The Influence of Composite Type and Shade Selection on Depth of Cure of Light-activated Composites

Isra'a A. Al- Aubi B.D.S., M.Sc.*

Abstract

Background: This study investigated the influence of composite type and shade on depth of cure of light- activated composites.
Materials and methods: This study investigated the depth of cure of two composite materials using two different shades. Parameters included two shades (A1 and C3) of two different light-activated composites(Helio Progress and King Dental) cured for 40 seconds.
Results: Statistical analysis of the data by using the one-way analysis of variance revealed that, both composite type and shade significantly affect composite depth of cure.
Conclusion: This study indicated that, Although, both composite type and shade were significantly affect depth of cure but the effect of composite type on composite depth of cure is much more than that of composite shade.

Key words: Resin composite, composite shade, composite depth of cure and composite photo-activation.

Introduction

A common problem associated with photocuring is that the amount of light available to excite the photoinitiator dramatically decreases from the top surface inward as a result of light absorption and scattering [(1)]. This decrease in light intensity (attenuation) results in what is referred to as the "*depth of cure*" problem. Knowing the depth of cure of a particular shade of light-activated composite material would guide dentists in regard to the thickness of a composite layer that could be adequately cured clinically and provide them with a valuable baseline information about the specific depth of cure of different light-activated composite materials used by dentists. The ISO depth of cure (scraping) test ensured adequate polymerization of most resin-based composites [(2)]. The International Standardization Organization, or ISO [(3)], defined "Depth of cure" as 50% of the length of the cured composite sample after the soft, uncured portion has been scraped away manually. The length of the cured portion is measured with a micrometer to an accuracy of 0.1 mm, this value is divided by two (in compliance with ISO CD4049: 2000), and recorded as depth of cure. This method was also recommended by Morrow *et al.*, [(4)] and Manhart *et al.*, [(5)] in composite depth of cure determination. The objective of this research was to investigate the influence of composite type and shade on composite depth of cure.

Materials and Methods

A conventional Quartz tungsten halogen light-curing unit Astralis-3 (Ivoclar, Vivadent, Schaan/Liechtenstein) with an 8 mm diameter curing tip and 530mW/cm^2 curing light intensity was used for all the curing procedures in this study.

* Assistant lecturer, Department of Conservative Dentistry, College of Dentistry, University of Baghdad

Two different light-activated resin composite materials of A1 and C3 Vita shades were selected: Helio Progress (microfilled composite) (Ivoclar, Vivadent AG 9494 Schaan/Liechtenstein.Lot: F65176) and King Dental (microhybrid midifilled composite)(King Dental Corp., West Palm Beach, Florida. U.S.A. Lot: FD296). Forty specimens of light- activated composite were prepared and assigned into 4 groups, each group consisted of 10 samples:

Group 1: 10 specimens prepared using Helio Progress light-activated composite of A1 Vita shade.
Group 2: 10 specimens prepared using Helio Progress light-activated composite of C3 Vita shade.
Group 3: 10 specimens prepared using King Dental light-activated composite of A1 Vita shade.
Group 4: 10 specimens prepared using King Dental light-activated composite of C3 Vita shade.

For the preparation of each cylindrical specimen, a two-piece aluminum mold with a diameter of 4-mm and a height of 8-mm (Iraqi construction) was used as a mold for the composite specimens (Figure 1). A Transparent celluloid strip band (Hawe-Neos Dental, CH-6925 Gentilino, Switzerland) was placed on a flat glass slide (Blue star glass industries, Delhi, India) (Blue star glass industries, Delhi, India) on top of a white filter paper (England) then, the mold was placed over the transparent celluloid-strip and slightly overfilled it in one increment with the composite materials being tested then, a second transparent celluloid-strip was placed on top of the mold and overlaid it with a second glass slide, then a finger pressure was applied to the glass slide to extrude excess material.

The exit window of the curing light was placed over the second glass slide (the light tip in contact with the glass slide) and each composite specimen was cured, through the transparent celluloid strip and the glass slide, with Astralis-3 light-curing devise for 40 seconds.

After completing curing, the composite specimen was removed from the mold and the uncured material at the bottom of the sample, was removed by scraping it away manually with a plastic spatula.

The height of the cylinder of cured material was measured with a micrometer (Hommel Werke, England) to an accuracy of 0.01 mm (Figure 2). This value was divided by two (in compliance with ISO CD4049: 2000), and recorded as depth of cure for that composite specimen.

Mean and standard deviation were calculated for each specific depth of cure. The results were analyzed with one-way ANOVA, Least Significant Difference (LSD)-test and Student t-test, all at significance level 0.05.

Results

Mean depths of cure (in milimeters) and standard deviations of the four groups were listed in Table I. Figure 3 represents mean depths of cure (in mm) of the four groups.
Statistical analysis of the data by using the one-way analysis of varience test (ANOVA) revealed that, there was statistically very high significant difference ($p<0.001$) of depth of cure of the four groups as shown in Table II.

Least significant difference (LSD) test was carried out to examine the differences between the subgroups (1 X 2 & 3 X 4) and indicated that, there was statistically very high significant difference ($p<0.001$) of depth of cure for the subgroups as shown in Table III.

Student t-test was carried out to compare between each pair of groups seperately, also revealed that, there was statistically very high significant difference ($p<0.001$) of depth of cure for each pair of groups as shown in Table IV.

	Group	N	Minimum	Maximum	Mean/mm	Std. Deviation
Helio A1	1	10	2.050	2.280	2.17800	0.065115
Helio C3	2	10	1.900	2.050	1.98300	0.044485
King A1	3	10	3.000	3.090	3.04100	0.026541
King C3	4	10	2.850	3.025	2.94250	0.055340
Valid N (listwise)		10				

Table I: Mean depths of cure (in mm) and standard deviations of the four groups.

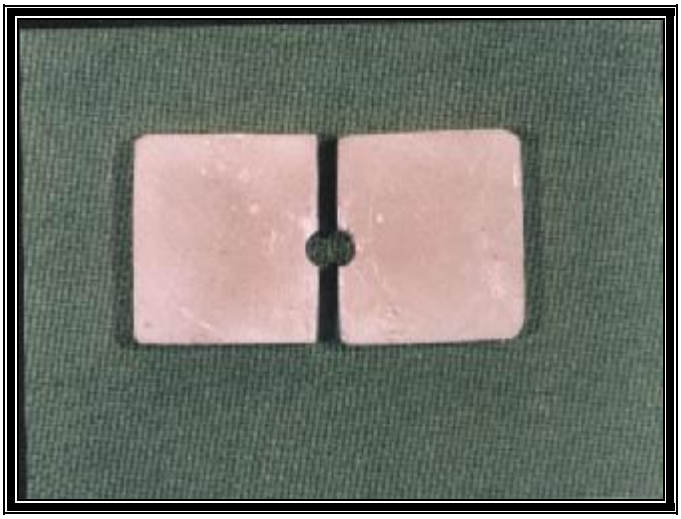

Figure 1: An aluminum mold of 8-mm in height and 4-mm in diameter was used as a mold for the composite material for measuring the depth of cure.

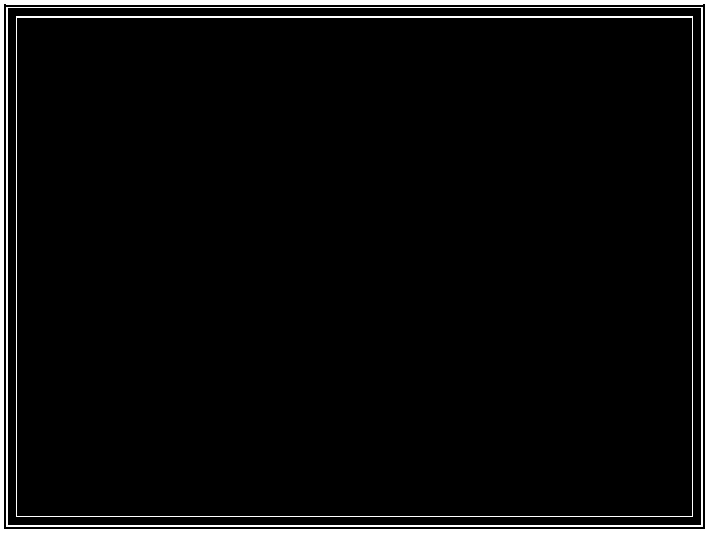

Figure 2: The micrometer devise for measuring the depth of cure.

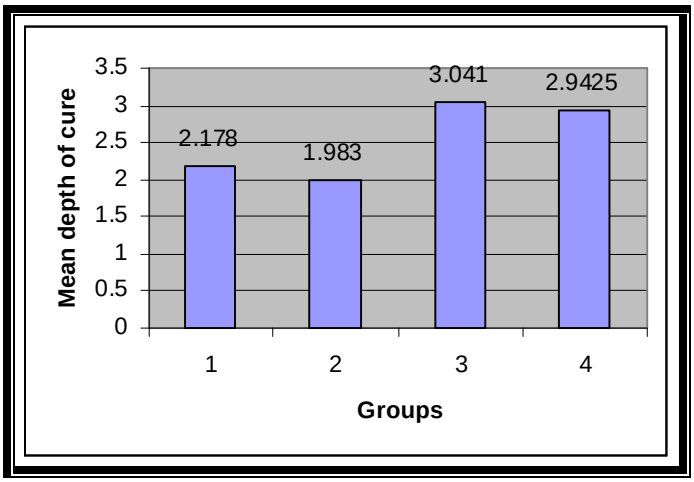

Figure 3: Mean depth of cure (in mm) of the four groups.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.542	3	2.847	1140.603	.000
Within Groups	8.987E-02	36	2.496E-03		
Total	8.632	39			

Table II: One-way analysis of varience test (ANOVA) of the four groups.

Subgroups	Sig.	
1 x 2	.000	***
3 x 4	.000	***
***:Very highly significant difference		

Table III: LSD test of depth of cure for the subgroups.

	Groups	Sig.	t	df	Sig.
VALUE	1 and 2	.299	7.819	18	.000
VALUE	3 and 4	.041	5.075	18	.000
VALUE	1 and 3	.035	-38.811	18	.000
VALUE	2 and 4	.454	-42.734	18	.000

Table IV: t-test of the differences between different pair of groups.

Discussion

In this study, although both composite type and shade were significantly affect depth of cure but (Figure 3) demonstrated that, the effect of composite composition on the depth of cure is much more than that of composite shade and this finding is in agreement with the finding of DeBacker & Dermaut [7] who found that, the most important factor

affecting the polymerization depth are the composition and the physical properties of the composite. Regardless of the composite shade, King dental light-activated composite exhibited higher depth of cure values than Helio Progress light-activated composite (Figure 3).

Depth of cure of light activated resin-based composites is a function of the material's filler composition and resin chemistry, its shade and translucency, the intensity of the light source, and the length of the radiation exposure [8]. The data of this study is in agreement with the findings of Jain & Pershing [9] in that microhybrid resin-based composites had significantly greater depth of cure values than microfilled resin-based composites. In this study, King dental light-activated composite is a microhybrid midifilled composite with average particle diameter of 1.4 micron (manufacturer's data) while Helio Progress light-activated composite is a microfilled composite with average particle diameter of 0.01-0.1 micron (manufacturer's data). It is believed that microfills exhibit this reduced depth of cure because their small filler particles cause light scattering, which decreases the effectiveness of the curing light [10]. In this study, high contrast shades (A1 & C3) for both types of composites were selected to examine the effect of shade selection on the depth of cure. The results of this study also indicated that, the dark shade (C3) of both composite types significantly reduced depth of cure values in comparison with the light shade (A1). This finding was in agreement with the finding of Bayne *et al*. [11] who found that; pigments and colorants associated with composite darker shades minimize light penetration through the composites.

References

1- Myers ML, Caughman WF & Rueggeberg FA: Effect of restoration composition, shade, and thickness on the cure of a photoactivated resin cement. *J Prosthodont,* 1994; 3:149-157.

2- Cook WD, Standish PM: Cure of resin based restorative materials, II: white light photopolymerized resins. *Aust Dent J*, 1983; 28: 307-11.

3- International Organization for Standardization: ISO 4049:2000: Dentistry-polymer-based filling, restorative and luting materials. 3rd ed. Geneva, Switzerland: *International Organization for Standardization*; 2000.

4- Morrow L, Wilson NH & Setcos JC: Single-use, disposable, presterilized light activation probe: the future? *Quintessence Int*, 1998; 29(12): 781-5.

5- Manhart J, Chen HY, & Hickel R: The suitability of packable resin-based composites for posterior restorations. *J Am Dent Assoc*, 2001: 132(5): 639-645.

6- Yap AUJ, Soh MS & Siow KS. Effectiveness of composite cure with pulse activation and soft-start polymerization. Oper Dent, 2002; 27:44-49.

7- DeBacker J & Dermaut L: Visible light sources and posterior visible light cured resins: a particle mixture. *Quintessence Int*, 1986; 17: 635-41.

8- Rueggeberg FA, Caughman WF & Curtis JW & Davis HC: A predictive model for the polymerization of photo-activated resin composites. *Int J Prosthodont*, 1994; 7: 159-166.

9- Jain P & Pershing A: Depth of cure and microleakage with high-intensity and ramped resin-based composite curing lights. *J Am Dent Assoc*, 2003; 134 (9): 1215-1223.

10- Kawaguchi M, Fukushima T & Miyazaki K: The relationship between cure depth and transmission coefficient of visible light-activated resin composites. *J Dent Res*, 1994; 73:516-521.

11- Bayne S, Heymann H & Swift F: Update on dental composite restorations. *J Am Dent Assoc*, 1994; 125 (6): 687-701.