**Introduction**

Luting cements must withstand the forces of mastication and parafunction in the warm and moist oral environment for many years and maintain their integrity while transferring stress from crowns or FPDs to tooth structures.

**Objectives**

**Purpose**

- Determine long-term bond strength of various luting cements to high-gold-content alloy
- Determine influence of artificial aging
- Examine the mode of failure

**Material and Methods**

**Preparation of specimens**

- High-gold-content alloy (Portadur P4; Wieland, Germany) specimens (Ø = 10 mm, h = 1 mm)
- Plastic ring, embedded with slow-polymerizing epoxy (Palapress Vario; Heraeus Kulzer, Germany)
- Wet grinding to 600 grit using SiC sandpaper (Buehler, USA)
- Ultrasonic cleaning in 96% isopropanol for 3 min

**Surface Treatment**

- Airborne-particle abrasion with 100 µm aluminium oxide at 2.8 bar and a distance of 10 mm for 10 seconds
- Application of alloy primer according to the manufacturer's instructions (Panavia F/Alloy primer; Nexus 2/Optibond solo plus; Calibra/Prime&Bond NT and Selfcureactivator)

**Material**

<table>
<thead>
<tr>
<th>Material</th>
<th>Manufacturer</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PermaCem</td>
<td>DMG Hamburg, Germany</td>
<td>dual-polymerizing compomer cement</td>
</tr>
<tr>
<td>RelyX ARC</td>
<td>3M ESPE Seefeld Germany</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>Panavia F</td>
<td>Kuraray Osaka Japan</td>
<td>dual-polymerizing resin cement</td>
</tr>
</tbody>
</table>
**Bonding Procedure**

- Specimens randomly assigned to 12 groups (n = 8 each)
- Materials handled according to the manufacturer's instructions (Table 1)
- Gelatin capsules (Ø = 5.5 mm; Torpac Inc., Fairfield, USA) filled with composite to within 2 mm below the rim
- Capsules bonded perpendicular to the pre-treated high-gold-content alloy surface, applying a weight of 200 g for 10 min using a custom-made device

**Specimen Treatment**

- Group A = aged and tested after 150 day / 37° water storage
- Group B = aged and tested after 150 day / 37° water storage, subsequently thermally cycled 37,500 times (Willytec Typ V2.8; Willytec, Germany) between 5 °C and 55 °C

**Bond Strength Testing**

- Applying shear force using a universal testing machine (Zwicki 1120; Zwick, Germany) at constant crosshead speed of 0.5 mm/min (Figure 1)

**Mode of failure**

- Examination under a light microscope (Stemi 2000-C; Zeiss, Germany), magnification 30x
- Cohesive failure within the bonding substrate, adhesive failure between the cement-bonding substrate interface, or mixed failure

**Statistical Analysis**

- Two-way ANOVA model with all main effects (cementing agent (6 levels) and time of measurement (2 levels))
- Multiple pairwise comparisons (Tukey)
- Significance level (α=0.05)

---

**Table 1: Luting cements**

<table>
<thead>
<tr>
<th>Cement</th>
<th>Manufacturer</th>
<th>Origin</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nexus 2</td>
<td>Kerr Orange</td>
<td>USA</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>DeTray</td>
<td>Dentsply</td>
<td>Germany</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>Konstanz</td>
<td>DeTray</td>
<td>Germany</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>3M ESPE</td>
<td>Calibra</td>
<td>Germany</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>Seefeld</td>
<td>RelyX Unicem</td>
<td>Germany</td>
<td>self-adhesive universal resin cement</td>
</tr>
</tbody>
</table>

---

Fig 1: Mounting jig
Results

- Two-way ANOVA model analyzed significant differences between all main effects (all p<0.0001) and all corresponding interactions (p=0.0376)

- Significant differences (p<0.0001) existed between the six luting cements, and the two times of measurement

- Panavia F reached the highest bond strength values (10.8 ± 2.0 MPa), followed by RelyX Unicem (9.4 ± 0.8 MPa)

- Significant differences (all p<0.02) were seen between Panavia F and all other materials (PermaCem, RelyX ARC, Nexus 2, Calibra, and RelyX Unicem)

- After 150 days of storage in water and subsequent thermal cycling (37,500X), bond strength was significant lower (6.1 ± 2.7 MPa) than after 150 days of storage in water alone (7.5 ± 2.3 MPa) (p<0.0001)

- Failure modes were completely adhesive between the cement-bonding substrate interface

![Fig 2: Mean bond strengths of luting cements to high-gold-content alloy (Portadur P4), pre-treated with 100 µm Al2O3](image)

Conclusion

- The resin cement Panavia F and the self-adhesive universal resin cement RelyX Unicem yielded the highest bond values to high-gold-content alloy over time and after artificial aging

- These cements may be more suitable for the application examined in this in-vitro study

Bibliography


This Poster was submitted by Dr. med. dent. Andree Piwowarczyk.

Correspondence address:
Dr. med. dent. Andree Piwowarczyk
Department of Prosthodontics
School of Dentistry
ZZMK (Carolinum)
J. W. Goethe University
Theodor-Stern-Kai 7
D-60590 Frankfurt
Germany
Durability of Bonds between Luting Cements and High-Gold-Content Alloy

A. Piwowarczyk, K. Zatorska*, K. Lindemann, H.-Ch. Lauer
Johann Wolfgang Goethe University, Frankfurt, Germany

Introduction
Luting cements must withstand the forces of mastication and passivation in the oral and occlusal environment for many years and maintain their integrity while transforming stresses to a consistent force in tooth structures.

Materials and methods
Preparation of specimens
- High-gold-content alloy (Pobrada P4, Wieland, Germany) specimens (N = 10, d = 1 mm)
- Plastic ring, embedded in-slab-polymerizing epoxy (Polykaros Vitis, Heraeus Kulzer, Germany)
- Specimens ground to 480 grit using SC sandpaper (Buehler, USA)
- Ultrasonic cleaning in 96% isopropyl alcohol for 3 min

Surface treatment
- Arterial-patent obstruction with 100 µm aluminum oxide at 2.8 bar and a distance of 15 mm for 10 seconds
- Application of etch primer according to the manufacturer's instructions (Pobrada F/Primer primer; Nexus 2/Optibond occlusal primers; Cambodia/PremixBond # 20 and # 39)

Table 1. Luting cements

<table>
<thead>
<tr>
<th>Material</th>
<th>Brand</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramill</td>
<td>DMG, Hamburg, Germany</td>
<td>dual-polymerizing composite cement</td>
</tr>
<tr>
<td>Relux ARC</td>
<td>3M ESPE, Seefeld, Germany</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>Porelay L</td>
<td>Kunita, Osaka, Japan</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>Nexus 2</td>
<td>Kerr, Orange, USA</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>Cibera</td>
<td>Geplan/Dentsply, Konstanz, Germany</td>
<td>dual-polymerizing resin cement</td>
</tr>
<tr>
<td>Relux Universal</td>
<td>3M ESPE, Seefeld, Germany</td>
<td>dual-polymerizing self-adhesive resin cement</td>
</tr>
</tbody>
</table>

Bonding procedures
- Specimens randomly assigned to 12 groups (n = 4 each)
- Materials handled according to the manufacturer's instructions (Table 1)
- Cylindrical specimens (D = 5.5 mm; Torx inc., Farfield, USA) filled with composite to within 1 mm below the rim
- Copolymer bonded perpendicular to the pre-treated high-gold-content alloy surface, applying a weight of 200 g for 10 min using a computerized device

Specimen treatment
- Group A = aged air dried after 150 day/37°C water storage
- Group B = aged and tested after 100 day/37°C water storage, subsequently thermally stressed (11 200 times; 37°C up and 12°C down)
- Wilhens, Germany, between 5°C and 55°C

Bond strength testing
- Applying slow force using a universal testing machine (Zwick 2000/3: Zwick, Germany), magnification 3x
- Cylindrical failure within the bonding substrate, adhesive failure between the cement-bonding substrate interface, or mixed failure

Statistical analysis
- Two-way ANOVA model with all main effects (cementing agent, 6 levels) and time of measurement (2 levels)
- Multiple pairwise comparisons (Tukey)
- Significance level (p < 0.05)

Results
Two-way ANOVA model analysis significant differences between all main effects (p < 0.0001) (please find corresponding interactions, 37°C/37°C).
- Significant differences (p < 0.0001) existed between the six luting cements, and the time of measurement.
- Pobrada F revealed the highest bond strength values (19.8 ± 2.6 MPa), followed by Relux AR3 (16.4 ± 1.9 MPa).
- Significant differences (all p < 0.0001) were seen between Pobrada F and all other materials (Ceramill, Relux ARC, Nexus 2, Cambria, and Relux Universal).
- After 300 days of storage in water and under repetitive thermal cycling (12 200 times), bond strength was significantly lower (6.1 ± 2.7 MPa) than after 150 days of storage in water alone (7.5 ± 3.6 MPa) (p < 0.0001).
- Failure mostly cohesive within the bonding substrate interface.

References

Conclusions
- The main cement Pobrada F and the self-adhesive universal resin cement Relux Universal yielded the highest bond values to high-gold-content alloy over time and after artificial aging.
- These cements may be more suitable for the application encountered in this in-vitro study.