Effect of LED Curing Modes on Postoperative Sensitivity After Class II Resin Composite Restorations

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Purpose: The aim of this study was to compare postoperative sensitivity following placement of posterior composite restorations using the fast- or step-curing modes of an LED curing light.

Materials and Methods: Thirty patients participated, with each having two homologous contralateral posterior teeth with Class II carious lesions. One restoration was cured using the fast.curing mode of the LED curing light (Mini L.E.D), and the contralateral restoration cured using the step mode of the same curing light. The patients were contacted after 2 and 7 days postoperatively and asked about the presence or absence of sensitivity on a scale from 0 to 3. 0: no sensitivity, 1: slight sensitivity, 2: moderate sensitivity, and 3: severe sensitivity. If the patient experienced sensitivity at 7 days postoperatively, he/she was contacted again after 30 and 90 days.

Results: There was a statistically significant difference in postoperative sensitivity between the two curing modes at days 2 and 7 postoperatively ($p = 0.014$ and 0.046, respectively) but not at days 30 and 90 ($p = 0.317$ and 1.000, respectively). The intensity of sensitivity was also different between the two curing modes at days 2 and 7 postoperatively ($p = 0.007$ and 0.025, respectively) but not at days 30 and 90 ($p = 0.317$ and 1.000, respectively).

Conclusion: The step mode of the LED curing light reduced the incidence and severity of postoperative sensitivity following placement of posterior composite restorations compared to the fast mode of the same curing light.

Keywords: clinical trial, resin composites, LED curing lights.

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Postoperative sensitivity following resin-based posterior composite restorations remains a challenge to clinicians.[24,25,30] In most studies, the incidence of postoperative sensitivity was up to one-third of the study sample.[1,14,24,25,31] Postoperative sensitivity may result from induced mechanical stresses on tooth structure due to polymerization shrinkage of the resin composite.[3,9,10] Several compensatory mechanisms have been advocated to minimize the negative effects of polymerization shrinkage. The use of soft-start curing (initially curing the composite at low light intensity, followed by full light intensity) to permit greater flow and stress relief in the composite has been suggested.[7,15,23,27] Studies with soft-start polymerization showed improved marginal integrity of restorations.[17,19,21]

In addition to the conventional halogen-based light activation units, new devices for light-activated polymerization of resin composites have been introduced. These include light-emitting diode (LED), plasma arc, and laser. LEDs are becoming increasingly popular because they possess several advantages over halogen-based units, including: longer lifetimes, increased efficiency in converting electricity to light, lack of need for filters, and resistance to shock and vibration.[11,18,28,29] A higher degree of polymerization has been reported for resins cured using LEDs vs halogen-based units.[6,22]

In reviewing the literature, there appear to be no clinical studies conducted to test the effect of LED curing light modes on the performance of resin composite restorations. This study compared postoperative sensitivity following placement of resin composite restorations cured using the fast or step modes of an LED curing light.

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Table 1 Frequency (%) of tooth type and location

	Fast curing		Step curing		
	Molars	Premolars	Molars	Premolars	Total
Maxillary	9 (15.0)	12 (20.0)	9 (15.0)	12 (20.0)	42 (70.0)
Mandibular	7 (11.7)	2 (3.30)	7 (11.70)	2 (3.30)	18 (30.0)
Total	16 (26.7)	14 (23.3)	16 (26.7)	14 (23.3)	60

MATERIALS AND METHODS

Selection of Patients

Thirty adult patients attending the Health Science Center, Faculty of Dentistry, Kuwait University, with homologous contralateral posterior teeth with Class II carious lesions were selected for the study. The patients were free of orofacial pain, including toothache. Patients who were taking medications that could interfere with pain perception were also excluded from the study. Patients were over 18 years old, with a mean age of 37 ± 12 years (range 20 to 65 years). After patients were given a brief explanation of the investigation, they all signed a consent form approved by the Research Committee, Kuwait University, Faculty of Dentistry.

Selection of Teeth

The homologous contralateral teeth that were selected for the study were neither tender to percussion nor had any sign of loss of vitality. Teeth with old restorations were excluded from the study. Teeth selected for restoration were not sensitive to cold before the treatment. Of the 60 experimental teeth, 42 were in the maxilla, and molars accounted for 53.4% of the selected teeth (Table 1). Radiographically, each tooth had a Class II carious lesion located in the outer third of dentin. If maxillary teeth were selected, both right and left teeth were restored at the same visit. On the other hand, if mandibular teeth were selected, one tooth was restored at each visit.

Cavity Preparation

Following the administration of local anesthesia, the experimental teeth were isolated with rubber-dam throughout the operative procedure. Cavities were prepared with a high-speed handpiece using a #330 tungsten carbide bur, cooled with a water spray. Residual caries was removed with a round bur in a slow-speed handpiece. The buccolingual dimension of all cavities was less than half the intercuspal width and their gingival wall did not extend below the cementoenamel junction. For each patient, the depth and width of the two cavities were almost of the same size, as measured with a graduated periodontal probe. No bevels were placed on the cavosurface margins. The cavities were cleaned with a water spray from the triple syringe of the dental unit.

Restorative Procedures

The enamel and dentin walls of the prepared cavity were acid etched with 30% phosphoric acid, rinsed, and dried, leaving the dentin moist; then a dentin bonding agent (Opti-Bond Solo Plus, Kerr; Orange, CA, USA, batch #5-1026) was applied and cured. Resin composite restorations (Prodigy Condensable, Kerr, batch #419088, shade A2) were placed in 2-mm increments. Each increment was cured separately. The manufacturer's instructions were followed for each material.

Curing of the Restorations

One curing light unit (Mini L.E.D, Satelec, Merignac, Cedex, France) with a curing guide of 7.5-mm diameter was used through out the study. For each patient, the bonding agent and each increment of the restoration in one of the cavities was cured for 15 s using the fast-curing mode of the LED curing device (light intensity 1100 mW/cm^2). The contralateral homologous restoration was cured for 20 s using the step-curing mode (soft-start curing for 10 s from 0 to 1100 mW/cm^2 followed by 1100 mW/cm^2 for 10 s). After finishing and polishing, the restorations were checked for appropriate occlusion. The selection of the right and left teeth for the fast- or step-curing modes was random. All clinical work on all patients was done by one clinician.

Evaluation of Postoperative Sensitivity

Patients were contacted after 2 and 7 days postoperatively. They were asked about the presence or absence of postoperative sensitivity to cold. The patients were asked to specify the intensity of the pain on a scale from 0 to 3: 0 for no sensitivity, 1 for slight sensitivity, 2 for moderate sensitivity, and 3 for severe sensitivity. If a patient experienced sensitivity or discomfort 7 days after placement of the restoration, he or she was contacted after 30 days and 90 days to assess the degree of sensitivity at those intervals.

Statistical Analysis

After data collection, the results were entered into a personal computer and differences in reported postoperative sensitivity with respect to curing mode were analyzed using Friedman and Wilcoxon matched pairs rank sum tests at a significance level of $p < 0.05$, with SPSS Software, version 12 (SPSS; Chicago, IL, USA).

RESULTS

Figure 1 shows the frequencies and percentages of postoperative sensitivity according to curing mode at day 2 after restoration. More teeth had slight postoperative sensitivity among those bearing restorations cured with the fast-curing mode (n = 6, 20%) compared to those cured with the step-curing mode (n = 3, 10%). Only teeth in which the restorations were cured with the fast-curing mode showed moderate cold sensitivity (n = 3, 10%). Wilcoxon matched pairs rank test showed statistically significant differences in prevalence and intensity of postoperative sensitivity to cold between the two curing modes (p = 0.014 and 0.007, respectively).

Figure 2 shows positive postoperative sensitivity reports at day 7 after restoration. The range and degree of sensitivity revealed that the step-curing mode resulted in fewer sensitive teeth, with less severe sensitivity than the fast-curing mode (p = 0.046 and 0.025, respectively).

As shown in Fig 3, only one of the restorations cured with the fast-curing mode was associated with postoperative sensitivity to cold 30 days postoperatively. No teeth showed postoperative sensitivity to cold when the restorations were cured with the step-curing mode. There was no statistically significant difference between the two curing modes in prevalence or intensity of postoperative sensitivity at this time (p = 0.317).

There was no spontaneous pain from any of the restorations placed during the study. In addition, there was no postoperative sensitivity to cold 3 months postoperatively.

The percentages of teeth with no postoperative sensitivity at days 2, 7, and 30 were 70%, 83.3%, and 96.7%, respectively, for the fast-curing mode. On the same days, the percentages for the step-curing mode were 90%, 96.7%, and 100%, respectively.

The Friedman nonparametric test showed a statistically significant difference in the prevalence of postoperative sensitivity between days 2, 7, and 30 for the fast-curing mode (p = 0.003), but not for the step-curing mode (p = 0.097).

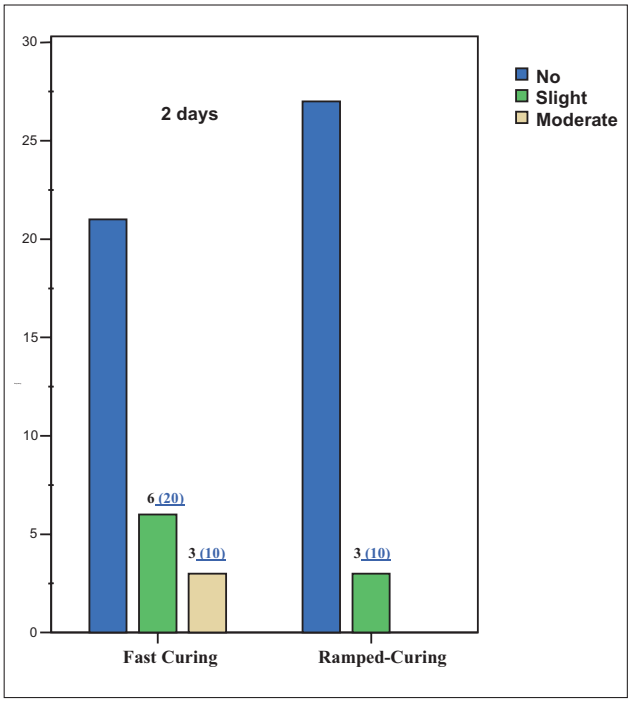

Fig 1 Frequency (%) of different degrees of severity of postoperative sensitivity after 2 days.

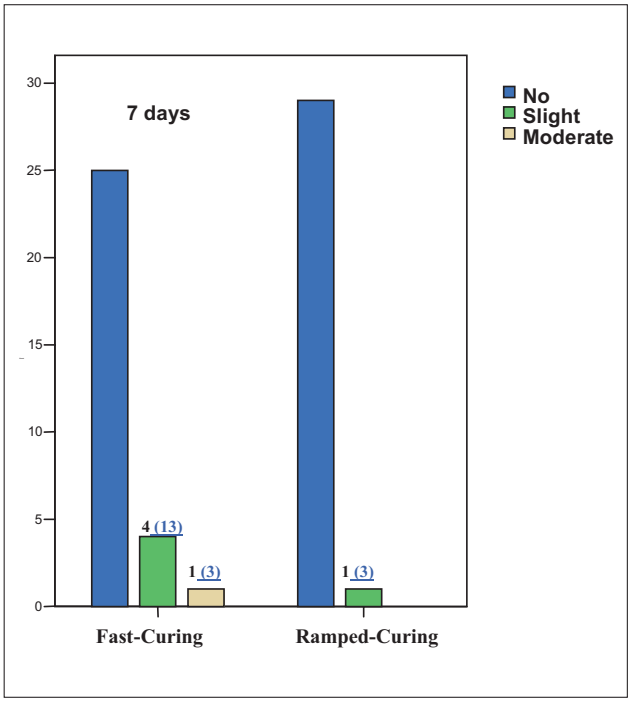

Fig 2 Frequency (%) of different degrees of severity of postoperative sensitivity at 7 days.

DISCUSSION

Class II carious lesions located in the outer third of dentin were selected in this study. Deeper cavities were excluded to eliminate the need for liners or bases which could affect standardization of the study. Exclusion of deep cavities also minimized the confounding effect of preoperative pulp disease on the prevalence and severity of postoperative sensitivity. All cavities were restored using the same adhesive and resin composite restorative material. To reduce the variability among clinicians in handling and manipulating materials, all clinical work was carried out by one clinician.

The variability in the response to pain among patients was eliminated in this study by using homologous contralateral posterior teeth; therefore, each patient acted as his own control. Previous clinical studies that assessed postoperative sensitivity from posterior composite restorations used sample sizes of about 20 to 40.[2,14,27] In the present study, 30 subjects were included. The power of the test was approximately 75%, which is acceptable for this kind of study.

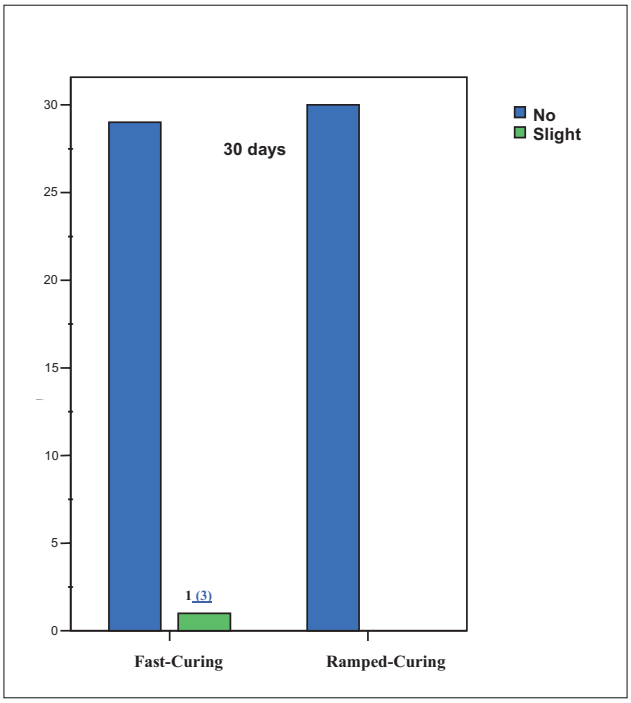

Fig 3 Frequency (%) of different degrees of severity of postoperative sensitivity at 30 days.

Polymerization shrinkage forces results in deformation of the restoration and tooth structure, and this transmits hydraulic pressure to the odontoblastic processes to cause pain.[3] Soft-start curing has been found in laboratory studies to partially relieve shrinkage stresses and decrease tooth deformation.[4,20,28] Furthermore, soft-start polymerization resulted in reduced microleakage.[21] In this study, step curing resulted in less postoperative sensitivity than fast curing; this may be due to the fact that step curing allowed more time for the resin composite to flow, and therefore resulted in decreased stresses on the tooth from polymerization shrinkage and reduced microleakage.

The reported incidence of postoperative sensitivity following posterior composite restorations varies in the literature. For Class I restorations, it ranges from 10% to 20%, while it was 2% to 40% for Class II restorations.[14,24,25] In this study, the incidence of postoperative sensitivity was 30% among the restorations cured with the fast-curing mode and 10% among the teeth cured with the step-curing mode at 2 days postoperatively. Variation in the results between studies might be due to differences in cavity size, number of clinicians, or restorative materials and techniques followed. In the present study, the number of confounding variables was reduced by having one clinician perform all of the clinical work and by using the same restorative materials throughout the study.

The pain assessment method followed in this study was conducted in accordance with similar studies in the literature.[14,24,25,27] Another method to assess sensitivity involves visual analogue scales, with or without a stimulus.[2,8] Fixed categories of pain were chosen for this investigation, because our pilot study established it as an easier method of communication with the patients from many nations attending the Kuwait dental health center, who also have low level of education. Furthermore, more cooperation from the patients was expected if phone calls rather than recall visits were requested from the patients.

LED curing lights can achieve degree of conversion ratios, hardness, and bond strength values similar to those achieved using conventional halogen-based curing lights.[4,5,13,29,32] Although the curing time was different between the two curing modes used in this study, the total energy delivered was the same (16.5 J/cm^2). The method of delivering the energy to the restoration was different. Step curing delivers low levels of energy initially, allowing the resin composite to flow and release the stresses of polymerization shrinkage, preserving marginal integrity and reducing microleakage.[12,16,23,26,28]

This study was carried out in ideal clinical conditions, under rubber-dam isolation. Other limitations of the study were the number of patients participating and the strictly followed protocol for selection of patients and teeth. Further studies using different materials, a larger number of patients, and different types of cavities are needed.

CONCLUSIONS

This clinical study showed that postoperative sensitivity, as a short-term determinant of clinical success of posterior composite restorations, can be reduced by using step-curing mode of LED curing lights. However, it also showed that postoperative sensitivity is a temporary problem, and in most cases resolves spontaneously within a month of placing the restoration.

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Clinical relevance: Using the step-curing mode of an LED curing light to cure posterior composite restorations decreased the incidence and severity of postoperative sensitivity.