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Editorial

Light Curing Explored in Halifax

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I do not remember a time during my dental career when direct resin restorations were not being disparaged by someone. Some of the expressed concerns have validity. Certainly the earlier composite resins offered little wear resistance or ability to predictably create a bonded interface. The chemical activation system used in early materials also limited the ability of a practitioner to form and sculpt restorations.

I remember being taught that the placement of a composite resin restoration should include the same level of care and attention to detail provided to direct gold restorations. I have held the opinion that many of the problems associated with composite resin restorations can be attributed to approaching their placement in a way that mimics the approach taken when placing amalgam, a material that is much more forgiving of less-than-optimal handling.

An important issue in the placement of light-activated composite resin is the amount and type of light energy that is actually being received by the material. Inadequate light curing can easily result in compromised restorative material properties, compromises that likely have a negative influence on restoration longevity. It has been well documented that, worldwide, many offices have been using inadequate amounts of energy and less-than-optimal technique and are delivering inadequate amounts of energy when light curing resins.[1-9] If that is the case, then it should be no surprise to anyone when reading reports about the substandard performance of posterior composite resin restorations.[10-13]

More than 40 key opinion leaders and company scientists met at Dalhousie University in May 2014 to discuss ways to address issues surrounding light curing. Arranged by Dr. Richard B. Price, the symposium participants included:

Bob Angelo, Ahmed Abuelyaman, Suham Alexander, Sibel Antonson, Steve Armstrong, Oliver Benz, Uwe Blunck, Ellen Bruzell, John Burgess, Peter Burtscher, Liang Chen, Ivo Correa, Matt Dailey, Colin Deacon, Omar El-Mowafy, Christopher Felix, Jack Ferracane, Reinhard Hickel, Thomas Hill, Neil Jessop, Hilde Kopperud, Daniel Labrie, Hui Lu, Bernhard Möginger, Lori Moilanen, John O'Keefe, Joe Oxman, Frank Pfefferkorn, Jeffrey Platt, Richard Price, Jean-François Roulet, Fred Rueggeberg, Janine Schweppe, Adrian Shortall, Jeffrey Stansbury, Howard Strassler, Byoung Suh, Andreas Utterodt, David Watts, and Stacy Wyatt.

The symposium received support and active participation from Benco, BISCO, BlueLight Analytics, DENTSPLY, Gigahertz-Optik, Henry Schein, Heraeus-Kulzer, Ivoclar Vivadent, Kerr, Patterson Dental, SDI, 3M-ESPE, and Ultradent.

The group adopted a glossary of terms that are based on the International System of Units (SI) definitions associated with light technology and is encouraging the use of them during communication on the subject (Table 1).[14] In addition, a consensus statement reflecting areas of agreement within the group was drafted and is included here as Figure 1.

Inadequate light curing can easily result in compromised restorative material properties. These compromises will likely have a negative influence on restoration longevity.

The included guidelines are provided for the benefit of your patients and are simultaneously being published here and in the following journals: *Journal of Adhesive Dentistry*, *Dental Materials*, and *Journal of the Canadian Dental Association*.

Table 1: *Glossary of Terms for Light Curing*[a]

Term	Unit Commonly Used in Dentistry	Symbol	Notes
Radiant energy	Joule	J	This describes the energy from the curing light.
Radiant exposure	Joule per square centimeter	J/cm^2	Also referred to as fluence and sometimes incorrectly as "energy density".
Radiant energy density	Joule per cubic centimeter	J/cm^3	This is the correct definition of "energy density".
Radiant flux or radiant power	Watt	W or J/s	Radiant energy per time unit.
Radiant exitance (excitance) or Radiant emittance	milliWatt per square centimeter	mW/cm^2	Radiant power/flux emitted from a surface (eg, a curing light). To be used instead of power density or irradiance when describing the output from a curing light.
Irradiance (incident irradiance)	milliWatt per square centimeter	mW/cm^2	Radiant power/flux incident on a surface. This is what the resin receives.
Spectral radiant power	milliWatt per nanometer	mW/nm	Radiant power per wavelength.
Spectral irradiance	milliWatt per square centimeter per nanometer	$mW/cm^2/nm$	Irradiance received by the resin at each nanometer.

Light Curing – Guidelines for Practitioners
A Consensus Statement from the 2014 Symposium on Light Curing in Dentistry held at Dalhousie University, Halifax, Canada*

When selecting a light curing unit (LCU):

- **Recognize that all lights are not created equal.** Use a LCU from a manufacturer who provides contact information, a user manual, and service. Preferably the LCU should have received a favorable report or certification from a reputable independent 3rd party.
- **Know** the key performance parameters of your LCU, when new:
  (i) the light output (averaged irradiance over the beam incident area in mW/cm^2 and spectral output from the LCU), (ii) whether the beam has a uniform and effective output (profile) across the light tip, and (iii) the diameter of the light beam.
- **Be cautious** when using high (above 1,500 to 2,000 mW/cm^2) output LCUs that advocate very short (e.g. 1 to 5 seconds) exposure times. When used for such short times, it is critical that the light tip is stabilized over the resin during exposure. Although some resin composites are matched to specific high output curing lights, high output LCUs may not adequately cure all of today's resin-composites to the anticipated depth when used for short exposure times. Seek peer-reviewed literature validating the efficacy and safety of such lights and materials.

Before you light cure, remember to:

- **Regularly monitor** and record the light output over time, with the same measurement device and light guide. Repair or replace the LCU when it no longer meets the manufacturer's specifications.
- **Inspect and clean** the LCU before use to ensure it is on the correct setting, in good working order, and free of defects and debris.
- **Consider that every resin-based material** has a minimum amount of energy that must be provided at the correct wavelengths to achieve satisfactory results. [Energy (Joules/cm^2) = output (W/cm^2) x exposure time (seconds)]. However, minimum irradiation times are also required.
- **Follow the recommended light exposure times and increment thickness recommended by the resin manufacturer,** making allowances if you use another manufacturer's light. Increase your curing times for increased distances and darker or opaque shades.
- **Select a LCU tip that** delivers a uniform light output across the light tip and that covers as much of the restoration as possible. Cure each surface independently, using overlapping exposures if the light tip is smaller than the restoration.
- **Position** the light tip as close as possible (without touching) and parallel to the surface of the resin composite being cured.
- **Stabilize and maintain** the tip of the LCU over the resin composite throughout the exposure.
- **Always use** the appropriate "blue blocking" glasses or shield to protect your eyes as you watch and control the position of the curing light.

Precautions:

- **Avoid** conditions that will reduce light delivery to the resin-composite, e.g.:
  - Holding the light tip several millimeters away.
  - Holding the light tip at an angle to the resin surface.
  - Dirty or damaged light-guide optics.
- **Supplementary light exposures** should be considered under circumstances that may limit ideal light access, such as shadows from matrix bands, intervening tooth structure, or from restorative material.
- **Beware of potential thermal damage** to the pulp and soft tissues when delivering high energy exposures or long exposure times.
- **Air-cool** the tooth when exposing for longer times, or when using high output LCUs.
- **Never shine** the LCU into the eyes, and avoid looking at the reflected light, except through an appropriate 'blue-blocking' filter.
- **Testing surface hardness** of the resin-composite in the tooth using a dental explorer provides NO information about adequacy of curing depth.

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