The Effect of Compressive Cyclic Loading on the Retention of Cast Single Crowns Cemented to Implant Abutments

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Purpose: The aim of this study was to evaluate and compare the retention strength of three cements commonly used in implant-supported prostheses before and after compressive cyclic loading. Materials and Methods: The working model consisted of five solid abutments, 7 mm in height and with a 6-degree taper, screw retained to five implant analogs secured in a rectangular block of self-curing acrylic. On the abutments, 30 metal Cr-Ni alloy copings were cemented using three luting agents: glass ionomer, resin urethane-based, and compomer cement (n = 10). Two tensile tests were conducted with a universal testing machine, before and after 100,000 cycles of 100 N and 0.72 Hz compressive cyclic loading in a humid environment. Results: Before applying the compressive load, the retention strength of the resin urethane-based cement was slightly higher than that of the compomer cement and 75% greater than the glass-ionomer cement. After compressive loading, the resin urethane-based cement showed the highest percentage of loss of retention (64.45%, compared with 50% for glass-ionomer and compomer cement). However, the glass-ionomer cement showed the lowest mean retentive strength with 50.35 N as opposed to 75.12 N for the compomer cement and 71.25 N for the resin urethane-based. Conclusions: Compressive cyclic loading significantly influences the retention strength of the luting agents tested. All three cements may favor the retrievability of the crowns. Int J Prosthodont 2016;29:80–82. doi: 10.11607/ijp.4355

Implant-supported fixed partial prostheses can be screw-retained or cement-retained. Clinicians usually choose screw-retained prostheses due to their greater retrievability.1 However, cement-retained restorations can offer predictable retrievability.2 Ideally, the cement should be strong enough to hold the restoration in place indefinitely but also weak enough to allow it to be removed by the dentist when necessary. The degree of retrievability depends on whether provisional, temporary, or permanent cements are used. Resin urethane-based and glass ionomer cements are widely used in implant dentistry;3 the compomer cement may also be an alternative in clinical practice. There are few studies comparing retentiveness before and after compressive cyclic loading simulating mastication to assess whether the final retention of these cements can aid prosthesis retrievability.2,4,5 Thus, the aim of the present study was to assess and compare retention before and after compressive cyclic loading of three dental luting agents when cementing cast crowns to implant abutments in relation to the retrievability of the restoration. The null hypotheses were: (1) the tensile failure loads of glass-ionomer, compomer, and resin urethane-based cements before and after compressive cyclic loading are the same and (2) the tensile failure loads of glass-ionomer, compomer, and resin urethane-based cements after compressive cyclic loading are the same.

Materials and Methods

The working model consisted of five implant analogs secured in a self-curing acrylic block (70 × 30 × 20 mm). Five prefabricated solid abutments were screw retained on the analogs (30 N torqued) (Fig 1). Thirty metal copings numbered 1 to 30 were fabricated and randomized into the three cements to be assessed (n = 10) and also randomly assigned to each abutment. Three luting agents were evaluated: glass-ionomer cement, compomer cement, and resin urethane-based cement (Table 1). The cementation protocol for...
the three cements was in accordance with the manufacturer’s instructions, using automix syringes or mechanical mixing capsules. After the initial tensile test, the copings were cemented again and each cement group was subjected to a cyclic compressive load of 100 N, with a frequency of 0.72 Hz, until 100,000 cycles were completed (Fig 2). A universal testing machine (EM1/5FR, Microtest) was used. The analysis of variance test with post hoc Tukey test was used at $P < .05$ significance level.

Table 2 shows the retention strength data before and after cyclic compressive loading and the retention index of the three cements. Retention index = $(1 - \text{retention after loading/retention before loading}) \times 100$. 

### Table 1  Cements and Implant Components Used

<table>
<thead>
<tr>
<th>Material</th>
<th>Trade Name</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant</td>
<td>Stark-D 4 × 10</td>
<td>Sweden &amp; Martina</td>
</tr>
<tr>
<td>Solid abutment</td>
<td>Unnamed (ref XMDPC7.5R)</td>
<td>Sweden &amp; Martina</td>
</tr>
<tr>
<td>Premachined castable coping</td>
<td>Unnamed (ref XCAP7.5)</td>
<td>Sweden &amp; Martina</td>
</tr>
<tr>
<td>Glass-ionomer cement</td>
<td>Fuji I Capsule</td>
<td>GC</td>
</tr>
<tr>
<td>Compomer cement</td>
<td>Stay Bond</td>
<td>KDM</td>
</tr>
<tr>
<td>Resin urethane-based cement</td>
<td>Premier Implant Cement</td>
<td>Premier</td>
</tr>
</tbody>
</table>

### Table 2  Mean Tensile Retention Strength of the Tested Cements and Comparison of Mean Retention Values (n = 10)

<table>
<thead>
<tr>
<th>Cement Type</th>
<th>Retention before loading (N (SD))</th>
<th>Retention after loading (N (SD))</th>
<th>$P$</th>
<th>Retention Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass-ionomer Temporary/Permanent</td>
<td>100.41 (33.55)</td>
<td>50.35 (30.37)</td>
<td>.007</td>
<td>50.17</td>
</tr>
<tr>
<td>Compomer Temporary/Permanent</td>
<td>161.13 (53.34)</td>
<td>75.12 (72.63)</td>
<td>.005</td>
<td>50.99</td>
</tr>
<tr>
<td>Resin urethane-based Temporary</td>
<td>174.76 (45.59)</td>
<td>71.25 (73.86)</td>
<td>.005</td>
<td>64.45</td>
</tr>
<tr>
<td>Tukey test</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

SD = standard deviation; NS = no significance.

Results

Table 2 shows the retention strength data before and after cyclic compressive loading and the retention index of the three cements. Retention index = $(1 - \text{retention after loading/retention before loading}) \times 100$. 

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Discussion

In this study, different but homogenous values of tensile strength were shown in the three cements before compressive load application. The use of different abutments and commercial differences in cement composition may explain the differences compared with data from others studies cited in the dental literature. After 100,000 cycles of compressive cyclic loading, the compomer and glass-ionomer cements’ retention strength decreased by about 50%, and in the case of resin urethane-based cement it decreased by 65%. Despite this retention strength loss, resin urethane-based cement maintained a retention strength similar to that of compomer cement and both showed 50% more retention strength than the glass-ionomer cement. These results confirm that cyclic compressive loading significantly reduces the retentiveness of the cements, though not to the same degree. The glass-ionomer cement showed lower retention than the provisional/temporary resin urethane-based cement. However, this result does not agree with the higher values cited in other articles that report retention strength after cyclic compressive loading. On the other hand, it was not possible to compare compomer cement data due to lack of information in the literature, whereas for the resin urethane-based cement lower and higher retention values are reported.

In treatment with a cemented implant-supported prosthesis, one of the main concerns of the clinician is to use a cement that allows restoration retrievability in the event of a complication. The data show that despite the large percentage of retention loss for the three cements, the use of any of them would favor prosthesis retrievability as only a maximum force of 7.6 kg would be necessary to dislodge compomer or resin urethane-based cement luting crowns and only 5.1 kg in the case of glass-ionomer cement.

Conclusions

Within the limitations of this study, the null hypotheses have been accepted.

Acknowledgments

The authors reported no conflicts of interest related to this study.

References


Literature Abstract

Birth-Weight, Pregnancy Term, Pre-Natal and Natal Complications Related to Child’s Dental Anomalies

The study investigated whether there is an association between low birth weight, preterm birth, and prenatal and natal complications with specific dental anomalies including enamel defects, total decayed/missing/filled teeth (DMFT), and disturbances in shape and number of teeth. Three hundred files of children ages 2 to 17 were reviewed. The associations found were preterm birth and low birth weight (< 2500 g) with hypomineralization in both primary and secondary dentitions. Also, preterm birth and high-risk pregnancy may predict abnormal tooth numbers in both dentitions. There was no association with increased caries, hypoplasia, or abnormal tooth shape, which is in contrast to the findings of other studies. However, different inclusion criteria and the low number of samples in the present study may account for this.

—Steven Soo, Singapore

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