ABSTRACT #1872

Effect of High-Intensity Light Curing on Depth-of-Cure and Intrapulpal-Temperature Increase

Slack WE,[1] Yancey EM,[2] Lien W,[3] Sheridan RR,[4] Phoenix RD,[5] Vandewalle KS[4]

[1]USAF, Wright-Patterson AFB, OH, USA; [2]USAF, Offutt AFB, NE, USA; [3]USAF, DRCS, Ft. Sam Houston, TX, USA; [4]USAF, JBSA-Lackland, TX, USA; [5]USU, Ft. Sam Houston, TX, USA

INTRODUCTION

The Exposure Reciprocity theory has been utilized by light-curing unit manufacturers to justify marketing products featuring increased light intensity to decrease overall cure time. Several high intensity units on the market claim 1-3 second cure times for a 2mm cure depth. Curing at manufacturer recommended times may produce under-curing while repeated exposures may cause thermal pulpal damage.

OBJECTIVE

The purpose of this *in vitro* study was to investigate the effect of rapid high-intensity light curing on depth-of-cure of composite resins and temperature changes in the pulp.

MATERIALS and METHODS

A 3.1mm-deep proximal box was prepared in an extracted human molar. Composite resin (Esthet-X HD, Dentsply) was placed in the preparation and cured using high-intensity light-curing units (Cybird, Dentazon; S.P.E.C. 3, Coltene; Valo, Ultradent; Flashmax P3, CMS Dental) at their maximum irradiance settings. The composite resin specimens were removed and tested for hardness along the intaglio surface at 0.5-mm increments occlusal-gingivally. Exposure times were varied over three groups. The first group was set according to manufacturer settings (Recommended), the second group had exposure times that were set to yield an 80% of maximum hardness value of the composite resin samples at the 2mm increment (Experimental), and the third group was set to an exposure time of 20 seconds (Extended). Data were analyzed with a two-way ANOVA and multiple one-way ANOVAs for each light-curing unit and exposure time.

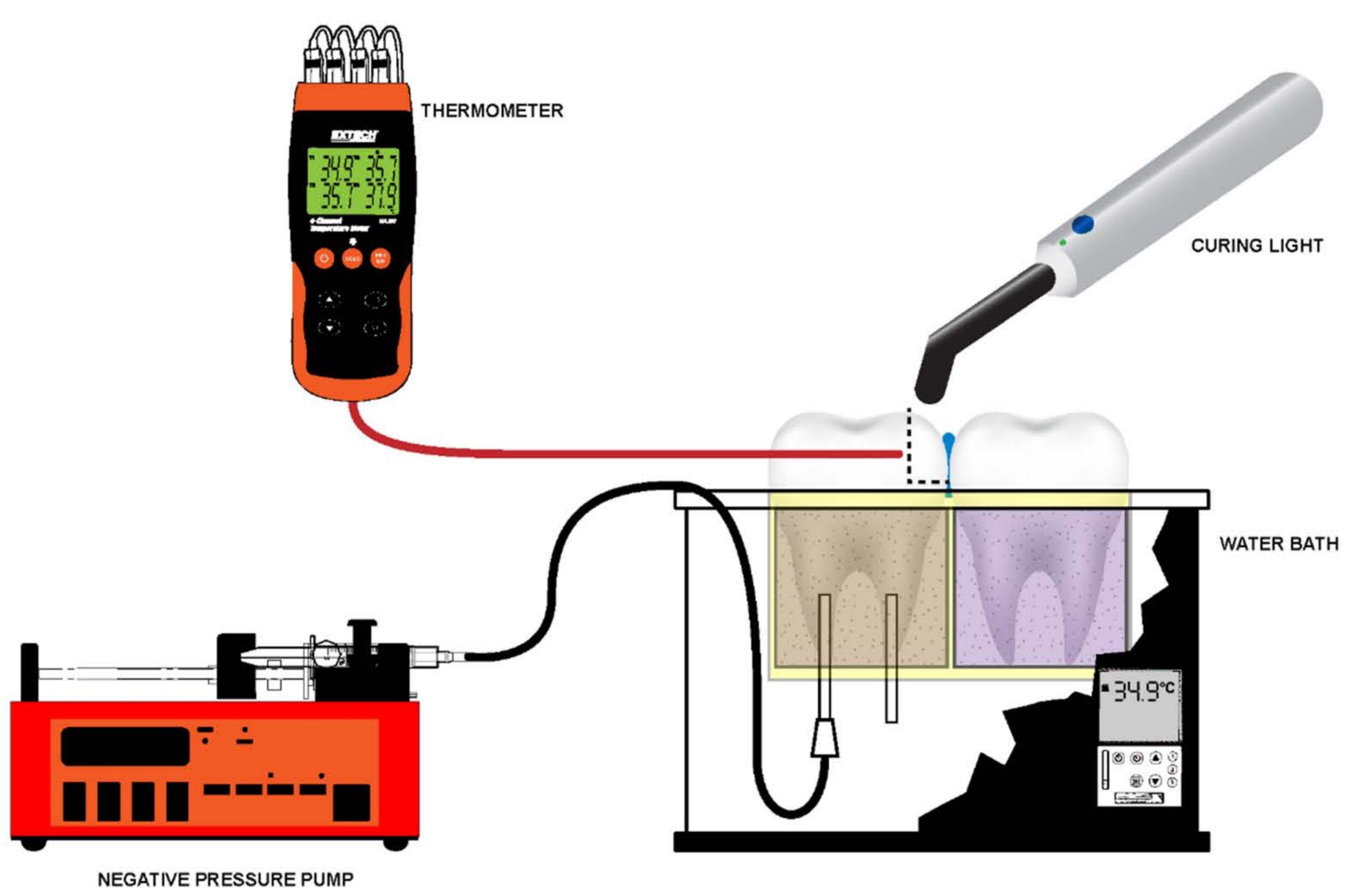

Figure 1: Experimental Setup Diagram

RESULTS

Based on the hardness ratios determined experimentally, the exposure time necessary to adequately polymerize the composite resin (80% of maximum) at 2mm depth was 9 seconds for the Cybird and Valo and 12 seconds for S.P.E.C. 3 and Flashmax P3. See Figure 2. The temperature change for the Extended group was significantly greater than the Experimental group which was significantly greater than the temperature change for the Recommended group. See Table 1 and Figure 3.

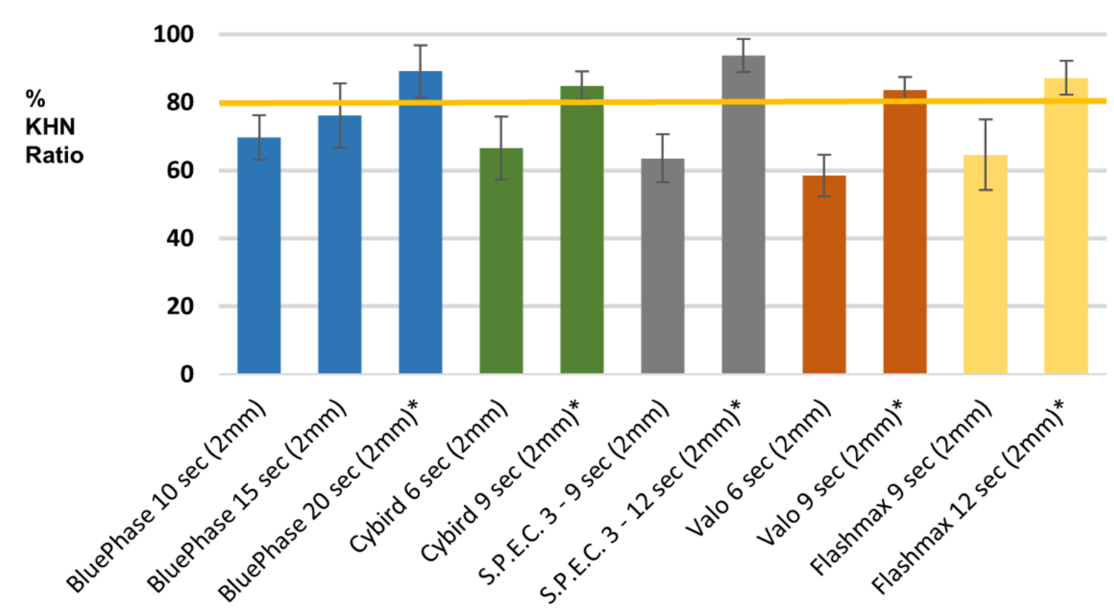

Figure 2: Polymerization Times by Curing Unit

Light-curing unit	Power (mW)	Irradiance (mW/cm²)	Mean (st dev) Increase in Pulpal Temperature ºC								
			Recommended			Experimental			Extended		
			1/3/10 secs			9/12/20 secs			20 secs		
			Radiant Exposure (J/cm²)	↑ Pulpal Temp (°C)		Radiant Exposure (J/cm²)	↑ Pulpal Temp (°C)		Radiant Exposure (J/cm²)	↑ Pulpal Temp (°C)	
Cybird	1404 (24)	3179 (53)	9.5 (0.2)	1.0 (0.2)	Ac	28.1 (0.5)	1.7 (0.1)	Ba	62.4 (1.1)	2.9 (0.1)	Cbc
Valo	1093 (14)	2473 (32)	7.4 (0.1)	0.8 (0.1)	Abc	22.6 (0.3)	2.3 (0.04)	Bb	50.3 (0.6)	4.0 (0.2)	Cd
S.P.E.C 3	1336 (69)	3024 (156)	3.0 (0.2)	0.3 (0.2)	Aa	38.9 (2.0)	2.3 (0.3)	Bb	64.9 (3.1)	3.4 (0.4)	Ccd
Flashmax P3	1194 (11)	2702 (24)	8.1 (0.07)	0.5 (0.1)	Aab	32.2 (0.3)	1.7 (0.2)	Ba	53.7 (0.5)	2.6 (0.1)	Cb
Bluephase 20i	567 (6)	1282 (14)	1.3 (0.1)	0.9 (0.1)	Ac	25.6 (0.3)	1.8 (0.1)	Ba	25.6 (0.3)	1.8 (0.1)	Ba
Groups with the same lower case letter per column and upper case letter per row are not significantly different (p>0.006).											

Table 1: Mean Increase in Pulpal Temperature

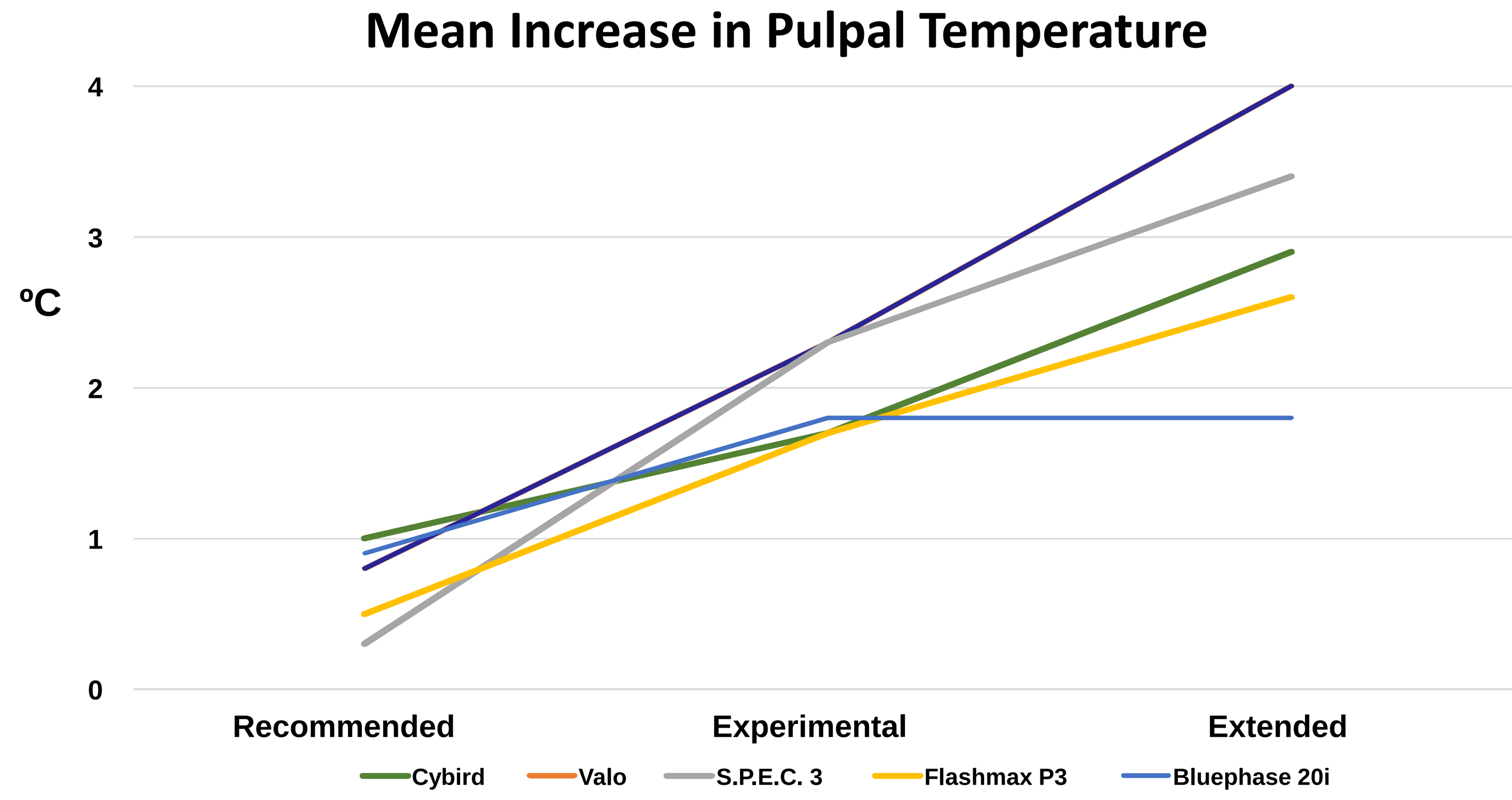

Figure 3: Graphical Display of Mean Increase in Pulpal Temperature

CONCLUSIONS

None of the high-intensity light-curing units adequately polymerized the composite resin at the manufacturer-recommended minimum exposure times of one or three seconds. The exposure times necessary to adequately polymerize a 2mm increment of composite resin resulted in a maximum pulpal temperature increase of 2.3°C – well below the temperature increase of 5.5°C associated with possible pulpal necrosis.