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www.dentaladvisor.com

THE DENTAL ADVISOR
3110 West Liberty
Ann Arbor, MI 48103
Toll free: 800.347.1330
E-mail: info@dentaladvisor.com
www.dentaladvisor.com

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TRANSLATING THE SCIENCE

High-intensity LED Light-curing Units - The Heat They Produce

Ron Yapp, M.S., John M. Powers, Ph.D.
THE DENTAL ADVISOR Biomaterials Research Center
Dental Consultants, Inc., Ann Arbor, Michigan

A primary goal for improvement of LED light-curing units has been to increase the light intensity - the thought being, the higher the intensity, the more rapid and more thorough the cure. Unfortunately, heat generation is a typical consequence of higher light intensity. The amount of heat that develops when light interacts with tooth tissue, resin composite or soft tissues is dependent on: the intensity of the light, how much of the light is reflected or absorbed by the particular material, and how fast the heat is conducted away.

A recent survey of 160 Clinical Consultants of THE DENTAL ADVISOR indicated three of their principal concerns about the high-intensity light-curing units coming into the marketplace were:

1. **Is there a risk of damaging the pulp with a high-intensity light?**
2. **How much does the temperature of the composite restoration increase during light curing?**
3. **Can a patient's oral soft tissues be burned with the tip of the light?**

To answer these concerns, THE DENTAL ADVISOR conducted experiments using several high-intensity (1000-1600 mW/cm²) and ultra-high-intensity (4000-5000 mW/cm²) lights (see table) to determine the increase in temperature of the dental pulp and composite restoration during a typical curing cycle and the temperature increase of soft tissue in direct contact with the tip of the curing lights.

Temperature increase of the dental pulp ranged from 0.0 to 1.2 °C, with many of the light-curing units showing no increase in pulp temperature. This insignificant temperature rise can be explained by the fact that the time the light was on was short enough that the insulating qualities of the tissues and composite restoration protected the pulp. Therefore, following the recommended curing times should protect the pulp tissue from excessive heating.

Temperature increase of the composite restoration was higher, ranging from 8 to 27 °C for a single curing cycle of the light. There are times, however, when a clinician will use three curing cycles in succession to ensure thorough curing. When three cycles were simulated in our experiment, temperature increases were as high as 40 °C. However, when each pulse was followed by a 6-8 second delay, the temperature increase was similar to that of a single curing cycle. A short delay in between pulses can, therefore, protect the restoration from increasing in temperature with each consecutive pulse.

Direct contact with soft tissue caused temperatures in the range of 42 to 58 °C. Intolerable pain is produced with a contact temperature of 50°C. Every one of the lights tested can produce a painful burning sensation if the light-curing tip is inadvertently placed in contact with the lip, tongue, cheek, or gingiva over the length of the curing cycle. Therefore, care must be taken to avoid direct contact with these tissues especially when consecutive pulses are used.

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Table. Average Temperature Increase (ΔT) in Restoration and Pulp Chamber and Maximum Temperature of Soft Tissue in Direct Contact with the Curing Tip						
LED Curing Light	**Manufacturer**	**Light Energy Intensity, [Light Intensity X Time]**	**Restoration Average ΔT, °C (Standard Illumination Period)**	**Restoration Average ΔT, °C (Three consecutive illuminations [1 second between each])**	**Average ΔT, °C in Pulp Chamber From 37°C**	**Average Maximum Temp., °C of Soft Tissue in Direct Contact with Light Tip**
Fusion (20 s, 9.5mm ø tip)	DentLight, Inc.	1500 X 20= 30000	27.2	38.9	1.2	57.2
The Cure (20 s, 8mm ø tip)	Spring Health Products	1200 X 20= 24000	18.3	23.3	0.8	52.8
Flashlite Magna (20 s, 11mm ø tip)	Discus Dental	1100 X 20= 22000	25.0	30.6	1.0	58.3
Demi (20 s, 7.2mm ø tip)	Kerr Corporation	1100 X 20= 22000	18.3	25.6	1.0	50.0
Coltolux (20 s, 8mm ø tip)	Coltene Whaledent	1000 X 20= 20000	9.4	9.4	0.0	48.9
Valo (Standard --20 s, 9mm ø tip)	Ultradent Products, Inc	1000 X 20= 20000	17.8	22.2	0.8	50.0
Celalux2 (20 s, 7mm ø tip)	VOCO	1000 X 20= 20000	12.2	10.8	1.1	46.2
starlight pro (20 s, 6.8mm ø tip)	mectron	1000 X 20= 20000	8.1	10.7	0.5	42.0
Fusion (10 s, 9.5mm ø tip)	DentLight, Inc.	1500 X 10=15000	20.6	26.1	0.6	51.1
Flashmax (3 s, 4mm ø tip)	CMS Dental	5000 X 3= 15000	9.4	14.4	0.0	56.1
Valo (Plasma--3 s, 9mm ø tip)	Ultradent Products, Inc	4500 X 3= 13500	17.8	21.1	0.1	53.3
The Cure (10 s, 8mm ø tip)	Spring Health Products	1200 X 10= 12000	11.1	17.2	0.0	42.2
Beyond CL 628 (10 s, 7.7mm ø tip)	Beyond Dental	1100 X 10= 11000	11.1	12.8	0.0	46.7
Flashlite Magna (10 s, 11mm ø tip)	Discus Dental	1100 X 10= 11000	17.8	22.2	0.0	46.7
Celalux2 (10 s, 7mm ø tip)	VOCO	1000 X 10= 10000	11.7	11.1	na	42.2
starlight pro (10 s, 6.8mm ø tip)	mectron	1000 X 10= 10000	7.6	10.1	0.1	42.3
Valo (High--4 s, 9mm ø tip)	Ultradent Products, Inc	1400 X 4= 5600	8.3	17.8	0.0	45.0
Acteon Mini 2 (5 s, 7.5mm ø tip)	Acteon Dental	1000 X 5= 5000	12.2	13.3	0.0	50.0

Clinicians may be concerned that the light produced by their curing light is too intense and is creating high temperatures. The intensity of the light is generally a function of the inverse of the distance to the lighted surface. So, for most lights, moving the light further from the subject decreases the resulting heat. However, some lights focus the light at a point away from the tip. For example, one of the lights tested (***Valo***, *Ultradent Products, Inc.*, Plasma mode) was hottest at a distance of about 2 mm from the tip. The best way to tell if you could produce pain in a patient's soft tissue is to experiment with the light on your fingertip.

In conclusion, all of the lights tested were safe when the manufacturer's instructions were followed.