

The effect of light-cured nanofilled composite resin shades on their under-surface temperature

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Abstract. The objective of this study was to observe the effect of shades of light-cured nanofilled composite resins on their under-surface temperature. Resin composites specimens of shades bright, medium, and dark shade were obtained from a cylindrical mold. While polymerizing using a curing unit, the under-surface temperature was determined at the bottom of the specimens using a thermocouple wire 20 sec after the start. Results showed that the under-surface temperature of the darker shade specimens were relatively higher than those of the brighter shades with significant differences between the resin composites of different shades. To conclude, the under-surface temperature of the light-cured nanofilled resin composites raised from the brighter to the darker shades.

1. Introduction

Light-cured composite resins are widely used as anterior and posterior restorations due to their versatility and esthetically pleasing appearance. Their variation in color (shades) are available to meet the needs in allowing the material to resemble natural tooth [1,2]. Most manufacturers cross-reference their shades of resin composites with those of the Vita Lumin shade guide tab system (Vita Zahnfabrik, Bad Sackingen, Germany) [3,4]. When polymerizing a resin composite using a light curing unit, the total heat is the sum of heat arising from the light irradiance and polymerization reaction of the material. Heat conductivity and diffusivity in a resin composite is $0.0015 \text{ cal/s/cm}^2/^\circ\text{C/cm}$ and $0.183 \text{ mm}^2/\text{s}$, respectively. This may cause the possibility to raise heat inside a tooth pulp chamber [5-7]. When exceeding to $42.5 \text{ }^\circ\text{C}$, pulp tissue may experience an irreversible damage [8].

In-vitro studies showed that there is a relation between the temperature of a resin composite and its shade. A hybrid resin composite (Z250, 3M-ESPE, USA) with bright (B1), medium (C2 and B3), and dark (A4) shades (Spectrum, Dentsply, Germany) polymerized by a 20-second light curing unit showed increased under-surface temperature from bright to dark shades [9]. Microfilled resin composites of dark shade (A4, Spectrum, Dentsply, Germany) also produced a higher under-surface temperature than those produced by a bright shade (A2, Z100 MP, 3M, USA; Durafill VS, Heraeus Kulzer, Germany; Solitaire2, Heraeus Kulzer, Germany) [10].

The nanofilled composite resins (Filtek™ Z350XT, 3M ESPE, USA) is a relatively new material and were of interest. There are various shades of this resin composite, ranging from the lighter to darker, which has not been studied in the under-surface temperature. This study therefore, analyzes the influence of nano-filled light-cured resin composite shades on their under-surface temperature.

2. Materials and Methods

Nano-filled light-cured resin composite (Z350XT, 3M ESPE, St. Paul, MN, USA) of different shades were employed in this study. The shades B1, C3 and A3 were selected due to a relatively bright, medium and dark shades, respectively. We prepared specimens of 6 mm in diameter and 2 mm in thickness by packing the resin composite in a mold placed on a transparent plastic strip. After hand-pressed using a flat surface to extrude excess material and to obtain flat and smooth surface, each resin



composite was light cured by a light curing unit (Elipar™ S10, 3M ESPE, USA) with an irradiance of 900 mW/cm² in 20 sec. While polymerizing, we measure the under-surface temperature of the specimens using a "K" type digital thermocouple thermometer (Krisbow® KW06-283, China) with the wire tip was located placed as close as possible to the transparent plastic strip beneath the specimen.

Temperature measurement was determined 20 sec after the start in room temperature (23±1°C). The measurement between specimens was carried out with 60 seconds interval and light irradiance was monitored after every five polymerizations. Mean values were calculated from 10 specimens for each resin composite shade and a total of 30 specimens were measured in temperature. Data were analyzed by a one-way ANOVA test and an LSD Post-hoc test with a significance level of 0.05.

3. Results and Discussion

3.1 Results

Mean and standard deviation (SD) of the under-surface temperature of the resin composite specimens can be seen in Table 1.

Table 1. Mean and standard deviation (SD) of the under-surface temperature of the light-cured nanofilled resin composite specimens of shades B1, A3, and C3

Resin composite shade	Number of specimens	Under-surface temperature (°C)
B1	10	49.3 ± 1.5
A3	10	50.9 ± 1.0
C3	10	52.7 ± 2.3

The lowest under-surface temperature was 49.3 ± 1.5 °C, obtained from the specimens of the bright shade (B1), the highest was 52.7 ± 2.3 °C, from the bright shade (B1), whereas the the mid range, 50.9 ± 1.0 °C was from the medium shade (C3).

The data were tested for homogeneity and showed a normal distribution. One-way ANOVA indicated significant differences ($p < 0.05$) among the under-surface temperature values of all specimens. The LSD post-hoc test found significant differences between each under-surface temperature values (Table 2).

Table 2. The significant differences between the under-surface temperature of the light-cured nanofilled resin composite specimens of shades B1, A3, and C3

Color composite resins	B1	A3	C3
B1	---	*	*
A3	---	---	*
C3	---	---	---

*significant difference: $p < 0.05$

3.2 Discussion

The composite resin with brighter shade has greater ability to transmit the absorbed light than does the dark shade [11,12]. In this study, the composite resin with bright shade (B1) may have had the most bright pigment, that is able to transmit more light than those of the medium (A3) and dark (C3) shades. When polymerizing the specimens in 20 seconds, exothermic heat level in the resin composite specimen shade B1, due to its fast ability to transmit light, may be relatively lower than those of shades A3 or C3. This cause a fast decrease of heat. When the under-surface temperature was determined using a thermocouple, the temperature of B1, therefore, was the lowest. In contrast, the resin composite specimens shade C3 transmitted less light than those of shades A3 and B1. This cause

accumulated heat from irradiance and exothermic heat in the specimen. On measurement of the under-surface heat, it revealed with relatively high value of the specimen of dark shade (C3), and the specimen of medium shade (A3) has the under-surface temperatures in the mid range of those of shades B1 and C3.

4. Conclusion

Nano-filled light-cured resin composite of the bright shade (B1) has a distinctly lower under-surface temperature than that of the medium shade (A3) and the medium shade (A3) showed the under-surface temperatures which fall between those of shades B1 and C3.

Acknowledgments

The authors appreciated the Faculty of Dentistry of Universitas Indonesia for the access to its facilities and to 3M of Indonesia for donating the materials used in the study.

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