# The Occurrence of Postoperative Tooth Sensitivity after Application Of Pulse-Lighting Curing Units in Different Time

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**Abstract**

Restorative procedures may lead to tooth postoperative sensitivity. The objective of this study was to observe postoperative tooth sensitivity in dental patients after application of light curing units.

The clinical trial included 90 subjects with occlusal Class I carious lesions. Subjects were given a resin composite restoration and assigned into 3 groups based on the chosen light-curing unit: (i) a pulse lighting curing unit of 1,000 mW/cm2 in 10 sec, (ii) a pulse lighting curing unit of 1,000 mW/cm2 in 20 sec, and (iii) a single light exposure from a continuous lighting curing unit of 900 mW/cm2 in 20 sec, as a comparison. After light curing, weasked the subjects using a questionaire containing 6 questions of tooth sensitivity at time points, i.e., at the time ofthe light exposure; right after light exposure; 15, 30, 45 and 60 minutes after light exposures. The assessment was based on the four-level sensitivity of none (score=1), slight (score=2), moderate (score=3) and severe (score=4). Reply of each patient on the presence or absence of the sensitivity was recorded as a postoperative tooth sensitivity score providing the total score is 6 (minimum) to 24 (maximum).

Results showed that 87.8% of subjects reported post operative tooth sensitivity score of 6; 8.9% and 3.3% of the subjects showed light sensitivity (scores 7 and 8, respectively), however, the sensitivity faded away within 15 minutes. The application of the experimental curing units observed insignificant difference intooth sensitivity when using the pulse lighting at 1,000 mW/cm$^2$ in 10 or 20 sec, and also when those were compared to the commercially available continuous lighting at 900 mW/cm$^2$in 20 sec.

**Clinical article (J Int Dent Med Res 2019; 12(3): 1079-1083)**

**Keywords:** Lighting mode, Curing unit, Postoperative tooth sensitivity, Questionnaire.

**Received date: 11 February 2019** **Accept date: 19 March 2019**

## Introduction

The dramatic rise in use of composite resin materials and the introduction of LED-LCUs for tooth restoration have revolutionized dentistry. Their main advantage has been eased of handling. Specifically, their use has allowed dentists to approach treatments without manually mixing the materials for chemical curing (polymerization).[1-6] The third-generation LCU-LEDs with continuous-lighting was recently marketed as characterized with high irradiance technologythat reachmore than 3,000 mW/cm$^2$, which allows reducing the lighting exposure time.[7-8] As the consequence, these LED-LCUs have been associated with high heat generation. High heat from an LED LCUs following polymerization of resin composite restorations may cause changes to the dental pulp.[9-11]

During our previous study, an experimental LED-LCU curing unit constructed by an “on and off” system to regulate the emitting light as a pulse was constructed with an irradiance of 1,000 mW/cm$^2$ for 20 sec and associated with an output light temperature of 37±1°C. This temperature was significantly lower than the one from the commercially available curing unit with continuous lighting and the same duration.[12]The study also demonstrated that cell viability had adequate values when using either irradiance level. However, higher cell viability occurred when using the experimental pulse-lighting with an irradiance of 1,000 mW/cm$^2$ vs the commercially of 900 mW/cm$^2$ in 20 sec.[13]

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Additionally, a similar experimental pulse-lighting curing unit was prepared with light exposure for 10 sec. However, the experimental pulse-lighting curing units with the irradiances of 1,000 mW/cm$^2$ for both 10 and 20 sec have not been analyzed for postoperative sensitivity following restoring resin composites.

The 4-level pain sensitivity scale has been used to observe postoperative pulp sensitivity. For clinical trials, the ordinal categories of 4 levels sensitivity scale appears fordental patients not to have trouble following. Some previous study has compared postoperative sensitivity following placement of posterior composite restorations by means of fast- or step-curing modes of an LED curing light. There was a statistically significant difference in postoperative sensitivity between the two curing modes up to days 7 postoperatively.[10, 11]

As with any new technology, the possible heat generation capacity should be evaluated to prevent potential side effects in patients. The present study used an experimental a curing unitwithpulse-lighting and an irradiance of 1,000 mW/cm$^2$ for either 10 or 20 sec that have not been in a clinical trial. Besides, to evaluate postoperative tooth sensitivity, the 4-level ordinal categories are considered adequately valid and reliable. Therefore, we aimed at observing postoperative tooth sensitivity in dental patients followingplacement of resin composites restoration cured by the experimental light curing unit with an irradiance of 1,000 mW/cm2 in 10 and 20 sec and compared to the commercially available continuous lighting of 900 mW/cm2 in 20 sec.

## Materials and methods

### Preparation of a Curing Unit

In the present study, we used the experimental pulse-lighting LED-LCU, with an irradiance of 1,000 mW/cm$^2$ for 10 and 20 sec, which was the same as in the previous study.[12,13] As a comparison to the pulse lighting, the continuous lighting of a commercially available curing unit (Elipar 3M ESPE, St. Paul, MN, USA) with an irradiance of 900 mW/cm$^2$operatedonly in 20 sec was employed. The output light irradiance was checked following each application on patient with room temperature maintained at 23±1ºC.

### Selection of Subjects

Ethical approval was granted by the Ethical Committee, Faculty of Dentistry, Universitas Indonesia. In a private clinic in South Tangerang, Indonesia, a clinician operator announced the opportunity for patients to enroll in the clinical trial. Patients were recruited from a general population searching for dental treatment who were being evaluated by dental operators at the clinical sites. Notification of the clinical trial participation was written as a description to potentially advise subjects.

The inclusion criteria were as follows: 25 to 40 years old; presence of caries lesions diagnosed as irritation of the pulpae and requiring class I restoration; willing to comply with all study requirements based on the site operator's instructions; and capable of signing a written informed consent form in order to participate in the study.

The exclusion criteria were as follows: enrollment in any other clinical study; Deep Class I cavity; teeth sensitivity to airflow, as in recession gingiva and attrition tooth; history of allergic reactions to resin composites and bonding agents; treatment with analgesics taken 12 hr prior to the tooth sensitivity measurement; or alcoholism.

### Subjects' preparation and procedures

The design of the study was a randomized, single-blind clinical trial. Each patient (prospective subject) was given an informed consent form containing a detailed explanation in a room of the clinic and they signed the consent form. A total of ninety subjects of male and femalewere included. Subjects were not informed about the light curing unit used, to eliminate the possibility of bias (single blind design). In addition, technical factors including class I cavity, the diamond burs and operative technique were standardized in all patients. After preparing a Class 1 cavity in a molar tooth in each subject, a resin composite material (Filtek™ Z350XT, 3M ESPE, USA) was restored into a cavity and subsequently cured using the curing units. Subjects were randomly assigned into 3 study groups based on the type of LCU used for resin curing and duration of light exposure: 1. a single light exposure from a pulse-lighting curing unit with an irradiation of 1,000 mW/cm$^2$ in 10 sec; 2. a single light exposure from a pulse-lighting curing unit with an

irradiation of 1,000 mW/cm2 in 20 sec; and 3. a single light exposure from a commercially available continuous-lighting curing unit that has only an irradiation of 900 mW/cm2 and operated only in 20 sec, as a comparison to the pulse-lighting curing unit. To reduce the variability among clinicians in manipulating materials, as well as, in handling light exposure, each work was carried out by one clinician.

### Assessment of postoperative tooth sensitivity

In addition to comparing the proportion of postoperative tooth sensitivity by light curing method, postoperative tooth sensitivitywere compared by genders. Data collection was through clinical observance of the subjects' replies.

The assessment was conducted using a custom prepared questionaire. The questionnaire contained 6 questions asking whether there was sensitivity in tooth based onthe 4-level - sensitivity, as "No Senstivity" (none, score=1);"Slight Senstivity" (no need for treatment, score=2);"Moderate Senstivity" (relieved by analgesics, score=3) and "Severe Senstivity" (occuredwith swelling that is not relieved by simple analgesics and requiring an unscheduled visit, score=4). Each patient's reply was recorded at different time points based on Question-1: at the time of light exposure; Question-2: right after the light exposure; Question-3: 15 min after light exposure; Question-4: 30 min after light exposure; Question-5: 45 min after light exposure; Question-6: 60 min after light exposure. The subjects were informed to call the clinician or visit the clinique whenever he/she experinces tooth sensitiviy beyond 60 min after the last question. Questions 1 and 2 were carried out chair side, wheras, quesionts 3 to 6 through phone calls. The six-question survey asked patientwas scored with postoperative tooth sensitivity by recording replies that the total score finally would be from 6 to 24, for no postoperative tooth sensitivy and greatest postoperative tooth sensitivy, respectively.

### Statistical Analysis

The Kolmogorov-Smirnov test with a confidence level of 95% was used to analyze the postoperative tooth sensitivity data. The proportion of postoperative tooth sensitivity was examined by light curing mode and genders. The number of postoperative tooth sensitivity was compared between these groups using the KruskalWalis test. A p-value<0.05 was considered as statistically significant.

## Results

The baseline demographic characteristics of enrolled subjectsaged 25-40 years old showed that among 90 subjects,30 were males (22.3%) and sixty were females (66.7%). Our results show thatthe subjects experiencing postoperative tooth sensitivity following placing resin composite restorations and polymerized using the pulse-and continuous-lighting curing units are in Table 1.

As seen in Table 1, 79 subjects were scored 6 (no sensitivity), as they did not experience postoperative tooth sensitivity; whereas only 8 subjects were scored 7 (slight sensitivity) and 3 subjects were scored 8 (moderate sensitivity), both indicating postoperative tooth sensitivity that gradually disappeared within 10sec period. No further postoperative tooth sensitivity occured among subjects with scores 7 and 8. With respect to the lighting modes of the curing units (Table 1), subjects with score 6 were those who underwent the pulse-lighting in10 sec (28 subjects) and in 20 sec (28 subjects), and the continuous-lighting in 20 sec (24 subjects).Statistical analysis of differences in the postoperative tooth sensitivity score among 3 groups showed insignificant difference (p=0.077).

| Lighting mode of the curing units | Irradiance ($mW/cm^2$) | Lighting duration (sec) | Total Subjects with postoperative tooth sensitivity | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Score 6 | | Score 7 | | Score 8 | |
| | | | M | F | M | F | M | F |
| Pulse-lighting | 1,000±0 | 10 | 8 | 20 | 1 | 1 | 0 | 0 |
| | | 20 | 9 | 19 | 1 | 0 | 0 | 1 |
| Continuous-lighting (comparison) | 900±0 | 20 | 8 | 15 | 2 | 3 | 1 | 1 |
| Total | | | 79 | | 8 | | 3 | |

*M=Male; F-Female

**Table 1.** Postoperative tooth sensitivity in subjects following placement of composite resin restoration and cured using the pulse- and continuous-lighting curing units.

Specifically, among the scored-6subjects who underwentthe pulse lighting in 10 sec (28

subjects), 8 were males and 20 were females. The number were near to the other 28 subjects who were giventhe same lighting mode but in 20 sec, i.e., 9 were males and 19 were females. The data were also close to the 23 subjects applied with the continuous lighting, 8 and 15 subjects of malesand females, resectively. No significant differences (p=0,298) in the proportion of the postoperative tooth sensitivity were noted between the 3 groups comparing males and females.

## Discussion

Postoperative tooth sensitivity has been one of possible clinical concern of the high irradiance of LED light curing unit that influence on postoperative tooth sensitivity from the heat generated during the light exposure process, especially when high irradiances is used. However, we found only a small number of subjects reported postoperative tooth sensitivity (scored 7 and 8); most subjects in this study did not experience postoperative tooth sensitivity (scored 6)when applied with each mode of the curing units. Also, there was no difference in postoperative tooth sensitivy between males and females. As all incidence from our study were low and brief that gradually decreased with time and did not need any analgesic or intervention, the postoperative tooth sensitivity was predominantly considered as low level.

A few clinical trials were carried out to study the effect of lighting mode regimes, particularly when using the pulse lightingmode. Alomari Q *et al*., 2007 observed a postoperative sensitivity after the placement of posterior composite restorations but the incidence and severity of postoperative sensitivity could be reduced using the step and fast lighting mode of LED curing units.[10] In contrast to our results,.Our results was in concomitantwith another studywhichcompare the postoperative sensitivity in Class V composite restorations using soft start and constant lighting mode of LED curing units; it showed that restorations placed with both curing modes did not show significant changes in postoperative sensitivity when compared to the constant curing technique.[11]

We found contrast results to what we expected. Withrespect to clinical conditions, we believe that the present study was carried out in an ideal situation. The instrumentation techniques on the incidence of postoperative sensitivity were performed optimally.This was also supported by the clinicianthat the technical aspects in our studywere controlled by the same pre-operative diagnoses and the restorations were with the same procedure and resin composite. The reason for the insignificant result was likely to be, most of all, that the carious lesions selected for this study wereshallow cavitiesof occlusal surfaces prepared Class I. Shallow cavities consequently remained thick dentin.

Contrary to what we expected, remaining dentin thickness could have reduced heat transmission mechanism of the light curing units that further influenced the postoperative tooth sensitivity. With respect to the lighting mode, thepulse-lighting creates heat only when the pulse was “on,” and no heat is created when the pulse was “off,” leading decreased heat while the light still glows due to the solid-state behavior of gallium nitrate of the LED; whereas, the continuous-lighting unit produces light throughout the duration. Regarding the curing time, the pulse-lighting mode at an irradiance 1,000 mW/cm$^2$ in 10 sec produce energy density (light irradiance × exposure time)leading lowered heat than that created by the same lighting mode and irradiance but in 20 sec. Nevertheless, all heat probably have been further reduced by thermal conductivity and diffusivity of the remaining thick dentinthat likelyto suppressed the peripheral sensitizationin developing postoperative tooth sensitivity, all subjects, including themales and females.

The insignificant results of our study should be considered. In fact, remaining dentin thickness should be kept in mind to avoid their possible influence on temperature that could cause postoperative tooth sensitivity.In contrast, when restoring deep cavities, the potential risk of thermal transmission through a thinner remainingdentinmay be greater to raise the pulp chamber temperatureduring light curing. Therefore, further clinical trialin observing postoperative tooth sensitivity due to pulse and continuous lighting curing units should be conducted inpatients with deep tooth cavities.

## Conclusions

The experimental pulse-lighting curing unit with an irradiance of 1,000 mW/cm$^2$in either

10 or 20 sec used to polymerize resin composite restorations observed to have low incidenceand postoperative tooth sensitivity which were similar when applying with the continuous-lighting curing unit.

## Declaration of Interest

The authors report no conflict of interest. This study was supported by the research grant from the Ministry of Research-Technology and Higher Education, Indonesia. The authors acknowledge Ratna Dental Clinic in Pamulang, Indonesia, to conduct the clinical trial. Our thanks go to Bernard and Mutawali of the Faculty of Dentistry, Universitas Indonesia, in helping the observation and the curing unit maintenance. All authors have made substantive contribution to this study and/or manuscript, and all have reviewed the final paper prior to its submission.

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