Chapter 7 Effect of Glass-Ionomer Cement Lining on Postoperative Sensitivity in Posterior Teeth Restored with Resin Composite—A Randomized Clinical Trial

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Clinical Relevance

Glass-ionomer lining showed no benefit in reducing postoperative sensitivity associated with posterior resin composite restorations. Use of self-etching adhesive demonstrated postoperative sensitivity similar to that of total-etching adhesive.

SUMMARY

The purpose of this study was to investigate the ability of a resin-modified, glass-ionomer cement lining to reduce postoperative sensitivity in teeth restored with resin composite. In addition, the effects of a total-etching adhesive and a self-etching adhesive on postoperative sensitivity were also compared. Patients who had moderate to deep occlusal caries of at least one molar were recruited and assessed for eligibility using standardized criteria. Overall, 106 restorations were placed in 72 participants, with an average age of 22.8 ± 3.8 years. Two patients (3 restorations) dropped out and were excluded before data analysis. Preoperatively, each tooth was evaluated for cold-stimulated tooth sensitivity using a visual analog scale. If present, tooth sensitivity induced by a cold/hot drink or occlusal function was also noted. Caries was stained with a caries detector dye and then removed using slow-speed burs and hand excavators. The cavity was restored with one of four randomly allocated restorative procedures: (1) bonded with a two-step, total-etching adhesive (Single Bond 2); (2) lined with a resin-modified glass-ionomer cement (GIC) liner (Fuji Lining LC), and then bonded with the total-etching adhesive; (3) bonded with a two-step, self-etching adhesive (Clearfil SE Bond); and (4) lined with GIC, and then bonded with the self-etching adhesive. Cavities were incrementally filled with a nano-filled, hybrid resin composite. At recall, postoperative sensitivity was evaluated at 1 week and 1 month.
Overall, postoperative sensitivity in daily function was rare. No significant difference in the postoperative sensitivity, either in daily function or in response to a cold stimulus, was observed between the restorative procedures with or without the GIC liner, regardless of the adhesive used ($P > 0.05$). No difference in postoperative sensitivity was noted between use of self-etching adhesive and total-etching adhesive.
INTRODUCTION

When light-cured resin composite was first introduced, its use was limited to direct restoration of anterior teeth. Since then, resin composite has been continuously developed and can be used in both anterior and posterior restorations. The cavity preparation required for resin composite restorations is relatively conservative, and the restoration can bond to tooth substrate when used with a dental adhesive. However, resin composite still has limitations and disadvantages especially when restoring posterior teeth.\(^1\) In particular, shrinkage stress created during polymerization is a major concern. Polymerization shrinkage stresses negatively affect the bond between the restoration and the cavity walls. Consequently, gap formation, leakage and cuspal deflection may occur.\(^1, 2\) Clinical studies have reported that postoperative sensitivity is occasionally observed after resin composite restoration and is more frequently detected in restorations in deep cavities.\(^3, 4\)

Some approaches have been proposed to eliminate or reduce postoperative sensitivity. In a cavity with a remaining dentin thickness of less than approximately 1.5 mm, a liner/base should be applied to protect the pulp.\(^5\) It has been suggested that postoperative sensitivity may be reduced by application of a lining material such as glass-ionomer cement (GIC). Using a self-etching primer adhesive as an alternative to a total-etching adhesive has been also recommended.\(^6\) Conversely, some clinicians believe that lining application is not an important factor in reducing postoperative sensitivity even when the remaining dentin thickness is minimal.\(^3\) Remaining dentin of 0.5-1.0 mm thickness might be enough to protect the pulp from toxic irritants.\(^7\)
Furthermore, it is believed that a hybrid layer, which is a resin-impregnated collagen fiber network, is an effective protective barrier although the thickness of this layer is only a few micrometers.\(^8\)

Unemori and co-workers\(^3\) studied postoperative sensitivity after resin composite restorations were placed by undergraduate students. They concluded that liner protection with GIC did not reduce postoperative sensitivity. However, the operators were inexperienced and not calibrated in this retrospective study, and data were pooled from both anterior and posterior restorations. In contrast, a decrease in the prevalence of postoperative sensitivity when a GIC lining was applied has been reported in a clinical trial of posterior resin composite restorations.\(^9\) Thus, the ability of GIC lining to reduce postoperative sensitivity associated with resin composite restorations is unclear.

The purpose of this randomized controlled clinical trial was to investigate the ability of a GIC lining to reduce postoperative sensitivity after occlusal resin composite restoration placement. In addition, effects of a total-etching adhesive and a self-etching adhesive on postoperative sensitivity were also compared. The null hypothesis was there is no significant difference in postoperative sensitivity between teeth restored with and without GIC lining, regardless of the type of adhesive used.
METHODS AND MATERIALS

This randomized controlled clinical trial was conducted following the Consolidated Standards of Reporting Trials (CONSORT) Statement\textsuperscript{10,11} and the Recommendations for Conducting Controlled Clinical Studies of Dental Restorative Materials,\textsuperscript{12} in the Postgraduate Clinic of the Department of Operative Dentistry, the Faculty of Dentistry, Mahidol University, Thailand. The project was approved by the Ethics in Human Research Committee of the University of Melbourne, Australia (ethics ID 0607777) and the committee of Mahidol University, Thailand (ethics ID- MU 2007-109).

Recruitment of participants and sample size

Patients aged between 18-40 years old who had occlusal caries in molars were screened from the waiting list of the department. Each patient was examined and assessed for eligibility by one researcher (DB). Participants who had at least one moderate to deep occlusal caries lesion in a first or second maxillary/mandibular molar were recruited. Before inclusion, each participant was informed of the nature of the study, and consent was obtained.

The sample size was calculated using Minitab\textsuperscript{14} statistical software (Minitab Inc., State College, PA, USA). The calculated minimum sample size of each group was 13 restorations, following these input conditions: power 0.9; level of significance 0.05;
estimated standard deviation, calculated from the data of Casselli and Martins (2006)\textsuperscript{4} and the result of our pilot study, is 13 on a visual analog scale; and the difference in clinical significance\textsuperscript{13} is 20 on a visual analog scale. To compensate for drop-out of participants during follow-up, the sample size was increased to 25 restorations per group.

### Inclusion and exclusion criteria

Inclusion and exclusion criteria are listed in Table 7-1. Participants were not enrolled in the clinical trial if any medical problems were present. Moreover, patients who were unwilling to return for follow-up were not admitted into the study. The criteria for the investigated tooth are also described in the table. Additionally, if cavity depth after caries removal was less than 2 mm, the tooth was excluded. In case of a pulp exposure or near pulp exposure in which calcium hydroxide application was indicated, the tooth was also excluded.

### Preoperative records

Patients’ general information, such as gender and age, were recorded. To maintain privacy and confidentiality, a serial number was used to replace each patient’s name. Medical and dental histories were taken. The investigated tooth and supporting periodontal tissues were thoroughly examined. Existence of opposing tooth/teeth and occlusal function were confirmed. Preoperative radiographic examination using bite-wing radiographs was routinely taken to rule out proximal caries.
Under isolation from the adjacent teeth with gauze, the investigated tooth was tested with a 5-mm diameter ice stick applied to the buccal surface for 20 s or until the patient sensed the stimulus. Tooth sensitivity to the cold stimulation was recorded on a visual analog scale (score 0-100), and the response time in seconds was also recorded. Prolonged tooth sensitivity after removal of the stimulus was noted, if present. If there was any tooth sensitivity on a daily basis to any stimuli (occlusal function, cold/hot water or sweet) the tooth sensitivity was recorded using the same scale.

The original visual analog scale is a ten-centimetre line which is labelled at each end; the label at the beginning is “no pain at all” whereas that at the other end is “worst pain ever”. ¹⁴ To make it easier to understand, a modified VAS was used in this study (Figure 7-1); an illustration of facial expressions with the colour codes in response to the levels of pain was incorporated with the line. Each participant was requested to mark the level of tooth sensitivity on the line, and then the marked point was measured in millimetres, which ranged from 0 to 100 mm.

In this time-series study, the marked scale of preoperative or previous measurement was shown to the participant before making a new mark for the following measurement. It is likely to reduce the patient’s perception error by reminding patients where the point was previously marked as the level of previous tooth sensitivity. ¹⁴
Caries removal and cavity preparation

If requested, a local anaesthetic - 1.5-1.8 ml of Mepivacaine hydrochloride 2%, with epinephrine 1:100,000 (Scandonest 2% special, Septodont, Saint-Maur-des-Fosses Cedex, France) was administered to control tooth pain/sensitivity during caries removal. The field of operation was isolated with application of a rubber dam if moisture control was difficult to achieve. Otherwise, placing gauze/cotton rolls and using a saliva ejector with high power evacuation were employed for moisture control.

Caries was removed using a minimal intervention technique. To gain visible access, entrance to the lesion was initially gained using a round or a fissure high-speed diamond bur (Intensiv SA, Grancia, Switzerland) under air-water coolant. Next, dentin caries at the pulpal floor and surrounding walls was stained with a caries detector dye (Caries Detector, Kuraray Medical Inc., Okayama, Japan) for 10 s. Dye-stained areas were removed using slow-speed round steel burs (similar sizes to the caries lesions) (Emil Lange, Engelskirchen, Germany) and spoon excavators (Sci-Dent Inc., Algonquin, IL, USA). The procedure was repeated two to three times until the dentin surface was stained pale pink. The surface hardness of the dentin was subjectively assessed using a blunt explorer, with remaining affected dentin being relatively hard. Next, the prepared cavity was washed with an air-water spray, and the external tooth surface was cleaned with a pumice and water slurry on a rubber cup.
The cavity was evaluated, and the following details recorded: (1) cavity size in mm in the mesio-distal and bucco-lingual directions at the greatest distances; (2) depth in mm of the cavity at the deepest point; (3) overall caries activity- inactive (slowly progressing) or active (rapidly progressing) lesion. An inactive lesion was discolored (dark brown or black) and slightly softened tooth tissue, while an active lesion was slightly discolored (yellow) and markedly softened tooth tissue. A periodontal probe (PCP-UNC 15, Hu-Friedy, Chicago, IL, USA) was used to measure the dimensions and the depth of each cavity.

**Allocation of investigated restorative procedures**

One to four restorations were randomly allocated in each patient according to a computer-generated blocking randomization list (block length was 8) by the operator (DB). In cases where multiple restorations were allocated, the restorations were placed separately in different quadrants at separate appointments. Each participant was unaware of the restoration type. Blinding the operator to which intervention was allocated was not possible.

The manufacturers, compositions and batch numbers of materials are listed in Table 7-2 and were applied according to the manufacturers’ instructions. The prepared cavity was restored using one of the following restorative procedures: (1) SB2-bonded with a two-step, total-etching adhesive (Single Bond 2) without lining; (2) SB2/FLC- lined with a resin-modified GIC liner (Fuji Lining LC), and then bonded with the total-etching adhesive; (3) SE- bonded with a two-step, self-etching adhesive.
(Clearfil SE Bond); and (4) SE/FLC- lined with the GIC liner and then bonded with the self-etching adhesive. The code for the restorative procedure was sealed in an envelope labelled with the restoration number according to the blocking randomization list. When the next available participant was recruited, the code was unsealed and revealed to the operator. Lining and bonding procedures are described below.

In the groups in which lining with GIC was indicated, base and catalyst were mixed for 10 s, applied in 0.5-1 mm thickness over the entire dentin surface and then light cured for 20s using a LED light curing unit (Bluephase, Ivoclar Vivadent AG, Schaan, Lichtenstein) in high power mode.

In the groups bonded with the total-etching adhesive, the entire cavity (and lining if present) was etched with 35% phosphoric acid for 15 s and then rinsed. Excessive water was removed by light air blowing from a triple syringe and using a high power evacuation tip. The cavity was dried (but not desiccated) to achieve moist dentin. SB2 was applied in two coats and then light cured for 10 s.

In the groups in which the self-etching adhesive was used, the entire cavity as well as lining (if present) was treated with the self-etching primer for 20s and gently air blown. Next, the bonding agent was applied, gently air blown and then light cured for 10 s.
Each lined and/or bonded cavity was incrementally filled with a nano-filled hybrid resin composite (Filtek Supreme XT, shade A2B). Each increment did not exceed 2 mm in thickness to ensure light-curing effectiveness, and was light cured for 40 s.

Finishing and polishing were performed immediately after curing the composite. Each restoration was checked for occlusal interference, and interferences were corrected with high-speed and slow-speed finishing diamond burs (Intensiv SA, Grancia, Switzerland), under air-water coolant. Restoration margins were checked with an explorer and finished using finishing diamond burs. Next, a series of abrasive-impregnated silicone polishing burs (Astropol, Ivoclar Vivadent AG, Schaan, Lichtenstein) was sequentially used under copious water until a smooth and glossy surface was obtained.

The participants were instructed to avoid taking any analgesic or anti-inflammatory drugs and to report any postoperative tooth sensitivity during the trial period. Each patient was recalled at approximately 1 week (1-2 weeks) and 1 month (4-6 weeks) after restoration.
Postoperative sensitivity assessment

At recall, the evaluator (DB) was blinded to the intervention that was being evaluated. Each restoration was examined, and postoperative sensitivity to cold stimulation and on a daily basis due to any stimuli was evaluated in exactly the same manner as the preoperative evaluation.

If postoperative tooth sensitivity in daily function was severe, the participant was recalled and evaluated as soon as possible. Causes of the tooth sensitivity were identified, and treatment was provided to relieve the sensitivity. If postoperative sensitivity, regardless of the severity, still persisted after the one-month recall, the patient was recalled periodically until the sensitivity disappeared.

Statistical analysis

Data were blindly analyzed using Minitab14 statistical software. General linear model analysis of variance (ANOVA) was used to compare the treatments, and then multiple comparisons with Tukey’s test were performed, with level of significance set at 0.05.
RESULTS

From December 2007 to September 2008, 106 restorations were placed in 72 participants, 54 females and 18 males. Patients' ages ranged from 18 to 37 years old (mean 22.8 ± 3.8 years). Two patients (3 restorations) were lost during recall and excluded before data analysis (from telephone interviewing, these patients reported no postoperative tooth sensitivity in daily function). Of the remaining participants, another five patients (5 restorations) missed the recall at 1 week; however, these patients were still included in the data analysis. All patients attended the one-month recall. Flow of participants through each stage of the clinical trial is presented in the diagram in Figure 7-2. For the 103 restorations evaluated, 54 restorations were placed in maxillary molars, and 49 restorations were placed in mandibular molars. Overall, the average depth of the prepared cavity was approximately 3 mm, and ranged from 2.0 to 4.5 mm. Cavity width and length averaged approximately 3 mm and 4 mm, respectively. In the majority of lesions, caries activity of 93 lesions was rated as inactive. For the remainder, 11 lesions were active, and 2 lesions were mixed active/inactive caries. Number of restorations, patients’ age and cavity depth of each treatment group are shown in Table 7-3.

Overall prevalence of preoperative sensitivity in daily function was low (4 restorations, 4%). One restoration was in the SB2 group, while the other three restorations were in the SE group. Most had low to moderate sensitivity in response to cold water or occlusal function, which was absent after restoration. Mean VAS score in each group was very low (< 5) or zero at the preoperative stage, one-week and one-
month measurements (Table 7-4), with the median of all groups being zero at all time-periods. Thus, no significant difference in means of tooth sensitivity on a daily basis was found among the restorative procedures with or without a GIC lining, regardless of the adhesive used, at preoperative baseline as well as at recall ($p>0.05$). In addition, there was no significant difference in tooth sensitivity between the two adhesives at baseline or recalls ($p>0.05$).

Preoperative sensitivity to cold stimulation was present in 21.4% of lesions (22 cases). Levels of preoperative sensitivity were low (VAS score 3-26, in 15 cases) to moderate (VAS score 34-60, in 7 cases). After restoration, the overall prevalence of postoperative sensitivity was 10.7% at 1 week (11 cases) and 8.7% at 1 month (9 cases). Intensity of postoperative sensitivity at recall was usually low (VAS score 2-25); a few cases reported postoperative sensitivity in the moderate range (VAS score = 40). Prevalence and mean of tooth sensitivity to cold stimulation according to restoration type are shown in Table 7-5. Regardless of the presence of a GIC lining, the prevalence in the groups bonded with a self-etching adhesive tended to decrease gradually over the period, while the prevalence in the groups using a total-etching adhesive decreased at one week and only changed slightly thereafter. In all groups, means of tooth sensitivity were very low at both preoperative and postoperative records, and the medians of tooth sensitivity in all groups at all times were zero. No significant differences ($p>0.05$) were found among treatment groups at baseline or at either recall, and within each group, no differences were found between baseline and either recall. However, a significant difference was found among the three time-points when data were pooled from all groups; tooth sensitivity to cold stimulation at 1 week
and 1 month were lower than at preoperative baseline \((p=0.02\) and \(p=0.01\) respectively), but were not significantly different from each other \((p>0.05)\).
DISCUSSION

In this study, the effect of GIC lining on postoperative tooth sensitivity was examined in occlusal cavities (class I). It is believed that less postoperative sensitivity might be anticipated if a restoration provides a superior seal of the dentin.\textsuperscript{16} In occluso-proximal cavities (class II), cuspal deflection may also play an important role in postoperative sensitivity.\textsuperscript{2} In order to exclude the effect of cuspal deflection, we limited the investigation to occlusal cavities. Also, teeth with existing restorations were excluded because the pulpal status of previously restored teeth might be altered due to the pulpal insult from previous procedures.\textsuperscript{17} Furthermore, shallow cavities were not included since postoperative sensitivity is usually low or infrequently detected as reported in other clinical studies.\textsuperscript{3, 4} In this study, cavity depth was determined by measuring the deepest point of each cavity using a periodontal probe. The proximity of the cavity to the pulp (remaining dentin thickness) may be sometimes estimated from a bite-wing radiograph, but most of the occlusal carious lesions in this study were radiographically overlapped by buccal and lingual intact tooth structures.

In this study, operative procedures were performed carefully to minimize the effects of operative trauma.\textsuperscript{18} Caries detector dye was used in an attempt to distinguish between outer/infected dentin, which is stained and must be removed, and inner/affected dentin, which is unstained and should be preserved.\textsuperscript{19, 20} However, the caries detecting dye must be used with caution as it can also stain less-mineralized dentin close to the pulp or at the dentino-enamel junction.\textsuperscript{21} Even though caries
detector dye was used with caution and caries removal was carefully performed, carious dentin was occasionally over-prepared because of the difficulties in selective removal of a caries lesion.\textsuperscript{22}

In this study, the majority of caries lesions were inactive, a condition in which dentinal sclerosis and tubular occlusion are frequently detected and dentin permeability is reduced.\textsuperscript{15} Preoperative tooth sensitivity is unlikely to occur in a tooth with an inactive lesion. In this clinical study, preoperative tooth sensitivity due to regular function was rarely observed. The participants were recalled at one week and one month after restoration.

It has been reported that most postoperative sensitivity usually disappears within 30 days after restoration placement.\textsuperscript{17, 23} None of the participants in this study reported postoperative sensitivity during regular function at the one-month recall. The infrequency of postoperative sensitivity in teeth with occlusal restorations was similar to another study.\textsuperscript{24} However, other clinical trials have reported a higher prevalence of sensitivity, about 10-20%, at one week and one month recalls.\textsuperscript{9, 25} Since the prevalence was minimal in this study, no significant difference in postoperative sensitivity due to the regular function was detected among the restorations with or without a lining, regardless of the adhesive used. The lack of difference between the two adhesive systems has been also reported in other clinical studies.\textsuperscript{4, 24-26} In contrast, a lower prevalence of postoperative sensitivity when the restorations were lined with a
resin-modified GIC (Vitrebond, 3M ESPE) and using a two-step, total-etching adhesive was reported in one clinical trial.9

The insignificant difference in postoperative sensitivity induced by cold stimulation, between total-etching adhesive and self-etching adhesive was similarly reported in another clinical trial,4 in which the results were obtained mostly from restorations in shallow or moderate occlusal cavities. Despite the fact that the cavities in our study were moderate to deep, the results still showed the same trend. In our study, the lack of difference in postoperative sensitivity to cold between teeth restored with or without a GIC liner was dissimilar to the result previously reported, which showed reduced postoperative sensitivity of teeth in which cavities were lined with GIC.9 Postoperative sensitivity to cold commonly decreased over time, while the response time usually increased, which is similar to observations reported in other clinical studies for restorations using total-etching adhesives without a lining.9, 24, 25 These changes might be explained by the healing of the pulp after mild injury and trauma from the procedure and, as a result, the pain/sensitivity threshold was restored to the normal level.

In this study, all restorations were placed by an experienced operative dentist in an academic environment. In addition, adhesive and restorative materials were used according to the manufacturers’ instructions. Hence, the results of this clinical trial may not be totally applicable to a general practice situation. Some factors which might explain the differences between academic and general practice are operator’s
experience/skill, operation time and familiarity with use of the materials. A clinical trial with the same protocol in a general practice should be further investigated.
CONCLUSIONS

In conclusion, the null hypotheses were accepted. No significant difference in patient-reported tooth sensitivity or in response to cold stimulation was found among the restorations with and without a resin-modified GIC lining, regardless of the adhesive used (total-etching or self-etching). Postoperative sensitivity was not a major problem following restoration of moderate to deep occlusal cavities if the restorative procedures are carefully performed. Further investigations should be conducted in a general practice setting as well as in other types of cavities, such as occluso-proximal restorations, to support these results.
CHAPTER 7: POSTOPERATIVE SENSITIVITY

REFERENCES


CHAPTER 7: POSTOPERATIVE SENSITIVITY


Figure 7-1 Modified visual analog scale. Illustration of the facial expressions with the color codes was added below the line in attempt to make the scale easier to understand. Each participant was requested to mark the level of tooth sensitivity on a daily basis as well as in response to cold stimulation.
Figure 7-2 Modified CONSORT flow diagram showing the flow of participants through each stage in this randomized controlled clinical trial.
Table 7-1: *Inclusion and exclusion criteria used for the recruitment of participants in the clinical trial*

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Dental- an investigated tooth:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) clinically diagnosed as moderate to deep occlusal caries; no caries detected on other surfaces</td>
<td></td>
</tr>
<tr>
<td>(2) did not have any signs or symptoms of pulpal and periapical disease</td>
<td></td>
</tr>
<tr>
<td>(3) may exhibit preoperative sensitivity, but relieved immediately after stimulus removal</td>
<td></td>
</tr>
<tr>
<td>(4) had at least one antagonist tooth with occlusal contact more than 50% of the occlusal surface</td>
<td></td>
</tr>
<tr>
<td>(5) had healthy or mildly inflamed gingival tissues, without gingival recession/ alveolar bone loss</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Exclusion criteria</th>
<th>Patients with one of the following medical conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) psychological disorders</td>
<td></td>
</tr>
<tr>
<td>(2) neurological diseases</td>
<td></td>
</tr>
<tr>
<td>(3) temporo-mandibular disorders</td>
<td></td>
</tr>
<tr>
<td>(4) pregnancy or breast feeding</td>
<td></td>
</tr>
<tr>
<td>(5) taking any analgesic or anti-inflammatory drugs regularly</td>
<td></td>
</tr>
<tr>
<td>(6) allergy to materials used in this trial</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dental- an investigated tooth:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) with previous restoration(s), tooth surface loss (attrition, erosion, abrasion or abfraction)</td>
</tr>
<tr>
<td>(2) diagnosed as “cracked tooth syndrome”</td>
</tr>
<tr>
<td>(3) received orthodontic treatment within the previous 3 months</td>
</tr>
</tbody>
</table>
Table 7-2: Materials, components, batch numbers and manufacturers

<table>
<thead>
<tr>
<th>Materials</th>
<th>Components</th>
<th>Batch no.</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuji Lining LC Paste Pak (FLC)</td>
<td>Paste A- Alumino silicate glass 70-80%, HEMA 10-15%, Urethane dimethacrylate 5-10%; Paste B- HEMA 30-40%, Polyacrylic acid 25-35%, Proprietary Ingredient 5-10%, Silica powder 1-5%</td>
<td>0611082, 0605093</td>
<td>GC Corp., Tokyo, Japan</td>
</tr>
<tr>
<td>Single Bond 2 (SB2)</td>
<td>Etchant- 35% phosphoric acid Bonding- Bisphenol-A diglycidyl ether dimethacrylate, HEMA, dimethacrylate, colloidal nanofiller 10%, solvent, water</td>
<td>7KH, 7JB, 7KC, 6JR</td>
<td>3M ESPE, St. Paul, MN, USA</td>
</tr>
<tr>
<td>Clearfil SE Bond (SE)</td>
<td>SE Primer- 10-MDP, HEMA, hydrophilic dimethacrylate, dl-camphoquinone, N,N-diethanol-p-toluidine, water SE Bond- 10-MDP, Bis-GMA, HEMA, hydrophobic dimethacrylate, dl-camphoquinone, N,N-diethanol-p-toluidine, silanated colloidal silica</td>
<td>00683A, 00664A, 00976A, 00946A</td>
<td>Kuraray Medical Inc., Okayama, Japan</td>
</tr>
<tr>
<td>Filtek Supreme XT shade A2B</td>
<td>BIS-GMA, UDMA, TEGDMA, Bis-EMA, inorganic fillers 59.5% (by volume)</td>
<td>6GY</td>
<td>3M ESPE, St. Paul, MN, USA</td>
</tr>
</tbody>
</table>

*HEMA: 2-hydroxyethyl methacrylate; 10-MDP: 10-methacryloyloxydecyl dihydrogen phosphate; BIS-GMA: Bisphenol A diglycidyl methacrylate; UDMA: urethane dimethacrylate; TEGDMA: triethylene glycol dimethacrylate; Bis-EMA: Bisphenol A polyethylene glycol dimethacrylate*
Table 7-3: General information and cavity depth according to each treatment group. Patients’ ages and cavity depths are presented as means and SD in parenthesis.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of restorations</th>
<th>Patients’ age (years)</th>
<th>Cavity depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) SB2</td>
<td>26</td>
<td>22.7 (3.7)</td>
<td>3.0 (0.5)</td>
</tr>
<tr>
<td>(2) SB2/FLC</td>
<td>24</td>
<td>21.4 (3.4)</td>
<td>2.8 (0.6)</td>
</tr>
<tr>
<td>(3) SE</td>
<td>26</td>
<td>22.5 (2.6)</td>
<td>2.8 (0.5)</td>
</tr>
<tr>
<td>(4) SE/FLC</td>
<td>27</td>
<td>22.7 (4.5)</td>
<td>2.8 (0.8)</td>
</tr>
</tbody>
</table>
Table 7-4: Prevalence (percentage) and means (in VAS score) of tooth sensitivity on a daily basis at the three time-points are shown according to the four restorative procedures.

<table>
<thead>
<tr>
<th>Group</th>
<th>Tooth sensitivity on a daily basis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preoperative baseline</td>
</tr>
<tr>
<td></td>
<td>Prevalence (%)</td>
</tr>
<tr>
<td>1) SB2</td>
<td>4.0 (3.5)</td>
</tr>
<tr>
<td>2) SB2/FLC</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>3) SE</td>
<td>13.0 (12.0)</td>
</tr>
<tr>
<td>4) SE/FLC</td>
<td>0.0 (0.0)</td>
</tr>
</tbody>
</table>

No significant difference in means of the tooth sensitivity was found among the four groups, regardless of the time-point (p>0.05). In addition, there was no significant difference between the tooth sensitivity at the preoperative baseline and at the recalls within each restorative procedure (p>0.05).
Table 7-5: Prevalence (percentage) and means (in VAS score) of tooth sensitivity in response to cold stimulation at the three time-points are shown according to the four restorative procedures.

<table>
<thead>
<tr>
<th>Group</th>
<th>Tooth sensitivity in response to cold stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preoperative (baseline)</td>
</tr>
<tr>
<td></td>
<td>Prevalence (%)</td>
</tr>
<tr>
<td>1) SB2</td>
<td>18.2</td>
</tr>
<tr>
<td>2) SB2/FLC</td>
<td>33.3</td>
</tr>
<tr>
<td>3) SE</td>
<td>23.8</td>
</tr>
<tr>
<td>4) SE/FLC</td>
<td>35.0</td>
</tr>
</tbody>
</table>

No significant difference in means of cold-stimulated tooth sensitivity was found among the four restorative procedures regardless of time (p>0.05). Moreover, there was no significant difference between cold-stimulated tooth sensitivity at preoperative (baseline) and at recall within each restorative group (p>0.05).
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