

Light curing

Inadequate light curing of composite resin can lead to less than optimal outcomes.

Background

The debate regarding composite resin's shorter than expected service life is ongoing. The properties of this restorative material seem to only have a minor effect on restoration longevity, and the major reasons for failure can be attributed to the patient and the skills of the operator. Inadequate light curing (photopolymerisation) of the resin is also an important contributing factor in less than optimal patient outcomes involving posterior resin composite restorations.¹

The concern for the general dental practitioner is in keeping up to date with changes in the chemistry of the resin composites, together with the advancements being made in light curing technology. Several factors affecting curing are under the clinician's control, and the following tips aim to inform the practitioner on those aspects that may interfere with light curing, and consequently affect restoration longevity.

1. Irradiance

Irradiance (also expressed in units of mW/cm^2) is the radiant power incident on a surface and describes what the resin receives. A 2mm increment of composite should receive $16,000\text{mW}/\text{cm}^2$ radiant exposure to be adequately polymerised, but energy quality (distance from resin and orientation of the tip) and material properties (opacity and shade) must be taken into account. For complete conversion, sufficient light must reach all extremes of the resin composite, both in terms of width and depth of the restoration. Therefore, the diameter of the light curing tip should be taken into consideration (Figure 1).

REMEMBER

- Know the following points relating to your light curing unit (LCU), when new:
 - the light intensity in mW/cm^2 ;
 - spectral output;
 - if the beam has a uniform output across the light tip; and,
 - the diameter of the light beam.
- Always consult the resin manufacturer's recommendation regarding radiation times, bearing in mind that these are often based on ideal

clinical situations and not taking into account limitations within the oral cavity that may result in collimation with distance and incorrect light orientation.

- Position the light tip as close as possible (without touching) and parallel to the surface of the resin composite being cured (Figure 2).
- Increase exposure time for darker composite shades.



FIGURE 1: The diameter of the light tip needs to be taken into account, particularly when curing a wide mesio-occlusal-distal (MOD) cavity with a bulkfill composite.

2. Exposure times

Some new LED LCUs with very high-power diodes recommend very short curing times; however, short exposure times may not allow the activation chemistry in the resin-based composite (RBC) to function efficiently, resulting in inadequate polymerisation. Increased radiant emittance values (particularly associated with the more recently developed high-powered LED LCUs) and increased exposure times can result in a temperature rise within the composite resin layer during resin polymerisation, as well as within the pulp chamber, increasing the risk of soft and pulpal tissue damage.²

REMEMBER

- Use external cooling from an airflow when exposing for longer times, or when using high-output LCUs.
- Do not sweep or move the LCU when photo-curing resin composite, e.g., when light curing multiple restorations stabilise and maintain the tip of the LCU over the resin composite throughout the exposure.

3. Spectral wavelength matching

In recent years there have been significant developments and changes to the photo-initiators used in composite resins. Different photo-initiators can have



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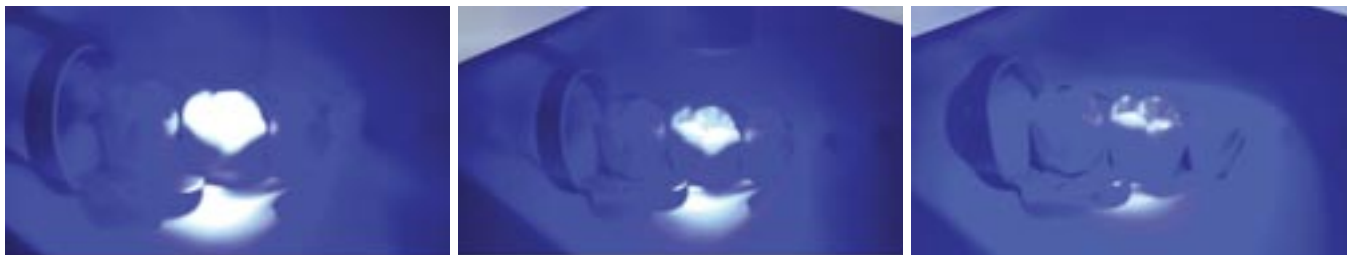


FIGURE 2: Light tip held at increasing distance from target. Note how the light intensity decreases with increasing distance, and how the area exposed to light increases with increasing distance.

different peak absorption spectra and different types of curing light emit light at different wavelengths.

REMEMBER

- Ensure that the wavelength of the light (check technical specifications) and the peak absorption of the photo-initiator (check resin manufacturer's instructions) are compatible. If not, consider purchasing a new, broader-spectrum LCU.

4. Depth of cure

- As light is transmitted through the material, the extent of light loss due to reflection, absorption and scattering can be significant, resulting in partially or evenly uncured RBC at the base of the restoration. The RBC closest to the light source polymerises and hardens first.
- In order to calculate the time needed to cure a 2mm increment of composite, use the formula below. If using a curing light with intensity of 1,000mW/cm²:

$$\text{Dose/intensity of the light} = \text{Maximum curing time} \\ 16,000/1,000 = 16 \text{ seconds}$$

REMEMBER

- Conventional dental composites should be placed in 2mm increments to allow sufficient light penetration and polymerisation.
- Supplementary light exposures are recommended in clinical situations that may limit ideal light access, e.g., matrix bands, intervening tooth structure, soft tissues.

5. Safety

The dental team can be exposed to harmful amounts of blue light on a daily basis when light curing, and it is important that they are aware of the potential retinal damage as a result of relatively short exposures. All LCU manufacturers supply and recommend the use of protective blue blocking orange filters to protect the eyes from the bright blue light.

REMEMBER

- Protect the eyes sufficiently when ensuring and maintaining the correct position of the light while curing throughout the working day.

6. Maintenance of LCUs

LCUs must be maintained to maximise performance. It is recommended to check the irradiance of your light at least every six months. A simple device



FIGURE 3: Bluephase Meter II for light irradiance monitoring.



FIGURE 4: Comparison of an old and new light tip.



FIGURE 5: Radiometer readings from the same light curing unit, but comparing the old and new tips illustrated in Figure 4. Significant drop in output can be seen.

from Ivoclar Vivadent called the Bluephase Meter II is readily available and considered sufficient (Figure 3).

REMEMBER

- Inspect and clean the LCU before use to ensure that it is on the correct setting, in good working order, and free of defects and debris (Figure 4).
- 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 (Figure 5).
- Always use protective polyethylene disposable sheath coverings to prevent cross-contamination and adherence of RBC materials and bonding agents to the end of the light tip.

References

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2. Gomes, M., DeVito-Moraes, A., Francci, C., Moraes, R., Pereira, T., Froes-Salgado, N., *et al.* Temperature increase at the light guide tip of 15 contemporary LED units and thermal variation at the pulpal floor of cavities: an infrared thermographic analysis. *Oper Dent* 2013; 38 (3): 324-333.