Curious Curing

How do you know if you’re getting the right output from your LCU?

Dental curing units, or light-curing units (LCUs), are essential in dental offices; they are used daily in restorative dentistry, orthodontics and hygiene to cure resin-based restoratives, luting materials and sealants. The clinical success of all these materials depends on the LCU delivering sufficient light to polymerize the resin—otherwise, incomplete polymerization will occur (Figs. 1a–1c, p. 52).

Continued on p. 52
Incomplete polymerization may result in clinical failures such as bracket debonding, increased postoperative sensitivity, bulk fracture of the restoration, secondary caries because of adhesive failure between the tooth and the resin composite, and color changes within the restoration (Figs. 2a–2c). Having to redo such failed dental work at no charge is a recipe for financial disaster.

Although light-emitting diodes (LEDs) have the potential to last for thousands of hours, they can be damaged rapidly if subjected to a high-current density in an attempt to deliver a high light output. This can cause overheating of the LED chip and yellowing of the epoxy around the LED (Figs. 3a–3b, p. 53), resulting in a reduced output of light.

Despite technological advances and the availability of LCUs that can provide a stable, high light output, most published studies show that LCUs used in offices around the world often deliver inadequate light. The dentists, however, were unaware that their lights weren’t able to adequately cure their restorations.²⁻⁹

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Figs. 1a–c: Examples of incomplete polymerization. The composite is hard at the occlusal surface but soft and inadequately cured at the bottom of the proximal box.

Figs. 2a–c: Examples of clinical failures, likely because of incomplete polymerization. Note the yellow color, the debonding at the margins and the fractured resin. (Images courtesy of Dr. A. Shortall and Dr. H. Strassler)
An LCU may deliver sufficient light output when new, but the light output will drop over time because the light source itself, as well as filters or reflectors within the unit, will deteriorate with use. Autoclaving the fiber-optic light probe can reduce the light output. Physical damage to the light tip and the presence of cured composite resin on the light tip are also common findings that will reduce the light output (Figs. 3a–3e). In addition, disinfectant sprays could erode the O-rings used to stabilize the light guide, and the residual fluid could be baked onto the optics inside the housing, thus reducing the light output.
Monitoring output

When using a curing light, it’s impossible for the clinician to visually evaluate the quantity and quality of the light output, and the top surface of the restoration will feel hard to the touch after light curing. The combination of the intense blue light and the hard resin at the surface of restorations can provide a false sense of security that the LCU is adequately polymerizing all of the restorative material.

Thus, in view of the vital role of LCUs and their susceptibility to deliver less light output over time, every dental office should regularly monitor the output from its LCUs for optimal patient care and for medical/legal reasons.

Limitations

The simplest and most dentist-friendly method for measuring LCU output in the office is a dental radiometer. Unfortunately, most previous studies have reported that dental radiometers cannot accurately or reliably measure irradiance from dental LCUs in mW/cm² (light output). In fact, most dental radiometers claim an accuracy of only ±20 percent, most likely because most dental radiometers have only a narrow aperture where the light enters into the meter. As a result, different areas of high or low irradiance values may be measured depending on the position of the light tip over the aperture into the meter. Thus, the values may not represent the irradiance across the whole light tip (Figs. 4a–b).

Additionally, in some instances, the emission spectrum from the curing light may extend beyond what dental radiometers can detect. For example, Ivoclar Vivadent’s Bluephase G2 and Bluephase Style deliver a wavelength of light from 385 nanometers to 515nm, and yet some dental radiometers don’t measure light below 400nm or above 500nm.

Bluephase Meter II

The Bluephase Meter II is a new dental radiometer that uses a large sensor. It can measure both the power in mWatts and, when the light-tip diameter is entered into the meter, it can also calculate the irradiance (Figs. 5a–b). The manufacturer claims that
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This new meter can measure the power output from a curing light with an accuracy of ±10 percent, provided that the light tip is between 5–13 mm in diameter.

In addition, the Bluephase Meter II can measure light from 385–550 nm and report the irradiance from 300–12,000 mW/cm². A recent study presented at the 2016 AADR meeting in Los Angeles reported that the meter met the manufacturer’s specifications and could accurately measure the power from seven different curing lights tested.

Conclusion

An easy to use dental radiometer that accurately reports the power (mW) and irradiance (mW/cm²) from their LCUs should result in more reliable curing and greater longevity of resin-based restorations. For medical/legal reasons alone, it’s recommended that dentists record the power output from their LCUs when new and keep a daily record. They can then respond appropriately to any decrease in light output from the LCU.

References