Factors associated with postoperative sensitivity of amalgam restorations

Précis:
Younger patients, females, and pre-operative sensitivity to cold may be predictive of postoperative sensitivity following placement of amalgam restorations.

Abstract:
Postoperative sensitivity is a common clinical problem with restorative treatments. Study aims: To identify factors that may be predictive of reported postoperative sensitivity to cold following placement of class I and II amalgam restorations in primary carious lesions.

Materials and methods:
One hundred and twenty patients were recruited. Patients were telephoned on days two and seven postoperatively and asked about sensitivity to cold and its intensity. If sensitivity remained up to day seven, patients were also contacted on days 30 and 90.

Results:
Of the 51 teeth that had sensitivity at day two, 17 experienced mild pain, 26 were moderately painful and eight had severe pain. The percentage of females experiencing postoperative sensitivity was higher than that of males at days two, seven and 30 (P=0.000, 0.016 and 0.028, respectively). Younger patients reported significantly more postoperative sensitivity than older ones at day two (P=0.010) but not at days seven and 30 (P=0.157 and 0.877). Postoperative sensitivity did not differ among the different tooth types at days two, seven and 30 (P=0.219, 0.236 and 0.338, respectively), nor with respect to class I and class II cavities at days two, seven and 30 (P=0.219, 0.769 and 0.259, respectively). Patients who had some pre-operative pain had significantly more postoperative sensitivity (P=0.000, 0.000, and 0.004 at days two, seven and 30, respectively).

Conclusions:
Regression analysis suggested that younger patients, females, and pre-operative sensitivity to cold might be predictive of postoperative sensitivity following placement of amalgam restorations.
a cavity liner, but more recently, dentine bonding agents and amalgam bonding have gained popularity as cavity liners. The use of glass ionomer cements as a base under amalgam restorations has been found to reduce sensitivity to cold. Furthermore, disinfection of the cavity preparation prior to restoration is gaining wider clinical acceptance. Studies have shown that the depth of the cavity is a significant factor to be considered in relation to postoperative sensitivity. On the other hand, Gordan et al found no clinical difference in postoperative sensitivity experienced by patients following placement of amalgam restorations in cavities of different depths.

Many biological variables, treatment factors and restorative considerations can potentially have an effect on the outcome of restorative treatment. However, few attempts have been made to study these variables. In a previous paper, we found that both the depth of the lesion and the nature of cavity treatment affected the postoperative sensitivity reported by patients. There is little published information regarding other factors that may also contribute to the occurrence and severity of postoperative sensitivity. The purpose of this study was to identify variables that may be predictive of postoperative sensitivity reported by patients following restoration of primary carious lesions with amalgam restorations.

Material and methods
Patients attending for routine restorative care at the Faculty of Dentistry, Jordan University of Science and Technology, were consecutively screened for inclusion in the study on the basis of the following criteria: each patient had to have a diagnosis of a primary carious lesion that required either a class I or a class II amalgam restoration, the diagnosis having been established by clinical examination and verified by standard bitewing radiographs. Patients having replacement amalgam restorations were excluded from the study, as were those who were taking medications that could interfere with pain perception. Patients who were obviously apprehensive and anxious about the treatment were also excluded from the study. All other patients were randomly distributed to the various groups. Fully informed consent was obtained from patients for their participation in the study. The research was approved by the Deanship of Research, Jordan University of Science and Technology, as well as the University’s Human Rights Committee.

One hundred and twenty patients were included. All the restorations were placed by dental students working under the close supervision of members of staff of the Department of Restorative Dentistry who, in turn, had been fully apprised of the purpose of the study by the investigators.

Lesions limited to the outer one-third of dentine were excluded from the study, with the result that the sample comprised patients with middle third and inner third lesions only. For each of the two groups, patients were randomly and evenly assigned among one of three groups based on the treatment of the dentine after cavity preparation, and a group that received no pre-treatment prior to amalgam placement (Table 1). Patients with pre-operative symptoms were included in the study. Manufacturers’ instructions were followed for each pre-treatment material that was used. After that, teeth were restored with a dispersed-phase amalgam (Amalgam 48, TNMC Medical Devices Ltd., Guildford, UK), carved and burnished. Restorations were carefully checked for appropriate occlusion. All patients were contacted by telephone on days two and seven postoperatively. They were questioned about the presence or absence of postoperative sensitivity to cold. If sensitivity was reported, they were asked to specify its intensity according to an ordinal rating scale from 0-3: zero: no sensitivity; one: slight sensitivity; two: moderate sensitivity; and, three: severe sensitivity. Any patient who was found to experience sensitivity or discomfort seven days after placement of the restoration was contacted again at 30 days and 90 days to assess the degree of sensitivity at those times.

After data collection, the results were entered into a computer and verified by standard bitewing radiographs. Patients were asked to specify its intensity according to an ordinal rating scale from 0-3: zero: no sensitivity; one: slight sensitivity; two: moderate sensitivity; and, three: severe sensitivity. Any patient who was found to experience sensitivity or discomfort seven days after placement of the restoration was contacted again at 30 days and 90 days to assess the degree of sensitivity at those times.
Patient (<30 years or ≥30 years) and tooth type (premolar or molar), multivariate logistic regression analysis with postoperative sensitivity as the dependent variable was performed. The odds ratios (OR) and 95% confidence intervals (CI) were calculated.

Results
The study sample was made up of 55 males and 65 females. Table 2 shows the frequencies of different degrees of postoperative sensitivity according to gender at day two. The percentage of females with postoperative sensitivity was significantly higher than that of males at day two (P=0.000), seven and 30 postoperatively (P=0.016 and 0.028, respectively).

There were significant differences among the different types of treatment/liners, with dentine treatment with chlorhexidine producing the fewest sensitive teeth, followed by the cavity varnish group; however, the differences between liners was not significant at day 90.19

The age of the patients ranged from 16 to 65 years, with a mean age of 28 years. The distribution of sensitivity among the age groups on day two is shown in Table 3. A statistically significant difference between the age groups was evident at day two (P=0.01), but not at days seven and 30 (P=0.157 and 0.877, respectively). When the total sample was grouped into <30 year olds (n=57) and ≥30 year olds (n=63), the difference between the two groups at day two was significant (P=0.001), but not at days seven and 30 (P=0.104 and 0.593, respectively).

Table 4 shows the frequencies of positive reports of postoperative sensitivity according to tooth type. Molars outnumbered premolars in the total number of teeth restored, and no significant differences among the different types of teeth were evident at day two, at one week and at one month (P=0.219, 0.236 and 0.338, respectively). Similarly, there was no significant difference in reported sensitivity between teeth in the upper and lower jaws at day two, at one week and at one month (P=0.325, 0.902 and 0.231, respectively) (Table 5).

Frequencies of different degrees of severity of postoperative sensitivity according to class of cavity showed no significant difference between the two groups at day two, at one week and at one month (P=0.219, 0.769 and 0.259, respectively) (Table 6).

Table 7 shows the degree of sensitivity at day two in relation to the presence or absence of pain before treatment. Significantly more patients with pre-operative sensitivity experienced postoperative

<table>
<thead>
<tr>
<th>Gender</th>
<th>Degree of postoperative sensitivity</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>Male (55)</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Female (65)</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Total (120)</td>
<td>17</td>
<td>26</td>
</tr>
</tbody>
</table>

Wilcoxon rank sum (Mann-Whitney) at days two, seven and 30, P=0.000, 0.016, 0.028.

<table>
<thead>
<tr>
<th>Age (n)</th>
<th>Degree of postoperative sensitivity</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>11-20 (20)</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>21-30 (47)</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>31-40 (26)</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>41-50 (17)</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>51-60 (7)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>61-70 (3)</td>
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<td>0</td>
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<tr>
<td>Total (120)</td>
<td>17</td>
<td>26</td>
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</tbody>
</table>

Kruskal-Wallis test at days two, seven and 30, P=0.01, 0.157, 0.877.

<table>
<thead>
<tr>
<th>Tooth (n)</th>
<th>Degree of postoperative sensitivity</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>Upper molar (44)</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Upper premolar (20)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Lower molar (51)</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Lower premolar (5)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total (120)</td>
<td>17</td>
<td>26</td>
</tr>
</tbody>
</table>

Kruskal-Wallis test, P=0.219.

<table>
<thead>
<tr>
<th>Tooth (n)</th>
<th>Degree of postoperative sensitivity</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>Upper jaw (63)</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Lower jaw (57)</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Total (120)</td>
<td>17</td>
<td>26</td>
</tr>
</tbody>
</table>

Wilcoxon rank sum (Mann-Whitney), P=0.325.

| Cavity type (n) | Degree of postoperative sensitivity | Total (%) |
|                | Mild | Moderate | Severe |          |
| Class I (75)   | 8 | 18 | 3 | 29 (38.7) |
| Class II (45)  | 9 | 8 | 5 | 22 (48.9) |
| Total (120)    | 17 | 26 | 8 | 51 (42.5) |

Wilcoxon rank sum (Mann-Whitney), P=0.322.

<table>
<thead>
<tr>
<th>Pre-operative sensitivity (n)</th>
<th>Degree of postoperative sensitivity</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
</tr>
<tr>
<td>Absent (79)</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Present (41)</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>Total (120)</td>
<td>17</td>
<td>26</td>
</tr>
</tbody>
</table>

Wilcoxon rank sum (Mann-Whitney), P=0.000.
Microleakage is considered to be a significant cause of postoperative sensitivity. Previous research found that such lesions had less postoperative sensitivity than class I cavities. For the purpose of allocating patients to groups was impossible to eliminate all the variations between large numbers of subjects. To limit any potential cause of perceived pain to one source, it was ensured that patients in the study tooth, and therefore not risk confounding the outcome with any other newly restored teeth that were not part of the study, it was ensured that patients in the study received only one restoration each over the duration of the follow-up period. For the same reason, the restoration of differently treated cavities in the same patient would have been an obvious source of error, and was thus excluded as an option. The decreasing reports of sensitivity from day two through to day 30 were significant (P=0.000).

The results of the multivariate regression analysis are presented in Table 8, showing that the factors that had a significant effect on postoperative sensitivity were: gender (OR 2.82, CI 1.213-6.575), age (OR 2.05, CI 0.971-4.350) and the presence of pre-operative pain (OR 2.05, CI 0.971-4.350).

Table 8: Results of multiple logistic regression analysis, with postoperative sensitivity as dependent variable.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>P-value</th>
<th>Odds ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-5.627</td>
<td>0.012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>1.068</td>
<td>0.020</td>
<td>2.911</td>
<td>1.182–7.168</td>
</tr>
<tr>
<td>Age</td>
<td>0.720</td>
<td>0.060</td>
<td>2.055</td>
<td>0.971–4.350</td>
</tr>
<tr>
<td>Tooth type</td>
<td>0.754</td>
<td>0.124</td>
<td>2.126</td>
<td>0.813–5.564</td>
</tr>
<tr>
<td>Jaw</td>
<td>0.448</td>
<td>0.229</td>
<td>0.639</td>
<td>0.308–1.326</td>
</tr>
<tr>
<td>Cavity</td>
<td>0.194</td>
<td>0.689</td>
<td>1.214</td>
<td>0.469–3.143</td>
</tr>
<tr>
<td>Depth</td>
<td>1.068</td>
<td>0.016</td>
<td>3.094</td>
<td>1.234–7.757</td>
</tr>
<tr>
<td>Pre-operative pain</td>
<td>1.125</td>
<td>0.006</td>
<td>3.080</td>
<td>1.183–8.016</td>
</tr>
</tbody>
</table>

Discussion

In clinical studies, variations among operators and patients can be confounding factors. A limitation of this study was the large number of dental student operators. All of the procedures were, however, carried out under close supervision, which might reduce this effect, as might the fact that students may be more inclined to achieve a level of standardisation of technique. Moreover, because the current study is a clinical-based study, all attempts were made to reduce the variability between patients by assigning excluding and including criteria. However, apparently in clinical-based studies, it is almost impossible to eliminate all the variations between large numbers of subjects. To limit any potential cause of perceived pain to one source as much as possible, viz. the study tooth, and therefore not risk confounding the outcome with any other newly restored teeth that were not part of the study, it was ensured that patients in the study received only one restoration each over the duration of the follow-up period. For the same reason, the restoration of differently treated cavities in the same patient would have been an obvious source of error, and was thus excluded as an option. The determination of cavity depths for the purpose of allocating patients to groups was performed radiographically, and confirmed clinically. Lesions in the outer third of dentine were excluded from the study because previous research found that such lesions had less postoperative sensitivity than class I cavities.

Microleakage is considered to be a significant cause of postoperative sensitivity, arising from the hydrodynamic effect. According to Brännström, cold water may affect the pulp through microleakage along the interfacial gap of newly placed amalgam restorations that have not yet self-sealed. Microleakage would rapidly create a temperature gradient, resulting in a rapid pulpal response to a cold stimulus. In this study, we used admixed amalgam. Admixed particle alloys have demonstrated less microleakage than spherical particle alloys in laboratory tests.

The prevalence of postoperative sensitivity varies widely among studies. The frequency of postoperative pain was found to range from around 30% in some studies, to around 75% of the teeth restored with amalgam in others. In the present study, the prevalence of postoperative sensitivity was around 40%, 30%, 10%, and 0% at days two, seven, 30 and 90, respectively. The reason for the variation in the results between the different studies may be explained on the basis of different materials used, different techniques and different study sample sizes.

Previous research found teeth restored with posterior composite and amalgam restorations not to be different between molars and premolars in their responses to cold stimuli, although teeth in the upper arch were more sensitive to cold stimuli than teeth in the lower arch. In the present study, there was no difference in postoperative sensitivity to cold between different types of teeth or between upper and lower jaws. The difference between results could be due to sample size, our sample having comprised 120 patients while the other study had only 27 subjects. Furthermore, in our study, only one restoration per patient was permitted, while in the cited study between three and four restorations per patient were placed, which, as discussed earlier, can affect the patient’s interpretation of the pain response.

Postoperative pain following endodontic therapy has been reported to be no different between males and females, although younger people experienced higher pain levels. In this study, the percentage of females with postoperative pain after routine amalgam fillings was almost three times higher than in males, while younger patients also reported postoperative sensitivity twice as frequently as older ones. This is most likely due to occlusion of dentinal tubules due to secondary dentine formation as an ageing phenomenon.

Previous research found that gender and pre-operative pain experience are important risk factors for pain after successful root canal treatment. Our results concur broadly with their conclusions, with the most important factor associated with postoperative pain being the presence or absence of pain before placement of the restoration.

Although the difference was not statistically significant, class II cavities had more postoperative sensitivity than class I cavities (49% vs. 39%). This difference might be explained by the fact that around two-thirds of class II cavities were in the inner third of dentine, while only around one-third of class I cavities were that deep. As the cavity becomes deeper, dentinal tubules increase in number and become wider in diameter. These morphological factors could explain why deeper cavities had more reports of postoperative sensitivity, as well as pain of greater severity.

The present results also agree with previous findings inasmuch as the...
degree of postoperative pain decreased with time.\textsuperscript{13,16,19} The proportions of those reporting postoperative sensitivity reduced steadily: 43% at two days, 26% at seven days, 8% at 30 days, and none at 90 days.

In interpreting the results of this study, it should be remembered that the results obtained apply to the materials used and the prevailing clinical conditions. Having been carried out in a teaching setting, it cannot be considered representative and thus is not fully applicable in routine dental practice. A further limitation of this study was contacting patients on the phone postoperatively rather than by clinical examination, which may have detracted from reporting accuracy. For greater clarification of the outcomes in general practice, a similar practice-based study seems warranted.

Conclusions

The prevalence of postoperative sensitivity to cold following placement of routine amalgam restorations was 42% at day two postoperatively. Postoperative sensitivity to cold decreases after the first week both in prevalence and severity. Among the different factors that might affect the occurrence of postoperative cold sensitivity, and thus be predictive of the condition, are the depth of the cavity, gender, age and the presence of pre-operative pain. Tooth type, arch location and class of cavity had no effect on the occurrence of postoperative sensitivity to cold after amalgam restoration.

References