SOLUBILITY OF FOUR DENTAL LUTING CEMENTS

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Abstract

Solubility is an important feature in assessing the clinical durability of luting cements. Solubility may cause degradation of the cement, leading to debonding of the restoration and recurrent decay. The aim of this study was to evaluate and compare water solubility values of luting resin cement with other three conventional luting cements.

Four commercial dental luting cement materials were selected: GIC cement (SPOFA DENTAL a.s , Markova 238), Zinc polycarboxylate cement (SS White Group, P.C.I, Unit 9 Madleaze Estate, Bristol Road, England), Zinc Phosphate cement (SPOFA DENTAL a.s Praha, Cernok.) and Resin cement (Densply Caulk 38 West Clarke Ave, U.S.A). Ten disc specimens were prepared for each cement material using a stainless steel mold with 10 mm in inner diameter and 2 mm in thickness. Water solubility of different cement materials were calculated by weighting the samples before and after water immersion (15 days) and desiccation. Data were analyzed by one-way ANOVA and Student t-test at 5% level of significance.

Statistical analysis of data by using one-way analysis of variance (ANOVA) revealed that, there was statistically significant difference (P<0.05) in solubility values between the four luting cements being tested.

Resin cement has the highest resistance to solubility in comparison with other conventional luting cements.

Keywords: Luting cement, cement solubility, cement physical properties.

Introduction

Presently, various types of adhesive cement are used for permanent and temporary cementation of indirect restorations. These cements had different mechanical and biological characteristics1-5. Amongst which, the most important characteristic is stability in the oral environment or resistance against decomposition and degradation. Decomposition of cements results in deterioration of restorations, and may even cause secondary caries6. The solubility of restorative materials directly affects their selection criteria. Materials designed for the same clinical purpose differ in their behavior with respect to long-time aging in water.

Zinc phosphate cement is one of the oldest materials used for the cementation of restorations7,8. But of late, many other adhesive quality cements have been developed. These cements give better results than zinc phosphate cement10. They adhere firmly to the surfaces of both dentin and metal prostheses, and thus reduce microleakage to a greater extent11. These lately developed adhesive cements include glass ionomer cement, polycarboxylate cement, and resin cement12. Besides, composite resins with dual-cure system for bonding inlays and laminate veneers have also been introduced13,14.

Solubility is an important feature in assessing the clinical durability of luting cements. Consequently, solubility of luting cements has been widely evaluated in vitro15. Solubility may cause degradation of the cement, leading to debonding of the restoration and recurrent decay16.
Material and Methods

Four commercial dental luting cement materials were selected: GIC cement (SPOFA DENTAL a,s, Markova 238), Zinc polycarboxylate cement (SS White Group P.C.I, Unit 9 Madleaze Estate, Bristol Road, England), Zinc Phosphate cement (SPOFA DENTAL a.s Praha, Cernok,) and Resin cement (Densply Caulk 38 West Clarke Ave, U.S.A).

Ten disc specimens were prepared for each cement material using a stainless steel mold with 10 mm in inner diameter and 2 mm in thickness (Figure 1).

All the cements were mixed according to the manufacturer’s instructions. The materials were placed in the mold and pressed between two plastic matrix strips and glass microscope slides under hand pressure to extrude any excess material. After specimens were removed from the mold, any excess material was removed by gentle, dry grinding on both sides.

The specimens were transferred to an air oven and dried for 2 hours at 37°C. Then the specimens were transferred a desiccator containing silica gel, freshly dried for 2 hours at 20°C. The specimens were weighed using an analytical balance to an accuracy of ± 0.1 mg. This cycle was repeated until a constant mass (mₒ) was obtained. For each cement material, ten specimens were prepared (n=10) and placed in a glass vial containing 20 ml distilled water. The vials were wrapped in aluminum foil to exclude light and placed in an incubator at 37°C for 15 days.

The specimens were placed in desiccator using the same cycle as described above but the temperature was 58 °C to obtain (mₚ). This cycle was repeated until constant mass was obtained. The values of solubility S were calculated using the following equations (ISO 4049:2000): S= mₒ - mₚ/V

Where mₒ is the specimen mass before water immersion (mg), mₚ is the specimen mass after immersion and desiccation (mg), and V is the specimen volume before immersion (mm³).

For each group, the means and standard deviations for solubility were calculated.

Results

Table (1) summarizes solubility means (Figure 2) and standard deviations (in parenthesis) of glass ionomer, Zinc phosphate, Zinc polycarboxylate, and resin cement respectively in µg/mm³.

Statistical analysis of data by using one-way analysis of variance (ANOVA) revealed that, there was statistically significant difference (P<0.05) in solubility values between the four cement groups being tested as shown in Table (2).

Table 1. Mean solubility values and standard deviations (in parenthesis) of the four tested cements.
Figure 2. Solubility means in µg/mm³ for the four cement groups.

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>3</td>
<td>0.002362</td>
<td>0.000794</td>
<td>4.49</td>
<td>0.009</td>
</tr>
<tr>
<td>Error</td>
<td>36</td>
<td>0.008362</td>
<td>0.000177</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>0.008744</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. One-way Analysis of Variance (ANOVA) test.

Further analysis of the data was needed to examine the differences between different pairs of groups using the t-test analysis and indicated that, pairs no. 2, 4 & 5 showed statistically insignificant difference (P > 0.05) while pairs no. 1, 3 & 6 showed statistically significant difference (P < 0.05) Table (3).

<table>
<thead>
<tr>
<th>Pair No.</th>
<th>Sig. (2-tailed)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 A-B</td>
<td>0.026</td>
<td>*</td>
</tr>
<tr>
<td>Pair 2 A-C</td>
<td>0.771</td>
<td>NS</td>
</tr>
<tr>
<td>Pair 3 A-D</td>
<td>0.004</td>
<td>*</td>
</tr>
<tr>
<td>Pair 4 B-C</td>
<td>0.216</td>
<td>NS</td>
</tr>
<tr>
<td>Pair 5 B-D</td>
<td>0.237</td>
<td>NS</td>
</tr>
<tr>
<td>Pair 6 C-D</td>
<td>0.000</td>
<td>*</td>
</tr>
</tbody>
</table>

* : Significant difference  
NS : Insignificant difference

Table 3. t-test for different pairs of cement groups analysis.

Discussion

Solubility or leaching of cement components has a potential impact on both its structural stability and biocompatibility. The rate of dissolution can be influenced by the conditions of the test. Other factors may include time of dissolution, concentration of the solute in the dissolution medium, pH of the medium, specimen shape and thickness, and powder/liquid ratio of cement.

The chemical structure of the solutions used for in vitro tests is important because it has to simulate the complexity of the oral environment. The in vitro tests made are only static solubility tests because they do not simulate the pH and temperature changes of the oral cavity. Clinical conditions vary, even within the same person, making it virtually impossible to reproduce a natural environment.

Cattani-Lorente et al. found that deterioration of the physical properties of the cements after long-term storage in an aqueous environment could be related to the water absorption of these materials. Part of the absorbed water acted as a plasticizer, inducing a decrease in strength. Weakening resulted to erosion and plasticizing effect of water. In our study, the glass ionomer cement exhibited the highest mean solubility value followed by zinc phosphate cement, polycarboxylate cement and resin cement exhibited the lowest mean solubility value (Figure 2).

Polycarboxylate cement is much less soluble during immersion in distilled water. In contrast, the resin cements are basically insoluble, but may release small amounts of unpolymerized monomer constituents. Therefore, the main cause behind the high solubility values of the glass ionomer cement could be related to the fact that, glass ionomer cements are sensitive to water erosion. It may probably be due to same hydrolysis of the cement components. This phenomenon is apparently aggravated in oral environment due to the presence of aggressive compounds in the saliva.

Clinical success with glass ionomer cements depends on early protection from both hydration and dehydration. It is weakened by early exposure to moisture, while desiccation, on the other hand, produces shrinkage cracks in the recently set cement. Some studies conclude that glass ionomer cements are more resistant to degradation than zinc phosphate cements, although Knibbs and Walls reported that marginal defects around crowns appeared sooner with glass ionomer than with zinc...
phosphate, possibly because of the greater susceptibility of glass ionomer to contamination by moisture and this finding is in consistence with the results of this study.

Conclusions

Resin cement had the highest resistance to solubility followed by polycarboxylate, zinc phosphate and glass ionomer which exhibited the least resistance to solubility in this study.

Declaration of Interest

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References