composite. The tip of the LED light curing unit (Woodpecker Light Curing LED.D, China) was placed in contact with the cellophane strip and the tip of the *type-K digital thermocouple* (KW 06-278, Krisbow, China) cable was placed in contact with the base surface of the bulk fill resin composite. Then the bulk fill resin composite was polymerized using an LED light curing unit for 20 seconds, and the base surface temperature measurement of the bulk fill resin composite was carried out simultaneously with the irradiation. The results of measurements of the base surface temperature of the bulk fill resin composite were recorded. Irradiation of the specimen was then carried out after 2 minutes so that the elastomer master cast could return to its initial temperature.

The data was analyzed computerized using the SPSS version 20. The data obtained was tested for normality using the Shapiro-Wilk test for small samples (less than 50). It turned out that the data was normally distributed (p> 0.05). Next, the test was continued using the *One Way* ANOVA test to determine whether there was a difference or not in the base surface temperature of the bulk fill resin composite with different thicknesses and the LSD post hoc test to analyze which groups were significantly different.

## RESULTS

The base surface temperature mean and standard deviation (SD) of bulk fill resin composites were presented in Table 1. There were differences in the base surface temperature of bulk fill resin composite with different thicknesses (p<0.05)

Based on the results of the LSD post hoc test, between groups I and II the value of p = 0.206 (p>0.05) was obtained and between groups II and III the value of p = 0.100 (p>0.05) was obtained, which means that there was no significant differences in base surface temperature between the 4 mm thickness group and the 5 mm thickness group and between the 3 mm thickness group and the 4 mm thickness group. The significant value obtained between groups I and III was p = 0.006 (p<0.05), which means that there was a significant difference in base surface temperature between the 3 mm thickness group and the 5 mm thickness group. (Table 2).

**Table 1.** The Base Surface Temperature Mean and Standard Deviation (SD) of Bulk Fill Resin Composites

| Group | Mean ± SD (°C) | *p-value* |
|---|---|---|
| I | 37.56 ± 1.06 | |
| II | 36.89 ± 1.23 | 0,02* |
| III | 36.0 ± 1.20 | |

* there was a significant difference (p<0.05) using One Way ANOVA
Group I: bulk fill resin composite with a thickness of 3 mm
Group II: bulk fill resin composite with a thickness of 4 mm
Group III: bulk fill resin composite with a thickness of 5 mm

**Table 2.** Post Hoc LSD Test Results of Base Surface Temperature of Bulk Fill Composite Resin with Different Thicknesses

| Between Group | | *p-value* |
|---|---|---|
| I | II | 0.206 |
| | III | 0.006* |
| II | III | 0.100 |

* there was a significant difference ($p<0.05$) using LSD post hoc test.

Group I: bulk fill resin composite with a thickness of 3 mm

Group II: bulk fill resin composite with a thickness of 4 mm

Group III: bulk fill resin composite with a thickness of 5 mm

## DISCUSSION

Both the heat produced by the light source and the heat released during the exothermic process of polymerization of light-activated dental materials increase. There are various levels of pulpal damage that can result from applying heat to dental structures. Between 42°C and 42.5°C was the critical temperature for the irreversible damage of dental pulp. The pulp tissue will suffer permanent damage if the intrapulpal temperature exceeds 5.5 °C above the critical temperature of the pulp.[8]

Numerous investigations into the rise in intrapulpal temperature have been carried out, with varying degrees of success according to reports[14,15]

Based on this research data in table 1, it showed that the thicker the bulk fill resin composite, the lower the base surface temperature. The results of this research are in line with the research of Al-Qudah et al. who examined conventional resin composite with exposure using an incremental technique, that the thicker the composite resin, the lower the resulting base surface temperature. This could be explained by pointing out that as the resin composite thickens, the intensity of the light decreases or weakens. This occurred because the light from the light curing unit is partially scattered, so that the thicker the resin, the less light reaches the base surface, and thus the heat produced decreases, resulting in a lower surface temperature.[10]

The temperature of the resin composite can rise, especially when irradiated. Radiant heat from the light curing unit and exothermic heat from polymerization both contribute to the resin composite's temperature increase. These two heats are transmitted to the resin composite's base surface in line with its conductivity and thermal diffusivity values. Although heat is reduced towards the base, heat can accumulate at the resin composite's base surface, particularly when polymerization is slow.[8,10 13]

The heat generated on the base surface of the resin composite will be transmitted to the tooth tissue beneath. This will, of course, disrupt the teeth's normal temperature range of 33.2-36.2°C, which is lower than the normal intraoral temperature of 37°C. In addition, this delivery will affect the increase in pulp temperature. This may cause thermal trauma to the pulp, particularly if the remaining dentin layer is thin. The temperature increase exceeds 8°C in a 0.4 mm thick dentin layer. However, when the intrapulpal temperature rises above 5.5°C above the critical temperature of the pulp, the risk of irreversible pulp damage increases.[8,10-13]In this study, there was no significant difference in base surface temperature between group I (3 mm thickness) and group II (4 mm thickness), and between group II (4 mm thickness) and group III (5 mm thickness). This means that the resulting base surface temperature was not much different if the radiation depth was 3 mm versus 4 mm and 4 mm versus 5 mm. Meanwhile, between group I (3 mm thickness) and group III (5 mm thickness) there was a significant difference in the base surface temperature of the bulk fill resin composite produced, which means that polymerization carried out using the bulk technique is better than the incremental technique (layer by layer). when using bulk fill resin composites. The light produced during polymerization can affect the temperature on the base surface. Base surface temperature will determine damage to the pulp chamber. Maintaining these temperature changes is critical because significant increases can cause irreversible pulp irritation, potentially even necrosis. Based on research conducted by Ertugrul et al., it showed that the highest temperature that pulp can still tolerate is 42-42.5˚C.[9] This study is similar to previous bulk fill resin composite study using the same light source, irradiation time, and product, with a thickness of 4 mm leading to a base surface temperature within the acceptable range for the pulp.[13]

In this research, the highest base surface temperature of bulk-fill composite resin was found at a thickness of 3 mm, namely with an average base surface temperature of 37.56±1.06°C, this base surface temperature could still be tolerated by the pulp. This means that using bulk fill resin composite with a thickness or depth of cure of 3 mm, 4 mm or 5 mm is still safe for the pulp based on this research.[13] Thus, it can be explained that the thickness of the bulk fill resin composite can affect the base surface temperature.

In conclusion, the base surface temperature of the resulting bulk fill resin composite with 3-5 mm depth of cure is in the range of 34.8-38.62°C. The temperature is assumed to be still safe for the pulp. It can be concluded that the thicker the bulk fill resin composite, the lower the base surface temperature.

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**CONFLICT OF INTERESTS**
All authors have none to declare

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