Dear Reader,

Welcome to the 85th General Session of the IADR. We would like to invite you to visit the 3M ESPE Hospitality Center and meet our oral care research staff including representatives from 3M Unitek, OMNI Preventive Care, and Brontes Technologies, Inc. You’ll be invited to select from a variety of Expertise™ scientific and technical resources, including this latest edition of Expertise™ Scientific Facts, CD collections, brochures and website registration information. We hope that you find value in this independent, objective information covering the latest advances in dentistry. Our goal is to provide knowledge you can use and information you can trust.

Throughout this brochure we have reproduced scientific abstracts unchanged as submitted by their respective authors. Based on the data contained in these abstracts, we have added graphics and “Aim of the Study” and “Results of the Study” summaries. We would especially like to highlight research in the following areas:

Cements and Provisional Products

3M ESPE has brought many firsts to dental professionals worldwide. Now, we bring you Protemp® Crown Temporization Material, the world’s first single-unit self-supporting, malleable, light-curable composite crown. Protemp material comes in one universal shade and a variety of preformed sizes. You can learn more about this exciting new product by reviewing the three in vitro studies found in this collection which explore the handling and mechanical properties of Protemp® Crown and the fracture resistance and marginal adaptation of this revolutionary new material.

3M™ ESPE™ RelyX™ Unicem Self-Adhesive Universal Resin Cement is characterized by a higher moisture tolerance, as compared to multi-step composite cements. RelyX Unicem cement releases fluoride ions, has high dimensional stability and adhesion to tooth structure, and is available in a variety of shades. RelyX Unicem cement is now available in the award winning Clicker™ Dispenser. Twenty-three abstracts are included in this publication specific to RelyX Unicem cement. This kind of attention is not surprising for a product that has changed the basis of competition in the universal resin cement category. The subject matter of the abstracts range from bond strength and material properties overviews to a study comparing the retentive values of 3M™ ESPE Fiber Post cemented with RelyX Unicem cement. You will also find a clinical study reviewing the use of RelyX Unicem cement in combination with Lava™ Crowns and Bridges from 3M ESPE.

Lab and Digital Products

The new Lava™ Scan ST Scanner, part of the Lava™ CAD/CAM system from 3M ESPE, is a non-contact, optical 3-D scanning device which is 50% faster than the first generation Lava™ Scan and delivers excellent marginal fit. By offering the Lava Scan ST scanner, laboratories can either outsource the framework or coping to an Authorized Lava™ Milling Center (ALMC) or use the Lava Scan ST to design their own coping for milling at an ALMC. This option provides more design control and allows for closer collaboration between dentists and their local dental laboratory when creating Lava restorations. We would like to call your attention to one specific abstract which shows that the new Lava Scan ST shows the same accuracy at a larger scan length when compared with the original Lava scan software.

Several abstracts are presented in this collection which further documents the high strength of Lava crowns and bridges. Clinical performance was evaluated in three in vivo studies following 300 bridges made from a variety of zirconia materials. As expected, Lava bridges are performing well in these studies. We believe that Lava crowns and bridges, together with recent acquisition of Brontes Technologies, Inc. (developer of a three-dimensional intraoral scanning solution) will allow 3M ESPE to drive the digital workflow approach in the dental marketplace. We are very excited about these new opportunities.
Direct Restorative Products

3M ESPE restorative products are characterized by a series of firsts. Just a few examples:
- Scotchbond™ Adhesive represented the first commercially successful dental adhesive.
- Vitrebond™ Light-Cure Glass Ionomer Liner/Base was the first light-cure glass ionomer.
- Filtek™ Supreme Universal Restorative introduced the first true nano-composite. Adper™ Prompt™ L-Pop™ Self-Etch Adhesive, in its award winning package, represents the first unit-dose two-part self-etch system.

Current products include Filtek™ Supreme Plus Universal Restorative, which offers the unique combination of strength and esthetics provided by 3M ESPE patented nanotechnology; Filtek™ Supreme Plus Flowable, which offers strength and wear properties very similar to those of its universal counterpart; Adper Prompt, which offers excellent performance on dentin, cut enamel, as well as an excellent etch on uncut enamel; Adper™ Scotchbond™ Multi-Purpose Adhesive and Adper™ Single Bond Plus Adhesive, two proven total-etch dental adhesive systems; and the time-proven Ketac™ line of conventional glass ionomers. You will find study results for these products in this year’s IADR synopsis.

Preventive Products

With increasing recognition of the link between oral health and total health, it is more important than ever to provide patients with solutions to address early indicators of oral disease. 3M ESPE sees a way to make a difference in this field with unique science and technology. Our acquisition of OMNII Preventive Care will enable us to deliver more value, preventive expertise and products. As an example, we are pleased to introduce Vanish® 5% Sodium Fluoride White Varnish from OMNII which provides enhanced flow characteristics for thorough coverage. Rapid set allows the patient to eat or drink immediately, and unit-dose packaging assures convenience and dosage consistency.

The abstracts contained in this publication demonstrate our strong commitment to cooperative research with internationally respected universities, researchers and world-renowned clinicians. Thank you very much for your work, which provides the foundation for this independent, objective view of our products and helps us create exciting and innovative dental solutions.

Sincerely,

Dr. Bettina Richter
Global Scientific Marketing Manager
St. Paul, MN and Seefeld, Germany
March 2007
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Temperature effect on the setting of dental impression materials

T. KLETTKE, B. KUPPERMANN, D. RANFTL, and R. HAMPE, 3M ESPE, Seefeld, Germany

Objectives: The purpose of this study was to compare setting of two groups of impression materials, 3M ESPE Polyether and common VPS, as a function of temperature.

Methods: Four impression materials were investigated: Impregum Penta (IP), 3M ESPE, Impregum Penta Soft (IPS) 3M ESPE, Aquasil Ultra DECA 380 Monophase (AqU) Dentsply, Affinis 360 MonoBody (Aff) Coltene. Measuring the setting kinetics was performed at different temperatures using a dynamic stress rheometer (Physica MCR300, Anton Paar) equipped with 25 mm parallel plate geometry (flat surfaces, 1 mm gap size). Temperature was controlled within 0.1°C. Measurements were strain controlled and performed at a frequency of 1Hz with strain amplitude of 0.001. The storage modulus G’ was monitored over time (one data point per second). The point of inflection PoI (Berg et al., J Prosth Dent 2003, 150–161) obtained from the curves of G’ (t) of the individual materials (n=5) was used as the reference point.

Results: A general linear model and a Tuckey test for pairwise comparisons was used for analysis (p<0.05).

<table>
<thead>
<tr>
<th>Temperature [°C]</th>
<th>PoI [s]</th>
<th>G’(t) [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IP(SD)</td>
<td>IPS(SD)</td>
</tr>
<tr>
<td>15</td>
<td>901(19.6)</td>
<td>979(15.5)</td>
</tr>
<tr>
<td>18</td>
<td>691(8.9)</td>
<td>707(68.8)</td>
</tr>
<tr>
<td>23</td>
<td>464(14.7)</td>
<td>522(9.6)</td>
</tr>
<tr>
<td>25</td>
<td>399(4.4)</td>
<td>446(4.5)</td>
</tr>
<tr>
<td>33</td>
<td>232(9.7)</td>
<td>251(8.2)</td>
</tr>
<tr>
<td>total change PoI/°C</td>
<td>37.2(a*)</td>
<td>40.4(a)</td>
</tr>
</tbody>
</table>

* Same letters are not significantly different within the same row.

The setting time of all materials tested was shortened when higher temperatures were applied. However, AqU was most sensitive to temperature change which is pronounced at lower temperatures. IP and IPS were least sensitive to temperature change.

Conclusions: Within the limitations of this study polyethers IP and IPS demonstrated a significantly less temperature sensitive setting than the VPS AqU and Aff, supporting the high clinical reliability of 3M ESPE polyether impression materials.

Temperatures and corresponding times for the PoI obtained from G’ (t).

Aim of the Study: It is well known that the setting reaction of dental impression materials is a function of temperature; the higher the temperature the faster the set. This fact is important because the initial temperature at which a material is used may vary due to storage conditions and seasonal changes.

Results of the Study: The setting of Impregum Penta Soft and Impregum Penta was least sensitive to temperature change. The low sensitivity to temperature change supports the high clinical reliability of 3M ESPE polyether impression materials.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Flowability of impression materials during working time
K. OHKUMA, R.A. YAPP, and J.M. POWERS, Dental Consultants, Inc, Biomaterials Research Center, Ann Arbor, MI, USA

Objectives: This study characterized the flowability of addition silicone and polyether impression materials relative to working time and dry vs. wet environments utilizing the Shark Fin test.

Methods: The Shark Fin test employing a 2 mm mold was used. The maximum height of the shark fin was measured for two, light-bodied impression materials [Affinity VPS Light body HF/ Clinician’s Choice (AS), 3M ESPE Impregum Garant L Duo Soft/3M ESPE (PE)] at four time points (25, 90, 120, 150 seconds after completion of mixing) using wet and dry mold components. Data were analyzed by three-way ANOVA and Fisher’s PLSD test at the 0.05 level of significance.

Results: The heights of the shark-fin are listed. Fisher’s PLSD intervals (p=0.05) for material, condition and time were 0.4, 0.4 and 0.6 mm, respectively.

<table>
<thead>
<tr>
<th>Time</th>
<th>AS-dry</th>
<th>AS-wet</th>
<th>PE-dry</th>
<th>PE-wet</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>15.2(1.1)</td>
<td>13.9(0.9)</td>
<td>13.0(0.4)</td>
<td>11.2(0.4)</td>
</tr>
<tr>
<td>90</td>
<td>7.2(2.0)</td>
<td>9.1(2.3)</td>
<td>14.0(1.0)</td>
<td>17.6(0.5)</td>
</tr>
<tr>
<td>120</td>
<td>4.1(0.6)a</td>
<td>4.3(0.6)a</td>
<td>14.2(0.9)</td>
<td>14.6(1.0)</td>
</tr>
<tr>
<td>150</td>
<td>2.6(0.4)b</td>
<td>2.3(0.7)b</td>
<td>3.6(0.1)</td>
<td>5.8 (1.0)</td>
</tr>
</tbody>
</table>

At 90 to 150 seconds, heights of the shark fin for PE were higher than for AS and wet mold surfaces produced greater shark fin heights than dry surfaces for PE.

Conclusions: PE had higher flowability than AS after 30 seconds of working time. After 25 seconds, PE had higher flowability in the wet than dry condition.

Aim of the Study: The monophase and 1-step heavy-body, light-body impression technique in particular require a light bodied impression material with high flow. This study used the shark fin tool to determine flow properties under dry vs. wet conditions. Affinity VPS Light Body HF and Impregum Garant L DuoSoft were compared.

Results of the Study: Impregum showed very high flow throughout its entire working time in contrast to the VPS material. In the shark fin test, Impregum had higher flow in the wet environment after 30 seconds. High flow throughout the working time of an impression material, especially in a wet environment, is an indicator of predictable clinical results.
Initial Water and Saliva Wettability of Elastomeric Impression Materials

F. Rupp, A.M. Martin, I. Stephan, D. Axmann, and J. Geis-Gerstorfer, University Hospital Tuebingen, Germany

Objectives: Usually, wettability studies of unset impression materials are performed with water drops placed on thin material films. Clinically, however, the impression materials will contact physiological solutions, e.g. saliva. This study focuses on whether water is a proper model liquid instead of physiological solutions for hydrophilicity studies, especially for the clinically relevant “initial hydrophilicity”.

Methods: Three additional curing silicones (Affinis, Flexitime, Panasil Contact Plus) and one polyether (Impregum L Duosoft Quick) were studied 30s, 60s and 90s after mixing by high resolution drop shape analysis for initial contact angles of 1/25s and 1s old drops of pure water and modified Fusayama saliva containing bovine serum albumin. Each measurement was repeated fivefold and the mean contact angles of water and saliva were tested for statistically significant differences (t-test, p<0.05).

Results: All materials showed 30s after mixing for both drop times analyzed (1/25s and 1s) no statistically significant differences between water and saliva mean contact angles (p>0.05). The mean difference (standard deviation) between water and saliva of all measurements was 0.7° (4.2°) for 1/25s old drops and 0.7° (2.7°) for the 1s drops and thus being small compared to the measurement accuracy (mean standard deviation of 6.3° for repeated measurements). The 95% confidence interval of all differences of 1/25s old drops ranges from −2.0° to 3.4° and of 1s old drops from −1.1° to 2.4°.

Conclusions: Based on this study, pure water is suitable for hydrophilicity studies during the setting time of impression materials. Since water contact angle data are comparable to those of saliva used here and lead to the same results in the evaluation of materials, water can be used as a model liquid simulating physiological wetting conditions.

Aim of the Study: One very important feature for impression materials is their hydrophilicity. From a clinical perspective, this is of major importance during intraoral application within the working time. Previously reported contact angle measurements [IADR 2004 #1385, IADR 2005 #3084] used water as the fluid and showed that Impregum impression materials have the highest wettability in the unset stage. This study compared contact angles measured using water with those measured using artificial saliva.

Results of the Study: Water contact angle data are comparable to those of salvia. The study confirms the superior hydrophilicity of Impregum impression materials under clinically relevant conditions.
Detail Reproduction of Impression Materials on a Wet Surface

R. PERRY, G. KUGEL, E. APPELIN, and B. GREEN, Tufts University, Boston, MA, USA

Objectives: To measure impression detail reproducibility on a wet surface.

Methods: A SiMetricS Micostructure Monocrystal-Silicon standard block (dimensions: groove-depth=5µm, groove-width=8µm) with 50 periods was used. The standard block was surrounded by a ring mould and 1-drop deionized water was placed inside. The ring mould was over-filled with impression material. A perforated cap, followed by a ring spacer, and then glass plates, were placed atop the mould (Total=11.36 kPa). Analysis of lines was done with respect to ISO 4823:2000(E) at 23°C. However, a SEM (LEO1530 VP), at magnification=200X, was used to view various polyether and vinylpolysiloxane impression microstructures. Impression materials used included:

Results: Using various impression materials, it was shown that groups 9–10 obtained a significantly higher detail impression reproducibility under wet conditions compared to all others. It was not possible to attain results for group 11 because it bonded to the standard block. Among groups 1–8, there was no significant difference in detail impression reproducibility.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Impression Material</th>
<th>Impression Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DMG Honigum Light</td>
<td>VPS</td>
</tr>
<tr>
<td>2</td>
<td>Dentsply Aquasil Ultra XLV</td>
<td>VPS</td>
</tr>
<tr>
<td>3</td>
<td>Dentsply Aquasil Ultra LV</td>
<td>VPS</td>
</tr>
<tr>
<td>4</td>
<td>Heraeus Kulzer Flexitime Correct Flow</td>
<td>VPS</td>
</tr>
<tr>
<td>5</td>
<td>GC Examix NDS</td>
<td>VPS</td>
</tr>
<tr>
<td>6</td>
<td>Kettenbach Panasil contact</td>
<td>VPS</td>
</tr>
<tr>
<td>7</td>
<td>Coltene Whaledent Affinis</td>
<td>VPS</td>
</tr>
<tr>
<td>8</td>
<td>GC Senn Light Body</td>
<td>VPS-Polyether/Hybrid</td>
</tr>
<tr>
<td>9</td>
<td>3M ESPE Impregum Garant Soft*</td>
<td>Polyether*</td>
</tr>
<tr>
<td>10</td>
<td>3M ESPE Permadyne Garant 2:1*</td>
<td>Polyether*</td>
</tr>
<tr>
<td>11</td>
<td>Heraeus Kulzer P2 Polyether**</td>
<td>Polyether**</td>
</tr>
</tbody>
</table>

* Cationic curing    ** Condensation curing

Statistics for groups 1–11 were analyzed using a One-way ANOVA (p-value 0.000, α=0.05).

Conclusions: Higher detail impression reproducibility is a valuable characteristic when removing intra-oral impressions. Groups 9–10 demonstrated a significantly higher detail impression reproducibility on a wet surface as compared to all other impression materials. Groups 9–10 may indicate a more reliable choice for intra-oral use. Clinical detail impression reproducibility was unable to be determined for group 11.

Graph adapted from original source.

Aim of the Study: To evaluate the detail reproduction of Type 3 precision impression materials on a wet surface. Three different types of materials were investigated including: three polyethers (two cured via cationic ring-opening polymerization and one cured via condensation reaction) and eight hydrophilized polysiloxanes cured via hydrosylation.

Results of the Study: Impregum and Permadyne, the polyethers cured via cationic ring-opening polymerization, have the highest detail reproduction when tested under clinically relevant moist conditions.
Impregum™/Imprint™ 3

Tear strength and dimensional accuracy of elastomeric impression materials

Y. WHITEMAN, and D. NATHANSON, Boston University, MA, USA

Objectives: This study evaluates new impression materials for tear strength and effect of time and storage temperature on dimensional accuracy.

Methods: Low-viscosity impression materials: A. Imprint (3M ESPE); B. Imprint Quickset (3M ESPE); C. Flexitime (Heraeus Kulzer); D. Aquasil (Dentsply); E. Impregum (3M ESPE) were tested for tear strength. Specimens (ADA Specification #19) were prepared in special molds and tested in tension (Instron) 24 hours after setting. Materials A, B, and E were also tested for effect of time/temperature on dimensional accuracy. Impressions (n=27/group) made of a standard stainless steel die (Spec #19) were measured under a measuring microscope with +/-1 Micron resolution 1 hour after setting. Each group was further divided into 3 groups (n=9 each) according to storage temperature: 1. 21°C; 2. -12°C; and 3. 37°C; and kept at these temperatures for 2 weeks, then retested for dimensions.

Results: Data (shown) were analyzed using ANOVA and Tukey-Kramer Multiple Comparisons test:

<table>
<thead>
<tr>
<th>Material</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tear Strength (N/mm²)</td>
<td>0.324 (.05)</td>
<td>0.261 (.01)</td>
<td>0.214 (.02)</td>
<td>0.373 (.02)</td>
<td>0.328 (.02)</td>
</tr>
<tr>
<td>% Change 21°C</td>
<td>0.041%</td>
<td>N/A</td>
<td>N/A</td>
<td>-0.129%*</td>
<td>-0.148%</td>
</tr>
<tr>
<td>% Change -12°C</td>
<td>-0.074%*</td>
<td>N/A</td>
<td>N/A</td>
<td>-0.198%*</td>
<td>-0.009%</td>
</tr>
<tr>
<td>% Change 37°C</td>
<td>0.047%</td>
<td>N/A</td>
<td>N/A</td>
<td>-0.13%*</td>
<td>-0.079%</td>
</tr>
</tbody>
</table>

A significant difference in tear strength was found among the materials–Material C was lower than A, D, and E (p=.001); Material B was lower than D (p=.001) and E (p=.05). Storage (2 wks) generated significant dimensional differences in Group B at all temperatures and in Group A at -12°C, however all differences were within accepted clinical parameters.

Conclusions: Tear strength varied significantly among the materials tested. Storage (2 wks) at 21°C, -12°C and 37°C generated some dimensional changes. All changes were small and within ADA specifications and accepted clinical parameters.

Aim of the Study: Tear strength and effect of storage time and temperatures on dimensional accuracy was evaluated.

Results of the Study: High tear strength and dimensional stability after storage at various temperatures were recorded for Impregum and Imprint 3 impression materials.

Impregum™/Imprint™ 3

Flow of Fast and Regular Set Elastomeric Impression Materials
A. Hadley, N.C. Lawson, J.O. Burgess, and L.C. Ramp, UAB School of Dentistry, Birmingham, AL, USA

Precise impressions are crucial for preparing accurate dental restorations. For dental impressions, it is important to have materials with increased flow at the end of the setting time to increase the ability of the impression material to capture the prepared subgingival margins and decrease folds in the impression material.

Objectives: This research compares flow of seven different impression materials with different viscosities (light and extra light) and setting times (fast and regular).

Methods: Flow was measured using a shark fin testing apparatus. Each impression material was injected into a shark fin mold and the weighted caste was dropped into the impression material 30 seconds after injection. The mold was then placed in a 37°C incubator. Additional trials were performed at 30 second intervals. Impression material flowed up the triangular notch in the caste creating a “shark fin” which was measured for each time/material combination.

Results:

<table>
<thead>
<tr>
<th>Impression Material</th>
<th>Mean shark fin height (mm) 30s,60s,90s,120s,150s,180s,210s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquasil LV</td>
<td>20.98, 16.87, 8.06, 3.18, 1.08, 0, 0</td>
</tr>
<tr>
<td>Aquasil LV-fast</td>
<td>14.98, 7.37, 3.08, 0.56, 0</td>
</tr>
<tr>
<td>Aquasil XLV</td>
<td>25.81, 25.60, 24.55, 17.70, 6.96, 2.38, 0</td>
</tr>
<tr>
<td>Aquasil XLV-fast</td>
<td>25.77, 10.24, 1.62, 0, 0, 0</td>
</tr>
<tr>
<td>Genie LB-rapid</td>
<td>26.24, 24.43, 15.70, 3.86, 1.03, 0, 0</td>
</tr>
<tr>
<td>Genie XLB</td>
<td>25.58, 22.28, 3.77, 2.06, 0, 0, 0</td>
</tr>
<tr>
<td>Imprint 3 LB</td>
<td>25.69, 21.34, 16.34, 8.56, 5.51, 0, 0</td>
</tr>
<tr>
<td>Imprint 3 LB-quick</td>
<td>23.57, 17.32, 9.93, 3.03, 1.14, 0, 0</td>
</tr>
<tr>
<td>Impregum LB</td>
<td>25.47, 24.92, 25.05, 24.96, 17.73, 3.08, 0.61</td>
</tr>
<tr>
<td>Impregum LB-quick</td>
<td>25.09, 25.61, 26.71, 14.02, 0.8, 0, 0</td>
</tr>
<tr>
<td>Senn LB</td>
<td>25.97, 23.48, 13.86, 7.03, 2.10, 0.76, 0</td>
</tr>
<tr>
<td>Senn LB-fast</td>
<td>25.13, 15.86, 3.32, 0.73, 0, 0, 0</td>
</tr>
<tr>
<td>Stand Out W-fast</td>
<td>24.01, 14.22, 5.81, 2.86, 0, 0, 0</td>
</tr>
<tr>
<td>Stand Out W-superfast</td>
<td>23.95, 13.80, 4.04, 1.71, 0, 0, 0</td>
</tr>
<tr>
<td>Virtual XL-fast</td>
<td>24.84, 11.44, 3.63, 0.79, 0, 0, 0</td>
</tr>
<tr>
<td>Virtual XLB</td>
<td>26.00, 24.75, 24.92, 22.76, 11.88, 5.57, 0.39</td>
</tr>
<tr>
<td>Virtual XLB-fast</td>
<td>25.74, 24.68, 21.28, 5.91, 1.51, 0, 0</td>
</tr>
</tbody>
</table>

The data were analyzed using a three factor ANOVA. Separate ANOVA’s and Tukey HSD post-hoc analysis were used to determine significant inter group differences (p=.05). Significant differences in shark fin height were recorded for the various impression materials. In general, low viscosity impression materials produced higher flow. Impression material, fast or regular setting time, and measurement time were highly significant factors (p<.01).

Conclusions: Flow of impression materials varies by brand, therefore, impression material selection should be based in part upon the depth of the preparation and the speed of the operator. Supported by NSF EEC-0244050 Grant.

Aim of the Study: The study used the shark fin method to measure the flow of regular and fast setting light bodied impression materials. Measurements were conducted at mouth temperature (37°C) in intervals of 30 seconds from 30 seconds to 210 seconds.

Results of the Study: This study validates the very high flow of Impregum over a prolonged period of time under clinically relevant conditions.
Aim of the Study: Excellent flow properties are especially important when syringing impression material into the sulcular area of a preparation. Clinically relevant flow characteristics may depend on the chemical composition as well as on the curing mechanism employed. This study evaluated the flowability of Type 1, Type 2 and Type 3 impression materials at 25 seconds after start of mix and at 80% of the working time using the shark-fin tool. Three different types of materials were investigated: polyether cured via cationic ring-opening polymerization (Impregum, Permadyne), polyether cured via condensation reaction (P2 Polyether) and polysiloxanes cured via hydrosylation, VPS (Aquasil Ultra).

Results of the Study: The polyether cured via cationic ring-opening polymerization showed superior flow properties. Only Impregum Garant L DuoSoft and Permadyne Garant 2:1 maintained high flow in this time-dependent measurement which is an indicator of the clinical reliability of 3M ESPE polyether impression materials.

Table: The flow properties of light materials were significantly higher than those of bodies materials. In regard to different time elapsed since the start of mix, all materials (except for Permadyne Garant 2:1 and Impregum Garant L DuoSoft) showed a significantly reduction of flow ability.

Conclusions: The flow properties of light materials were significantly higher than those of bodies materials. In regard to different time elapsed since the start of mix, all materials (except for Permadyne Garant 2:1 and Impregum Garant L DuoSoft) showed a significantly reduction of flow ability.
Flow of fast and regular set elastomeric impression materials

J.C. BROOME¹, J.O. BURGESS¹, and N.C. LAWSON¹, ¹UAB School of Dentistry, Birmingham, AL, USA, ²Louisiana State University, Tulane University, New Orleans, USA

Objectives: Making accurate impressions is critical for restorative dentistry. The ability to capture the prepared tooth margin is crucial in this process and may be improved by using impression materials with improved flow.

Methods: This study examined the flow of 13 impression materials (representing polyether, hybrid and polyvinylsiloxane) from 60 seconds to 240 seconds after mix. Methods: A metal mold was assembled and placed into an incubator and maintained at 98.6°F. The impression materials were mixed following the manufacturers directions and inserted into the mold. The pin was removed to generate the shark fin at 60, 90, 120, 180 and 240 seconds for each impression material. The mold was returned to the incubator and after polymerization the mold was disassembled and the fin measured at its highest point. A two-factor ANOVA evaluated the data for intergroup differences. Tukey B post-hoc analysis. Significance=.05.

Results: Height=mm (n=5). Fin height at 60s, 90s, 120s, 180s, 240s. Impregum Soft Quick Step Light 24.0, 16.0, 6.1, 0.5, 0.0; SENN fast set 9.7, 3.6, .30, 0.0, 0.0; Aquasil Ultra LV fast set 3.4, 1.2, 0.2, 0.0, 0.0; Affinis light fast set 6.0, 1.8, 0.5, 0.0, 0.0; Virtual light fast set 14.1, 3.2, 0.2, 0.0, 0.0; Exafast injection 7.5, 1.0, 0.0, 0.0, 0.0; Genie Ultra light fast set 6.1, 0.9, 0.1, 0.0, 0.0; Splash Lite half time 3.5, 0.7, 0.0, 0.0, 0.0; Precision Lite 9.2, 2.6, 1.4, 0.0, 0.0; Aquasil Ultra LV regular set 5.3, 2.6, 0.9, 0.1, 0.0; Aquasil XLV regular set 16.2, 8.9, 3.9, 0.6, 0.0; Genie Ultra Light standard set 7.8, 2.5, 0.5, 0.1, 0.0. Time and material were significant factors p<.05.

Conclusions: Impression material selection should be partially determined by the flow of the material especially when making impressions of multiple prepared teeth. Impregum had significantly greater flow than all other impression materials (p<.05).

Time-dependant heights of shark fin at 98.6°F [mm]

Aim of the Study: This study used the shark fin tool as a measurement device. Tests were performed at 98.6°F to simulate mouth temperature. Measurements were carried out at 60, 90, 120, 180 and 240 seconds.

Results of the Study: The results of this study validate the superior flow of Impregum over a prolonged period of time under clinically relevant conditions.

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**Measuring Flow of Regular Set Impression Materials Using Oscillating Rheometer**

S. STPHO, C. MAILOLO, W. JONES, R. PERRY, and G. KUGEL, Tufts University, Boston, MA, USA

**Objectives:** The purpose of this study was to measure the ratio of plastic (G’”) and elastic (G’) properties of eight regular set impression materials during the whole working time to determine the best flowable materials.

**Methods:** An oscillating rheometer was set at 37°C and a small sample of impression material was mixed and placed onto the base plate within 15 seconds. After 30 seconds, the rheometer program began recording the polymerization of the material until the end of working time. The ratio (δ) represents G’”/G’ and this value was obtained to determine which materials gave the best flow; the higher the δ value, the better the flow. The materials used were: Impregum Garant Soft Light Body (ImS, 3M ESPE), Aquasil Ultra XLV (AqUXLV, Dentsply), Aquasil Ultra LV (AqULV, Dentsply), Affinis Light Body (AFL, Coltene), Splash Extra Lite Body (SpXL, Discus Dental), Examix NDS Injection Type (ExNDS, GC), Flexitime Correct Flow (FC, Heraeus-Kulzer), P2 Polyether (P2, Heraeus-Kulzer).

**Results:** (n=5) for 45 sec and 1min 15 sec were analyzed by ONE-WAY ANOVA and Tukey test (p<0.05).

H0: All impression materials have the same flowability.

<table>
<thead>
<tr>
<th>Material</th>
<th>ImS</th>
<th>AqUXLV</th>
<th>AqULV</th>
<th>AFL</th>
<th>SpXL</th>
<th>ExNDS</th>
<th>FC</th>
<th>P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean δ (45 sec)</td>
<td>68.5</td>
<td>48.1</td>
<td>52.3</td>
<td>32.1</td>
<td>49.1</td>
<td>68.8</td>
<td>47.9</td>
<td>40.9</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.8</td>
<td>0.2</td>
<td>0.5</td>
<td>0.8</td>
<td>0.3</td>
<td>0.3</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Ranking</td>
<td>A</td>
<td>C</td>
<td>B</td>
<td>E</td>
<td>C</td>
<td>A</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>ImS</th>
<th>AqUXLV</th>
<th>AqULV</th>
<th>AFL</th>
<th>SpXL</th>
<th>ExNDS</th>
<th>FC</th>
<th>P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean δ (1 min 15 sec)</td>
<td>61.4</td>
<td>54.1</td>
<td>38.1</td>
<td>28.8</td>
<td>37.1</td>
<td>45.1</td>
<td>34.7</td>
<td>37.3</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>3.0</td>
<td>2.2</td>
<td>1.8</td>
<td>2.8</td>
<td>5.2</td>
<td>2.2</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>Ranking</td>
<td>A</td>
<td>C</td>
<td>C,D</td>
<td>E</td>
<td>C,D</td>
<td>B</td>
<td>D</td>
<td>C,D</td>
</tr>
</tbody>
</table>

**Conclusions:** Impregum and Examix showed the best flow with highest δ values. After 1 min 15 sec elapsed, only Impregum continued to retain the most plastic behavior while the other materials became more elastic. This shows that Impregum has the most flowability and would indicate high clinical reliability during working time. This study was sponsored in part by 3M ESPE.

**Flow (loss factor δ) after 1min 15sec at 37°C**

**Aim of the Study:** High flow of light bodied impression materials is crucial for clinical success. Flowability may alter with time especially at elevated temperature. The study investigates the flowability of eight light bodied regular setting impression materials at 37°C as a function of time using a common rheometer method monitoring the loss factor (δ).

Three different types of materials were compared: a polyether cured via cationic ring-opening polymerization (Impregum Garant Soft Light Body), a polyether cured via condensation reaction (P2 Polyether Light Body) and polysiloxanes cured via hydrosilylation, VPS (Aquasil Ultra XLV, Aquasil Ultra LV, Affinis Light Body, Splash Extra Light Body, Examix NDS Injection Type, Flexitime Correct Flow).

**Results of the Study:** Only the polyether cured via cationic ring-opening polymerization, Impregum Garant Soft Light Body, retained a high level of flow over the entire course of the products’ stated working time. These results support the high clinical reliability of Impregum impression materials.
Effects of Various Adhesive Materials on Implant Coping Torque Strength

R. PERRY, G. KUGEL B. GREEN, and E. APPELIN, Tufts University, Boston, MA, USA

Objectives: To measure in vitro torque strength exerted on a sandblasted, cylindrical simulated implant coping by embedding it into various impression materials.

Methods: Each impression well was filled with various polyether and vinylpolysiloxane impression materials and leveled:

<table>
<thead>
<tr>
<th>Group</th>
<th>Impression Material</th>
<th>Impression Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heraeus Kulzer Flexitime Monophase</td>
<td>VPS</td>
</tr>
<tr>
<td>2</td>
<td>Dentsply Aquasil Ultra Monophase</td>
<td>VPS</td>
</tr>
<tr>
<td>3</td>
<td>Kettenbach Dental Monopren transfer</td>
<td>VPS</td>
</tr>
<tr>
<td>4</td>
<td>DMG Honigum</td>
<td>VPS</td>
</tr>
<tr>
<td>5</td>
<td>Coltene® Affinis</td>
<td>VPS</td>
</tr>
<tr>
<td>6</td>
<td>3M ESPE Impregum Penta</td>
<td>Polyether*</td>
</tr>
<tr>
<td>7</td>
<td>3M ESPE Impregum Penta Soft</td>
<td>Polyether*</td>
</tr>
<tr>
<td>8</td>
<td>Heraeus Kulzer P2 Monophase</td>
<td>Polyether**</td>
</tr>
</tbody>
</table>

* Cationic curing ** Condensation curing

The simulated implant coping was immediately inserted into a perforated cap and pushed into the filled tray, thereby inserting the implant coping into the impression material. Tray spillways allowed excess material to escape upon insertion of the implant coping. 15-minutes elapsed before each sample was torqued. A Mark-10 Corporation Digital Torque Gauge (model MGT50; range from 0–570 NCM and a resolution of 0.5 NCM) measured all values. Statistics for groups 1–8 were analyzed using a One-way ANOVA (p-value 0.000, α=0.05).

Results: Using various impression materials, it was shown that Groups 6–7 materials obtained a significantly higher torque strength compared to all others. Group 8 showed a significantly lower torque strength compared to all other impression materials. There were significant differences in torque strengths among groups 1–5

Conclusions: Groups 6–7 demonstrate a significantly higher torque strength compared to Groups 1–5, 8 Higher torque strength, which decreases implant rotation, is advantageous when removing intra-oral impressions. Therefore, Groups 6–7 may indicate more reliable choice for intra-oral use.

Graph adapted from original source.

Aim of the Study: This study compares the amount of torque required to rotate a cylindrical sandblasted implant coping in set impression materials. The higher the torque the lower the chance the coping will be dislodged. Three different types of materials were investigated.

Results of the Study: Impregum Penta Soft and Impregum Penta required the highest torque strength to rotate the implant coping. High torque decreases the chance of accidental implant displacement. The results show that because of their strong fixation ability, 3M ESPE polyether materials are a preferred material for making implant impressions.
Accuracy of High Viscosity VPS Impression Materials Using Dual-arch Trays
A. H. KANG, G.H. JOHNSON, and X. LEPE, University of Washington, Restorative Dentistry, Seattle, USA

Objectives: A VPS impression material line has been reformulated; therefore the accuracy must be confirmed. Purpose was to compare accuracy of two high viscosities (putty, heavy) for the newly formulated (Imprint 3) and an existing product, using dual-arch trays.

Methods: Evaluated were Dentsply-Caulk Aquasil-Ultra Rigid Fast-Set vinylpolysiloxane and LV (AQ-R), Dentsply-Caulk Aquasil-Ultra Heavy Fast-Set vinylpolysiloxane and XLV (AQ-H), 3M ESPE Imprint 3 Penta Putty and Quick-Step Regular Body (IM3-P); and 3M ESPE Imprint 3 Quick-Step Penta Heavy Body and Quick-Step Light Body (IM3-H) using Premier Triple-Trays. Impression accuracy was assessed by measuring gypsum dies (Type-4, ResinRock, WhipMix) of a modified typodont. Ten dual-arch impressions for each material were made; all were spray disinfected (Cavicide, 10-min). Measurements of dies were made for buccolingual (BL), mesiodistal (MD), occlusogingival-buccal (OG-B) and occlusogingival-lingual (OG-L) aspects and compared to the stainless-steel master crown preparation. Single-factor ANOVA for each dimension with Dunnett’s-T3 multiple comparisons (α=0.05).

Results: Mean difference for gypsum die minus master crown preparation dimension shown below. SD in parentheses. Significant differences shown as < or >.

<table>
<thead>
<tr>
<th></th>
<th>IM3-P</th>
<th>IM3-H</th>
<th>AQ-R</th>
<th>AQ-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL</td>
<td>-0.077 (.027)</td>
<td>&lt; -0.018 (.002)</td>
<td>&lt; -0.005 (.007)</td>
<td>= -0.005 (.005)</td>
</tr>
<tr>
<td>MD</td>
<td>+0.010 (.008)</td>
<td>&gt; -0.003 (.002)</td>
<td>= -0.001 (.003)</td>
<td>= -0.003 (.002)</td>
</tr>
<tr>
<td>OG-B</td>
<td>-0.012 (.008)</td>
<td>= -0.014 (.005)</td>
<td>= -0.014 (.007)</td>
<td>= -0.011 (.007)</td>
</tr>
<tr>
<td>OG-L</td>
<td>+0.011 (.006)</td>
<td>&gt; +0.002 (.005)</td>
<td>= +0.004 (.005)</td>
<td>= +0.001 (.005)</td>
</tr>
</tbody>
</table>

No significant differences were detected among IM3-H, AQ-R, AQ-H for locations MD, OG-B and OG-L. IM3-P was significantly different from the other materials in three of four die dimensions. IM3-P dies were 77 µm smaller than the master in the buccolingual dimension, with comparatively high variability.

Conclusions: In general, gypsum dies from high viscosity, dual-arch impressions were clinically acceptable since the differences observed can be compensated with die relief. IM3-P may require additional laboratory accommodation. Supported in part by 3M ESPE.

Aim of the Study: An in vitro study was conducted to determine the accuracy of the newly formulated Imprint 3 Penta Putty and Imprint 3 Penta Heavy Body when used in dual arch trays.

Results of the Study: The accuracy of Imprint 3 Penta Heavy Body was found to be acceptable in this in vitro study when compared to other impression materials of similar viscosity. Imprint 3 Penta Putty showed a marked deviation in the buccolingual dimension. This is due to elastic recoil of the material in the dimension where the tray lacks support. Imprint 3 Penta Putty should be recommended for use with stiff trays (e.g. metal only).
Tear Strength of Seven Elastomeric Impression Materials

P. BECK, N.C. LAWSON, J.O. BURGESS, and L.C. RAMP, UAB School of Dentistry, Birmingham, AL, USA

In clinical situations requiring impressions of tooth structure when margins are below the gingiva, a light bodied or extra light bodied hydrophilic impression material is often employed. In these situations, thin portions of the impression are produced that are susceptible to tearing when the impression is removed from the oral cavity.

Objectives: This study measures the tear strength of six addition silicone materials (Affinis, Imprint 3, Genie Prototype, Stand Out, Aquasil, Virtual), one polyether material (Impregum), and one hybrid material (Senn) with fast and normal set times and with light and extra light consistencies.

Methods: Tear strength specimens were prepared using a notched plexiglass mold to produce 70 mm x 10 mm x 1.9 mm samples. In the center of the mold was a notch that produced a 0.1 mm thick slit. The specimens remained in the mold according to the manufacturer’s setting time while stored in an incubator at 37º C. After setting, the specimens were immediately removed from the mold and loaded in tension until failure using an Instron testing device. Specimens were tested at 500 and 1 mm/min. The maximum tensile force and the surface area across which it was applied were used to measure the tear strength of each impression material. Another group was prepared that was allowed 24 hrs additional room temperature set time.

Results: Significant differences were found between materials, set time, and strain rate with a two-factor ANOVA (p<0.05). The materials ranked in the following order (with highest values first): Aquasil LV, Imprint 3, Aquasil XLV, Virtual LB and XLB, Genie Prototype LB and XLB, Standout, Senn, and Impregum.

Conclusions: Our study shows that elastomeric impression materials rank (in order of increasing tear strength) polyethers, hybrid polyether/addition silicones, and addition silicones. Materials display higher tear strengths after longer set times and at faster strain rates.

Aim of the Study: To compare tear strength of modern impression materials for syringing.

Results of the Study: Aquasil Ultra and Imprint 3 showed the highest values for tear strength which may be especially beneficial in subgingival situations where extra tear strength is needed to capture complete margins.
Elastic Elongation and Recovery of Impression Materials

N.C. LAWSON, J. BURGESS, and L.C. RAMP, UAB School of Dentistry, Birmingham, AL, USA

Objectives: This study measures the elastic recovery and maximum elongation of five addition silicone materials and one hybrid material (Senn) with normal set times and light consistencies.

Methods: The specimens were prepared by dispensing impression material into a paddle shaped mold with a 20 mm long inner bar delineated by four semicircular notches. 25 seconds after dispensing, the specimen was placed in a 35°C water bath for the manufacturer’s oral setting time. 1.5 minutes after setting, the specimen was loaded in tension with a crosshead speed of 200 mm/min in a Zwick testing device until its length was increased by 0% (control), 50%, 100%, or 150% of the initial length (n=5 and n=2 for control). All specimens were stored at 23° C. 2 hours (±15 minutes) following specimen deformation, the distance between the semicircular notches was re-measured. The percentage of permanent deformation was calculated using the formula: [(final length–20 mm)/20 mm]*100%+ %shrinkage. The maximum elongation of the specimens was tested using the Zwick testing device with a crosshead speed of 200 mm/min (n=5).

Results: The data was analyzed with a Tukey-Kramer HSD Test (p=.05) for the 100% and 150% elongation groups. In both groups, the materials were divided into four significantly different categories. Imprint 3 and Examix were in the highest recovery category, Standout, Aquasil, and Senn were in the middle two categories, and Genie was in the last category.

<table>
<thead>
<tr>
<th>Elongation</th>
<th>Imprint 3(%)</th>
<th>Aquasil(%)</th>
<th>Genie(%)</th>
<th>Senn(%)</th>
<th>Stand Out(%)</th>
<th>Examix(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>-0.04±0.10</td>
<td>0.09±0.06</td>
<td>0.87±0.20</td>
<td>0.65±0.06</td>
<td>0.27±0.05</td>
<td>0.11±0.05</td>
</tr>
<tr>
<td>100%</td>
<td>0.09±0.17</td>
<td>0.79±0.15</td>
<td>2.28±0.25</td>
<td>1.65±0.15</td>
<td>0.72±0.05</td>
<td>0.15±0.03</td>
</tr>
<tr>
<td>150%</td>
<td>0.13±0.06</td>
<td>2.06±0.22</td>
<td>4.72±0.33</td>
<td>1.43±0.03</td>
<td>0.36±0.06</td>
<td></td>
</tr>
</tbody>
</table>

Conclusions: Different materials produced different levels of recovery from elongation. At 100% and 150% elongation, Imprint 3 and Examix had significantly greater recovery from elongation than all other materials. All materials had mean maximum elongations greater than 150% except for Senn.

Recovery from Elongation (with shrinkage compensation)

Aim of the Study: To compare elongation potential and elastic recovery of five addition silicone impression materials and one hybrid material. These physical properties are relevant when an impression is removed from the mouth. The higher the recovery potential after elongation, the lower the risk of distortion.

Results of the Study: Imprint 3 and Examix had the best recovery after elongation over the range of 50–155%. These materials offer a lower risk of distortion when an impression is removed from the mouth.
**Accuracy of a New Automixed VPS-Material Using a Standardized Abutment-Model**

S. YOUNAN, B. WÖSTMANN, J.-U.M. TABBERT, P. FERGER, and M. BALKENHOL, Justus-Liebig-University, Gießen, Germany

**Objectives:** Auto-mixing procedures are gaining popularity to improve standardization of impression taking. Most of the materials, dispensed from an auto-mixing device, are of medium- or heavy-body viscosity. Recently, a new auto-mixed vps-material (Express Penta Putty = EPP, 3M ESPE, Seefeld) was introduced to the market. It was the aim of this study to evaluate the accuracy of impressions taken with EPP in a standardized in-vitro setup and to compare it to a commercially available vps-material (Panasil Putty fast set = PPFS, Kettenbach) and a C-Silicone (Optosil Comfort = OC, Heraeus-Kulzer), respectively.

**Methods:** A master-model, consisting of four cylindrical test-abutments with parallel sided areas, fixed on a metal plate and completed with an acrylic mask to a lower jaw model, was used. The master-model and the impression trays were mounted in a Zwick1454 testing device (Zwick-Roell, Ulm) to standardize impression procedure. 20 two-stage putty-wash impressions per group were taken using EPP, PPFS and OC, respectively, at the end of the recommended working time (N=10) and as quick as possible (N=10). Force of impression taking was determined during impression procedure. Stone models were poured>1h after impression taking and stored for 7 days prior to measuring the diameters of the test-abutments (DTU). Data were subjected to parametric statistics (ANOVA: p=0.05).

**Results:** Average discrepancy of DTU ranged from -0.5 to -1.75 %. Significant differences were observed between the vps-materials (p<0.05) and the vps-materials and c-silicone (p<0.05), respectively for both working times. Force during impression taking was significantly higher for PPFS compared to EPP and OC (p<0.05). EPP showed the same force during impression taking as OC (p>0.05).

**Conclusions:** Within the limits of the study it can be concluded, that discrepancy between DTU and master abutment was lowest for EPP. Pressure during impression taking of EPP was comparable to the c-silicone.

Deviation between stone die and master cast in percent (∆d[%]). Figures above red bars denote the results of the pairwise comparison between the two points in time for impression taking using the U-test for the respective materials.

**Aim of the Study:** To test the *in vitro* accuracy of the newly introduced Pentamix putty compared to 2 other putty products.

**Results of the Study:** The accuracy of an *in vitro* impression was dependant on the amount of working time which had elapsed. The best results are obtained when a putty is used immediately after the mixing is complete. Express Penta Putty demonstrated better accuracy than the other materials tested.
Randomized Prospective Clinical Trial using a New Automixed Putty VPS-Material

T.A. NOACK, M. BALKENHOL, P. FERGER, and B. WÖSTMANN, Justus-Liebig-University, Gießen, Germany

Objectives: A standardized mixing process of impression materials is supposed to have an impact with regard to the accuracy of an impression and may therefore influence the fit of the final restoration. Recently, a new auto-mixed putty vps-impression material was introduced to the market. Hence the aim of this study was to test the accuracy of this newly introduced impression material (Express Penta Putty = EPP, 3M ESPE) and compare it to a commercially available hand-mixed material (Panasil Putty fast set = PPFS, Kettenbach) using a randomized, prospective clinical study design.

Methods: 38 impressions were taken from 70 prepared abutment teeth using a two-step putty-wash technique. The according impression material was randomly assigned. Impressions and dye models were assessed using a standardized case record form with defined criteria for the quality of the impression (Alpha, Bravo, Charlie, Delta). Number of retries were documented. Finally, accuracy was determined measuring the max. marginal discrepancies of the final castings in the patients mouth using five measuring explorers with standardized tip diameters of 100µm, 200µm, 300µm, 400µm and 500µm at 6 predefined measuring sites per tooth. Data were subjected to parametric statistics (Fishers exact test; p=0.05).

Results: The assessment of the quality of the impressions revealed no significant differences between the two materials tested (p>0.05). EPP showed a significantly higher number of Alpha ratings for the dye models assessed (p<0.05). EPP showed a higher amount of castings with max. marginal discrepancy of less than 200 µm. For both materials, the number of retries were not significantly different (p>0.05).

Conclusions: Under the limits of the study it can be concluded, that the newly introduced vps-material - mixed in an auto-mixing device - shows clinical results, which are comparable or better in performance than the conventional hand-mixed material tested.

Aim of the Study: To assess the clinical accuracy of the newly introduced Express Penta Putty when mixed with the Pentamix mixing unit. Compare these results with a standard hand-mix putty.

Results of the Study: Clinical results for Express Penta Putty were comparable or better (overall dye rating, marginal discrepancy) than the competitive hand-mix product.
Inorganic Particle Content and Elastic Recovery Determination of Impression Materials

H.L. CARLO1, R.B. FONSECA1, F.G. CARVALHO1, C.J. SOARES2, L. CORRER-SOBINHO1, and M.A.C. SINHORETI1, 1State University of Campinas, Piracicaba, Brazil, 2Universidade Federal de Uberlândia, Brazil

Objectives: this work evaluated the content of inorganic particles and elastic recovery in four elastomeric impression materials: Express Light Bodied, Oranwash L, Permlastic Light Bodied and Impregum Soft Light Bodied.

Methods: to determine the volumetric percentage of inorganic particles, the volume of the samples was calculated by a method based on the Archimedes' principle, which states that when a solid object is immersed in a fluid, it experiences a thrust force that is equal to the weight of the displaced fluid. So the samples were weighed in water before and after they were burned in oven for 550°C. An amount of unpolymerized material was washed in acetone and chloroform to characterize the particles by SEM pictures. The elastic recovery (%) was appraised according to ISO 4823:2000 by compressing the samples 30% in length. The results (α=0.05) were submitted to Kruskal-Wallis, Dunn and Pearson’s correlation test.

Results: Express showed the highest values of inorganic particles (40.29a) followed by Permlastic (39.35a) and Oranwash (29.83ab); Impregum presented the minors values (4.04b) being statistically different from Express and Permlastic. For elastic recovery Express showed the highest values too (99.73a), being followed of Impregum (99.35ab), Oranwash (98.49b) and Permlastic (98.34b). Oranwash and Permlastic are statistically different from Express. There was not significant correlation between the groups (p>0.05).

Conclusions: all materials are in conformity with ISO 4823:2000 norm for recovery. It seems that the quality of the polymer is more important for results of recovery that the content of inorganic particles.

Aim of the Study: To determine elastic recovery and the correlation to amount of inorganic particle content for 4 different syringeable impression materials.

Results of the Study: All materials tested were in compliance with the ISO requirements for elastic recovery. The best values were seen for 3M ESPE Express Light Body and Impregum. There was no significant correlation between inorganic particle content and elastic recovery.

Adhesion of Streptococcus mutans to Temporary Crown and Bridge Material

R. BÜRGER, M. ROSENTRITT, and G. HANDEL, University of Regensburg, Germany

Objectives: The aim of this in vitro study was to rank commonly used temporary crown and bridge materials according to their susceptibility to adhere S. mutans.

Methods: Test specimens of each of 11 temporary crown and bridge materials (see Table) were made according to the manufacturer’s instructions and polished using wet abrasive paper with a grit of 4000. Glass and composite (Sinfony, 3M ESPE, G) plates were used as references. Surface roughness was determined (Perthometer S6P, Perthen, G) and all specimens were incubated (2.5 hours/37°C) with S. mutans. Adherent S. mutans bacteria were marked with fluorescence dye (Resazurin, Sigma, G) and the intensity of fluorescence was verified (Fluostar, bmg, G). Medians and 25/75 percentiles were calculated, statistics: Mann-Whitney U-test (α = 0.05).

Results:

<table>
<thead>
<tr>
<th>System</th>
<th>Material</th>
<th>Manufacturer</th>
<th>Rel. fluor.- intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bis-acryl composite</td>
<td>Protemp 3 Garant</td>
<td>3M ESPE</td>
<td>4273 (2999/5896)</td>
</tr>
<tr>
<td></td>
<td>Luxatemp Automix</td>
<td>DMG</td>
<td>3286 (2809/6296)</td>
</tr>
<tr>
<td></td>
<td>Temphase</td>
<td>Kerr</td>
<td>9488 (7405/11749)</td>
</tr>
<tr>
<td></td>
<td>Structur premium</td>
<td>Voco</td>
<td>8594 (4719/9829)</td>
</tr>
<tr>
<td></td>
<td>Prevision CB</td>
<td>Heraeus Kulzer</td>
<td>7380 (4753/11788)</td>
</tr>
<tr>
<td></td>
<td>Cronmix K plus</td>
<td>Merz</td>
<td>10843 (8056/14644)</td>
</tr>
<tr>
<td>Methacrylate</td>
<td>Cronsin</td>
<td>Merz</td>
<td>4321 (2789/7870)</td>
</tr>
<tr>
<td></td>
<td>Trim</td>
<td>Bosworth</td>
<td>8237 (2969/11096)</td>
</tr>
<tr>
<td>Acrylic resin</td>
<td>Snap</td>
<td>Roeko</td>
<td>15368 (8753/20901)</td>
</tr>
<tr>
<td></td>
<td>Unifast LC</td>
<td>GC</td>
<td>11115 (8035/18445)</td>
</tr>
<tr>
<td></td>
<td>Glass</td>
<td>Marienfeld</td>
<td>4644 (4171/11581)</td>
</tr>
<tr>
<td>Composite</td>
<td>Sinfony</td>
<td>3M ESPE</td>
<td>11516 (5111/14148)</td>
</tr>
</tbody>
</table>

Conclusions: Protemp 3 Garant, Luxatemp and Cronsin showed comparable bacterial adhesion with the glass control. S. mutans adheres in similar quantities to bis-acryl and methacrylate materials, but slightly favors superior acrylic resin materials.

Aim of the Study: This in vitro study was conducted in order to assess 11 temporary crown and bridge materials regarding adhesion of S. mutans. Glass was chosen as a control material.

Results of the Study: Protemp 3 Garant showed a similar adhesion of S. mutans like the glass control which could be seen as a benefit for dentist and patient.
Handling Properties of Novel Preformed, Malleable, and Curable Temporary Crowns


Objectives: A novel preformed, malleable and light-curable composite crown, 3M™ ESPE™ Protemp™ Crown (PTC), has been developed to simplify the procedure for short-term temporization. The objective of this investigation is to characterize the rheological properties of the malleable PTC material.

Methods: A Rheometric Scientific Inc. ARES™ rheometer and a Texture Technologies Corp. TA-XT2i Texture Analyzer were used to measure rheological properties of the uncured PTC material in comparison with a universal composite filling material, 3M™ ESPE™ Filtek™ Z250 (FZ), a packable composite filling material, 3M™ ESPE™ Filtek™ P60 (P60) and a dental model wax, Heraeus™ Kulzer™ Modern #3 Pink (HKM). Standard composites (P60, FZ) were equilibrated (25°C) for at least 15 minutes prior to testing. Waxlike materials (HKM, PTC) were equilibrated for at least 96h prior to testing. The data were analyzed via one-way ANOVA and compared with Tukey’s T-test (p<0.05).

Results: Results of the experiments are summarized in the following table:

<table>
<thead>
<tr>
<th>Material</th>
<th>Texture Analyzer – Hardness (g, n=3-4)</th>
<th>ARES Rheometer – Complex Viscosity (Pa·s, n=3-4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25°C</td>
<td>37°C</td>
</tr>
<tr>
<td></td>
<td>avg(sd)</td>
<td>avg(sd)</td>
</tr>
<tr>
<td>PTC</td>
<td>1025(44)</td>
<td>391(16)</td>
</tr>
<tr>
<td>HKM</td>
<td>3744(103)</td>
<td>1765(149)</td>
</tr>
<tr>
<td>FZ</td>
<td>242(24)</td>
<td>94(6)</td>
</tr>
<tr>
<td>P60</td>
<td>414(48)</td>
<td>164(20)</td>
</tr>
</tbody>
</table>

Conclusions: At room temperature, uncured PTC material has an equivalent viscosity to a dental wax, and is statistically more viscous than either a packable (P60) or universal (FZ) composite. At 37°C, PTC is statistically more viscous than HKM, P60, or FZ. By texture analyzer, PTC is statistically softer than HKM, but statistically harder than either FZ or P60. Uncured PTC material has the right balance of rheological properties for the novel application of a preformed crown. It is freestanding and maintains its shape in storage and handling, but can be easily reshaped and customized at body temperature by a dental professional for excellent adaptation on a tooth prep.

Aim of the Study: To characterize the rheology of a new material developed for a novel performed, malleable and light-curable composite crown indicated for short term temporization.

Results of the Study: At room temperature the uncured novel material has a wax-like consistency which maintains its shape and is easily malleable. At body temperature the uncured material viscosity allows for easy reshaping and customization in order to obtain a good fit of the restoration.
A New Temporary Preformed Curable Crown Material: Mechanical Properties
T. JONES, N. KARIM, E. WINTERS, D. JACOBS, and R. RUSIN, 3M ESPE, Saint Paul, MN, USA

**Objectives:** The objective of this study was to compare the strength and 3-body wear characteristics of a novel preformed temporary composite crown material (3M™ ESPE™ Protemp™ Crown, PTC) with those of conventional crown temporization materials: 3M™ ESPE™ Protemp™ 3 Garant (PT3), Dentsply™ Caulk™ Integrity™ (ITG), DMG™ Luxatemp™ Automix (LUX), Voco™ Structur™ Premium (STP), Lang™ Jet™ (JET), and Bosworth™ Trim II™ (BT2). 3M™ ESPE™ Filtek Z250 Restorative (FZ) was used as a control.

**Methods:** For compressive (CS) and diametral tensile strength (DTS), samples were cured in 4 mm diameter glass tubes with the paste held under axial compression, then cut to 8mm (CS) and 2 mm (DTS) in length. Samples of size 2x2x25 mm for flexural strength (FS) testing were cured in multipart PTFE molds. Specimens were conditioned in de-ionized water at 37°C for 24 hours prior to testing on an Instron machine. For wear testing, the ACTA 3-body wear device and methodology were used (Pallav et al., J. Pros. Dent. 59(4) 1988). Wear data were normalized to the wear of FZ. The data were analyzed via one-way ANOVA and compared with Tukey’s T-test (p<0.05).

**Results:** Properties of the various materials are summarized in the table below:

<table>
<thead>
<tr>
<th></th>
<th>CS(MPa) Avg(SD)</th>
<th>DTS(MPa) Avg(SD)</th>
<th>FS(MPa) Avg(SD)</th>
<th>Wear ratio to FZ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=6–10</td>
<td>n=6–10</td>
<td>n=7–10</td>
<td>n=3</td>
</tr>
<tr>
<td>PTC</td>
<td>320.3(13.0)</td>
<td>78.9(5.4)</td>
<td>139.8(9.5)</td>
<td>1.72(0.05)</td>
</tr>
<tr>
<td>PT3</td>
<td>305.6(30.2)</td>
<td>48.0(4.4)</td>
<td>76.4(4.2)</td>
<td>5.04(0.09)</td>
</tr>
<tr>
<td>ITG</td>
<td>287.7(13.0)</td>
<td>56.5(3.3)</td>
<td>70.6(5.6)</td>
<td>3.63(0.15)</td>
</tr>
<tr>
<td>LUX</td>
<td>244.4(21)</td>
<td>53.5(4.7)</td>
<td>79.6(2.6)</td>
<td>3.35(0.33)</td>
</tr>
<tr>
<td>STP</td>
<td>376.7(46.7)</td>
<td>72.5(5.4)</td>
<td>74.9(6.2)</td>
<td>3.82(0.30)</td>
</tr>
<tr>
<td>JET</td>
<td>124.7(19.2)</td>
<td>32.8(3.8)</td>
<td>60.6(1.4)</td>
<td>7.13(22)</td>
</tr>
<tr>
<td>BT2</td>
<td>76.9(7.7)</td>
<td>18.0(2.5)</td>
<td>38.5(2.7)</td>
<td>9.91(0.27)</td>
</tr>
</tbody>
</table>

**Conclusions:** The new temporary preformed composite Protemp Crown material (PTC) exhibited comparable compressive and diametral tensile strength to conventional bis-acrylic materials. As well, PTC showed the highest flexural strength and least wear of the temporary crown materials tested, and hence would be expected to perform well clinically.

**Aim of the Study:** To compare the physical properties of a novel performed malleable and light curable composite crown indicated for short-term temporization to standard short-term temporization materials.

**Results of the Study:** The novel Protemp crown material performed similarly or better compared to standard temporization materials for compressive strength and diametral tensile strength. It demonstrated lowest wear and highest flexural strength.
Fracture resistance, wear and marginal adaptation of temporary composite crowns

M. ROSENTRITT, R. LANG, and G. HANDEL, University of Regensburg, Germany

Objectives: This in-vitro study compared the fracture resistance, occlusal wear and marginal adaptation of experimental and conventional temporary composite molar crowns.

Methods: Single molar crowns were fabricated of an experimental composite material (3M ESPE, USA) and two commercial provisional crown & bridge materials (Protemp 3 Garant, 3M ESPE and TRIM II, Bosworth). The roots of the human molars were covered with an 1 mm thick polyether layer to imitate the periodontium and eighth crowns of each group were luted with RelyX Temp NE (3M ESPE). For simulating oral service, the crowns were thermocycled and mechanically loaded (TMCL: 6000 x 5°C/55°C, 1.2 x 106 x 50N, 1.66 Hz) with human antagonists and then axially loaded to failure in an universal testing machine (Zwick 1446; v=1 mm/min). Failure detection was set to 10% of the maximum force. Occlusal wear was measured in comparison to the unworn surface by a 3-D scanning device (Willitec, G). The marginal adaptation (criteria: perfect margin and marginal gap) was determined in a scanning electron microscope (Phillips Quanta FEG 400, NL) via replica-technique before and after TCML. Statistical analysis was performed with the Mann-Whitney-U-test (P=0.05).

Results:

<table>
<thead>
<tr>
<th>Fracture resistance</th>
<th>Experimental composite (3M ESPE)</th>
<th>Protemp 3 Garant, (3M ESPE)</th>
<th>TRIM II, (Bosworth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median [N]</td>
<td>1419</td>
<td>750</td>
<td>Failed during TCML</td>
</tr>
<tr>
<td>Q1/Q3</td>
<td>921/1516</td>
<td>507/1204</td>
<td>-/-</td>
</tr>
</tbody>
</table>

All Trim II crowns failed due to fracture during thermal cycling and mechanical loading. Experimental composite crowns showed highest fracture resistance. For Protemp 3 Garant and experimental composite comparable marginal adaptation and wear was found.

Conclusions: Experimental composite and Protemp 3 Garant crowns showed fracture resistance, marginal adaptation and wear after artificial aging, which is expected to withstand the loading in posterior areas.

Aim of the Study: To compare fracture resistance, wear and marginal adaptation of Protemp Crown, a novel malleable light cure composite indicated for short-term temporaries.

Results of the Study: Protemp crown showed higher fracture resistance than Protemp 3 Garant. It was similar for marginal adaptation and wear. Trim II could not formally assessed as all crowns failed during TCML.
RelyX™ Adhesive Resin Cement

Influence of Ceramics on the Polymerization Depth of Resin Cements

M.A. KILICARSLAN, The Ministry of Health of Turkey, 75th Year Ankara Dental Hospital, Turkey, A. ZAIMOGLU, Ankara University, Turkey, and H. HASKAN, Haydarpasa Gulhane Military Medical Academy, Istanbul, Turkey

Objectives: The aim of this study was to determine the effects of ceramic shade, thickness and exposure time on polymerization of light and dual-activated resin cements.

Methods: Twelve disks, in two different thicknesses and six color shade were constructed using Colorlogic Porcelain (Ceramco Inc., USA). Two resin cements were selected (Light–activated; Tetric Flow, Ivoclar AG, Liechtenstein and dual-activated composite; RelyX ARC, 3M Dental, USA). The resins were polymerized through the disks at 30 and 60 seconds and hardness of them were determined by Barcol (Barber Colman Impessor, USA). Average hardness data were analysed using three–way analysis of variance. Multiple comparisons were performed with Dunnett T3 post-hoc test at a pre-set significance level of 5 % because of unequal group variances (p<0.001).

Results: Higher levels of hardness were acquired with dual-activated resin cement. According to these data using Dunnett T3 test with multiple comparisons the experimental samples showed significant differences from the control groups except for A1 and B1 shades (p<0.001). Within the experimental groups, A1 demonstrated significant differences from B3, C1 and C3, while A3, B1, B3 and C1 showed significant differences from C3. Poor polymerization that occurred due to increase in porcelain thickness was compensated by extending exposure times except for the cases of C3 in dual-activated and A3, B3, C3 in light-activated resin cement.

Conclusions: In all the test conditions, dual-activated resin cements were observed to show higher surface hardness than those of light activation. Increase in value of ceramic shade caused a decrease in hardness particularly for light-activated composite resin cement. Augment in porcelain thickness resulted in a decrease in hardness values for both of the cements and for each shade group.

Aim of the Study: This in vitro study investigates the influence of ceramic shade thickness and exposure time on the polymerization (surface hardness) of two different resin cements, one of them a light-cured cement and the other one the dual-cured cement RelyX ARC.

Results of the Study: RelyX ARC displayed higher surface hardness in all test parameters than the only light-cured material. Especially the parameter “ceramic shade” seems to have an impact on the surface hardness of the light-cured resin cement.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

**RelyX™ Adhesive Resin Cement**

**Bond-strength and dentine interface of dual-cure, auto-cure and auto-adhesive cements**

R. VAZ, M.F. DE GOES, V. DI HIP"LITO, and M. SINHORETI, Dental School of Piracicaba - UNICAMP, Brazil

**Objectives:** Bond strength evaluation of dual-cure, auto-cure and auto-adhesive luting cements to human dentin and indirect resin composite.

**Methods:** Oclusal enamel of 12 human molars was removed using a low-speed saw. The medium dentin exposed was ground with Sic (600 grit). Indirect composite resin discs (Sinfony, 3M ESPE) were confectioned and were sandblasted with 50µm aluminum oxide particles, and bonded to dentin surfaces, according to manufacture’s instructions with the following luting cements and adhesives: Rely X Unicem (3M ESPE, UN), Rely X ARC/Single Bond 2 (3M ESPE ARC) and C&B Cement/All Bond 2 (Bisco CB). After 24-hour water storage, each tooth was sectioned in X and Y directions to obtain twenty 0.8 ± 1 mm² cross-sectional area sticks. Specimens were tested in tension in an Instron at cross-speed of 0.5 mm/min. Statistical analysis included ANOVA and Tukey test (p≤0.05). The surfaces of 8 dentine discs (1.5 mm thick) were treated with each of the cements and adhesives and bonded to form disc-pairs for SEM analysis.

**Results:** (Mean MPa±S.D.) Rely ARC: 40.8±9.40; UNICEM: 31.3± 7.36 and CB:19.4±3.81. ARC resulted in statistically higher bond strength than UNICEM that was also significantly higher than CB cement. Fracture pattern analysis in SEM revealed predominance of cohesive cement fractures for UN, mixed fractures in cement, hybrid layer and adhesive for ARC and cohesive fractures in hybrid-layer for CB. Different from ARC and CB cements, the interface analysis of UNICEM did not reveal hybrid layer formation.

**Conclusions:** Dual-cure and auto-adhesive cements may present higher bond strength than auto-cure luting cements.

**Bond strength to dentin.**

![Bond strength to dentin chart](chart.png)

**Aim of the Study:** This *in vitro* study evaluates the bond strength of RelyX Unicem, RelyX ARC and another total-etch luting cement to human dentin

**Results of the Study:** RelyX ARC shows very high adhesion values. RelyX Unicem displays high adhesion values even without any pretreatment of the dentin. Both cements exceed significantly the bond strength of the tested total-etch luting cement.
RelyX™ Adhesive Resin Cement

**Hardness of a Dual Resin Cement Photocured under Composite Disks**

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**Objectives:** The aim of this study was to evaluate the Vickers surface hardness (VH) of a dual resin cement (RelyX ARC) cured under indirect resin composite disks (Cristobal, Microdont-CD) with different thicknesses (1, 2 and 3 mm).

**Methods:** Eighteen samples (2 X 2 mm) were confectioned using a mold and divided into six groups (n=3) according to the curing light source used: LED (Elipar Freelight 2 - 800 mW/cm²) and QTH (Optilight Plus/Gnatus, 500 mW/cm²), and according to the thickness of the indirect composite disks (CD), as follows: G1- QTH + CD (1mm); G2- LED + CD (1mm); G3- QTH + CD (2 mm); G4- LED + CD (2 mm); G5- QTH + CD (3 mm); G6- LED + CD (3 mm). Samples were stored in distilled water (37°C) for 24h. Hardness test was performed using a Digital Tester FM (Future-Tech, Japan). Three indentations (50gf for 15s) were done at the top and bottom of samples. Data were submitted to ANOVA three criteria and Tukey tests (5%) to verify the effect of the interaction among the experimental variables: thickness (CD), position (top/bottom) and light source (LED/QTH) and detected statistically significant difference (p=0.033).

**Results:** The mean VH and standard deviations of each group for top and bottom was respectively G1- 46.1 (9.89), 19.1 (4.54); G2- 41.7 (1.95), 32.0 (3.28); G3- 26.9 (11.98), 11.4 (4.67); G4- 35.7 (1.79), 11.5 (1.84); G5- 19.0 (14.97), 9.9 (8.36); G6- 32.2 (2.31), 7.5 (0.883). The lower hardness value was observed on the bottom of resin cement discs cured with LED CD with 3 mm of thickness; and the highest was detected on the top of resin cement discs cured with QTH with 1 mm.

**Conclusions:** The resin cement samples presented lower hardness values when cured under composite disks with increased thickness, independently of the curing light source used (p<0.05).

**Vickers hardness values of RelyX ARC**

![Graph showing Vickers hardness values of RelyX ARC](image)

**Aim of the Study:** This *in vitro* study investigates the influence of the thickness of composite disks on the Vickers surface hardness of RelyX ARC. Two different curing lights, one of them the Elipar Freelight 2, were used.

**Results of the Study:** The results show that the highest Vickers hardness values are reached with the thinnest composite disks. The curing light did not have an effect on the hardness.
Fatigue resistance of teeth with fiber post: effect of length cementation

L.F. VALANDRO1, P. BALDISSARA2, S.C. ZAMBONI1, F.P. CAMARGO1, G.Á.P. GALHANO1, M.A. BOTTINO1, and R. SCOTTI2, 1Sao Paulo State University, Sao Jose dos Campos, Brazil, 2University of Bologna, Italy

Objectives: to evaluate the influence of the cementation length of quartz-FRC on the fatigue resistance of bovine teeth restored with FRC. The hypothesis is that the longer length allows for a better fatigue resistance.

Methods: Thirty roots of single-rooted bovine teeth were allocated to 3 groups (n=10), according to the ratio of crown-length [C] / root-length [R] (cementation length): Gr1- 2/3; Gr2- 1/2; Gr3- 1/1. The roots were prepared with custom bur of a tapered glass fiber-reinforced composite post (Premier Anatomic IP-110-VR, Innotech®, Italy) (FRC). After preparation, each root was embedded in a plastic cylinder filled with self-cured acrylic resin. The FRCs were silicated and silanized, the coronal- and root-dentin were treated with a multi-step total-etch adhesive system (ScotchBond Multi Purpose plus, 3M ESPE), and the FRCs were cemented with resin (RelyX ARC, 3M ESPE). Then the cores were made of hybrid resin composite (W3D Master, Wilcos, Brazil), using plastic matrices standardized in dimensions. The specimens were submitted to the fatigue test (1 million mechanical cycles; 8Hz; 0–50N; water, 37°C). After fatigue testing, a score was given, considering the number of fatigue cycles until fracture: Score 0: sp fractured between 0 and 249,999 cycles; Score 1: sp fractured between 250,000 and 499,999 cycles; Score 2: sp fractured between 500,000 and 749,999 cycles; Score 3: sp fractured between 750,000 and 1 million cycles; Score 4: No root-, post-, or core-fracture and no loss of retention of the post. Data were submitted to statistical analysis.

Results: All the specimens were resistant to fatigue (score 4). No root-or post-fracture and no loss of retention of the post were observed. The hypothesis was rejected.

Conclusions: Considering the results of this study, the evaluated fiber post can be cemented considering the ratio of crown/root at 1/1. Further clinical studies must be conducted in this sense.
Adhesion of Core Build-Up Materials to RelyX Fiber Post

R. PEEZ, V. PORSFELD, B. LACHERMEIER, and P. BRAUN, 3M ESPE AG, Seefeld, Germany

Objectives: The aim of this in-vitro study was to evaluate the influence of different surface treatments of the new RelyX Fiber Post (RLXFP, 3M ESPE) on the adhesion of Filtek Z250 universal composite (Z250, 3M ESPE).

Methods: The conical part of RLXFP (Size 3) was used. The surface was either left untreated or silanized with RelyX Ceramic Primer (RLXCP) or treated with Adper Prompt L-Pop (L-Pop) or Adper Scotchbond 1-XT (1-XT) or Adper Scotchbond Multipurpose (MP) or RLXCP & L-Pop or RLXCP & 1-XT or RLXCP & MP (all from 3M ESPE). Subsequently Z250 was added and light-cured (discs: d=6,0 mm, h=4,0 mm). All specimens were stored for one hour at 36°C/>95% rel. humidity and for 23 hours in water at 36°C, some were additionally thermocycled (5,000 cycles 5°C / 55°C). Finally a pull-off test was made using an universal testing-machine.

Results: The following table summarizes the adhesion values measured after 24 h or thermocycling (TC). Analysis of variances showed that coating (P=0,000) and thermocycling (P=0,036) had an significant effect on adhesion. Treatment of the post surface with the bonding agents resulted in increased bond strength compared to untreated, silanized or silanized and bonded surfaces.

<table>
<thead>
<tr>
<th>Coating/Adhesion</th>
<th>None</th>
<th>RLXCP</th>
<th>L-Pop</th>
<th>1-XT</th>
<th>MP</th>
<th>RLXCP &amp; L-Pop</th>
<th>RLXCP &amp; 1-XT</th>
<th>RLXCP &amp; MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>24h [MPa]</td>
<td>14.0 ± 1.8</td>
<td>13.6 ± 1.2</td>
<td>17.6 ± 0.7</td>
<td>19.3 ± 0.8</td>
<td>16.7 ± 1.2</td>
<td>16.7 ± 1.3</td>
<td>16.8 ± 1.0</td>
<td>17.1 ± 0.5</td>
</tr>
<tr>
<td>TC [MPa]</td>
<td>Not tested</td>
<td>11.6 ± 1.1</td>
<td>19.9 ± 1.4</td>
<td>17.5 ± 1.1</td>
<td>19.1 ± 2.3</td>
<td>21.0 ± 1.6</td>
<td>19.2 ± 1.0</td>
<td>17.2 ± 1.2</td>
</tr>
</tbody>
</table>

Conclusions: There is no need to silanize the post, using the bonding agent of the core build-up material is advantageous.

Adhesion of Filtek Z250 to RelyX Fiber Post after 24 h and thermocycling

<table>
<thead>
<tr>
<th>[MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
</tr>
<tr>
<td>GLXCP</td>
</tr>
<tr>
<td>L-Pop</td>
</tr>
<tr>
<td>1-XT</td>
</tr>
<tr>
<td>MP</td>
</tr>
<tr>
<td>RLXCP &amp; L-Pop</td>
</tr>
<tr>
<td>RLXCP &amp; 1-XT</td>
</tr>
<tr>
<td>RLXCP &amp; MP</td>
</tr>
<tr>
<td>24h</td>
</tr>
<tr>
<td>TC</td>
</tr>
</tbody>
</table>

Aim of the Study: What kind of pre-treatment of the RelyX Fiber Post is necessary before placing a core build-up with Filtek Z250? The answer is given in this in vitro study where eight different pre-treatment methods are compared.

Results of the Study: The results show that it is not necessary to silanize the RelyX Fiber Post before doing the core build-up which simplifies the clinical procedure. But bond strength is increased when RelyX Fiber Post is pretreated with the corresponding bonding agent of the core build-up material.

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Flexural properties of radiopaque fiber reinforced root canal posts

P. MÜLLER, R. PEEZ, V. PORSFELD, and P. BRAUN, 3M ESPE AG, Seefeld, Germany

Objectives: The aim of this in vitro investigation was to evaluate the shear strength of RelyX™ Fiber Post (RXFP, 3M ESPE), a new glass fiber reinforced composite post, in comparison to other fiberposts.

Methods: RXFP and six other fiber reinforced composite posts of various brands were submitted to a shear strength test. Posts tested were FRC Postec® Plus (FRCP, Ivoclar Vivadent), Komet ER Dentin Post (ERDP, Brasseler), Fibiocore (FIBP, Anthogyr), Radix Fiber Post (RDFP, Dentsply), FibreKor® (FKOR, Jeneric) and DT Light Post® (DTLP, RTD). Posts were fixed in a metal block and loaded at an angle of 135 degrees relative to the long axis of the post using a universal testing machine (Zwick Z010, crosshead speed of 1 mm/min).

In order to investigate whether the mechanical properties of RXFP change due to thermal stressing shear strength was determined after thermo-cycling (5,000 cycles and 10,000 cycles 5°C/55°C, dwell time: 30 s, change time: 8 s).

Results: The following tables summarize the shear strength of the fiberposts tested. Thermocycling did not change shear strength of RXFP.

<table>
<thead>
<tr>
<th>Shear strength (GPa)</th>
<th>RXFP (Size 3)</th>
<th>FRCP (Size 3)</th>
<th>ERDP (Size 110)</th>
<th>FIBP (Size FBC 4)</th>
<th>RDFP (Size 4)</th>
<th>FKOR (Size 2)</th>
<th>DTLP (Size 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RXFP (5.000 TC)</td>
<td>1.4 ± 0.1</td>
<td>1.2 ± 0.3</td>
<td>1.2 ± 0.1</td>
<td>1.3 ± 0.2</td>
<td>1.3 ± 0.1</td>
<td>1.3 ± 0.1</td>
<td>1.5 ± 0.1</td>
</tr>
<tr>
<td>RXFP (10.000 TC)</td>
<td>1.4 ± 0.1</td>
<td>1.4 ± 0.1</td>
<td>1.4 ± 0.1</td>
<td>1.4 ± 0.1</td>
<td>1.4 ± 0.1</td>
<td>1.4 ± 0.1</td>
<td>1.5 ± 0.1</td>
</tr>
</tbody>
</table>

Conclusions: RXFP showed shear strength comparable to other fiberposts. Mechanical properties of RXFP are not prone to thermal stressing.

Shear strength of different FRC posts.

Aim of the Study: This in vitro test investigates an important mechanical property of FRC posts, the shear strength. Seven different FRC posts were compared. Additionally the effect of thermal stressing on the mechanical performance of RelyX Fiber Post was evaluated.

Results of the Study: The shear strength of RelyX Fiber Post is in the same range like the other tested FRC posts. Thermal stressing does not change the mechanical characteristics of RelyX Fiber Post.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.
### RelyX™ Fiber Post

#### Adhesion of Filtek P60 to RelyX Fiber Post

**R. PEEZ, V. PORSFELD, B. LACHERMEIER, and P. BRAUN,** 3M ESPE AG, Seefeld, Germany

**Objectives:** The aim of this in-vitro study was to evaluate the influence of different surface treatments of the new RelyX™ Fiber Post (RLXFP, 3M ESPE) on the adhesion of Filtek™ P60 posterior composite (P60, 3M ESPE).

**Methods:** The conical part of RLXFP (Size 3) was used. The surface was either left untreated or silanized with RelyX™ Ceramic Primer (RLXCP) or treated with Adper™ Prompt™ L-Pop™ (L-Pop) or Adper™ Scotchbond™ 1-XT (1-XT) or Adper™ Scotchbond™ Multipurpose (MP) (all from 3M ESPE). P60 (shade A3) was added in two increments and each increment light-cured for 40 s (discs: d=6,0 mm, h=4,0 mm). All specimens were stored for one hour at 36°C/> 95% rel. humidity and for 23 hours in water at 36°C, some were additionally thermocycled (5,000 cycles 5°C/55°C). Six specimens were tested for each data set. Adhesion was measured by a pull-off test using an universal testing-machine (crosshead speed: 1 mm/min).

**Results:** The following table summarizes the adhesion values measured after 24 h with and without thermocycling (TC). Two way analysis of variances showed that coating (P=0.00) had a significant effect on adhesion. Thermocycling did not have a significant effect on adhesion values (P=0.18). Treatment of the post surface with the bonding agents resulted in increased bond strength compared to untreated or silanized surfaces.

<table>
<thead>
<tr>
<th>Coating / Adhesion</th>
<th>None</th>
<th>RLXCP</th>
<th>L-Pop</th>
<th>1-XT</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>24h [MPa]</td>
<td>8.6 ± 2.4</td>
<td>10.2 ± 1.5</td>
<td>17.7 ± 1.1</td>
<td>17.5 ± 1.0</td>
<td>5.7 ± 0.9</td>
</tr>
<tr>
<td>24h &amp; TC [MPa]</td>
<td>Not tested</td>
<td>11.3 ± 3.4</td>
<td>20.2 ± 0.9</td>
<td>17.7 ± 1.8</td>
<td>15.8 ± 2.2</td>
</tr>
</tbody>
</table>

**Conclusions:** There is no need to silanize the post surface, using the bonding agent of the core build-up material is advantageous.

**Adhesion values after 24 h with and without thermocycling**

![Adhesion Graph](image)

**Aim of the Study:** This *in vitro* study investigates the effect of pretreating the surface of the new RelyX Fiber Post with different substrates on the adhesion of Filtek P60 posterior composite.

**Results of the Study:** The authors observed that silanisation of the fiber post surface does not lead to significantly higher adhesion values than no pre-treatment, while applying the bonding agent of the core build-up material can increase bond strength.

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The Optimum Luting Cement and Surface Pre-treatment Combination for Lava

D.P. SENYILMAZ, University of Birmingham, The School of Dentistry, United Kingdom, W. PALIN, University of Birmingham, England, Uk, A. SHORTALL, University of Birmingham -, England, Uk, and F.J.T. BURKE, University of Birmingham, United Kingdom

Appropriate surface treatment and cement selection are desirable for a strong and durable bond to all-ceramic restorations and will assist in achieving successful clinical results for non-erodable ceramics (e.g., Lava Zirconia, 3M, ESPE).

Objectives: The aim of this study was to define the optimum luting cement and surface treatment combination to be used with the Lava Zirconia all-ceramic system. Shear bond strengths of commercial luting cements, (a)Panavia F (Kuraray), (b)RelyX Unicem (3M ESPE), (c)MaxCem (Kerr) to Lava were evaluated and compared after Air-particle abrasion and CoJet treatment in dry and thermo-cycled conditions.

Methods: 90 Lava disc specimens were prepared for the following test groups: I. Control group. II. Airbone abrasion with 100µm Aluminum-oxide particles (at 5 bar pressure, 10s at 10 mm distance). III. Cojet system (tribochemical silica coating)+ ESPE-Sil(3M ESPE). Composite resin cylinders were bonded to the zirconia specimens with the above cements. Specimens from all combinations of cement and surface pre-treatment were tested dry or thermo-cycled (1000 thermocycles, between 4 and 65±1°C) conditions. The shear bond strength tests were performed in an Instron tester at a cross-head speed of 0.5 mm/min. The data were analyzed.

Results: Shear bond strength values (MPa) obtained for the pre-treatment groups in dry/thermo-cycled conditions were: I. Group: (a) 13.9 ± 2.5/3.92 ± 0.76 (b) 4.0 ± 0.6/2.88 ± 0.49 (b) 6.6 ± 1.1/1.8, II. Group: (a) 16.9 ± 1.8/4.44 ± 2.80, (b) 11.2 ± 1.2/8.89 ± 1.33 (c) 12.2 ± 1.1/5.15 ± 1.35, III. Group: (a) 20.8 ± 0.8/13.29 ± 2.9 (b) 11.7 ± 1.29/11.65 ± 4.9 (c) 18.6 ± 1.49/2.4 ± 2.19.

Conclusions: Pre-treatment of Lava ceramic surfaces with Air-particle Abrasion or Cojet significantly increased the bond strength of resin cements to ceramic surface. The two adhesive resin cements Panavia F and RelyX Unicem gave superior results compared with MaxCem.

Results found in abstracts for RelyX™ Unicem Self-Adhesive Universal Resin Cement also apply to products registered under the following name(s): RelyX™ U100 Self-Adhesive Universal Resin Cement.
**RelyX™ Unicem Self-Adhesive Universal Resin Cement**

**Bond strength of self-adhesive resin cements used for onlays luting**

O. RAFFAELLI, C. GORACCI, A. CANTORO, F. PAPACCHINI, and M. FERRARI, University of Siena, Italy

**Objectives:** To evaluate strength of the interface on dentin by the Experimental luting (EL, Ivoclar-Vivadent), RelyX Unicem (RU, 3M ESPE), and Maxcem (M, Sybron-Kerr), applied under two standardized clinically seating pressures.

**Methods:** composite overlays (Paradigm MZ100, 3M ESPE) were luted on coronal dentin surfaces of 12 extracted molars, which are randomly divided in three groups (EL, RU, M). Each group is divided in two subgroups depending on the different seating pressures applied. During the initial 5 min auto-cure period, a pressure of 20 or 40g/mm² was maintained on the overlay. Curing was completed by light irradiation from the top of the overlay for 20 s. Microtensile sticks were obtained from the luted teeth. The Two-Way Analysis of Variance was applied with bond strength as the dependent variable, cement, and seating pressure as factors. The Bonferroni test was applied for post-comparisons among cements and between factors interactions. In all the analyses the level of significance was set at p<0.05.

**Results:** The bond strengths (MPa) in dentin were: EL 20g/mm² 8.28±5.44, 40g/mm² 13.19±5.44; RU 20g/mm² 6.8±2.6, 40g/mm² 14.5±5.3; M 20g/mm² 4.1±1.8, 40g/mm² 5.2±1.6. The Two-Way ANOVA revealed that cement, seating pressure and the interaction between these factors significantly influenced bond strength (p<0.05). Significantly stronger bonds were established under the heavier seating pressure. With regard to the cement factor, RelyX Unicem and the Experimental luting agent achieved levels of adhesion significantly higher than Maxcem. Significant between factors interactions are reported in the Table.

**Conclusions:** Interfacial strength self-adhesive dual-cure cements are enhanced if a seating force heavier than finger pressure is maintained throughout the initial autocure period. Table CEMENT SEATING PRESSURE Mean (MPa) s.d. Significance P<0.05 Experimental 20g/mm² 8.28 5.44 A, B 40g/mm² 13.19 5.44 A,a RelyX Unicem 20g/mm² 6.8 2.6 A,bc 40g/mm² 14.5 5.3 A,a Maxcem 20g/mm² 4.1 1.8 B,c 40g/mm² 5.2 1.6 B,c.

**Bond strength to dentin (MPa)**

<table>
<thead>
<tr>
<th>CEMENT</th>
<th>SEATING PRESSURE</th>
<th>Mean (MPa)</th>
<th>s.d.</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Luting</td>
<td>20 g/mm²</td>
<td>8.28</td>
<td>5.44</td>
<td>A, B</td>
</tr>
<tr>
<td>RelyX Unicem</td>
<td>20 g/mm²</td>
<td>6.8</td>
<td>2.6</td>
<td>A,bc</td>
</tr>
<tr>
<td>Maxcem</td>
<td>20 g/mm²</td>
<td>4.1</td>
<td>1.8</td>
<td>B,c</td>
</tr>
<tr>
<td></td>
<td>40 g/mm²</td>
<td>13.19</td>
<td>5.44</td>
<td>A,a</td>
</tr>
<tr>
<td></td>
<td>40 g/mm²</td>
<td>14.5</td>
<td>5.3</td>
<td>A,a</td>
</tr>
<tr>
<td></td>
<td>40 g/mm²</td>
<td>5.2</td>
<td>1.6</td>
<td>B,c</td>
</tr>
</tbody>
</table>

**Aim of the Study:** The influence of two different, clinically relevant seating pressures (average and strong finger pressure) on microtensile bond strength of self-adhesive resin cements was evaluated.

**Results of the Study:** RelyX Unicem self-adhesive resin cement and Experimental Luting material achieved significantly higher bond strength under both seating conditions than Maxcem. Higher seating pressure was beneficial for all materials.
Retentive strength of all ceramic crowns after long-term water storage

C.-P. ERNST, E. AKSOY, J.G. HORN, E. STENDER, and B. WILLERSHAUSEN, Johannes Gutenberg University Mainz, Germany

Objectives: The retentive strength of a resin cement in combination with a conventional adhesive (Variolink II/Syntac Classic, Ivoclar Vivadent), two resin cements with self etching adhesives (Panavia F 2.0/ED Primer, Kuraray, Multilink/Multilink Primer A/B, Ivoclar/Vivadent), two self adhering cements (RelyX Unicem, 3M ESPE, Maxcem, sds Kerr), and a resin modified glassionomer-cement (Fujicem, GC) were examined for luting zircon-oxide ceramic crowns (LA V A, 3M ESPE) on extracted human teeth.

Methods: 160 extracted teeth (n=20) were prepared in a standardized manner (10°, h=3 mm). The resin cements and the adhesive system were used according to manufacturers’ recommendations; in dual-curing systems, only the self-curing approach was conducted. The crowns inner surfaces were sandblasted (Rocatec Pre). Additional pretreatment was carried out with Multilink (Metallprimer or Monobond S). With RelyX Unicem also one group with Rocatec Plus pretreatment was examined. After thermocycling (5000 x, 5/55°C), 50 % of the cemented ceramic crowns (Rocatec-pretreatment at the outer surface; connected over a low shrinkage epoxy resin to macro-mechanical undercuts in a resin block, made out of Paladur denture base material) of each group (n=10) were removed along the path of insertion (Zwick 1425); the remaining samples after 1a of water storage. The retention surface was determined individually for each tooth. Statistical analysis: Wilcoxon test/Bonferroni adjustment, 5% level.

Results: The retentive strength values [N/mm²] were (Min/Q1/Median/Q3/Max): Variolink II/Syntac: 1.0/1.9/2.5/3.3/5.2, Panavia F 2.0: 1.5/1.8/2.0/3.6/5.4, Multilink/Metallprimer: 2.9/4.6/5.3/9.1/11.7, Multilink/Monobond S: 4.1/4.8/5.4/7.7/12.6, RelyX Unicem: 3.9/6.3/7.5/9.0/10.7, RelyX Unicem/Rocatec Plus: 4.4/5.5/7.2/9.4/11.9, Maxcem: 0.9/2.3/3.0/3.3/4.5, Fujicem: 1.6/2.7/4.3/5.4/6.7. Both, Multilink and Unicem should significantly higher median retentive strength values than Variolink II and Maxcem, while Unicem proved superior results to Panavia, too.

Conclusions: RelyX Unicem and Multilink showed the highest median retentive strength values. Long term water storage did not affect the retentive strength determined. This study was supported by Ivoclar Vivadent, 3M ESPE, Kuraray, and sds Kerr.

Median values of retentive strength

Aim of the Study: This study investigated the ability of selected resin cements and a resin-modified glass ionomer cement to retain a zirconium-oxide ceramic crown (LA V A, 3M ESPE) under simulated clinical conditions.

Results of the Study: RelyX Unicem showed the highest median retentive strength initially and after 1 year in this clinically very relevant study design.

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Bond-strength and dentine interface of dual-cure, auto-cure and auto-adhesive cements

R. VAZ, M. F. DE GOES, V. DI HIP"LITO, and M. SINHORETI, Dental School of Piracicaba - UNICAMP, Brazil

Objectives: Bond strength evaluation of dual-cure, auto-cure and auto-adhesive luting cements to human dentin and indirect resin composite.

Methods: Oclusal enamel of 12 human molars was removed using a low-speed saw. The medium dentin exposed was ground with Sic (600 grit). Indirect composite resin discs (Sinfony, 3M ESPE) were confectioned and were sandblasted with 50µm aluminum oxide particles, and bonded to dentin surfaces, according to manufacture’s instructions with the following luting cements and adhesives: Rely X Unicem (3M ESPE, UN), Rely X ARC/Single Bond 2 (3M ESPE ARC) and C&B Cement/All Bond 2 (Bisco CB). After 24-hour water storage, each tooth was sectioned in X and Y directions to obtain twenty 0.8 ± 1 mm² cross-sectional area sticks. Specimens were tested in tension in an Instron at cross-speed of 0.5mm/min. Statistical analysis included ANOVA and Tukey test (p≤0.05). The surfaces of 8 dentine discs (1.5 mm thick) were treated with each of the cements and adhesives and bonded to form disc-pairs for SEM analysis.

Results: (Mean MPa ± S.D.) Rely ARC: 40.8±9.40 ; UNICEM: 31.3± 7.36 and CB:19,4±3.81. ARC resulted in statistically higher bond strength than UNICEM that was also significantly higher than CB cement. Fracture pattern analysis in SEM revealed predominance of cohesive cement fractures for UN, mixed fractures in cement, hybrid layer and adhesive for ARC and cohesive fractures in hybrid-layer for CB. Different from ARC and CB cements, the interface analysis of UNICEM did not reveal hybrid layer formation.

Conclusions: Dual-cure and auto-adhesive cements may present higher bond strength than auto-cure luting cements.

Bond strength to dentin.

Aim of the Study: This in vitro study evaluates the bond strength of RelyX Unicem, RelyX ARC and another total-etch luting cement to human dentin.

Results of the Study: RelyX ARC shows very high adhesion values. RelyX Unicem displays high adhesion values even without any pretreatment of the dentin. Both cements exceed significantly the bond strength of the tested total-etch luting cement.
**RelyX™ Unicem Self-Adhesive Universal Resin Cement**

**Proximal Adaptation of Partial Ceramic Crowns with Different Luting Techniques/Materials**

M. FEDERLIN, K.-A. HILLER, H. REINHARD, D. FRITZSCH, and G. SCHMALZ, University of Regensburg, Germany

**Objectives:** With all-ceramic restorations, the application of multiple-step/one-step adhesive systems, and the resin-coating-technique are frequently used adhesive methods to achieve a tight adhesion between tooth and ceramic. An alternative approach to simplify procedures is the use of a self-adhesive-universal-resin-cement. The present in-vitro study evaluated the interfacial adaptation of partial ceramic crowns (PCC) luted with three different adhesive luting techniques/materials and compared it to the interfacial adaptation achieved with a self-adhesive-universal-resin-cement.

**Methods:** PCC-preparations were performed on 48 extracted human molars. Proximal margins were placed 1mm below the cemento-enamel-junction (CEJ). PCC were fabricated using the Cerec-3-system. Specimens were assigned to the following groups: luting with (1) Syntac Classic/Variolink II without resin-coating (SYCL); (2) Syntac Classic/Variolink II with resin-coating with Tetric-Flow (SYRC); (3) Multilink (ML) and (4) RelyX-Unicem (RXU). Thermocycling/mechanical loading (TCML) was applied (5000x5°C/55°C,30s/cycle;500000x72.5N/1.6Hz). Marginal adaptation was assessed by SEM margin analysis on replicas and by silver staining on multiple tooth sections. Data were statistically analyzed with the Mann-Whitney U-test and Error Rates Method (ERM).

**Results:** Silver staining(%) and marginal adaptation (perfect margin (%PM); marginal imperfections (%MI).

<table>
<thead>
<tr>
<th></th>
<th>SYCL</th>
<th>SYRC</th>
<th>ML</th>
<th>RXU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Silver Staining(%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td>Median(25–75%)</td>
<td>Median(25–75%)</td>
<td>Median(25–75%)</td>
<td>Median(25–75%)</td>
</tr>
<tr>
<td>Ceramic</td>
<td>0(0/5)</td>
<td>0(0/1)</td>
<td>1(0/4)</td>
<td>1(0/4)</td>
</tr>
<tr>
<td>Dentin</td>
<td>58(45/95)</td>
<td>59(34/59)</td>
<td>50(36/68)</td>
<td>15(11/29)</td>
</tr>
</tbody>
</table>

**SEM Analysis**

<table>
<thead>
<tr>
<th></th>
<th>SYCL</th>
<th>SYRC</th>
<th>ML</th>
<th>RXU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM(%) Ceramic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before TCML</td>
<td>31(24/34)</td>
<td>60(51/74)</td>
<td>35(25/45)</td>
<td>95(87/98)</td>
</tr>
<tr>
<td>After TCML</td>
<td>24(18/29)</td>
<td>57(34/73)</td>
<td>19(13/25)</td>
<td>92(88/98)</td>
</tr>
<tr>
<td><strong>MI(%) Ceramic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before TCML</td>
<td>69(66/73)</td>
<td>48(26/45)</td>
<td>65(55/75)</td>
<td>3(1/7)</td>
</tr>
<tr>
<td>After TCML</td>
<td>74(71/81)</td>
<td>41(27/66)</td>
<td>80(74/87)</td>
<td>2(1/6)</td>
</tr>
<tr>
<td><strong>PM(%) Dentin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before TCML</td>
<td>57(47/70)</td>
<td>38(22/54)</td>
<td>39(24/55)</td>
<td>2(1/8)</td>
</tr>
<tr>
<td>After TCML</td>
<td>90(83/93)</td>
<td>69(55/78)</td>
<td>66(53/77)</td>
<td>2(1/10)</td>
</tr>
</tbody>
</table>

ERM revealed a statistically significant influence of the luting technique/material used. However, neither system completely sealed the dentin/luting agent interface. RXU reveals the highest percentages for PM and lowest values for silver staining.

**Conclusions:** Resin-coating may improve interfacial adaptation within the dentin, but luting with a self-adhesive-universal-resin-cement is less technique-sensitive and showed the best interfacial adaptation.

**Aim of the Study:** Federlin et al. compared the interfacial adaptation of partial ceramic crowns on human molars after different adhesive cementation protocols: multi-step cementation with or without previous resin coating, cementation with self-etching primer and cementation with the self-adhesive universal resin cement RelyX Unicem. Interfacial adaptation was analysed with dye penetration and SEM.

**Results of the Study:** RelyX Unicem self-adhesive resin cement showed the best interfacial adaptation of the materials tested, while additionally being the least technique sensitive.
RelyX™ Unicem Self-Adhesive Universal Resin Cement

Material Properties of Different (Self-)Adhesive Resin Cements
C.A. WIEDIG, R. HECHT, G. RAIA, and M. LUDSTECK, 3M ESPE AG, Seefeld, Germany

Objectives: The purpose of this in vitro investigation was to compare different self-adhesive and one adhesive resin cement regarding their linear expansion, susceptibility to discoloration, pH-profile and long-term stability.

Methods: Materials tested were universal self-adhesive resin cement RelyX™ Unicem (RXU), experimental self adhesive paste/paste (EXP; both 3M ESPE), Maxcem™ (MAX, Kerr) and Panavia F 2.0 (PAN, Kuraray). Susceptibility to discoloration was investigated by incubating the cement specimens in standardized coffee solution (72h, 36°C). Linear expansion of standard specimens (storage in water/36°C) was measured at RT using a digital caliper. pH was analysed for the self-adhesive materials by applying the cement onto a moist pH-indicator paper (Sigma, Merck). Flexural strength was measured after water storage (36°C) according to ISO-standards to monitor long-term stability. Statistics (linear regression) was used if applicable.

Results: The results are summarized in the table below (lc/sc=light-/self-cured):

<table>
<thead>
<tr>
<th>Test</th>
<th>Linear expansion (n=3, 30d, %)</th>
<th>Exogenic staining (n=3, 3d, ∆E*)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>curing mode</td>
<td>lc</td>
<td>sc</td>
</tr>
<tr>
<td>RXU</td>
<td>0.5±0.1</td>
<td>0.4±0.1</td>
<td>8.8±0.8</td>
</tr>
<tr>
<td>EXP</td>
<td>0.5±0.1</td>
<td>0.4±0.0</td>
<td>9.5±1.9</td>
</tr>
<tr>
<td>PAN</td>
<td>0.4±0.1</td>
<td>0.4±0.0</td>
<td>16.3±0.7</td>
</tr>
<tr>
<td>MC</td>
<td>1.1±0.0</td>
<td>1.1±0.0</td>
<td>30.9±5.8</td>
</tr>
</tbody>
</table>

RXU and EXP showed the lowest discoloration and fast neutralization. Linear expansion of RXU and EXP was comparable to PAN. MC displayed strong discoloration and expansion. Flexural strength over time revealed a decreasing trend for MC within 12 month and steadiness for RXU over 48 months.

Conclusions: RXU and experimental self-adhesive paste/paste material showed best performance for susceptibility to exogenic staining, and linear expansion comparable to that of the traditional resin cement PAN. MC performed worst in both tests. Material neutralization, which is important for its durability, was achieved quickly by RXU and Experimental material. Long-term stability observations confirm this material superiority.

Aim of the Study: Different self-adhesive and one multi-step adhesive cementation material were compared regarding several physical and chemical properties and their long-term stability.

Results of the Study: RelyX Unicem Aplicap and RelyX Unicem Clicker (EXP) self-adhesive universal resin cements were least susceptible to exogenic staining and performed comparably to Panavia F 2.0 and superior to Maxcem regarding linear expansion. Compared to Maxcem, RelyX Unicem quickly reached the desired inert neutral state and showed excellent long-term stability.
Tensile Bond Strength of RelyX Unicem to Ceramics

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Objectives: The purpose of this study was to evaluate the bond strength of a self-adhesive luting resin (Unicem, 3M ESPE, USA) to densely sintered alumina ceramic (Procera, Noble Biocare, S) and to glass-ceramic (Empress I, Ivoclar-Vivadent, FL) after long-term storage.

Methods: Plexiglas tubes (inner diameter 3.2 mm) filled with resin (Clearfil F2, Kuraray, J) were bonded to ceramic disks. Procera disks were air-abraded with 50 µm alumina particles at 0.25 MPa for 15s, while Empress disks were etched with 5% hydrofluoric acid for 60s (Ceramic etching gel, Ivoclar-Vivadent) and then silanated (ESPE Sil, 3M ESPE). The following groups of 16 samples each were tested: Empress (EL) and Procera (PL) bonded with Unicem in a dual-curing mode by using a curing light, and Empress (ES) and Procera (PS) bonded with Unicem in its self-curing mode without light application. Eight specimens of each group were stored in water either for three days with no thermal cycling (3) or for 150 days with 37,500 thermal cycles (150). Following the different storage conditions, the tensile bond strengths of specimens were determined with a universal testing machine (Z010/024, Zwick, FRG) at a crosshead speed of 2 mm/min. Statistical analysis was done using three-way ANOVA.

Results: The mean tensile bond strengths (TBS) in MPa were: (EL-3) 37.2±6.5; (EL-150) 30.6±6.2; (ES-3) 42.0±7.3; (ES-150) 33.8±4.0; (PL-3) 35.4±4.9; (PL-150) 13.8±2.6; (PS-3) 27.1±5.5 and (PS-150) 16.3±4.6. There were statistically significant differences (SSD) among groups as shown by three-way ANOVA. The ceramic material and the storage time had a significant influence (p<0.001) on TBS whereas the polymerisation mode had not (p>0.05).

Conclusions: The resin bond strength of RelyX Unicem to alumina ceramic was significantly lower than to glass-ceramic. The bond strengths of the self-cured groups did not differ from the groups with additional light-application.

Aim of the Study: The authors compared the adhesion of RelyX Unicem to sintered alumina ceramics (Procera) and glass ceramics (Empress I) before and after long-term storage and thermocycling.

Results of the Study: RelyX Unicem showed good retentive strength to both tested ceramic materials, independent of the curing mode. Retention was generally higher to etched and silanated glass ceramics than to alumina ceramics. No competitive material was run in the same test series as control.
Marginal Adaptation of Ceramic Inlays Using Different Cements

M. ROSENTritt1, S. HAHNel1, M. BEHR1, and G. HANDEL1, 1University of Regensburg, Germany, 1University Medical Centre Regensburg, Germany

Objectives: The aim of this in-vitro study was to determine the marginal adaptation of ceramic inlays to dentin and enamel using two self-adhesive resin cements and one adhesive resin cement with its corresponding bonding system.

Methods: All-ceramic inlays (IPS Empress, Ivoclar-Vivadent, FL) were inserted in MOD-Class 2 cavities with cervical margins located both in A) dentin and in B) enamel. Three cements were tested: one resin cement Panavia F 2.0 with ED Primer (Kuraray, J) and two self-adhesive luting cements: exp. self-adhesive Paste (3M ESPE, G) and Maxcem ™ (Kerr, USA). A self-adhesive resin cement in capsules (RelyX™ Unicem, 3M ESPE) was used as a control. The approximal margins were evaluated after thermal cycling and mechanical loading (TCML: 6000x5°/55°C, H₂O, 2 min each cycle, 1.2*10⁶x50N). Marginal adaptation was determined using scanning electron microscopy before and after TCML. Microleakage was assessed at the cervical margins by a dye penetration test after TCML (0.5% fuchsine solution, 16h).

Statistics: Mann-Whitney-test (p≤0.05).

Results:

<table>
<thead>
<tr>
<th>Before/after TCML</th>
<th>Margin</th>
<th>Maxcem</th>
<th>experimental self-adhesive paste</th>
<th>Panavia F 2.0</th>
<th>RelyX Unicem (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfect margin [%]</td>
<td>Enamel</td>
<td>98 (96–100)/97 (95-100)</td>
<td>100 (96–100)/98 (95–100)</td>
<td>96 (92–97)/98 (95–98)</td>
<td>98/99</td>
</tr>
<tr>
<td>Microleakage [%]</td>
<td>Enamel</td>
<td>12.5</td>
<td>17</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Dentin</td>
<td>20</td>
<td>23</td>
<td>21</td>
<td>12</td>
</tr>
</tbody>
</table>

Conclusions: All cements showed comparable marginal adaptation. Microleakage was lower at enamel interface for all cements. The self-adhesive systems without any bonding may be an alternative to adhesive resin systems comparing microleakage and marginal adaptation.

Aim of the Study: Investigation of marginal adaptation of ceramic inlays to dentin and enamel achieved with different (self-)adhesive cementation materials.

Results of the Study: The percentage of perfect margin determined by SEM microscopy for RelyX Unicem and RelyX Unicem Clicker (=experimental) was comparable or higher than for the conventional resin cement/primer system Panavia F 2.0.
Shear Bond strength of Luting Cements to Zirconia after Thermocycling

M. IRIE1, K. SUZUKI1, and D. WATTS2, 1Okayama University, Japan, 2University of Manchester, England, UK

Objectives: One of the major concerns with indirect restorative materials is their long-term bonding ability and durability of the bond (Dent Mater, 2001;17:347). The purpose of this study was to evaluate the effect of 20,000 thermocycles on the bond strength of composite inlays (Z250, 3M ESPE) to zirconia (Lava, 3M ESPE) cemented with two self-adhesive resin cements (RelyX Unicem, 3M ESPE; Multilink Sprint, Ivoclar Vivadent), and the two new adhesive resin cements (Clearfil Esthetic Cement, Kuraray Medical; ResiCem, Shofu).

Methods: The surfaces of Lava samples were pretreated by sandblasting with 50-micron aluminum-oxide particles (n=10). The Clearfil Esthetic Cement and ResiCem groups were pretreated by manufacturer’s instructions. Composite inlay samples, approximately 3.4 mm in diameter and approximately 2 mm in height, were prepared and inserted into a PTFE mold, 3.6 mm in diameter and 2.0 mm in height, for cementation to Lava samples with four resin cement groups. The shear bond strength (SBS, MPa, Mean(SD)) tests between the composite inlays and Lava were performed using a universal testing machine after one-day storage (1-D) and after 20,000 thermocycles (TC 20k). The flexural strength (FS, MPa, Mean(SD)) of luting cements were measured with the same materials under same conditions. Statistical analyses were performed with t-Test (1-D vs. TC 20k, p<0.05, S: significantly difference, NS: not significantly different).

Results:

<table>
<thead>
<tr>
<th>RelyX Unicem</th>
<th>Multilink Sprint</th>
<th>Clearfil Esthetic Cement</th>
<th>ResiCem</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBS</td>
<td>FS</td>
<td>SBS</td>
<td>FS</td>
</tr>
<tr>
<td>1-D</td>
<td>14.1(4.2)</td>
<td>68.8(4.4)</td>
<td>9.8(2.8)</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>TC 20K</td>
<td>9.0(1.7)</td>
<td>48.8(5.7)</td>
<td>6.7(2.5)</td>
</tr>
</tbody>
</table>

Conclusions: The bonding ability of two self-adhesive resin cements to Lava with composite inlays showed a significant decrease after TC 20k compared to 1-D testing, except the two new adhesive resin cements. The flexural strength of all luting cements exhibited a significant reduction.

Shear bond strength of Luting Cements to Zirconia after Thermocycling

Aim of the Study: In this study the authors compared flexural strength and the SBS of two self-adhesive and two new adhesive resin cements to Lava zirconia ceramic both initially and after 20,000 thermocycles.

Results of the Study: RelyX Unicem self-adhesive resin cement showed best initial results to sandblasted Lava zirconia while Multilink Sprint displayed the lowest SBS to Lava both initially and after TC. Flexural strength of all materials decreased after thermocycling.

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RelyX™ Unicem Self-Adhesive Universal Resin Cement

Bond strength of self-adhesive cementing agents to dentin and enamel

A. PIWOWARCZYK, J. BREGULLA, and H.-C. LAUER, Johann Wolfgang Goethe-University Frankfurt, Frankfurt/Main, Germany

Objectives: This in-vitro study determined the bond strength of self-adhesive cementing agents to dentin and enamel of human molars. Additionally, the influence of polymerization method was evaluated.

Methods: A total of 288 extracted non-carious and not root-filled human molars were ground flat with water-cooled 600-grit silicon carbide sandpaper to expose dentin and enamel surface. The following cementing agents were examined: 1a) RelyX Unicem Aplicap (3M ESPE), auto-polymerized, 1b) RelyX Unicem Aplicap, light-polymerized, 2a) Experimental self-adhesive resin cement paste/paste (3M ESPE), auto-polymerized, 2b) Experimental self-adhesive resin cement paste/paste, light-polymerized, 3a) Maxcem (Kerr), auto-polymerized, 3b) Maxcem, light-polymerized. Twelve specimens per group were fabricated. One subgroup was tested after 24 hours water storage at 37°C; the other subgroup was stored 14 days and subsequently thermally cycled (1,000X, 5-55°C). All specimens were stressed in shear at a constant crosshead speed of 0.5 mm/min until failure. Statistical analysis was performed by multifactorial analysis of variance (ANOVA) taking interactions between effects into account (α=0.05).

Results: In a 4-way ANOVA model RelyX Unicem Aplicap showed the highest bond strengths for dentin (6.5 ± 3.2 MPa) and enamel (6.2 ± 2.0 MPa), independent of polymerization method and time. Experimental self-adhesive resin cement reached values of 6.4 ± 3.9 MPa (dentin) and 5.7 ± 2.8 MPa (enamel), followed by Maxcem (dentin: 0.4 ± 1.7 MPa; enamel: 4.0 ± 3.3 MPa). 2-way ANOVA revealed that the two main effects cementing agents (p<0.0001), substratum type (p=0.0171) and the interaction (p<0.0001) differed significantly. Polymerization using light activation (dentin: 5.9 ± 4.5 MPa; enamel: 5.3 ± 3.5 MPa) yielded higher strengths than that without light activation (dentin: 3.5 ± 3.1 MPa; enamel: 5.0 ± 2.8 MPa) (p<0.0001).

Conclusions: Bond strength is dependent on the choice of self-adhesive cementing agents. Adhesion to dentin and enamel can be improved by light-polymerization of the dual-curing materials.

Bond strength of self-adhesive cementing agents to dentin and enamel independent of storage time and curing mode

Aim of the Study: The authors compared the shear bond strength of different dual-cure self-adhesive resin cements to human dentin and enamel.

Results of the Study: RelyX Unicem Aplicap achieved the highest bond strength to both substrates independent of the curing mode or additional stress test, directly followed by RelyX Unicem Clicker (experimental). Maxcem showed lower bond strength than both RelyX Unicem Aplicap and Clicker.

Results found in abstracts for RelyX™ Unicem Self-Adhesive Universal Resin Cement also apply to products registered under the following name(s): RelyX™ U100 Self-Adhesive Universal Resin Cement.
RelyX™ Unicem Self-Adhesive Universal Resin Cement

Bonded and Self-Adhesive Cements’ Bond Strengths between Zirconia and Dentin

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Objectives: To examine the shear bond strengths of two different cement types—Bonded Resin Cements and Self-Adhesive Resin Cements—between zirconia discs (Cercon, Dentsply Prosthetics) and dentin in vitro. The following groups were tested:

Group 1: Bonded Resin Cement: Prime & Bond NT with Calibra Resin Cement (DENTSPLY Caulk)

Group 2: Self-Adhesive Resin Cement: Rely-X Unicem Resin Cement (3M ESPE)

Group 3: Self-Adhesive Resin Cement: investigational SAR cement (DENTSPLY Caulk)

Methods: Forty-five 5 mm zirconia discs were micro-etched (sandblasted with 50µ alumina). Discs were cemented to dentin of human extracted molars according to manufacturers’ directions for each of the three cement groups; N=15. Cemented teeth were stored in distilled water for 3 days at 37°C, then thermocycled for 300 cycles between 5°C and 55°C with a dwell of 30 seconds. Instron machine with crosshead speed of 5mm/min. was used to test shear bond strength of each sample.

Results: Data were analyzed using one-way ANOVA and Scheffe test (p<0.05).

Table 1: Mean Maximum Load of each group during shear bond testing:

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Max. Load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>226</td>
</tr>
<tr>
<td>2</td>
<td>192</td>
</tr>
<tr>
<td>3</td>
<td>141</td>
</tr>
</tbody>
</table>

There is no statistically significant difference between the shear bond strengths of Group 1 vs. Group 2 (p>0.05). There is significant statistical difference between the shear bond strengths of Group 1 vs. Group 3 (p<0.05). There is significant statistical difference between the shear bond strength of Group 2 vs. Group 3 (p<0.05).

Conclusions: The group samples with Bonded Resin Cements (Group 1) demonstrated the highest Mean Maximum Load/shear bond strengths of zirconia to dentin while Self-Adhesive Resin Cements (Group 2 & 3) had weaker bond strengths. However, there was no statistically significant difference between Groups 1 & 2 whereas Group 3 was statistically different/weaker than the other groups. (Research sponsored in part by DENTSPLY Caulk).

Aim of the Study: Shear bond strengths of one conventional (bonded) adhesive and two self-adhesive resin cements were compared when luting Cercon zirconia ceramics to human dentin.

Results of the Study: RelyX Unicem self-adhesive universal resin cement performed comparably to the conventional resin cement Calibra and significantly higher then Dentsply’s investigational self-adhesive resin material.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Results found in abstracts for RelyX™ Unicem Self-Adhesive Universal Resin Cement also apply to products registered under the following name(s): RelyX™ U100 Self-Adhesive Universal Resin Cement.
Bonding of IPS-Empress-2 with different surface treatments and resin cements

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Objectives: To evaluate the microtensile bond strength (µTBS) of 3 resin cements to a lithia disilicate-based ceramic submitted to 2 surface conditionings.

Methods: Eighteen 5x6x8 mm ceramic blocks (IPS Empress 2) were fabricated according to manufacturer’s instructions and duplicated in composite resin (Tetric Ceram). Ceramic blocks were polished and divided into 2 groups (n=9/treatment): 1) no conditioning (control) and 2) 5% hydrofluoric acid etching for 20s and silanization for 1 min (HF+SIL). Ceramic blocks were cemented to the composite resin blocks with the self-adhesive universal resin cement (RelyX Unicem) or the resin-based luting agents (Multilink or Panavia F), according to the manufacturer’s instructions. Composite resin-ceramic blocks were stored in humidity at 37°C for 7 days, and serially sectioned into 1.0 mm² beams. Specimens were thermal cycled (5000 cycles, 5°C-55°C) and tested in tension at 1mm/min. µTBS data (MPa) were analyzed by ANOVA and Tukey’s multiple comparisons tests (α=.05).

Results: Mean µTBS and standard deviations (MPa) are listed below. For each column, groups labelled with the same lower case letters indicate no differences in the control groups and upper case letters indicate no differences in HF+SIL groups. Differences between surface treatments for each luting material are indicated by the row results. For each row, groups labelled with * are significantly different.

<table>
<thead>
<tr>
<th>Luting agent</th>
<th>Control</th>
<th>HF+SIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RelyX Unicem</td>
<td>9.6 (1.9) a</td>
<td>18.8 (3.5) A*</td>
</tr>
<tr>
<td>Multilink</td>
<td>6.2 (1.2) b</td>
<td>17.4 (3.0) A*</td>
</tr>
<tr>
<td>Panavia F</td>
<td>7.4 (1.9) b</td>
<td>15.7 (3.8) B*</td>
</tr>
</tbody>
</table>

Conclusions: Etching and silanization treatments appear to be crucial to resin-bond to a lithia disilicate-based ceramic, despite the used resin cement. When bonding with a self-adhesive luting agent, the manufacturer’s claim to eliminate the need for pretreatment of the ceramic surfaces seems to be doubtful, since higher bond strengths are attained following use of hydrofluoric acid and silane conditioning.

Bonding of IPS-Empress-2 with different surface treatments and resin cements

Aim of the Study: The authors investigated the adhesion of RelyX Unicem self-adhesive resin cement and two conventional adhesive resin cements to untreated or HF-etched and silanized lithia disilicate ceramics.

Results of the Study: RelyX Unicem showed the highest microtensile bond strength to Empress2, even if the ceramic was not pre-treated, which is against the manufacturer’s recommendations (3M ESPE, instruction for use).
RelyX™ Unicem Self-Adhesive Universal Resin Cement

**Bond strengths of self-adhesive resin cements to dentin**

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**Objectives:** This study compared the bond strengths to dentin of two self-adhesive resin cements (Maxcem, Kerr and RelyX Unicem, 3M) and two conventional resin cement systems (Panavia F, Kuraray and Multilink, Ivoclar).

**Methods:** 40 human molars had their cusps removed and the dentin surfaces were wet-ground flat with 600-grit silicon carbide paper. Composite resin blocks (N=40) (W3D/Wilcos) of 5x5x4mm were confectioned and randomly divided in 4 groups, according to the cement to be used: G1-Maxcem; G2-RelyX Unicem; G3- Panavia F and G4-Multilink. The resin blocks were cemented after treating the dentin surfaces according to the manufacturers instructions. The specimens were stored in distilled water at 37°C for 24 h and sectioned in two axes (x and y) with a diamond disk under coolant irrigation in order to obtain beams with approximately 1 mm² of adhesive area (n=52). Each beam was attached to an adapted device and the microtensile test was performed using a universal testing machine (crosshead speed: 1mm/min). The data (MPa) was subjected to Anova and Tukey tests (p<.05).

**Results:** The bond strength means were not statistically different for G2 (mean±standard deviation (MPa): 17.6±5.3), G3 (19.5±5.4) and G4 (17.7±6) However, G1(8.5±2.7) was significantly different from the other groups.

**Conclusions:** The self-etching resin cement Maxcem had lower bond strengths to dentin than the other materials studied.

**Aim of the Study:** Two self-adhesive and two conventional adhesive resin cements were compared regarding their microtensile bond strength to dentin.

**Results of the Study:** RelyX Unicem self-adhesive resin cement had the same bond strength to human dentin as the conventional resin cements Panavia F and Multilink. Maxcem showed significantly lower results.
It’s known that the bonding strength of Zirconia porcelain and resin cement was poor.

**Objectives:** to compare shear bond strength (SBS) of various resin cements used to cement Cercon to human dentin.

**Methods:** the resin cements used in this study were Calibra (Dentsply), Cement-It Universal C &B (Pentron), Linkmax (GC), Nexus2 Dual Syringe (Kerr), Panavia 21 (Kuraray), RelyX Unicem (3M ESPE). Human third molars were embedded in acrylic and the exposed dentin surfaces were polished with 600-grit sandpaper. Cercon cylinders (Dentsply, 2.5mm in diameter and 4mm long) were air-abraded with alumina (110um) at 3-4 bars for 10sec. The porcelain specimen was bonded to the dentin surface by the cement following the manufacturer’s instruction (etch, primer/bonding agent) under a vertical load of 1kg. The bonded specimens (n=8) were stored in 37°C water for 24-hour (24-H) or thermal cycled between 5 to 55°C for 1000 cycles (TC) before being debonded with shear force on an MTS mechanical tester at a cross-head speed of 1 mm/min.

**Results:** some specimens failed during the storage. The means±standard deviation of the SBS (MPa) of tested and the final sample size are listed in the following table.

<table>
<thead>
<tr>
<th></th>
<th>Linkmax</th>
<th>Nexus2</th>
<th>C&amp;B</th>
<th>RelyX</th>
<th>Panavia</th>
<th>Calibra</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-H</td>
<td>3.8±1.6</td>
<td>7.9±2.9</td>
<td>6.1±2.9</td>
<td>7.3±2.9</td>
<td>0.9±0.6</td>
<td>12.7±6.1</td>
</tr>
<tr>
<td>TC</td>
<td>0.0±0</td>
<td>0.0±0</td>
<td>7.0±4.0</td>
<td>6.2±2.7</td>
<td>5.0±4.1</td>
<td>20.1±4.7</td>
</tr>
</tbody>
</table>

In each row, means with the same superscripted letter are not statistically different from each other at p<0.05. 2-way ANOVA reveals that cement, storage condition and the interaction had significant influence on SBS between Cercon and dentin. Kruskal-Wallis One-Way ANOVA on Ranks was used to test the difference among the cements for both conditions, respectively and results are shown in the table.

**Conclusions:** Calibra had significantly higher SBS than other cements tested after TC.

**Aim of the Study:** Several resin cements were used to bond Cercon zirconia ceramics (air-abraded) to human dentin. Shear bond strengths were compared both after 24h water storage and thermocycling.

**Results of the Study:** Initially all tested materials except Panavia 21 and Linkmax showed good adhesion. RelyX Unicem performed statistically comparable to the multi-step resin cements Calibra and Nexus2. After thermocycling all materials except RelyX Unicem and two multi-step resin cements debonded.
Resin cements are widely used to cement porcelain restorations due to their strength and esthetics.

**Objectives:** to compare shear bond strength (SBS) of various resin cements used to cement Empress2 to human dentin.

**Methods:** the resin cements used in this study were Calibra (Dentsply), Cement-It Universal C&B (Pentron), Linkmax (GC), Nexus2 Dual Syringe (Kerr), Panavia 21 (Kuraray), RelyX Unicem (3M ESPE). Human third molars were embedded in acrylic and the exposed dentin surfaces were polished with 600-grit sandpaper. Empress2 cylinder (Ivoclar Vivadent, 2.5 mm in diameter and 5 mm long) were polished with 600-grit sandpaper and etched with IPS ceramic etching gel. The porcelain specimen was bonded to the dentin surface by the cement following the manufacturer’s instruction (etch, primer/bonding agent) under a vertical load of 1 kg. The bonded specimens (n=8) were stored in 37°C water for 24-hour (24-H) or thermal cycled between 5 to 55°C for 1000 cycles (TC) before being debonded with shear force on an MTS mechanical tester at a cross-head speed of 1 mm/min.

**Results:** The means of the SBS (MPa) of tested are listed in the following table with standard deviation in parenthesis.

<table>
<thead>
<tr>
<th>Cements</th>
<th>24-H</th>
<th>TC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linkmax</td>
<td>15.8 (4.1)</td>
<td>23.9 (12.0)</td>
</tr>
<tr>
<td>Nexus2</td>
<td>20.9 (6.9)</td>
<td>21.2 (3.7)</td>
</tr>
<tr>
<td>C&amp;B</td>
<td>22.4 (7.6)</td>
<td>21.3 (10.3)</td>
</tr>
<tr>
<td>RelyX Unicem</td>
<td>25.0 (7.5)</td>
<td>30.9 (8.3)</td>
</tr>
<tr>
<td>Panavia</td>
<td>5.2 (3.7)</td>
<td>14.1 (6.0)</td>
</tr>
<tr>
<td>Calibra</td>
<td>17.0 (9.4)</td>
<td>18.5 (9.0)</td>
</tr>
</tbody>
</table>

Cements with the same superscripted letter are not statistically different from each other at p<0.05. 2-way ANOVA reveals that cement had significant influence on SBS between Empress2 and dentin while storage condition and the interaction didn’t. Thus Kruskal-Wallis One-Way ANOVA on Ranks was used to test the difference among the cements for the pooled the data from both conditions.

**Conclusions:** Panavia 21 had statistically significant lower SBS than the other resin cements tested.

**Aim of the Study:** Several resin cements were used to bond Empress2 glass ceramics to human dentin. Shear bond strengths were compared both after 24h water storage and thermocycling.

**Results of the Study:** RelyX Unicem self-adhesive universal resin cement showed the overall highest bond strength both after 24h and after stress and performed significantly better than Panavia 21, Calibra and Linkmax.
RelyX™ Unicem Self-Adhesive Universal Resin Cement

Retentive Bond Strengths of 3 Generations of FRC Posts

P. SCHMAGE, H. SEN, S. SELCUK, U. PLATZER, and I. NERGIZ, University of Hamburg, Germany

Objectives: Fiber-reinforced composite (FRC) root posts were improved regarding radiopacity and translucency. Changing of the post composition might have an effect on the bond strengths. This in vitro study evaluated the retentive bond strengths of 3 generations of FRC posts without and with additional surface conditioning bonded with 2 resin cements.

Methods: Root canals of 140 extracted, wet stored anterior teeth were prepared for tapered posts (Erlangen system, Brasseler, size II and 12 mm length). Conventional (C), radiopaque (R) and translucent (L) FRC posts (DentinPost) were inserted as manufactured (M) or with additional surface conditioning (J, CoJet-system, 3M ESPE). Sandblasted titanium posts (T) were used for control. Groups of 10 posts each were bonded in the post spaces using the resin cements Panavia F (P, Kuraray) and RelyX Unicem (X, 3M ESPE). A tensile force test (Instron 1026) was performed after moist storage for 24 hours and thermocycling (5–55°C, 5000 times). Statistical analysis was carried out (one-way ANOVA-test, Fisher’s PLSD, α<0.05).

Results: Comparable retentive bond strengths were found using the three types of FRC posts with X-M (C 431±65N, R 405±64N, L 454±64N) and with X-T (410±69N, p>0.05). P-M revealed significantly lower values with FRC posts (C 331±26N, R 261±80N, L 222±61N) than with T (457±108N, p<0.05). The values decreased significantly between C and L with P-M (p<0.05). J improved the retentive bond strengths significantly for L-X (541±123N), C-P (444±40N) and R-P (450±61N) compared to M respectively (p<0.05). X showed significantly better results with C-M, R-M, L-M and L-J compared to P (p<0.05).

Conclusions: R and L-FRC posts did not influence bond strengths significantly except between C and L with P-M. The effectiveness of J was proven. Comparing FRC with T posts, X achieved similar and P lower values.

Adhesion to untreated FRC Posts

Aim of the Study: The study compared the tensile bond strength of RelyX Unicem self-adhesive universal resin cement and the resin cement Panavia F to three generations of fiber reinforced composite post with or without CoJet.

Results of the Study: RelyX Unicem showed significantly better results on all untreated FRC posts than Panavia F (however 3M ESPE only recommends no pre-treatment with RelyX Fiber Posts). CoJet proved to be an effective pre-treatment method and increased bond strength significantly in some cases, esp. in combination with Panavia F.
Adhesion of Self-adhesive Resin Cements to Various Core Build-up Materials

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Objectives: to evaluate the shear-bond strength (SBS) of different self-adhesive resin cements to various composite core build-up materials.

Methods: Materials tested were experimental self adhesive paste/paste material, universal self-adhesive resin cement RelyX™ Unicem (both 3M ESPE) and one other material not requiring tooth pretreatment (Maxcem™, Kerr). Two filling materials (Tetric™ EvoCeram, Ivoclar Vivadent; Filtek™ Supreme XT, 3M ESPE) and two core build-up composites (LuxaCore® Automix, Zenith/DMG; Core Paste, DenMat) were used as substrates. Composite disks were produced using a brass mold and either light-cured (3x20s/side) or self-cured (24h/36°C). Surfaces were prepared with 320grid sandpaper. Filtek Z250 (3M ESPE) composite buttons were cemented under pressure (20g/mm2) onto core build-up composite discs. Cementation was performed according to manufacturers’ instructions. After curing specimens were stored for 24h/36°C at 100% humidity and then thermocycled (240x 5/55°C). SBS was measured in a universal testing machine (Zwick Z010, crosshead speed 0.75 mm/min).

Data was analysed using Multiple-Range Test (LSD; p<0.05), n=5.

Results: the following table summarizes mean SBS and standard deviation.

<table>
<thead>
<tr>
<th>curing mode of resin cement</th>
<th>RelyX Unicem</th>
<th>Experimental</th>
<th>Maxcem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetric EvoCeram</td>
<td>&gt;18.5±5.2</td>
<td>&gt;14.8±1.8</td>
<td>7.4±1.9</td>
</tr>
<tr>
<td>sc</td>
<td>&gt;23.5±7.0</td>
<td>&gt;20.2±4.4</td>
<td>&gt;15.5±1.3</td>
</tr>
<tr>
<td>lc</td>
<td>&gt;19.0±2.2</td>
<td>&gt;17.2±3.9</td>
<td>6.0±1.3</td>
</tr>
<tr>
<td>Filtek Supreme XT</td>
<td>&gt;21.8±9.4</td>
<td>&gt;20.2±2.3</td>
<td>&gt;15.1±4.5</td>
</tr>
<tr>
<td>sc</td>
<td>&gt;22.8±2.2</td>
<td>&gt;18.4±6.1</td>
<td>1.9±2.8</td>
</tr>
<tr>
<td>lc</td>
<td>&gt;21.3±3.2</td>
<td>&gt;15.5±4.1</td>
<td>11.8±2.6</td>
</tr>
<tr>
<td>LuxaCore</td>
<td>&gt;17.9±2.6</td>
<td>&gt;17.2±5.1</td>
<td>5.4±0.9</td>
</tr>
<tr>
<td>sc</td>
<td>&gt;16.5±5.5</td>
<td>20.2±6.0</td>
<td>13.7±3.9</td>
</tr>
<tr>
<td>lc</td>
<td>&gt;17.9±2.6</td>
<td>&gt;17.2±5.1</td>
<td>5.4±0.9</td>
</tr>
</tbody>
</table>

(sc/lc = self/light-cured; > = cohesive failure within core build-up)

RelyX Unicem and Experimental showed slightly better performance than Maxcem if light-cured and significantly stronger adhesion if self-cured, independent of the core build-up material. Except for Maxcem, the majority of fractures occurred cohesively in the core build-up composite.

Conclusions: RelyX Unicem and Experimental showed comparable performance. Bond strength was better and significantly more reliable in both curing modes than Maxcem both on light-cured filling composites and self-cured core build-up materials.

Aim of the Study: The authors compared the shear bond strength and analysed the failure mode of different dual-cure self-adhesive resin cements to various composites used as core build-up materials.

Results of the Study: Both RelyX Unicem Aplicap and RelyX Unicem Clicker (EXP) self-adhesive resin cements showed comparable results in both curing modes on all composites tested, the majority of fractures occurred in the core-build-up material. Especially when self-cured, Maxcem generated a significantly weaker bond to all composite materials tested.
Aim of the Study: The authors investigated the shear bond strength of various conventional and self-adhesive resin cements to zirconia ceramics before and after stress test.

Results of the Study: Both RelyX Unicem Aplicap and RelyX Unicem Clicker self-adhesive resin cements performed equally or better than resin cements requiring additional pretreatment steps (Panavia F 2.0, Multilink, Variolink). This could be observed initially as well as after water storage or thermocycling.

Results found in abstracts for RelyX™ Unicem Self-Adhesive Universal Resin Cement also apply to products registered under the following name(s): RelyX™ U100 Self-Adhesive Universal Resin Cement.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Adhesion of RelyX Unicem Aplicap on RelyX Fiber Post

E.-M. POPP, R. PEEZ, V. PORSFELD, and B. LACHERMEIER, 3M ESPE AG, Seefeld, Germany

Objectives: The purpose of this in vitro investigation was to evaluate the influence of different surface treatments of the new RelyX™ Fiber Post (RXFP, 3M ESPE) on the adhesion of RelyX™ Unicem Aplicap™ self adhesive universal resin cement (RXU, 3M ESPE).

Methods: The conical part of RXFP (Size 3) was used. The surface was either left untreated or silane treated by using a) RelyX™ Ceramic Primer (RXCP, 3M ESPE) or b) Monobond-S (MON, Ivoclar Vivadent) or silicatized and silanized by using the Rocatec™ Pre/Plus system (ROC, 3M ESPE) and RXCP or acid etched with Etching gel (ETCH, 3M ESPE). After applying RXU to the surface (discs: d=6,0 mm, h=4,0 mm), the cement was light-cured for 40 seconds (LC) by using Elipar Trilight (3M ESPE). For comparison adhesion was also tested if RXU was used in the dark cure mode (DC) with untreated or silanized posts. Specimens were stored for one hour at 36°C/95% rel. humidity and for 23 hours in water at 36°C. Finally a pull-off test was made using an universal testing-machine (crosshead speed 1 mm/min). Six specimens were tested for each surface coverage.

Results: The following table summarizes the mean adhesion values of RXU to the post. Surface treatment does not have a significant influence on the adhesion (LC mode: p=0,086; DC mode: p=0,764).

<table>
<thead>
<tr>
<th>Surface-treatment</th>
<th>Adhesion (LC) [MPa]</th>
<th>Adhesion (DC) [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>24.1 ± 1.3</td>
<td>24.1 ± 1.2</td>
</tr>
<tr>
<td>Silanized - RXCP</td>
<td>25.0 ± 1.0</td>
<td>25.5 ± 1.2</td>
</tr>
<tr>
<td>Silanized - MON</td>
<td>25.0 ± 1.2</td>
<td>23.9 ± 0.8</td>
</tr>
<tr>
<td>Silicatized and silanized - ROC + RXCP</td>
<td>23.9 ± 0.8</td>
<td></td>
</tr>
<tr>
<td>Etched - ETC</td>
<td>19.4 ± 1.9</td>
<td>19.8 ± 2.5</td>
</tr>
</tbody>
</table>

Conclusions: Bond strength of RXU self adhesive universal cement to the fiberpost surface is high and independent of any of the surface treatments tested.

Adhesion values of RelyX Unicem to RelyX Fiber Post

Aim of the Study: The goal of this in vitro study was to get information about the effect of different surface treatments of the RelyX Fiber Post on the bond strength of RelyX Unicem.

Results of the Study: Different surface treatments of the RelyX Fiber Post do not improve the bond strength between RelyX Unicem and RelyX Fiber Post. Even with no pretreatment high adhesion values are displayed.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

RelyX™ Unicem Cement and RelyX™ Fiber Post

Adhesion of various adhesive resin cements to RelyX Fiber Post

V. PORSFELD, R. PEEZ, and B. LACHERMEIER, 3M ESPE AG, Seefeld, Germany

Objectives: The purpose of this in vitro investigation was to evaluate the bond strength of self adhesive and adhesive resin cements to RelyX™ Fiber Post, a new glass fiber reinforced composite post (RXFP, 3M ESPE).

Methods: RelyX™ Unicem Aplicap™ self adhesive universal resin cement, (RXU, 3M ESPE) and an experimental self adhesive paste/paste material (EXP, 3M ESPE), Maxcem™ (MC, Kerr) as well as Variolink® II (VAR) and Multilink® Automix (MUL, both from Ivoclar Vivadent) were used in combination with RXFP (size 3). Except for MUL and VAR the fiber post was not pre-treated. In case of MUL and VAR Monobond-S (MON, Ivoclar Vivadent) was used to silanize the post surface. Cements were light-cured (LC) or dark-cured (DC). Adhesion was tested on the conical part of the fiber posts and measured in a pull-off setup using an universal testing machine (Zwick Z010, crosshead speed 1 mm/min). Data obtained from the different groups were analyzed using ANOVA.

Results: The following table summarizes the mean adhesion values. Groups with no statistical significant difference are marked with the same character (Upper case: row / Lower case: column).

<table>
<thead>
<tr>
<th>Cement</th>
<th>RXU</th>
<th>EXP</th>
<th>MC</th>
<th>MON &amp; MUL</th>
<th>MON &amp; VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesion [MPa]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC</td>
<td>24.1 ± 1.3 A a</td>
<td>22.3 ± 2.0 A c</td>
<td>16.0 ± 0.8 B d</td>
<td>24.0 ± 1.3 A f</td>
<td>21.4 ± 1.7 A i</td>
</tr>
<tr>
<td>DC</td>
<td>19.4 ± 1.9 C b</td>
<td>21.9 ± 3.1 C c</td>
<td>2.8 ± 0.8 D e</td>
<td>3.7 ± 3.3 D g</td>
<td>3.0 ± 0.7 D j</td>
</tr>
</tbody>
</table>

Conclusions: RXU self adhesive universal resin cement and experimental self-adhesive paste/paste material showed best performance in both curing modes without any surface pre-treatment, whereas MC and MON&MUL were found to have significantly lower bond strength when the dark cure mode was used.

Adhesion values of different resin cements to RelyX Fiber Post

Aim of the Study: When speaking of adhesive cementation of FRC posts the dentist knows about the risk of debondings. Therefore this in vitro study investigates the bond strength of five different cements to the new RelyX Fiber Post in dark-cure and light-cure mode.

Results of the Study: RelyX Unicem Aplicap and RelyX Unicem Clicker (EXP) exceeded the adhesion values of the other tested resin cements even without pre-treatment of the RelyX Fiber Post. This was true for both curing modes. The results confirm the reliability of RelyX Unicem Aplicap and Clicker. Maxcem and Multilink (in combination with Monobond-S) displayed significantly lower adhesion values especially in the dark-cure mode.
RelyX™ Unicem Cement
and RelyX™ Fiber Post

Sealing and bonding ability of self-etch and self-adhesive resin cements

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di Siena - Clinica Odontoiatrica dell’, Italy, C. GORACCI, University of Siena, Livorno, Italy, S.
GRANDINI, Siena University, Firenze, Italy, and M. FERRARI, University of Siena, Italy

Objectives: The aim of the study was to assess the sealing ability and the bonding mechanism of two self-adhesive resin cements (RelyX Unicem, 3M ESPE, RU; Maxcem, Kerr, Ma) in comparison with a self-etch (Multilink, Ivoclar-Vivadent, Mu) and with a total-etch (Calibra, Dentsply, C) resin cement, when used for fiber post luting to root canal dentin.

Methods: RU was utilized in combination with RelyX fiber posts (3M ESPE). The adhesive Prime&Bond NT (Dentsply, PBNT) was used with the luting agent C. Microleakage tests and a scanning electron microscope evaluation of the material’s ability to form a resin-dentin interdiffusion zone (RDIZ) and resin tags with adhesive lateral branches were performed. A total of 60 extracted teeth were tested. In each group ten specimens were used for leakage test, whereas the remaining five were processed for SEM evaluation.

Results: Microleakage was observed in all the specimens, although significant differences in leakage scores were found among the groups (p<0.05). RU exhibited the greatest sealing ability. No resin tag formation could be observed in any of the specimens luted with RU and Ma. Conversely, resin tags with lateral branches were visible at the coronal and the middle third of the root canals in Groups where PBNT/C and Mu were used. In C specimens resin tags and lateral branches were seen at all the root levels.

Conclusions: Although the self-adhesive resin cement RU did not show any potential to form a resin-dentin interdiffusion zone and resin tags, the material’s sealing ability appeared satisfactory.

SEM Picture: RelyX Fiber Post luted with RelyX Unicem

Aim of the Study: The goal of this in vitro test was to get information about the sealing ability and the bonding mechanism of RelyX Unicem, Maxcem, Multilink and Calibra when used for cementing fiber posts to root canal dentin. RelyX Unicem was used in combination with RelyX Fiber Post.

Results of the Study: RelyX Unicem showed lowest microleakage scores and the best sealing ability of the materials tested. RelyX Unicem is therefore very well suited for luting fiber posts.
RelyX™ Unicem Cement and RelyX™ Fiber Post

Retention of Fiber Posts Cemented with a New Delivery System

M. DEL MASTRO, Z. ARMOUCH, ABOUSHALA, E. DOHERTY, and G. KUGEL, Tufts University, Boston, MA, USA

Objective: This study was to compare the retention values of fiber posts cemented with RelyX Unicem (3M ESPE) a new self-etching resin cement to those cemented RelyX ARC (3M ESPE) an adhesive resin cement.

Methods: Forty freshly extracted single-rooted teeth were decoronated and roots received endodontic therapy utilizing warm vertical condensation technique. Post spaces were then prepared using universal drill size 2 (3M ESPE) to a depth of 10 mm apically. RelyX Fiber Posts size 2 (3M ESPE) were cemented using RelyX ARC (n=20) and RelyX Unicem (n=20) per manufacturer’s instructions. Samples were stored at 100% humidity and 37°C until tested. Ten samples from each group were tested at 30 minutes and ten from each group were tested at 24 hours. Pull-out force was recorded in Newtons using a mechanical testing machine at a crosshead speed of 2 mm/minute.

Results: The following data were obtained, Group1 ARC/30 minutes(119.2±65.2), Group2 Unicem/30min(107.9±30.4), Group3 ARC/24hr(150.6±73.5), Group4 Unicem/24hr(170.3±30.9). There was no significant difference in retention strength between the two cements (ANOVA, p=0.818). However, Groups 3&4 had a number of fiber posts that failed in the grips before pulling out of the root. Group 4 had a significantly higher number of post failures (6) versus bond failures than Group 3 (2) (Test for two proportions, p=0.046).

Conclusion: RelyX Unicem self-etching resin cement provides retention for fiber posts that is comparable to RelyX ARC adhesive resin cement. Additional tests are needed to investigate the posts that are breaking before pulling out of the tooth.

Pull-out force at 30 min and 24 h

<table>
<thead>
<tr>
<th></th>
<th>RelyX ARC/30 min</th>
<th>RelyX Unicem/30 min</th>
<th>RelyX ARC/24 hr</th>
<th>RelyX Unicem/24 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
<td>150</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>200</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
</tbody>
</table>

Aim of the Study: This study evaluates the pull-out forces of RelyX Fiber Post cemented with RelyX Unicem and RelyX ARC.

Results of the Study: The authors observed that the retention values of RelyX Unicem are comparable to RelyX ARC. When using RelyX Unicem for the cementation of RelyX Fiber Post no pre-treatment of the root canal and no silanisation of RelyX Fiber Post are necessary.
Evaluation of Zirconia-based bridges in UK general practice: First-year results

R.J. CRISP, University of Birmingham UK, Cheshire, United Kingdom, and F.J.T. BURKE, University of Birmingham, England, Uk

Objectives: To evaluate the performance of Lava® zirconium oxide all-ceramic bridges using LavaCeram® veneering porcelain and cemented with the self-adhesive resin cement RelyX Unicem® (*3M ESPE, Seefeld, Germany) placed in general dental practices (2 English, 1 Scottish and 1 Northern Irish) over a three-year period.

Methods: Tooth preparation, bridge construction (at one centre) and cementation was to manufacturer’s instructions. Using modified Ryge criteria, the operator completed baseline assessments of marginal fit, colour match and gingival health. One-year reviews, completed by a calibrated examiner and the operator, also looked at secondary caries status, surface quality and post-operative sensitivity.

Results: To date 42 bridges have been placed, and 26 bridges (mean age 12.5 months) in 24 patients (18 Female and 6 Male) have been reviewed. No failures, secondary caries or staining were observed. One small veneering porcelain chip was detected, otherwise surface quality was optimal. One patient reported mild sensitivity and 96% of the bridges were optimal for marginal adaptation & colour match. The gingival health was as tabulated.

<table>
<thead>
<tr>
<th>1=healthy gingivae</th>
<th>Baseline % score</th>
<th>One-Year % score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2=mild inflammation</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>3=moderate inflammation</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td>4=severe inflammation</td>
<td>1 2 3 4</td>
<td>1 2 3 4</td>
</tr>
</tbody>
</table>

Facial 77 23 0 0 92 11 0 0
Mesial 77 23 0 0 100 0 0 0
Distal 81 19 0 0 92 8 0 0

Conclusions: After one year of clinical service the Zirconia based bridges were giving good clinical service but monitoring will continue to determine performance over the three-year period. This study was supported by 3M ESPE AG, Seefeld, Germany.

Aim of the Study: The performance of RelyX Unicem in combination with LAVA zirconia all ceramic bridges placed in general dental practices was evaluated after one year of clinical service.

Results of the Study: All reviewed restorations showed good performance especially regarding gingival health and marginal adaptation.
Significance of Resin Cement Color Stability

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Objectives: To evaluate the color stability of resin cements under all-ceramic restorations after accelerated aging.

Methods: IPS Empress Esthetic (Shade ETC1) discs (20 mm x 1 mm) were luted on white bases using four resin cements of similar shade (Nexus-2, Kerr; Variolink Veneer, Ivoclar; Calibra, Dentsply; RelyX Veneer, 3M ESPE) in light-cure form. Curing was performed according to ISO standards using an LED light (Flashlite 1401). Samples were stored in deionized water at 37ºC. Colorimetric measurements were performed on the ceramic discs with a color spectrophotometer (Color Eye 7000A) at 24 hours using D65 illuminator. Samples were subjected to 65 hours of accelerated aging (weathering). Color measurements were repeated from the same spot of each sample to measure changes in CIE L*a*b* coordinates (Optiview Lite 1.9 software). ΔE (ab)* data of ceramic discs luted with light cured resin cements were determined. A ΔE (ab)* value of 3 and above was considered clinically detectable. Color changes were statistically analyzed using a nested random effects model. Tukey’s post-hoc analysis was used to show the differences.

Results: Nexus-2 revealed a statistically significant color change (p=.001), however, the ceramic color difference was not clinically detectable. Mean ΔE (ab)* values are shown in Table below. Groups connected with same letter are not statistically significant.

<table>
<thead>
<tr>
<th>Level</th>
<th>Least Square Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nexus-2</td>
<td>A 0.92 ± 0.26</td>
</tr>
<tr>
<td>Variolink Veneer</td>
<td>B 0.49 ± 0.13</td>
</tr>
<tr>
<td>Calibra</td>
<td>B 0.47 ± 0.21</td>
</tr>
<tr>
<td>Rely-X Veneer</td>
<td>C 0.23 ± 0.09</td>
</tr>
</tbody>
</table>

Conclusions: Even though there were statistically significant differences for color change among the tested cements, they were not clinically detectable. Supplies were provided by respective companies.

Aim of the Study: The goal of this in vitro study was to assess the color stability of RelyX Veneer and three other resin cements under accelerated aging conditions when used for luting IPS Empress Esthetic discs.

Results of the Study: RelyX Veneer cement showed the lowest color change among the materials tested which is a clinical advantage.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Lava™ Crowns and Bridges

Biaxial Flexural Strength and Fatigue Life of Two Y-TZP Ceramics

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Objectives: The development of yttria partially-stabilized tetragonal zirconia polycrystalline (Y-TZP) has allowed the use of ceramics in load-bearing sites. The aim of this work was to examine the biaxial flexural strength, hardness and fatigue limit of coloured and uncoloured zirconia in the Lava™ system compared with uncoloured Cercon® system.

Methods: The development of yttria partially-stabilized tetragonal zirconia polycrystalline (Y-TZP) has allowed the use of ceramics in load-bearing sites. The aim of this work was to examine the biaxial flexural strength, hardness and fatigue limit of coloured and uncoloured zirconia in the Lava™ system compared with uncoloured Cercon® system.

Results: One-way analysis of variance (ANOVA) showed no significant difference in biaxial flexural strength among uncoloured and coloured Lava™ groups (p>0.05) whereas Cercon® group (820 MPa) had flexural strength significantly lower than Lava™ group (1100 MPa) (P<0.05). Two-way ANOVA analysis showed no significant differences in hardness value among four groups (uncoloured, FS4, and FS7 of Lava™ and Cercon®) (P>0.05). Furthermore, when comparing within the same specimen, hardness values for the polished side was not significantly different from the unpolished side (P>0.05) except FS7 (P<0.05). In addition, the Weibull modulus of Lava™ specimens were in the range of 8–15, the Cercon® specimens 7–11. Additionally, uncoloured, FS4, FS7, and Cercon® specimens survived 5x105 cycles when using a load 60–70% of mean biaxial flexural strength or lower.

Conclusions: Y-TZP ceramic has high flexural strength, hardness and good strength reliability. In addition, specimen colouring did not have an effect on the flexural strength. The polishing process also did not affect the hardness of zirconia. The fatigue limit of Y-TZP ceramic may be defined as lying between 60–70% of the stress to failure.

Flexural strength of Lava Zirconia in comparison to Cercon Zirconia

Aim of the Study: The aim of the study was to analyze the biaxial flexural strength, hardness and fatigue limit of colored and uncolored Lava and Cercon Zirconia.

Results of the Study: The result of the study showed that specimen colouring did not have an effect on the flexural strength of Lava. Moreover, Lava Zirconia showed a significantly higher flexural strength compared to Cercon Zirconia.
Gliding Contact Fatigue Damage Maps of Veneered Zirconia Structures

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Objectives: Dental restorations often fail from the seemingly innocuous chipping of porcelain veneers resulting from occlusal contact damage and wear, making contact fatigue studies relevant. However, most of the fatigue studies use uniaxial loading without any gliding action. This study investigates the effect of fatigue loading with a load-glide-unload action, emulating a masticatory cycle, on the longevity of ceramic restoratives.

Methods: A mouth-motion fatigue machine (Elf 3300, Bose/EnduraTEC) applied a controlled stroke profile in water: sphere (WC, r = 1.5 mm) contacting the specimen; specimen translating 0.7 mm with load applied; and sphere lifting off after each stroke. The maximum fatigue load range was 50–500 N and the number of cycles ranged from 1–1000,000. Flat porcelain veneered zirconia (LAVA) cores were tested along with a monolithic glass and a glass “veneer” bonded to zirconia core which served as a transparent control. Crack evolution is followed in-situ using a video camera system.

Results: Failure was defined as any occlusal surface damage which penetrates an entire veneer layer to the veneer/core interface or a flexural radial fracture originating at the internal cementation surface. Previous work demonstrated that traditional R-ratio and uniaxial mouth-motion fatigue damage maps (load-cycles-type of failure) are similar. For load-glide fatigue, the map of surface cone cracking shifted to lower loads but not flexural failure. The accelerated crack growth rate in load-glide-unload fatigue appears similar to that observed in pin-on-disc studies and likely occurs as a result of enhanced compressive and tensile stresses ahead and behind the indenter.

Conclusions: Fatigue loading with an occlusion-like gliding action is more severe in creating contact damage than the traditional R-ratio and uniaxial mouth-motion fatigue. Supported by the NYU Research Challenge Fund.

Aim of the Study: The aim of the study was to investigate the effect of fatigue loading with a load-glide-unload action, emulating a masticatory cycle, on the longevity of ceramic restoratives.

Results of the Study: Fatigue loading with an occlusion-like gliding action is more severe in creating contact damage than the traditional R-ratio and uniaxial mouth-motion fatigue. Supported by the NYU Research Challenge Fund.

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Lava™ Crowns and Bridges

Fatigue comparison of zirconia and gold-infiltrated alloy framework bridges

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Objectives: To test null hypothesis that there is no difference between Zirconia (3M LAVA) and gold-infiltrated alloy (Captek) framework three unit bridges submitted to mouth-motion step-stress accelerated fatigue.

Methods: Abutments and fixtures (Nobel Biocare) were embedded 19 mm apart in orthodontic PMMA resin, (to simulate bone support). The zirconia (LAVA) and gold-infiltrated alloy frameworks (Captek) (n=21 each) were fabricated and then veneered with the porcelain recommended by each manufacturer at a dental laboratory (Marotta Dental Studio, Inc). After cementation, bridges of each design type (n=3 each) were Hertzian contact (WC sphere, r=3.18 mm) tested to obtain ultimate failure load and then to design step-stress profiles. Remaining specimens of each group were mouth motion step-stress cyclically loaded, on the pontic lingual slope of the buccal cusp, at 30˚ inclination (off-axis) to the long axis of the abutment using a distributed load (WC indenter r=3.18 mm with foil spacer). Three step-stress profiles were applied (ratio of 3:2:1) with maximum of 140K cycles and minimum of 50K cycles to 400 N load.

Results: Failure modes included flexural cracks on the pontic area, flexural cracks extending from the abutment margin and/or flexural cracks on the connector area. Multiple failure modes make Weibull stress level probability curves general (Alta Pro, Reliasoft), but with all failure modes included the reliability, R (2 side @ 90% confidence bounds) for a “mission” of 50K cycles at 200 N load was determined.

Reliability for a representative mission of 50K cycles at 200 N load

<table>
<thead>
<tr>
<th>Output</th>
<th>Zirconia (3M LAVA)</th>
<th>Gold-Infiltrated alloy (Captek)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper limit</td>
<td>0.93</td>
<td>0.92</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.79</td>
<td>0.81</td>
</tr>
<tr>
<td>Lower Limit</td>
<td>0.45</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Conclusions: No statistical difference was observed between groups for strength. For Captek, all failures were flexural cracking of the abutment or pontic area. For 3M Lava, failures were predominantly delamination of buccal aspect porcelain of the pontic.

Aim of the Study: The aim of the study was to test that there is no significant difference between Zirconia (3M LAVA) and gold-infiltrated alloy (Captek) framework three unit bridges submitted to mouth-motion step-stress accelerated fatigue.

Results of the Study: No statistical difference was observed between groups for strength. For Captek, all failures were flexural cracking of the abutment or pontic area. For 3M ESPE Lava, failures were predominantly delamination of buccal aspect porcelain of the pontic.
Flexural Strength of CAD/CAM Ceramic Framework Materials

M. LUPU, Boston University, MA, USA, and R. GIORDANO, Boston University, MA

Objectives: A number of new block materials have been developed for milled frameworks. Objectives of this study are to measure the flexural strength of a glass ceramic (Ivoclar e.max Cad) and zirconia block materials (Vita YZ, 3M LAVA, Ivoclar e.max ZirCad).

Methods: Bars, 2x4x25 mm, for strength testing were cut directly out of the CAD/CAM blocks using a Buehler Isomet diamond saw. The bars were sintered according to the manufacturer’s recommendations. A three point bend test, span 20 mm, was performed using an Instron with a crosshead speed of 0.5 mm/min. Subgroups of the e.max Cad glass ceramic were tested before crystallization firing, after crystallization firing, and after being subjected to simulated porcelain veneer firing cycles for 1, 3, 5 and 7 times. White (more translucent) and blue e.max Cad glass ceramic blocks were tested.

Results:

Flexural Strength of Zirconia Block Materials

<table>
<thead>
<tr>
<th>Zirconia Type</th>
<th>Flexural Strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vita YZ</td>
<td>950.89 ± 98.54</td>
</tr>
<tr>
<td>3M/ESPE LAVA</td>
<td>960.65 ± 100.83</td>
</tr>
<tr>
<td>Ivoclar e.max ZirCad</td>
<td>860.10 ± 90.51</td>
</tr>
</tbody>
</table>

Flexural Strength of Zirconia Block Materials

<table>
<thead>
<tr>
<th>e.max CAD Glass Ceramic Group</th>
<th>White Block Strength (MPa)</th>
<th>Blue Block Strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Received</td>
<td>133.97 ± 26.80</td>
<td>164.27 ± 32.06</td>
</tr>
<tr>
<td>Crystallization</td>
<td>261.52 ± 87.80</td>
<td>257.45 ± 81.12</td>
</tr>
<tr>
<td>Veneer 1</td>
<td>337.58 ± 111.58</td>
<td>302.41 ± 12.10</td>
</tr>
<tr>
<td>Veneer 3</td>
<td>296.55 ± 20.85</td>
<td>329.61 ± 16.78</td>
</tr>
<tr>
<td>Veneer 5</td>
<td>324.37 ± 75.33</td>
<td>308.32 ± 45.15</td>
</tr>
<tr>
<td>Veneer 7</td>
<td>246.08 ± 65.06</td>
<td>314.06 ± 31.73</td>
</tr>
</tbody>
</table>

Conclusions: ANOVA and Tukey test showed significant increase in strength after crystallization firing for e.MaxCad.

Aim of the Study: The aim of the study was to measure the flexural strength of different zirconia materials.

Results of the Study: 3M ESPE Lava Zirconia showed a high flexural strength.
Lava™ Crowns and Bridges

Retentive strength of all ceramic crowns after long-term water storage
C.-P. ERNST, E. AKSOY, J.G. HORN, E. STENDER, and B. WILLERSHAUSEN, Johannes Gutenberg University Mainz, Germany

Objectives: The retentive strength of a resin cement in combination with a conventional adhesive (Variolink II/Syntac Classic, Ivoclar Vivadent), two resin cements with self etching adhesives (Panavia F 2.0/ED Primer, Kuraray, Multilink/Multilink Primer A/B, Ivoclar/Vivadent), two self adhering cements (RelvyX Unicem, 3M ESPE, Maxcem, sds Kerr), and a resin modified glassionomer-cement (Fujicem, GC) were examined for luting zircon-oxide ceramic crowns (LAVA, 3M ESPE) on extracted human teeth.

Methods: 160 extracted teeth (n=20) were prepared in a standardized manner (10°, h=3 mm). The resin cements and the adhesive system were used according to manufacturers’ recommendations; in dual-curing systems, only the self-curing approach was conducted. The crowns inner surfaces were sandblasted (Rocatec Pre). Additional pretreatment was carried out with Multilink (Metallprimer or Monobond S). With RelvyX Unicem also one group with Rocatec Plus pretreatment was examined. After thermocycling (5000 x, 5/55°C), 50 % of the cemented ceramic crowns (Rocatec-pretreatment at the outer surface; connected over a low shrinkage epoxy resin to macro-mechanical undercuts in a resin block, made out of Paladur denture base material) of each group (n=10) were removed along the path of insertion (Zwick 1425); the remaining samples after 1 year of water storage. The retention surface was determined individually for each tooth. Statistical analysis: Wilcoxon test/Bonferroni adjustment, 5% level.

Results: The retentive strength values [N/mm²] were (Min/Q1/Median/Q3/Max): Variolink II/Syntac: 1.0/1.9/2.5/3.3/5.2, Panavia F 2.0: 1.5/1.8/2.1/3.6/5.4, Multilink/Metallprimer: 2.9/4.6/5.3/9.4/11.7, Multilink/Monobond S: 4.1/4.8/5.4/7.7/12.6, RelvyX Unicem: 3.9/6.3/7.5/9.0/10.7, RelvyX Unicem/Rocatec Plus: 4.4/5.8/7.2/9.4/11.9, Maxcem: 0.9/2.2/3.0/3.3/4.5, Fujicem: 1.6/2.7/4.3/5.4/6.7. Both, Multilink and Unicem should significantly higher median retentive strength values than Variolink II and Maxcem, while Unicem proved superior results to Panavia, too.

Conclusions: RelyX Unicem and Multilink showed the highest median retentive strength values. Long term water storage did not affect the retentive strength determined. This study was supported by Ivoclar Vivadent, 3M ESPE, Kuraray, and sds Kerr.

Retentive strength of Lava Zirconia crowns placed with different cements on human teeth

Aim of the Study: This study investigated the ability of selected resin cements and a resin-modified glass ionomer cement to retain a zirconium-oxide ceramic crown (LAVA, 3M ESPE) under simulated clinical conditions.

Results of the Study: Lava crowns cemented with RelyX Unicem showed the highest median retentive strength initially and after 1 year in this clinically very relevant study design.

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Lava™ Crowns and Bridges

Determining the marginal fit of CAD/CAM bridge frameworks
A. PIWOWARCZYK, J. W. Goethe University, Frankfurt, Main, Germany, and H.-C. LAUER, J.W. Goethe University, Frankfurt, Main, Germany

Objectives: This in-vitro study measured the marginal fit of four-unit CAD/CAM bridge frameworks prior to ceramic veneering.

Methods: Teeth 34 and 37 of a mandibular model were prepared for a four-unit all-ceramic bridge. Thirty master casts were produced from a metal super-master. Cases were randomly assigned to three groups of ten. The frameworks were fabricated at German processing centers, using one center per system (Lava, DCS Precident, Cercon) selected randomly from among eligible German centers. The all-ceramic frameworks were invested on their respective models, without cementing and using cold-curing resin, and segmented sagittally and bucco- orally. The absolute marginal discrepancy and the marginal gap were measured independently by two researchers under the stereomicroscope as described by Holmes et al. (1989). Statistical data analysis was performed using a single-classification analysis of variance (α=0.05). When comparing the researcher’s methods, the Bravais-Pearson correlation coefficients were determined and related using Bland-Altman plots.

Results: The differences between the absolute marginal discrepancies and marginal gaps of the framework systems were statistically significant, independent of the direction of segmentation, for premolars (p<0.0001) and molars (p<0.0001). Lava exhibited the smallest absolute marginal discrepancies (p: 37.7 ± 21.3 µm; m: 38.3 ± 19.4 µm), followed by Cercon (p: 69.5 ± 52.7 µm; m: 58.3 ± 28.6 µm) and DCS Precident (p: 104.7 ± 69.1 µm; m: 95.8 ± 64.2 µm). Lava had the smallest marginal gaps (p: 17.6 ± 14.6 µm; m: 20.0 ± 15.9 µm); followed by Cercon (p: 40.2 ± 33.0 µm; m: 38.6 ± 36.8 µm) and DCS Precident (p: 56.3 ± 54.4 µm; m: 83.5 ± 67.6 µm). The experimenter effect was not significant in any case.

Marginal and absolute marginal gap of 4-unit bridges made of Lava Zirconia and by the Lava system in comparison to other CAD/CAM systems.

Conclusions: In four-unit all-ceramic bridges, the system used for fabricating the framework has significant influence on the quality of marginal fit.

Aim of the Study: The aim of the study was to determine the marginal gap of 4-unit bridges milled by different CAD/CAM systems.

Results of the Study: 3M™ ESPE™ Lava Zirconia 4-unit bridges show an excellent marginal gap in comparison to the analyzed competitor systems.

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Clinical long-term behavior of Zirconia-based bridges (LAVA): Five years results

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CAD/CAM-processed zirconia ceramics can be used for the fabrication of all-ceramic bridges. The strength of the material allows the conventional cementation, which simplifies the daily clinical life. Some in-vitro studies on three- and four-unit posterior bridges revealed that the strength is high enough to run controlled clinical studies.

Objectives: The purpose of this prospective study was to observe the clinical performance of zirconia posterior bridges for the replacement of molars.

Materials and Methods: Since October 2000 a total of 31 bridges were placed. All abutment teeth were prepared for full crowns with a maximum 1.2 mm chamfer. Impressions were made with a polyether material. The axial wall-thicknesses of the zirconia-cores were constant 0.6 mm, the connector area was designed with a cross-sectional plane of minimum 9 mm2. All restorations were cemented conventionally with the glass-ionomer cement Ketac Cem. Recalls took place in March 2006 after an observation time of five years. 15 bridges could be evaluated clinically at that time. Judgements were made on the fit of the bridges on the abutment teeth, discoloration of the marginal gingiva, the quality of the surface, failures and allergenic reactions. Furthermore the survival of 6 bridges could be proved by questioning the patients by phone. 1 bridge was lost for endodontic reasons. One patient wearing 2 bridges died. 7 patients moved to unknown addresses.

Results: No changes in fit or secondary caries were observed. No total failures regarding the restoration's integrity happened. Slight chipping of the veneering material took place in single cases, but there was no need for retreatment. No allergic reactions and negative influences on the marginal gingiva could be observed.

Conclusions: After five years of clinical service one can conclude a high performance of zirconia based posterior bridges. This study was supported by 3M ESPE, Seefeld, Germany.

3-unit Lava posterior bridge after 5 years in situ

Aim of the Study: The aim of the study was to analyze the clinical performance of 3M ESPE Lava 3-unit posterior bridges after 5 years in situ.

Results of the Study: 68% of the restorations could be recalled after 5 years. All restorations are still in situ. No changes in fit or secondary caries were observed. No total failures regarding the restoration's integrity happened. Slight chipping of the veneering material took place in single cases, but there was no need for retreatment. No allergic reactions and negative influence on the marginal gingiva could be observed. The remaining patients (32%) unfortunately moved to unknown places. One dropped out due to endodontic reasons.

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In-Vitro Vertical Marginal Gap Comparison of CAD/CAM Zirconium Copings

A.J.T. SHANNON¹, F. QIAN², P. TAN¹, and D. GRATTON¹, ¹University of Iowa, Iowa City, USA, ²University of Iowa, College of Dentistry, Iowa City, USA

Objectives: Limited data exists regarding dental CAD/CAM system accuracy and precision. This study evaluated the vertical marginal gap of zirconium-oxide copings from contemporary CAD/CAM systems.

Methods: Zirconium-oxide copings were milled using KaVo Everest (ZH, ZS), Nobel Biocare Procerá (MOD40, Piccolo, Forte), 3M ESPE Lava, Wieland Zeno, and CERECinLab (InCeramZr) and compared to control cast copings (n=10). Ninety polyvinylsiloxane impressions were made of a master metal die exhibiting a 1 mm heavy chamfer preparation finish-line. TypeIV stone dies were scanned, finish line detected, and copings with 50µm cement space 1 mm from finish line were fabricated. Control copings were fabricated using the lost wax technique. Standardized digital photographs of each coping were taken on the metal master die and measured with ImageProExpress to obtain the mean vertical marginal gap in microns.

Results: The ANOVA on the log-transformed data revealed statistically significant differences in marginal gap between groups (p<0.0001). Tukey’s HSD test indicated gaps observed in Piccolo and MOD40 were significantly greater than those observed in Zeno, InCeramZr, EverestZH, cast, and Lava, while gaps in Forte and EverestZS were significantly greater than EverestZH, cast, and Lava. Gaps observed in Zeno, InCeramZr, and EverestZH were significantly greater than cast and Lava.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Marginal Gap (µm)</th>
<th>LN Mean Marginal Gap (µm)</th>
<th>Group Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procera-Piccolo</td>
<td>28.23±11.27</td>
<td>3.27±0.41</td>
<td>A</td>
</tr>
<tr>
<td>Procera-MOD40</td>
<td>25.80±10.08</td>
<td>3.17±0.45</td>
<td>A</td>
</tr>
<tr>
<td>Procera-Forte</td>
<td>24.29±8.71</td>
<td>3.13±0.39</td>
<td>A B</td>
</tr>
<tr>
<td>Everest-ZS</td>
<td>25.77±22.38</td>
<td>2.99±0.70</td>
<td>A B</td>
</tr>
<tr>
<td>Wieland-Zeno</td>
<td>11.85±5.78</td>
<td>2.38±0.42</td>
<td>B C</td>
</tr>
<tr>
<td>Cerec-InCeramZr</td>
<td>18.35±20.6</td>
<td>2.37±1.11</td>
<td>B C</td>
</tr>
<tr>
<td>Everest-ZH</td>
<td>10.59±6.42</td>
<td>2.15±0.73</td>
<td>C</td>
</tr>
<tr>
<td>Control-Cast</td>
<td>3.19±1.02</td>
<td>1.11±0.32</td>
<td>D</td>
</tr>
<tr>
<td>3M ESPE-Lava</td>
<td>3.00±0.74</td>
<td>1.07±0.24</td>
<td>D</td>
</tr>
</tbody>
</table>

Means with same letter not significantly different, p>0.05.

Conclusions: Vertical margin gap of the CAD/CAM copings were significantly greater for all groups except one as compared to the control cast copings. Further investigations regarding horizontal marginal gap and internal coping fit are required. Supported by NIH/NIDCR T32 DEO14678, KaVoAmerica, University of Iowa, College of Dentistry.

Aim of the Study: The aim of the study was to determine the vertical marginal gap of Zirconia copings manufactured by 9 different CAD/CAM systems.

Results of the Study: Copings made of 3M ESPE Lava Zirconia and fabricated with the Lava system showed the lowest vertical marginal gap. Moreover, the vertical marginal gap of Lava copings was not significantly different compared to cast copings.
Marginal Fit of Zirconia Crown-copings on Chamfer and Shoulder Preparations

D. RE, D. AUGUSTI, and G. AUGUSTI, University of Milano, Italy

Objectives: Marginal fit is evaluated as one of the most important criteria for the clinical quality and success of all-ceramic crowns. The aim of this in vitro study was to investigate the marginal fit of Lava™ Zirconia crown-copings on chamfer and shoulder preparations.

Methods: Two acrylic model teeth were selected to simulate the clinical preparations: one molar was prepared with a chamfer finish line (C) and one premolar was prepared with a rounded shoulder finish line (RS). Each resin model was duplicated 10 times using silicon-based impression material and poured in type IV dental stone for the fabrication of working dies. A total of 20 copings were divided into two groups (n=10 for each finish line). Ten measuring locations were chosen randomly along the margin on the dies and the gap width was measured under a light microscope with a magnification of 100X. Measurements were made without cementation. The mean marginal gap widths and standard deviations were calculated and a one-way ANOVA was conducted for different types of preparations in order to detect differences (α=.05).

Results: The mean marginal gap was 21±6μm for the C group and 11±6μm for RS group. The 1-way ANOVA showed a significant difference between the two groups (P<.05).

Conclusion: Within the limitations of this study, the marginal discrepancies were all within the clinical acceptable standard set at 120μm. The shoulder preparations showed the smallest gap dimension.

Marginal fit of Lava copings with different kind of preparations

Aim of the Study: The aim of the study was to investigate the marginal fit of Lava™ Zirconia crown-copings on chamfer and shoulder preparations.

Results of the Study: Lava copings showed very accurate marginal fit in both cases.
Lava™ Crowns and Bridges

Evaluation of Zirconia-based bridges in UK general practice: First-year results
R.J. CRISP, University of Birmingham UK, Cheshire, United Kingdom, and F.J.T. BURKE, University of Birmingham, England, UK

Objectives: To evaluate the performance of Lava® zirconium oxide all-ceramic bridges using LavaCeram® veneering porcelain and cemented with the self-adhesive resin cement RelyX Unicem® (*3M ESPE, Seefeld, Germany) placed in general dental practices (2 English, 1 Scottish and 1 Northern Irish) over a three-year period.

Methods: Tooth preparation, bridge construction (at one centre) and cementation was to manufacturer’s instructions. Using modified Ryge criteria, the operator completed baseline assessments of marginal fit, colour match and gingival health. One-year reviews, completed by a calibrated examiner and the operator, also looked at secondary caries status, surface quality and post-operative sensitivity.

Results: To date 42 bridges have been placed, and 26 bridges (mean age 12.5 months) in 24 patients (18 Female and 6 Male) have been reviewed. No failures, secondary caries or staining were observed. One small veneering porcelain chip was detected, otherwise surface quality was optimal. One patient reported mild sensitivity and 96% of the bridges were optimal for marginal adaptation & colour match. The gingival health was as tabulated.

<table>
<thead>
<tr>
<th>1=healthy gingivae</th>
<th>Baseline % score</th>
<th>One-Year % score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2=mild inflammation</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3=moderate inflammation</td>
<td>77</td>
<td>23</td>
</tr>
<tr>
<td>4=severe inflammation</td>
<td>77</td>
<td>23</td>
</tr>
</tbody>
</table>

Conclusions: After one year of clinical service the Zirconia based bridges were giving good clinical service but monitoring will continue to determine performance over the three-year period. This study was supported by 3M ESPE AG, Seefeld, Germany.

Aim of the Study: The performance of 3M ESPE Lava zirconia all ceramic bridges placed in four general dental practices was evaluated after one year of clinical service.

Results of the Study: All reviewed restorations showed no failures and a good performance especially regarding gingival health and marginal adaptation.
Aim of the Study: The aim of the study was to compare the clinical performance of
4 all-ceramic systems with 3 porcelain-metal systems.

Results of the Study: After one year in service no zirconia or metal structure break.
**Lava™ Scan ST**

Influence of Larger Scanlength on Accuracy of a CAD/CAM Scanner

M. KRAEMER, C. WASTIAN, G. HERTLEIN, and M. HARTUNG, 3M ESPE AG, Seefeld, Germany

**Objectives:** CAD/CAM fabricated zirconia frameworks are known to be a basis for clinically successful restorations. To guarantee good fit a high accuracy of the optical scanning device typically used within the CAD/CAM process is essential. Accuracy and the scanlength are often contradictory parameters with such devices. In this study the accuracy of a new 3M ESPE LAVA scanner (ST, scanlength=51 mm) was investigated with respect to its predecessor (LS, scanlength=38 mm).

**Methods:** 5 different stone models for bridge cases of a spanwidth >40 mm have been investigated. With all cases stumps not only at the ends of the bridges but also somewhere in-between were present. This allowed scanning first the cases with LS in two successive steps with a lateral shift of the models in-between in order to capture the full situation and matching secondly the two data sets together at the central stump, which has been captured by both scans. The resulting data were then overlaid by best-fit algorithms to a single scan obtained from ST, which did capture the full case due to the enlarged scanlength in one step. The distances of 10 arbitrarily selected spots on each distal surface of the outer stumps at the LS surface to the surface obtained with ST were computed. The mean distances (MD) for each case were compared to the MD from a reference test, which was obtained from overlaying LS and ST data from a single stump scanned in the center of the scanwindows of both scanners. The MD were compared using ANOVA (p<0.01).

**Results:** The distal MD for the investigated cases were (μm): 6.1±-2.6, 5.5±-2.0, 4.7±-3.1, 6.2±-3.3, 4.2±-3.2. None of them was statistically significant different from the reference (4.1±-2.0).

**Conclusions:** With the larger scanlength of ST no significant effect on the accuracy as compared to LS was found.

Mean distance between data sets of 5 different clinical cases scanned with Lava Scan ST and Lava Scan in comparison to reference (mean difference between scanned crown data).

**Aim of the Study:** In this study the accuracy of a new 3M ESPE Lava scanner with a larger scanlength was investigated with respect to its predecessor.

**Results of the Study:** The new scanner Lava Scan ST shows with a larger scan length the same accuracy compared to the previous Lava Scan.
Lava™ Crowns and Bridges and RelyX™ Unicem Cement

Shear Bond strength of Luting Cements to Zirconia after Thermocycling

M. IRIE1, K. SUZUKI1, and D. WATTS1, 1Okayama University, Japan, 2University of Manchester, England, Uk

Objectives: One of the major concerns with indirect restorative materials is their long-term bonding ability and durability of the bond (Dent Mater, 2001;17:347). The purpose of this study was to evaluate the effect of 20,000 thermocycles on the bond strength of composite inlays (Z250, 3M ESPE) to zirconia (Lava, 3M ESPE) cemented with two self-adhesive resin cements (RelyXUnicem, 3MESPE; MultilinkSprint, IvoclarVivadent), and the two new adhesive resin cements (Clearfil Esthetic Cement, Kuraray Medical; ResiCem, Shofu).

Methods: The surfaces of Lava samples were pretreated by sandblasting with 50-micron aluminum-oxide particles (n=10). The Clearfil Esthetic Cement and ResiCem groups were pretreated by manufacturer’s instructions. Composite inlay samples, approximately 3.4 mm in diameter and approximately 2 mm in height, were prepared and inserted into a PTFE mold, 3.6 mm in diameter and 2.0 mm in height, for cementation to Lava samples with four resin cement groups. The shear bond strength (SBS, MPa, Mean(SD)) tests between the composite inlays and Lava were performed using a universal testing machine after one-day storage (1-D) and after 20,000 thermocycles (TC 20k). The flexural strength (FS, MPa, Mean(SD)) of luting cements were measured with the same materials under same conditions. Statistical analyses were performed with t-Test (1-D vs. TC 20k, p<0.05, S: significantly difference, NS: not significantly different).

Results:

<table>
<thead>
<tr>
<th>Material</th>
<th>SBS</th>
<th>FS</th>
<th>SBS</th>
<th>FS</th>
<th>SBS</th>
<th>FS</th>
<th>SBS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-D</td>
<td>14.1(4.2)</td>
<td>68.8(4.4)</td>
<td>9.8(2.8)</td>
<td>102.7(7.1)</td>
<td>13.1(2.9)</td>
<td>146.6(6.5)</td>
<td>12.5(3.1)</td>
<td>118.6(6.2)</td>
</tr>
<tr>
<td>TC 20K</td>
<td>9.0(1.7)</td>
<td>48.8(5.7)</td>
<td>6.7(2.5)</td>
<td>84.7(5.9)</td>
<td>13.4(3.9)</td>
<td>135.2(6.8)</td>
<td>11.9(2.8)</td>
<td>102</td>
</tr>
</tbody>
</table>

Conclusions: The bonding ability of two self-adhesive resin cements to Lava with composite inlays showed a significant decrease after TC 20k compared to 1-D testing, except the two new adhesive resin cements. The flexural strength of all luting cements exhibited a significant reduction.

Aim of the Study: In this study the authors compared flexural strength and the SBS of two self-adhesive and two new adhesive resin cements to Lava zirconia ceramic both initially and after 20,000 thermocycles.

Results of the Study: RelyX Unicem self-adhesive resin cement showed best initial results to sandblasted Lava zirconia while Multilink Sprint displayed the lowest SBS to Lava both initially and after TC. Flexural strength of all materials decreased after thermocycling.
Impact of artificial aging of composites on their wear resistance

N. KOURNETAS¹, D. AXMANN², L. SCHEIDELER², and J. GEIS-GERSTORFER¹, "National and Kapodistrian University of Athens, Dental School, Greece, "University of Tuebingen, Center for Dental, Oral and Maxillofacial Medicine, Germany

Objectives: The aim of the present study was to investigate the relationship of alteration of hardness and roughness after artificial aging on the wear resistance of dental composites.

Methods: 15 cylindrical specimens of each of the following materials were manufactured: Artglass, Grandio, Sinfony. After polishing, the mean Vickers hardness (VHN) and the mean roughness value Ra (µm) of the specimens were measured. 5 specimens of each material were incubated in the following aging solutions a) 0.1N NaOH, b) solution of pseudocholinesterase (PCE) with an activity of 50 mU/ml, and c) distilled water. After 3 months at 37°C the mean hardness and roughness values of the specimens were measured again. The mean hardness difference (DHV) and mean roughness difference (DRa) were calculated. Subsequently, the specimens were loaded in a chewing simulator (Willytec, Munich) for 1.2x10^6 cycles. Volume and depth of the resulting wear cavities were measured. The impact of artificial aging expressed by means of DHV and DRa on the wear resistance of the examined materials was analysed by linear regression analysis.

Results: Artificial aging resulted in partially pronounced alteration of hardness and roughness of the materials tested. The mean hardness difference varied between 0.7 (Artglass in water) and 99 VHN (Grandio in NaOH) and the mean roughness difference varied between -0.02 (Sinfony in PCE) and 1.6 µm (Artglass in NaOH). Nevertheless, the measured mean alterations could not be associated with a statistically significant impact on the wear resistance of the tested materials.

Conclusions: Artificial aging (mainly in NaOH and much less in PCE) resulted in increased wear, reduced hardness and increased roughness for almost all the materials tested. Nevertheless, the in vitro wear resistance of the tested materials could not be explained by the model employed. More sophisticated models should be applied.

Aim of the Study: The aim of the study was to investigate the relationship of alteration of hardness and roughness after artificial aging on the wear resistance of dental composites.

Results of the Study: Artificial aging resulted in increased wear, reduced hardness and increased roughness for almost all the composite materials tested. However, a more sophisticated model should be developed in order to analyze and explain the in vitro wear resistance of the tested materials.
Edge-strength of fibre-reinforced resin-composites after water storage

K. ELGERGENI, University of Manchester, School of Dentistry, United Kingdom, P. BRUNTON, Leeds Dental Institute, United Kingdom, and D.C. WATTS, University of Manchester, School of Dentistry & Photon Science Institute, United Kingdom

Objectives: To measure the edge-strength after water-storage of three indirect resin-composites, with and without fibre-reinforcement

Methods: Sinfony (3M ESPE, Germany), Solidex (Shofu, Japan) and Gradia (GC Japan) were reinforced with unidirectional glass-fibres (Stick-Tech). Three material-groups (n=40) of Edge-Strength (ES) disks (12 x 2.5 mm) were prepared in open PTFE moulds. Each was divided into four sub-groups (n=10): 1 and 2 were fibre-reinforced as test groups; 3 and 4 were un-reinforced control groups. All disks were stored at 37°C for 1 month: sub-groups 1 & 3 in distilled water; sub-groups 2 & 4 in air. Disks were loaded by Vickers diamond at 0.5 mm radially inwards from their perimeter edge. Loads (N) to fracture were recorded on a CK10 instrument (Engineering systems, UK).

Results: For fibre-reinforced disks, the mean edge-strength of Sinfony was significantly higher than that of Solidex and Gradia. In wet & dry conditions the values were (359.8 & 378.00 N), (299.1 & 319.50 N) and (240.5 & 266.70N), respectively. But each reinforced composite was not statistically different in dry & wet conditions (p>0.05). Mean edge-strengths of reinforced composites were significantly higher than un-reinforced for both storage conditions (p<0.05 by paired-t-tests). The three un-reinforced resin-composites were significantly different both wet & dry (p= 0.00; One way ANOVA & Tukey test). Un-reinforced Sinfony was significantly stronger than Gradia and Solidex (p<0.05).

Conclusions: Fibre-incorporation into indirect composites enhanced edge-strength and also rendered this characteristic unaffected by water-storage. Both reinforced and unreinforced, Sinfony was strongest followed by Solidex and then Gradia.

Edge strength of different fibre-reinforced composite specimens stored in wet and dry conditions

Aim of the Study: The aim of the study was to measure the edge-strength after water-storage of three indirect resin-composites, with and without fibre-reinforcement.

Results of the Study: Fibre-incorporation into indirect composites enhanced edge-strength and also rendered this characteristic unaffected by water-storage. Both reinforced and unreinforced, Sinfony was strongest followed by Solidex and then Gradia.
Developments in the latest generation of adhesive systems have the potential to improve bond strength between composite materials and titanium alloys.

**Objectives:** The purpose of this study was to determine the microtensile bond strength of various composite/adhesive systems to Ti-6Al-4V at the as-processed condition and at 10-days aged in distilled water (37°C).

**Materials and Methods:** 3 mm thick blocks of Gradia (GR), Solidex (SOL), Diamond Crown (DC), and Sinfony (S) were bonded to 25.4 mm diameter Ti-6Al-4V disks with their respective adhesive systems according to the manufacturer’s instructions. From these disks, microtensile bars of ~1x1x6 mm were prepared using a diamond wafer blade and specimens (n=12) were separated and aged as designated above. Each specimen was loaded to failure under tension and later analyzed through SEM for failure mode assessment. Statistical analysis was performed through one-way ANOVA at 95% level of significance.

**Results:** The microtensile bond strength values for groups as-processed and at 10-days are presented in the table.

<table>
<thead>
<tr>
<th>Material</th>
<th>95%CI-As-processed condition</th>
<th>95%CI-10 days in distilled water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradia</td>
<td>29.96±5.74a</td>
<td>21.52±3.53b</td>
</tr>
<tr>
<td>Solidex</td>
<td>38.32±3.65a</td>
<td>20.10±2.91b</td>
</tr>
<tr>
<td>Diamond Crown</td>
<td>11.31±3.32c</td>
<td>10.95±2.72c</td>
</tr>
<tr>
<td>Sinfony</td>
<td>20.90±3.46b</td>
<td>23.27±3.40b</td>
</tr>
</tbody>
</table>

SEM micrographs showed different fracture modes for the different systems. GR/SOL presented mixed or cohesive in composite failure modes, and DC/S fractures occurred between the opaque layer and composite. Fracture modes were consistent at both as-processed and 10-day aged conditions for the different materials.

**Conclusions:** According to the results obtained thus far, aging specimens in water had an adverse effect on bond strength for GR, SOL. However, bond strength values were maintained for DC and S groups, where interface failure occurred between the opaque layer and composite materials. This project supported by the Dean’s Award for Summer Research at NYU College of Dentistry.

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**Aim of the Study:** The purpose of this study was to determine the microtensile bond strength of various composite/adhesive systems to Ti-6Al-4V at the as-processed condition and at 10-days aged in distilled water (37°C).

**Results of the Study:** No microtensile bond strength reduction was measured for Sinfony after aging in water. The failure occurred between the opaque layer and the composite material.
Influence of opaque resin thickness on metal-composite shear bond strength

J. GEIS-GERSTORFER, C. SCHILLE, and K. HERMES, University of Tuebingen, Center for Dental, Oral and Maxillofacial Medicine, Germany

Objectives: Depending on the dental technician and the application procedure used the thickness of opaque resins may vary between 50 and 250 µm. The goal of this study was to investigate the role of opaque thickness on the resulting metal-composite bond strength.

Methods: As substrates CoCr30Mo5 Microlit C (Schuetz Dental, Germany) metal plates (20x10x2 mm) were used. After sandblasting and silan modification of the surfaces with the rocatec system the veneering materials Dialog (Schuetz Dental), Gradia (GC) Solidex (Shofu) and Sinfony (3M ESPE) were applied according to the manufacturer recommendations with a diameter of 5 mm and 2 mm thick. Opaque resin thickness was varied from 65 µm, 128 µm to 240 µm with punched foils. After polymerisation of the samples in a two layer technique 15,000 thermocycles (+5/+55°C) were performed. Shear strength tests were conducted with application of the force at a distance of 0.5 mm from the surface of the metal plate (cutting angle 10°) with a constant cross head speed of 1 mm/min. All measurements were repeated 12 times.

Results: The mean bond strength results in the table are given in MPa:

<table>
<thead>
<tr>
<th></th>
<th>65 µm</th>
<th>128 µm</th>
<th>240 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ideal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dialog (Schuetz)</td>
<td>16.3 ± 4.6</td>
<td>9.9 ± 2.9</td>
<td>16.5 ± 2.3</td>
</tr>
<tr>
<td>Gradia (GC)</td>
<td>20.9 ± 2.3</td>
<td>12.8 ± 1.5</td>
<td>19.7 ± 5.6</td>
</tr>
<tr>
<td>Solidex (Shofu)</td>
<td>6.8 ± 1.4</td>
<td>4.2 ± 0.9</td>
<td>6.9 ± 1.2</td>
</tr>
<tr>
<td>Sinfony (3M ESPE)</td>
<td>11.0 ± 2.1</td>
<td>6.9 ± 1.3</td>
<td>11.4 ± 2.2</td>
</tr>
<tr>
<td><strong>Real</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dialog (Schuetz)</td>
<td>10.1 ± 1.5</td>
<td>10.4 ± 5.3</td>
<td>8.3 ± 3.3</td>
</tr>
<tr>
<td>Gradia (GC)</td>
<td>25.9 ± 2.7</td>
<td>16.6 ± 1.9</td>
<td>25.9 ± 2.7</td>
</tr>
<tr>
<td>Solidex (Shofu)</td>
<td>4.5 ± 0.8</td>
<td>6.2 ± 2.7</td>
<td>6.2 ± 1.0</td>
</tr>
<tr>
<td>Sinfony (3M ESPE)</td>
<td>7.2 ± 1.5</td>
<td>15.8 ± 2.1</td>
<td>9.5 ± 1.3</td>
</tr>
</tbody>
</table>

“Ideal” is related to the fracture surface area of the composites (diameter 5 mm).
“Real” is related to the measured real fracture surface area.

Conclusions: Shear bond strength depends on kind of opaque resin application, thickness and related fracture surface.

• The largest differences in bond strength values between the material systems was found with 240 µm opaque resin thickness.

• Relatively constant high bond strength values were found at 128 µm opaque resin thickness which corresponds to the range of thin layers attainable by dental technicians (105–140 µm).

Support of Schuetz Dental GmbH (Germany) is grateful acknowledged.
Shear Bond Strength Between the Titanium and an Indirect Resin

D.G. DUARTE, R.O.A. SOUZA, A.M.M. MESQUITA, G.A.P. GALHANO, R.M. MELO, C.A. PAVANELLI, and M.A. BOTTINO, Sao Paulo State University (Unesp/SJC), Sao Jose dos Campos, Brazil

**Objectives:** To evaluate, using a shear mechanic test, the influence of different polymerization units on the bond strength between a commercially pure titanium (Tritan-Dentaurum) and a laboratorial resin (Sinfony/3M ESPE/USA). The hypothesis was that the final polymerization in different units does not affect the shear bond strength.

**Methods:** Thirty metallic cylinders, with 5mm of length and 4 mm of diameter each one, were obtained by machining of titanium bars. The metallic cylinders were sandblasted with aluminum oxide (250µm), at 2 bars of pressure for 20 seconds, with 3 cm of distance. All cylinders were immersed in isopropyl alcohol 10% and cleaned in ultrasonic for 10 min. Two layers of opaque (Sinfony Opaque/3M ESPE) was applied on the metallic cylinders and submitted to initial polymerization in the Visio Alfa unit (3M ESPE/USA) and the final polymerization in the Visio Beta (3M ESPE/USA) unit, according the manufacturer. The metallic cylinders were divided into three groups (n=10) and the aesthetic veneer material was applied and polymerized using different units. In Gr1, the final polymerization was realized in the Visio Beta Vario unit connected to Visio Beta vacuum pump (3M ESPE). The groups Gr2 and Gr3 were submitted to final polymerization using respectively the Strobolux (EDG/BRAZIL) and Powerlux (EDG/BRAZIL) units, connected to Embraco (40NR - BRAZIL) vacuum pump. The three groups were submitted to shear test in a universal testing machine (model DL-1000, EMIC) with a 50 kg load cell at a speed of 1.0 mm/min. The data (MPa) were submitted to the analysis of variance (ANOVA) and the modes of failures were analyzed using a stereomicroscope (20x).

**Results:** The means and standard deviations obtained were: Gr1- 6.16±1.9 MPa, Gr2- 5.5±2.5 MPa, Gr3- 5.6±1.4 MPa. The null hypothesis was accepted.

**Conclusions:** The results showed no statistical significant difference between the groups.

**Shear bond strength of Sinfony on titanium polymerized in different polymerization units**

![Graph showing shear bond strength](image)

**Aim of the Study:** The aim of the study was to analyze the shear bond strength of Sinfony on titanium polymerized in different polymerization systems.

**Results of the Study:** The results showed no significant difference in shear bond strength after polymerizing the veneering material in different polymerization units. However, the Sinfony opaque layer was always polymerized in the Visio Alpha/Visio Beta system.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Influence of Polymerization Units in Shear Bond of Indirect Resin

H.A.M. BARBOSA, R.O.A. SOUZA, S.M.A. MICIDA, G.H.L. LOMBARDO, C.E.L. LOMBARDO, A.N. KOJIMA, and M.A. BOTTINO, Sao Paulo State University (Unesp/SJC), São José dos Campos, Brazil

Objectives: To evaluate, using a shear mechanic test, the effect of the different polymerization units on the bond strength between a gold-palladium alloy (Au-Pd) and an indirect composite resin (Sinfony/3M ESPE). The hypothesis was that the final polymerization in different units does not affect the shear bond.

Methods: Thirty metallic cylinders in gold-palladium alloy (Au-Pd), with 5 mm of length and 4 mm of diameter each one, were obtained by casting of acrylic patterns. The metallic cylinders were sandblasted with aluminum oxide (250μm), at 2 bars of pressure for 20 seconds, with 3 cm of distance. All cylinders were immersed in isopropyl alcohol 10% and cleaned in ultrasonic for 10 min. Two layers of Opaque Sinfony (3M ESPE/USA) were applied on the metallic cylinders and submitted to initial polymerization in the Visio Alfa unit (3M ESPE/USA) and the final the polymerization in the Visio Beta (3M ESPE/USA) unit, according the manufacturer. The metallic cylinders were divided into three groups (n=10) and the esthetic veneer resin Sinfony was applied and cured using different units. In Gr1, the final polymerization was realized in the Visio Beta Vario (3M ESPE) unit connected to Visio Beta (3M ESPE/USA) vacuum pump. The groups Gr2 and Gr3 were submitted to final polymerization using respectively the Powerlux (EDG/BRAZIL) and Strobolux (EDG/BRAZIL) units, connected to Embraco (40NR - BRAZIL) vacuum pump. The three groups were submitted to shear test in a universal testing machine (model DL-1000, EMIC) with a 50 kg load cell at a speed of 1.0 mm/min. The data (MPa) were submitted to the analysis of variance (ANOVA) and the modes of failures were analyzed using a stereomicroscope (20x).

Results: The means and standard deviations obtained were: Gr1- 9.46±2.5 MPa, Gr2- 7.5±2.0 MPa, Gr3- 7.4±3.9 MPa. The null hypotheses were accepted.

Conclusions: The results showed no statistical significant difference between the groups.

Shear bond strength of Sinfony on gold-palladium polymerized in different polymerization units

Aim of the Study: The aim of the study was to analyze the shear bond strength of Sinfony on gold-palladium alloy (Au-Pd) polymerized in different polymerization systems.

Results of the Study: The results showed no significant difference in shear bond strength after polymerizing the veneering material in different polymerization units. However, the Sinfony opaque layer was always polymerized in the Visio Alpha /Visio Beta system.
Fracture Resistance of Minimally Prepared CEREC Crowns

E. TSITROU, Aristotle University of Thessaloniki, Greece, S.E. NORTHEAST, University of Sheffield, United Kingdom, and R. VAN NOORT, University of Sheffield, Sheffield, England

Objective: The advantages of minimally invasive dentistry are well established, especially for direct restorations. However, when it comes to indirect restorations traditional tooth preparation designs are still advised by most manufacturers. The ability of a CAD/CAM system (CEREC) to produce minimal restorations has been previously reported. The purpose of this study was to investigate the fracture resistance of resin-bonded minimally prepared crowns fabricated with the CEREC system.

Methods: For the purpose of this study twenty sound maxillary molar teeth were used and divided in two groups of ten. In Group I a traditional tooth preparation design for crown was performed (1.2 mm shoulder margins, 1.5 mm occlusal reduction), while in Group II a minimal crown preparation design was applied (0.5 mm chamfer margins, 0.6 mm occlusal reduction). The CEREC Scan system was used for the scanning of the preparations, designing and milling of the crowns. Paradigm MZ100 (3M/ESPE) blocks for CEREC were used for the fabrication of the crowns. All crowns were bonded to the teeth using RelyX Unicem Aplicap (3M/ESPE). After 24 hours storage in water, specimens were loaded in a universal testing machine. Fracture loads (N) were recorded. One-way analysis of variance (ANOVA) was used for the statistical analysis of the data.

Results: The mean fracture load of the crowns for the traditionally prepared specimens (1683±396 N) was not significantly different from that of the minimally prepared (1750±338 N). Observation of the crowns after fracture showed that the majority of crowns in both groups exhibited the same mode of failure.

Conclusion: Within the limitations of this experimental design, it was found that for the Paradigm MZ100 system the application of minimal tooth preparation designs produced thinner restorations with equal fracture resistance to that of crowns bonded to traditionally prepared teeth.

Fracture strength of Paradigm MZ100 crowns with traditional tooth preparation (1.2 mm shoulder margins, 1.5 mm occlusal reduction) and minimal crown preparation (0.5 mm chamfer margins, 0.6 mm occlusal reduction).

Aim of the Study: The aim of the study was to investigate the fracture resistance of resin-bonded minimally prepared MZ100 crowns fabricated with the Cerek system.

Results of the Study: Within the limitations of this experimental design, it was found that for the Paradigm MZ100 system the application of minimal tooth preparation design is possible. However, further investigation needs to be done before using minimal crown preparation for MZ100 clinically.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.
MZ100™ and RelyX™ Unicem Cement

Bond strength of self-adhesive resin cements used for onlays luting

O. RAFFAElli, C. GORACCI, A. CANTORO, F. PAPACCHIINI, and M. FERRARI, University of Siena, Italy

Objective: To evaluate strength of the interface on dentin by the Experimental luting (EL, Ivoclar-Vivadent), RelyX Unicem (RU, 3M ESPE), and Maxcem (M, Sybron-Kerr), applied under two standardized clinically seating pressures.

Methods: composite overlays (Paradigm MZ100, 3M ESPE) were luted on coronal dentin surfaces of 12 extracted molars, which are randomly divided in three groups (EL, RU, M). Each group is divided in two subgroups depending on the different seating pressures applied. During the initial 5 min auto-cure period, a pressure of 20 or 40g/mm² was maintained on the overlay. Curing was completed by light irradiation from the top of the overlay for 20 s. Microtensile sticks were obtained from the luted teeth. The Two-Way Analysis of Variance was applied with bond strength as the dependent variable, cement, and seating pressure as factors. The Bonferroni test was applied for post-comparisons among cements and between factors interactions. In all the analyses the level of significance was set at p<0.05.

Results: The bond strengths (MPa) in dentin were: EL 20g/mm² 8.28±5.44, 40g/mm² 13.19±5.44; RU 20g/mm² 6.8±2.6, 40g/mm² 14.5±5.3; M 20g/mm² 4.1±1.8, 40g/mm² 5.2±1.6. The Two-Way ANOVA revealed that cement, seating pressure and the interaction between these factors significantly influenced bond strength (p<0.05). Significantly stronger bonds were established under the heavier seating pressure. With regard to the cement factor, RelyX Unicem and the Experimental luting agent achieved levels of adhesion significantly higher than Maxcem. Significant between factors interactions are reported in the Table.

Conclusion: Interfacial strength self-adhesive dual-cure cements are enhanced if a seating force heavier than finger pressure is maintained throughout the initial autocure period. Table CEMENT SEATING PRESSURE Mean (MPa) s.d. Significance P<0.05 Experimental 20g/mm² 8.28 5.44 A,b 40g/mm² 13.19 5.44 A,a RelyX Unicem 20g/mm² 6.8 2.6 A,bc 40g/mm² 14.5 5.3 A,a Maxcem 20g/mm² 4.1 1.8 B,c 40g/mm² 5.2 1.6 B,c.

Microtensile bond strength of Paradigm MZ100 luted on coronal dentin by different cements and with different seating pressures.

Aim of the Study: The influence of two different, clinically relevant seating pressures (average and strong finger pressure) on microtensile bond strength of self-adhesive resin cements was evaluated.

Results of the Study: RelyX Unicem self-adhesive resin cement and Experimental Luting material achieved significantly higher bond strength under both seating conditions than Maxcem.
Adper™ Prompt™ Self-Etch Adhesive

Enamel and Dentin Bond Strengths of Five Self-Etch Adhesives
P.N.R. PEREIRA, E.J. SWIFT, Jr., M.S. SHINOHARA, and G.V. MACEDO, University of North Carolina, Chapel Hill, USA

Objectives: The purpose of this study was to evaluate the microtensile bond strength (MTBS) of five self-etch adhesive systems—including two experimental materials—and one total-etch adhesive to ground (instrumented) enamel, unground enamel, and dentin.

Methods: In addition to two experimental self-etch primer systems, the materials tested were Adper Prompt L-Pop (self-etch adhesive), Adper Single Bond Plus (total-etch), Clearfil SE Bond (self-etch primer), and Clearfil S3 Bond (self-etch adhesive). Thirty extracted human molars were sectioned into halves, and specimens were assigned for treatment with each adhesive (n=5). Dentin and enamel (in the “ground” group) were polished to 600-grit. Adhesives were applied according to manufacturer’s directions, and composite resin was applied and cured on the treated surfaces. The bonded specimens were stored in water for 24h, and were sectioned into beams with a cross-sectional area of 0.8 mm². Microtensile bond testing was done using an EZ-Test tabletop apparatus, and the data were analyzed using one-way ANOVA for each substrate and Fisher’s PLSD test at a significance level of 0.05.

Results: MTBS (MPa ±SD) are summarized in this table:

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Substrate</th>
<th>Unground Enamel</th>
<th>Ground Enamel</th>
<th>Dentin</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXL-641A/EXL-671A</td>
<td>15.9 (8.2)</td>
<td>22.4 (10.7)</td>
<td>38.2 (17.2)</td>
<td></td>
</tr>
<tr>
<td>EXL-678/EXL-671A</td>
<td>22.5 (9.3)</td>
<td>26.1 (11.3)</td>
<td>43.1 (12.1)</td>
<td></td>
</tr>
<tr>
<td>Adper Prompt L-Pop</td>
<td>29.6 (10.9)</td>
<td>30.5 (11.0)</td>
<td>29.5 (12.1)</td>
<td></td>
</tr>
<tr>
<td>Adper Single Bond Plus</td>
<td>25.4 (11.6)</td>
<td>30.1 (11.3)</td>
<td>35.6 (15.3)</td>
<td></td>
</tr>
<tr>
<td>Clearfil SE Bond</td>
<td>25.0 (8.6)</td>
<td>30.9 (12.3)</td>
<td>51.1 (15.7)</td>
<td></td>
</tr>
<tr>
<td>Clearfil S3 Bond</td>
<td>26.7 (11.8)</td>
<td>21.3 (10.3)</td>
<td>42.4 (12.5)</td>
<td></td>
</tr>
</tbody>
</table>

Similar superscripts within a column denote means that are not significantly different.

Conclusion: The dentin bond strengths of the experimental adhesives were exceeded by only one other adhesive, but the experimental materials had lower bond strengths to unground enamel. Supported by 3M ESPE. ed_swift@dentistry.unc.edu

Aim of the Study: The authors used microtensile bond strength measurements to characterize a new dental adhesive system.

Results of the Study: The EXL 678/671 system displayed good bond values to enamel and dentin.
Microtensile Adhesive Strength and Number of Debonds to Gingival Walls

J. PURK1, V. DUSEVICH1, A. GLAROS2, and J.D. EICK1, 1University of Missouri Kansas City, USA, 2Kansas City University of Medicine and Biosciences, MO, USA

Objectives: Gingival margins in class II composite restorations frequently fail. To compare the 48 hour in-vitro microtensile bond strength of four adhesive systems; PQ1™ (Ultradent), Adper™ Prompt™ L-Pop™ (3M™ ESPE™), Single Bond Plus™ (3M™ ESPE™) and Touch & Bond™ (Parkell Inc.), bonded to the gingival wall of restored dentin cavity walls in class II composite molar restorations.

Methods: After IRB approval, two third molar teeth (unrestored and non carious) from the same patient were extracted. Eight teeth were collected from four patients. Each pair of teeth was stored in a phosphate buffered solution with 0.002% sodium azide. Each pair received a class II preparation in the proximal of each tooth to yield two preparations per tooth and four preparations per pair. Each preparation was randomly restored with one of the adhesives above and 3M™ ESPE™ Flitek™ Z250 Universal Restorative (Shade A3). Manufacturer’s directions were followed. The teeth were sectioned to obtain rectangular specimens with a surface area of ~0.5 mm² at the gingival wall. Samples were tested on the Enduratec at 1 mm/min till failure for microtensile strength.

Results:

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Chemistry</th>
<th>Steps</th>
<th>Etch</th>
<th>N</th>
<th>Mean in MPa (StD)</th>
<th># Debonds (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQ1</td>
<td>ethanol</td>
<td>Two</td>
<td>Total</td>
<td>18</td>
<td>38.2 (18.5)</td>
<td>1 (5.2)</td>
</tr>
<tr>
<td>Prompt L-Pop</td>
<td>water</td>
<td>One</td>
<td>Self</td>
<td>12</td>
<td>38.6 (16.1)</td>
<td>9 (42.9)</td>
</tr>
<tr>
<td>Single Bond Plus</td>
<td>ethanol</td>
<td>Two</td>
<td>Total</td>
<td>16</td>
<td>49.1 (20.1)</td>
<td>4 (20.0)</td>
</tr>
<tr>
<td>Touch &amp; Bond</td>
<td>4-META</td>
<td>One</td>
<td>Self</td>
<td>7</td>
<td>25.0 (20.1)</td>
<td>15 (68.2)</td>
</tr>
</tbody>
</table>

Conclusions: A one-way ANOVA did not find a statistically significant difference between adhesives p>0.05. Groups differed significantly in the number of debonds X²[3,N=29]=17.2, p≤0.001. 99% of the failures were adhesive.

Bond Strength of Self-Etch Adhesives

Aim of the Study: This study was designed to measure the microtensile bond to dentin of several new self-etch adhesives in comparison to a total etch controlled group.

Results of the Study: The bond strength of self-etch adhesives continues to improve. Adper Prompt displayed values of 38.6 MPa.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Adper™ Prompt™ Self-Etch Adhesive

Shear Bond Strength of Self-Etching Adhesives to Enamel and Dentin
M. RAJESH, J.O. BURGESS, and L.C. RAMP, UAB School of Dentistry, Birmingham, AL, USA

Objectives: To measure and compare the shear bond strength of an experimental self-etch adhesive with seven commercially available self-etching adhesives on enamel and dentin.

Methods: 160 extracted, intact, human molars were divided into two groups and ground with 600 grit wet wheel to obtain flat enamel (E-Group1) and dentin (D-Group2) surfaces. The materials used were Clearfil SE (CSE), Clearfil S3 (CS3), G Bond (GB), I Bond (IB), Adper Prompt L-Pop (AP), Xeno IV (X-IV), Optibond SoloPlus (OSP) and Experimental (IMB-3). The adhesives were applied to the bonding area according to manufacturer’s instructions. A plastic tube (diameter=1.5 mm) filled with composite-resin (Z100) was placed over the adhesive and cured for 40 seconds with an Optilux 501 curing light. Samples (n=10) were stored in water for 24 hours at 37°C in an incubator before testing. Specimens were then placed in a special fixture mounted on a Universal testing machine (INSTRON, model number 5562) and were loaded to failure at a crosshead speed of 1 mm/min. The failure load was converted to bond strength by dividing by the bonding area. The data were analyzed with ANOVA.

Results: Results are displayed below (Mean±SD). Statistical analysis showed no significant differences in shear bond strengths between the materials for both enamel and dentin (p>0.05MPa).

<table>
<thead>
<tr>
<th>Material</th>
<th>E</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE</td>
<td>18.9±6.2</td>
<td>25.1±4.9</td>
</tr>
<tr>
<td>CS3</td>
<td>19.8±5.7</td>
<td>24.8±6.9</td>
</tr>
<tr>
<td>GB</td>
<td>24.6±7.4</td>
<td>25.2±5.7</td>
</tr>
<tr>
<td>IB</td>
<td>17.7±4.7</td>
<td>25.5±5.9</td>
</tr>
<tr>
<td>AP</td>
<td>22.5±6.6</td>
<td>25.0±4.0</td>
</tr>
<tr>
<td>X-IV</td>
<td>21.2±4.3</td>
<td>28.8±4.8</td>
</tr>
<tr>
<td>OSP</td>
<td>24.6±5.6</td>
<td>30.3±5</td>
</tr>
<tr>
<td>IMB-3</td>
<td>21.5±5.7</td>
<td>24.5±6.4</td>
</tr>
</tbody>
</table>

Conclusions: Based on the results of this study, the experimental material showed comparable bond strength to that of other commercially available adhesives when applied to both dentin and enamel. This study was supported in part by Tokuyama Dental Corp., Tokyo, Japan.

Shear Bond Strength to Enamel and Dentin

Aim of the Study: The aim of this study was to measure the bond of several current self-etch adhesive systems to human enamel and dentin.

Results of the Study: Today’s self etch systems are capable of very high bond values to enamel and dentin. Adper Prompt displayed a bond of 22.5 Mpa to enamel and 25 MPa to dentin.
Adper™ Prompt™ Self-Etch Adhesive

Shear Bond Strength of 5 Adhesives to 3 Substrates
B.T. SMITH, J.O. BURGESS, and L.C. RAMP, UAB School of Dentistry, Birmingham, AL, USA

Objectives: To measure the pH of five bonding agents and correlate the shear bond strength produced by those adhesives to unground enamel, ground enamel and dentin. To correlate the adhesive bond strength with the pH of each adhesive for the 3 substrates.

Methods: 150 caries-free human incisors and molars were collected and divided ten teeth per group (5 products, 3 surfaces, 10 samples). For bonding, flat surfaces of mandibular and maxillary incisors were used for unground enamel and the occlusal surfaces of molars were wet ground to provide flat enamel and dentin surfaces. 5 additional teeth were treated with each adhesive, rinsed with acetone and examined to determine the etch pattern by SEM analysis. The pH of each adhesive was measured by litmus paper. Each bonding agent applied to the substrate and cured following manufacturers’ directions using a Optilux 501 curing light. Tubes filled with Z100 (3M ESPE) composite resin, shade A2, were placed over adhesive and cured for 60 seconds. The samples were stored in distilled water 37°C for 48 hours and then were placed in a fixture held in the Instron testing machine model 5565 and a shearing load was applied at a 1 mm/minute crosshead speed until failure. Failure loads were converted to MPa and data analyzed for intergroup differences using ANOVA and Tukey Kramer analyses at p=.05.

Results: shear bond strength MPa, n=10

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>pH</th>
<th>Unground Enamel</th>
<th>Ground Enamel</th>
<th>Dentin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control–Single Bond</td>
<td>0.5</td>
<td>22.7±7</td>
<td>27.6±10</td>
<td>33.9±11</td>
</tr>
<tr>
<td>Prompt L-Pop</td>
<td>0.8</td>
<td>20.1±9</td>
<td>30.3±6</td>
<td>28.8±6</td>
</tr>
<tr>
<td>Clearfil SE</td>
<td>2.0</td>
<td>21.4±9</td>
<td>33.1±6</td>
<td>38.4±5</td>
</tr>
<tr>
<td>G-bond</td>
<td>2.5</td>
<td>17.4±5</td>
<td>24.5±3</td>
<td>13.6±3</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.2</td>
<td>17.5±9</td>
<td>30.2±2</td>
<td>38.6±3</td>
</tr>
</tbody>
</table>

Conclusion: A correlation between pH and unground enamel only was present. Material and substrate were highly significant (p<.01). This supports a separate etch step on unground enamel when using a bonding agent with high pH.

Aim of the Study: This study was designed to investigate a hypothetical link between pH and bonding performance.

Results of the Study: pH was found to correlate with bonding to unground enamel, thus reinforcing the need to separately etch unground enamel with some self-etch systems.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Effect of tooth age on dentin-composite interfacial fracture toughness

E.S. GHANAME1, M. MACENTEE2, and N.D. RUSE2
1The University of North Carolina at Chapel Hill, USA, 2University of British Columbia, Vancouver, Canada

Objectives: The purpose of this in vitro study was to evaluate the effect of dentin age on the interfacial fracture toughness (K\textsubscript{IC}) of four dental bonding systems using the notchless triangular prism (NTP) specimen K\textsubscript{IC} test.

Methods: 80 human molars and pre-molars, 40 of them from patients not older than 45 years ("young") and 40 from patients not younger than 65 years ("old"), were wet ground on 600-grit silicon carbide abrasive paper to obtain a 4x4x4x4mm triangular prisms with the labial surface exposed for bonding. Within each of the two groups, the specimens were randomly assigned to four subgroups (n=10) according to the bonding system to be used for composite bonding: Adper Prompt L-pop (3M ESPE), Clearfil SE (Kuraray), Prime & Bond NT (Dentsply) and Scotch Bond MP (3M ESPE). The composite, Z-100 (3M ESPE), was bonded to each of the treated surfaces as per the manufacturer’s instructions to obtain a 4x4x4x8mm dentin-composite NTP specimens. The specimens were stored in water for 24h at 37°C and tested to determine K\textsubscript{IC}. The data was analyzed using Levene’s test for normality, two-way univariate analysis of variance (ANOVA), and Bonferroni tests for multiple means comparisons. A significance level of 0.05 was used for all tests. Selected fractured surfaces were characterized using a scanning electron microscope (SEM).

Results: While Adper Prompt L-pop and Clearfil SE achieved the highest K\textsubscript{IC} values for both age groups, Prime & Bond NT showed the lowest values. SEM observations of fractured samples revealed differences in fracture path. No statistically significant differences were observed between age groups.

Conclusions: The K\textsubscript{IC} values of the four dental bonding systems were not affected by age. Furthermore, statistically significant differences were observed between the K\textsubscript{IC} values of the four bonding systems, regardless of the age of the dentin.

Aim of the Study: The aim of this study was to evaluate the effect of patient age on bond to dentin using the novel approach of measuring interfacial fracture toughness.

Results of the Study: Dentin age did not prove a factor in this study, but self-etch systems such as Adper Prompt achieved the highest interfacial fracture toughness.
Adper™ Prompt™ Self-Etch Adhesive

Water pulpal pressure effect on self-adhesive bond strength
S. EL KON, Ismilia university, Dental school, Egypt

Objectives: To evaluate the effect of pulpal water pressure on the bond strength of some self-etching adhesives.

Methods: The materials were: Clearfil S tri bond, CSTB (Kuraray), Adper Prompt L- Pop, AP (3M ESPE), Futura Bond NR, FB (Voco), Optibond All-in-one, OB (Kerr) and Adhe SE, ASE (Vivadent). Extracted molar teeth were used. For each tooth, the root and the coronal enamel were removed to form a crown segment. A Plexiglas root portion was cemented to this segment. The root portion was connected to a water column to produce a pressure of 36 cm H2O at the surface of the crown segment. The adhesives were applied to dentin in three test methods: without pulpal water pressure; with pulpal water pressure for 24 hours, and with pulpal pressure for 6 months. Grandio composite was placed to a height of 5–6 mm. After adhesive and composite application, the segment was removed from the root portion, sectioned for microtensile bond measurement. The results were analyzed using two-way ANOVA test.

Results: Without pulpal pressure, the Bond strength of tested materials was (Mean ± SD MPa): CSTB, 33.2 ± 4.7; AP, 39.2 ± 3.8; FB, 39.3 ± 4.3; OB, 38± 2.8 and ASE, 36.5 ± 5.2. After water pressure for 24h, the values were: CSTB, 32± 4.6; AP, 36± 5.1; FB, 35± 4.2; OB, 35± 3.1 and ASE, 34± 3.9. After 6 months of water pressure the bond strength was: CSTB, 21± 3.2; AP, 28± 4.2; FB, 31± 2.9; OB, 33± 4.6 and ASE, 19± 2.7. There was no significant difference (p>0.05) in bond strength after 24h pulpal pressure. However, after six months, the bond strength of CSTB, AP and ASE were significantly (P<0.05) reduced.

Conclusion: pulpal water pressure can affect the durability of the bond of self-etch adhesives.

Effect of Water Pressure on Self-Etch Adhesion

Aim of the Study: To evaluate the effect of interpulpal water pressure applied for varying lengths of time

Results of the Study: While pulpal pressure had an effect on bond values, several systems displayed high bond values despite the water challenge.
Immediate Shear Bond Strength of Three Core Materials to Dentin

M.S. ELDIWANY1, J.C. ONTIVEROS2, J.M. POWERS3, and M. ELDIWANY4, 1University of Texas Dental Branch at Houston, USA, 2University of Texas Dental Branch, Houston, 3Dental Consultants, Inc, Biomaterials Research Center, Ann Arbor, MI, USA

Objectives: To determine the effect of polymerization mode of resin core materials and dental adhesives on the immediate bond strength to dentin.

Methods: Human third molars were ground to expose superficial dentin and polished to 600 grit. Three core materials [Core-Flo SC (CF), Luxacore DC (LX), Photo Core LC (PC)] and three adhesives with or without a corresponding activator [Contax (CX), Single Bond Plus/Bondlink (SB), Xeno IV (XI)] were placed in a cylinder mold (d=2.3 mm) and cured according to manufacturers’ instructions. Specimens were debonded immediately using an Instron, and shear bond strengths were calculated.

Results: Means with standard deviations in parentheses (n=8) are listed. Adhesives, cure modes, and core materials and their interactions were statistically significant (p<0.001). Fisher’s PLSD intervals for comparisons of means among adhesives, core materials and curing modes were 2.0, 2.0 and 1.7 MPa, respectively. Means with the same superscripted letters are not different statistically. Among core materials light-cured PC had the highest bond strength with XI and SB. There were incompatibilities between self-cured CF and CX, and it showed highest strength with dual-cured XI. Dual-cured LX showed highest strength with CX and comparable results with CX LC and XI DC. Fracture modes were predominantly adhesive for XI and cohesive for SB and CX.

<table>
<thead>
<tr>
<th>Core Materials</th>
<th>CF (Self Cure)</th>
<th>LX (Dual Cure)</th>
<th>PC (Light Cure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light-cured Adhesives:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CX</td>
<td>6.6 (1.0)</td>
<td>29.9 (5.8)</td>
<td>37.7 (4.3)</td>
</tr>
<tr>
<td>SB</td>
<td>20.9 (4.4)</td>
<td>25.0 (2.3)</td>
<td>41.3 (6.0)</td>
</tr>
<tr>
<td>XI</td>
<td>17.4 (3.2)</td>
<td>16.0 (4.1)</td>
<td>46.0 (5.3)</td>
</tr>
<tr>
<td>Dual-cured Adhesives:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CX</td>
<td>31.8 (5.2)</td>
<td>34.1 (7.0)</td>
<td>35.4 (5.6)</td>
</tr>
<tr>
<td>SB</td>
<td>24.2 (2.6)</td>
<td>19.3 (2.5)</td>
<td>30.8 (4.5)</td>
</tr>
<tr>
<td>XI</td>
<td>33.7 (7.3)</td>
<td>28.0 (6.8)</td>
<td>38.8 (6.9)</td>
</tr>
</tbody>
</table>

Conclusions: The following core material/adhesive combination gave the highest results: PC and light-cured XI, LX with dual-cured CX, and CF with dual-cured XI. Materials were provided by the manufacturers.
Adper™ Single Bond Plus

Core Material and Adhesive Cure Mode Effects on Bond Strengths

J.C. ONTIVEROS1, M. ELDIWANY1, J.M. POWERS2, and M.S. ELDIWANY3, 1University of Texas Dental Branch, Houston, USA, 2Dental Consultants, Inc, Biomaterials Research Center, Ann Arbor, MI, USA, 3University of Texas Dental Branch at Houston, USA

Objectives: To determine the shear bond strength of core materials Luxacore (DMG), Core-Flo (Bisco) and Clearfil PhotoCore (Kuraray) and 3 dental adhesives with and without a corresponding DC/SC activator; Single Bond Plus (3M ESPE)/BondLink (DenMat), Contax LC/DC (DMG), and Xeno IV LC/DC (Dentsply/Caulk).

Methods: Freshly extracted teeth were mounted in resin and superficial dentin was ground and polished to 600 grit. Adhesives were applied and cured using a Optilux 501 according to the manufacturers’ instructions. Core materials were loaded into a mold (d=2.3 mm) positioned flat against the dentin. All core materials were cured for 40 seconds with the exception Core-Flo, which was self-cured. After 24 hrs water storage, shear bond strengths were determined using an Instron at a speed of 1 mm/min.

Results: Interactions of adhesives, cure modes, and core materials were statistically significant (p<0.001). Fisher’s PLSD intervals for comparisons of means among adhesives, core materials and curing modes were 2.9, 2.9 and 2.4 MPa, respectively.

<table>
<thead>
<tr>
<th>Product</th>
<th>Cure Mode</th>
<th>Light Cure Adhesive</th>
<th>Dual Cure Adhesive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Contax</td>
<td>Single Bond</td>
</tr>
<tr>
<td>PhotoCore</td>
<td>Light Cure</td>
<td>43.1 (6.4)</td>
<td>46.5 (11.0)</td>
</tr>
<tr>
<td>LuxaCore</td>
<td>Dual Cure</td>
<td>35.0 (4.9)</td>
<td>33.0 (4.4)</td>
</tr>
<tr>
<td>Core-Flo</td>
<td>Self Cure</td>
<td>27.5 (4.8)</td>
<td>30.8 (5.7)</td>
</tr>
</tbody>
</table>

Means with the same superscripted letters are not different statistically.

Conclusions: The light cured core material, PhotoCore, demonstrated a statistically significant difference with all six dental adhesives whether light- or dual-cured when compared to the dual cure or self cure core materials after 24 hours. Supported in part by Bisco, Kuraray, DMG, 3M ESPE and Dentsply/Caulk

Aim of the Study: The use of dental adhesives with self-cure or dual-cure composites can be rather confusing. In this study all adhesives were light-cured prior to placement of self- or dual-cure composites. In this scenario, core buildups of light-cure, dual-cure, or self-cure chemistries all bonded to the light cured adhesives.

Results of the Study: Light cured Single Bond adhesive proved compatible with dual-cure or self-cure core buildup materials with the need for an additional dual-cure additive.
Experimental Self-Etch Adhesive

Shear Bond Strengths of Six Adhesives to Three Substrates
J.O. BURGESS, P. CHOPRA, and L.C. RAMP, UAB School of Dentistry, Birmingham, AL, USA

Objectives: To compare the shear bond strength of an experimental self-etch adhesive with other commercially available self and one total etch adhesives on un-ground enamel (UE), ground enamel (GE) and dentin.

Methods: 100 caries free human molar teeth and 50 central incisors were collected. Each bonding adhesive was applied to the un-ground flat facial surface of incisors following the manufacturers’ instructions except that a separate phosphoric acid etching was used only with Single Bond. The bonding agent was applied and cured with an Optilux 501 curing light (>600mW/cm2). A 1.5 mm diameter tube filled with Z100 (A2) composite resin was placed over the adhesive and light cured for 40 sec. The 100 molar teeth were ground using a series of abrasive disks ending with 400 grit to obtain flat enamel and dentin surfaces. The bonding agents were applied following the manufacturers’ directions and curing unit as described above. The samples were tested in shear to failure using an Instron (model 5565, Canton, MA) at a 1 mm/ min cross head speed. Failure loads were converted to MPa and the data analyzed using ANOVA and Tukey test.

Results: Mean bond strength (MPa) n=10

<table>
<thead>
<tr>
<th>Bonding agent</th>
<th>Unground Enamel</th>
<th>Ground Enamel</th>
<th>Dentin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single bond Plus</td>
<td>26.2±9</td>
<td>24.4±8</td>
<td>21.3±9</td>
</tr>
<tr>
<td>Adper prompt</td>
<td>19.2±12</td>
<td>17.3±6</td>
<td>16.1±8</td>
</tr>
<tr>
<td>Clearfill SE</td>
<td>15.2±8</td>
<td>19.7±7</td>
<td>22.3±11</td>
</tr>
<tr>
<td>Clearfill S3</td>
<td>9.8±12</td>
<td>15.6±4</td>
<td>20.2±6</td>
</tr>
<tr>
<td>Experimental</td>
<td>10.9±5</td>
<td>22.6±6</td>
<td>21.1±8</td>
</tr>
</tbody>
</table>

Materials and substrate were significant factors. Single bond with a phosphoric acid etch, produced significantly greater bond strengths than Clearfil 3S Bond on ground and unground enamel.

Conclusions: Various self etch materials exhibited comparable results to the total etch for GE and dentin. This could be because of the difference in acidity of the adhesives. This study supports the use of acid etching on unground enamel. Supported by a grant from 3M ESPE.

Shear Bond Values of Several Self-Etch Adhesives

Aim of the Study: In the oral environment bonding is essential to three substrates; unground enamel, ground enamel, and dentin. The aim of this study was to document the bonding ability of several current self etch systems to these substrates and compare them to a total etch control adhesive.

Results of the Study: While all systems displayed high bonds to ground enamel and dentin, bonding to unground enamel served to differentiate the products.
Experimental Two-Bottle Two-Step Self-Etching Primer System

Adhesion of Two New Self-Etching Primer Systems to Tooth Substance

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1Nippon Dental University, Tokyo, Japan, 2Harvard University, Boston, MA

Objectives: The purpose of this study was to examine the adhesion of two types of newly developed self-etching primer adhesive system to cervical enamel and dentin.

Methods: Four resin adhesive (3M ESPE), a new experimental two-bottle two-step self-etching primer system (EXL-678&EXL-671C:E2), a new experimental one-bottle one-step all-in-one system (EXL-683:E1), an all-in-one system on the market–Adper Prompt L-Pop Self-Etch Adhesive (AL) and a one-bottle self-priming adhesive system on the market–Single Bond (SB), were used. Standardized V-shaped cavity having an occlusal enamel bevel was prepared in the buccocervical region of 20 extracted human premolars. The cavities were pretreated clinically with the four systems according to the manufacturer’s instructions. The immediate tensile bond strengths (ITBS) of the systems to beveled enamel (E, n=5) and gingival dentin wall (D, n=5) were measured with a portable adhesion tester (JDR 75,1996). The data were statistically analyzed using ANOVA and Tukey’s q-test.

Results: The mean ITBS (s.d.) in MPa to E/D were E2;22.6(4.6)/21.0(3.3), E1;23.5(5.3)/27.9(4.4), AL;24.9(4.7)/26.8(5.1), and SB; 26.4(3.4)/17.9(4.0). The ITBS to D was influenced significantly by the difference in systems, but the value to E did not vary with the systems. The ITBS of E1/AL to D was statistically greater than that of SB (p<0.01/p<0.05). No significant difference in the ITBS between E and D was recognized in the systems except SB. The value SB to E was significantly greater than that to D (p<0.01).

Conclusions: Two new experimental systems, E2 and E1, could obtain a high bond strength to enamel that was similar to the value of SB which was evaluated as an excellent adhesion system for enamel. The dentin bond strength of the new systems was similar to or greater than those of AL and SB. The new systems could obtain both enamel and dentin bond strengths equally.

Immediate Tensile Bond Strength to Enamel and Dentin

Aim of the Study: This study characterized the immediate tensile bond strength to enamel and dentin of several current and experimental self etch adhesives.

Results of the Study: The two experimental systems proved efficacious in bonding to enamel and dentin.
Experimental Two-Bottle Self-Etching (SE) Adhesive

Thermocycling Adhesion Study of an Experimental Self-Etch Adhesive
V.A. RUSSELL, B.A. SHUKLA, R.R. WERTISH, and S.M. AASEN, 3M ESPE Dental Products, Saint Paul, MN, USA

Objectives: This study investigated the effects of thermally-induced stresses (thermocycling) on the shear bond strengths (SBS) of an experimental two-bottle self-etching (SE) adhesive EXM-678/EXM-671C (EXP, 3M ESPE) versus a fifth generation total-etch (TE) adhesive, Adper™ Single Bond Plus (SB+, 3M ESPE) on three substrates: bovine uncut enamel (UE), cut enamel (CE) and superficial dentin (D).

Methods: A notched-edge shear method was used to measure the SBS to bovine UE, CE and D (composite: Filtek™ Z250 A2, 3M ESPE). Specimens were stored either in water at 37°C for 24 hr for baseline data or thermocycled between 5°C and 55°C (30 sec cycles) with testing at 10,000 cycle intervals up to 30,000 cycles.

Results: Mean (std dev) SBS in MPa and p-values (two-sample t-tests, p<0.05) are listed in the table. EXP p-values for 0 vs. 30,000 cycles: UE 0.248, CE 0.102, D 0.876.

<table>
<thead>
<tr>
<th>Substrate</th>
<th>UE</th>
<th>UE</th>
<th>CE</th>
<th>CE</th>
<th>D</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 cycles</td>
<td>30,000</td>
<td>0 cycles</td>
<td>30,000</td>
<td>0 cycles</td>
<td>30,000</td>
</tr>
<tr>
<td>EXP</td>
<td>31.19 (11.60)</td>
<td>n=6</td>
<td>40.28 (12.79)</td>
<td>n=5</td>
<td>40.12 (10.68)</td>
<td>n=7</td>
</tr>
<tr>
<td>SB+</td>
<td>30.11 (15.15)</td>
<td>n=6</td>
<td>31.21 (16.00)</td>
<td>n=4</td>
<td>26.56 (4.45)</td>
<td>n=8</td>
</tr>
<tr>
<td>p-value*</td>
<td>0.893</td>
<td>0.399</td>
<td>0.017</td>
<td>0.011</td>
<td>0.881</td>
<td>0.043</td>
</tr>
</tbody>
</table>

* EXP vs. SB+ for a given substrate and number of thermocycles

Conclusions: The experimental SE adhesive EXP had a statistically equivalent or higher SBS compared to the TE control SB+, initially and after thermocycling for 30,000 cycles on all three substrates, UE, CE and D. There were no statistical differences in SBS for EXP after 30,000 thermocycles for UE, CE or D, compared to baseline data.

Aim of the Study: Hydrolytic stability is critical for dental adhesive systems. This study used thermal cycling to accelerate potential degradation effects on bonding.

Results of the Study: The experimental adhesive system proved very stable under the challenging conditions of this study.
Self-Etch “One-Bottle” Adhesive

A New One-Bottle Self-Etch Adhesive

S. AASEN, and C. THALACKER, 3M ESPE Dental Products, Saint Paul, MN, USA

Objectives: The goal of this study was to compare the adhesion performance of a new self-etch “one bottle” adhesive with commercially available one bottle adhesives.

Methods: The adhesion specimens were prepared for evaluation employing the “Notched Edge” test method. Manufacturers instructions were followed in placing the adhesive. The commercial adhesives employed were Xeno IV, Clearfil tri-S-bond (S3), i-Bond and G-Bond. The new experimental adhesive is designated as EXL 683. 3M ESPE Dental Filtek Z250 shade A2 was used as the composite for all adhesives. Adhesion performance was evaluated on enamel and dentin after 24 hour storage in water at 37C.

Results: For enamel adhesion the results were: Xeno IV (31.3 MPa), S3 (28.4), EXL 683 (27.9), i-Bond (22.5) and G-Bond (21.6). For dentin adhesion the results were: EXL 683 (45.6), S3 (35.4), G-Bond (34.2), i-Bond (32.8) and Xeno IV (11.9). Two sample t-test showed differences (p-value table will be presented). ANOVA (one-way) showed differences on dentin.

Conclusions: EXL 683 demonstrated very promising adhesion performance with respect to the commercially available adhesives.

Shear Bond of Experimental One-Step Adhesive to Enamel and Dentin

Aim of the Study: This study compared the bonding performance of several self-etch, single bottle adhesives.

Results of the Study: The experimental adhesive system from 3M ESPE proved to have very good bond to dentin and to prepared enamel.
Bonding Performance of All-in-one Adhesive Systems to Enamel and Dentin

Y. NARA1, M. HARA1, M. HASEGAWA1, T. SUZUKI1, T. MASEKI1, T. KIMISHIMA1, and I.L. DOGON2,
1Nippon Dental University, Tokyo, Japan, 2Harvard University, Boston, MA

Objectives: The purpose of this study was to examine the bonding performance of three all-in-one adhesive systems, a new experimental one-bottle system (EX, 3M ESPE), Adper Prompt L-Pop Self-Etch Adhesive (AP, 3M ESPE) and Clearfil Tri-S Bond (TS, KURARAY), to enamel and dentin as compared with those of Single Bond (SB, 3M ESPE) and Clearfil SE Bond (SE, KURARAY).

Methods: The uncut labial enamel surface (UE) of 25 human extracted incisors was cleaned simply with a rotated polishing-brush. Standardized V-shaped cavity having an enamel bevel was prepared in the buccocervical region of 25 extracted premolars. UD and both the cut surfaces of beveled enamel (CE) and gingival dentin wall (CD) of the standardized cavities were pretreated with the five systems according to the manufacturer’s instructions. The immediate tensile bond strength (TBS) of the systems to UE/CE/CD in MPa were measured (n=5) with a portable adhesion tester (JDR 75, 1996). The data were statistically analyzed using ANOVA and Tukey’s q-test.

Results: The mean TBS (s.d.) to UE/CE/CD were EX: 26.8(3.4)/23.5(5.3)/27.9(4.4), AP: 25.3 (5.6)/24.9(4.7)/26.8(5.1), TS: 20.5(4.7)/22.0(6.5)/25.4(4.8), SB: 27.5(3.5)/26.4(3.4)/17.9(4.0), SE: 24.4(5.8)/22.7(3.2)/24.4(4.6). The TBS of the systems except SB were not influenced statistically by the difference in bonded surfaces. The TBS of TS to UE was statistically smaller than the values of EX and SB at p<0.05. There was no significant difference in the TBS to UE among the five systems. The TBS of EX, AP, TS and SE to CD were statistically greater than that of SB at p<0.05

Conclusions: The three all-in-one adhesive systems demonstrated excellent bonding performance that was not influenced by the difference in bonded surfaces. Dentin bonding performance of the three systems was superior to that of SB. Especially the TBS of EX was similar to or greater than the values of the other systems regardless of the bonded surface.

Immediate Tensile Bond of Several Adhesive Systems

Aim of the Study: While 24 hour bond values are most commonly reported, it could be argued that immediate bond values are more pertinent. This study measures the immediate bond values of several self etch adhesives to prepared and unprepared enamel and prepared dentin.

Results of the Study: The experimental single bottle adhesive system from 3M ESPE displayed very good performance in this challenging test.
Enamel and dentin µTBS of simplified adhesives

J. PERDIGAO¹, G. GOMES², J. FUNDINGSLAND³, A. SEZINANDO⁴, P. MONTEIRO⁵, and I. GOMES⁶;
¹University of Minnesota, Minneapolis, USA, ²Instituto Superior Ciencias Saude Egas Moniz, Caparica, Portugal, ³3M ESPE Dental Products, St. Paul, MN, ⁴University of Lisbon, FMDUL, Lisbon, Portugal

Objectives: Dental adhesives have evolved from multi-step etch&rinse systems to all-in-one solutions. Compare the µTBS of an experimental all-in-one adhesive with four commercially available all-in-one adhesives using an etch&rinse adhesive as control.

Methods: 42 extracted third molars were randomly assigned to one of 7 groups: Clearfil S3 Bond (CS3, Kuraray); EXL 683 (3M ESPE) with 20s agitation (EXA); EXL 683 without agitation (EXNA); G-Bond (GB, GC America); iBond (iB, Heraeus Kulzer); Xeno IV (XE, Dentsply Caulk). Adper Single Bond Plus (SB, 3M ESPE) was used as control. For ground enamel, the proximal surfaces of 21 teeth was roughened with a diamond bur for 5s, bonded, and restored with Filtek Z250 (3M ESPE). Teeth were sectioned in X/Y directions to obtain sticks with a cross-sectional area of 0.8±0.2mm². For dentin, occlusal middle dentin was bonded in 21 teeth and crowns restored with Filtek Z250. Teeth were sectioned in X/Y directions to obtain sticks with a cross section of 0.7±0.2 mm². All sticks were fractured in tension (Instron 4204) at a crosshead speed of 1 mm/min. Statistical analysis for each substrate: 1-way ANOVA and Duncan’s, P<0.05 (for each column, superscript letters indicate significance).

Results: (Mean ± SD in MPa; PTF = pre-testing failures, 0 MPa)

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Mean±SD PTF N</th>
<th>Adhesive</th>
<th>Mean±SD PTF N</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS3</td>
<td>35.2±14.8 2</td>
<td>EXNA</td>
<td>44.9±21.3 2</td>
</tr>
<tr>
<td>EXA</td>
<td>35.2±14.8 2</td>
<td>GB</td>
<td>44.9±21.3 2</td>
</tr>
<tr>
<td>GB</td>
<td>35.2±14.8 2</td>
<td>iB</td>
<td>44.9±21.3 2</td>
</tr>
<tr>
<td>XE</td>
<td>35.2±14.8 2</td>
<td>SB</td>
<td>35.2±14.8 2</td>
</tr>
<tr>
<td>SB</td>
<td>35.2±14.8 2</td>
<td>EXA</td>
<td>35.2±14.8 2</td>
</tr>
<tr>
<td>EXNA</td>
<td>35.2±14.8 2</td>
<td>GB</td>
<td>35.2±14.8 2</td>
</tr>
<tr>
<td>GB</td>
<td>35.2±14.8 2</td>
<td>iB</td>
<td>35.2±14.8 2</td>
</tr>
<tr>
<td>iB</td>
<td>35.2±14.8 2</td>
<td>XE</td>
<td>35.2±14.8 2</td>
</tr>
<tr>
<td>XE</td>
<td>35.2±14.8 2</td>
<td>SB</td>
<td>35.2±14.8 2</td>
</tr>
</tbody>
</table>

Conclusions: The control group resulted in statistically higher µTBS than the all-in-one adhesives tested. For the all-in-one adhesives, EXL683 (without agitation) on dentin and Clearfil S3 Bond on ground enamel resulted in the highest µTBS. Supported by 3M ESPE.

Microtensile Bond to Enamel and Dentin

Aim of the Study: This study compared microtensile bond values for several current and experimental adhesive systems with a total etch control.

Results of the Study: The total etch control group displayed the highest values in this study. Self etch bond strength values were very high, however.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.
Thirty Operator Bond Strength Evaluation of an Experimental Adhesive

Objectives: This study compared the shear bond strengths (SBS) of a new one bottle self-etch adhesive EXL-683 (3M ESPE) applied without agitation (EXP-1, standard protocol) and with agitation (EXP-2) to Clearfil™ S3 Bond (CS3, Kuraray) and Xeno® IV (X4, Dentsply) on bovine cut enamel (E) and superficial dentin (D).

Methods: A notched edge shear test method was used to measure the SBS to E and D 24 hours after curing the composite (Filtek™ Z250 A2, 3M ESPE) buttons. A panel of 30 dentists applied the adhesives per manufacturers’ instructions, and a group of four experienced operators applied the composite buttons.

Results: Mean (std dev) SBS in MPa are listed in the table below. Two-sample t-tests (p<0.05) were used to compare individual sample sets.

<table>
<thead>
<tr>
<th>Substrate</th>
<th>EXP-1</th>
<th>EXP-2</th>
<th>CS3</th>
<th>X4</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>27.5 (4.5)</td>
<td>25.8 (7.5)</td>
<td>27.8 (3.3)</td>
<td>23.2 (8.0)</td>
</tr>
<tr>
<td>n = 31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>34.6 (11.4)</td>
<td>33.2 (14.4)</td>
<td>26.3 (9.9)</td>
<td>18.5 (22.4)</td>
</tr>
<tr>
<td>n = 31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions: No statistical differences were observed between EXP-1 and EXP-2 on either E or D. X4 had a statistically lower SBS than EXP-1 (p = 0.013) and CS3 (p = 0.005) on E. EXP-1 and EXP-2 had statistically higher SBS than both CS3 (p = 0.004 and 0.035, respectively) and X4 (p = 0.001 and 0.003, respectively) on D.

Shear Bond to Enamel and Dentin

Aim of the Study: Operator variability is key to adhesive performance but is often difficult to quantify. This study took the approach of having 30 clinicians make bonding samples with several adhesives.

Results of the Study: When averaged, the experimental dental adhesive from 3M ESPE displayed the highest bond strength.
Bond Strength of 3 Self-Etching Adhesives - Effects of Two Variables

A. SHAH, J.O. BURGESS, and L.C. RAMP, UAB School of Dentistry, Birmingham, AL, USA

Objectives: To compare the effects of 2 variables (dryness and agitation) on shear bond strengths of 3 self-etching bonding agents. The hypothesis tested was that moisture and agitation have no effect on bond strength.

Methods: Occlusal surfaces of 240 extracted, intact, human molars were wet-ground with a series of SIC paper ending with 600 grit to obtain flat enamel & dentin surface. (n= 10). Adhesive application Xeno IV (Dentsply Caulk), Clearfil S3 Bond (Kuraray) and experimental (3M ESPE) was done following manufacturers’ directions except that agitation was applied to the adhesive or not and a film of water was applied to the bonding surface and left or air dried (5s). The adhesives were light-cured for 10s and Z100 composite (3M ESPE) was placed over the bonding surface and cured for 40s. After 24 hr distilled water storage at 37°C the specimens were loaded in shear in an Instron 5565 to failure with a 1 mm/min crosshead speed. Failure loads were converted to bond strength and analyzed by ANOVA and Tukey post hoc analysis.

Results:

<table>
<thead>
<tr>
<th>SHEAR BOND STRENGTH (MPa) – Mean±S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DRY GROUP</strong></td>
</tr>
<tr>
<td>AGITATION</td>
</tr>
<tr>
<td>Xeno IV</td>
</tr>
<tr>
<td>Clearfil S3</td>
</tr>
<tr>
<td>EXL683</td>
</tr>
<tr>
<td>NO AGITATION</td>
</tr>
<tr>
<td>Xeno IV</td>
</tr>
<tr>
<td>Clearfil S3</td>
</tr>
<tr>
<td>EXL683</td>
</tr>
<tr>
<td><strong>WET GROUP</strong></td>
</tr>
<tr>
<td>AGITATION</td>
</tr>
<tr>
<td>Xeno IV</td>
</tr>
<tr>
<td>Clearfil S3</td>
</tr>
<tr>
<td>EXL683</td>
</tr>
</tbody>
</table>

Conclusion: Agitation did not significantly improve dry enamel SBS but did so for wet dentin. XENO IV bonded dentin and EXL 683 bonded enamel showed appreciable increase in SBS with agitated application. Moisture improved enamel SBS for Clearfil S3 & EXL 683 and dentin SBS for XENO IV & Clearfil S3. Overall, Clearfil S3 showed superior values among all groups. XENO IV showed better adhesion to dentin than to enamel under both dry & wet conditions.

Aim of the Study: This study evaluated two adhesive application variables of clinical relevance; specifically whether or not the adhesive is applied with agitation (rubbing) and if the adhesive is applied to wet or dry dentition.

Results of the Study: No clear trends were observed for agitation or for wet/dry dentition, indicating a degree of technique tolerance in application.
Experimental One-Bottle System

FE-SEM Observation of the Resin-Dentin Interface by New Self-Etching Adhesives
T. MASEKI, M. HASEGAWA, M. HARA, T. SUZUKI, T. KIMISHIMA, and Y. NARA, Nippon Dental University, Tokyo, Japan

Objectives: The purpose of this study was to investigate the resin-dentin interface formed with new experimental self-etching adhesive systems by a FE-SEM as compared with all-in-one adhesive systems.

Methods: Labial surfaces of 32 human extracted lower incisors were sectioned flatly, and then exposed dentin surface was ground with a rotated steel fissure bur. The dentin surfaces were pretreated by two new experimental systems, two-bottle two-step self-etching primer system: EXL-678/671C (E2, 3M ESPE) and one-bottle one-step all-in-one system: EXL-683 (E1, 3M ESPE), and two commercial all-in-one systems, Adper Prompt L-Pop (AP, 3M ESPE) and Clearfil Tri-S Bond (TS, Kuraray Medical). Pretreated dentin specimens were sectioned vertically, and the sectioned surface including resin-dentin interface was polished a series of aluminum polishing powder. The polished dentin surface was treated with Ar-ion laser etching for 15 sec (Elionix EIS-200ER) and then observed by a FE-SEM (Hitachi S-4000). The thickness of hybrid layer formed at the interface was measured by a standard microscale calibrated FE-SEM. The data were analyzed using ANOVA and q-test.

Results: The thickness of the hybrid layer did vary with the systems. The mean values of the thickness (SD) of the hybrid layer in micrometer were E1; 0.49(0.11), TS; 0.58(0.19), E2; 0.69(0.09), AP; 1.76(0.43). The thickness of hybrid layer formed with AP was significantly greater than those formed with the other systems at p<0.01. The thickness of E1 was statistically smaller than E2 at p<0.05. The clear meshwork was observed at the resin-dentin interface of AP and E2 specimens. On the other hand, the high-density layer was observed at E1 specimens, and the high-density meshwork was observed at TS specimens.

Conclusion: It could be suggested that both the formation of hybrid layer and the appearance of meshwork at the resin-dentin interface did vary with adhesive properties, i.e., decalcification ability and permeability.
Chlorhexidine affects long-term microtensile bond strength for etch-and-rinse adhesives

L. BRESCHI1, F. CAMMELLI1, E. VISINTINI1, A. MAZZONI1, M. CARRILHO2, F. TAY3, D. PASHLEY3, and R. DI LENARDA1
1University of Trieste, Italy, 2University of Bologna, Italy, 3Medical College of Georgia, Augusta, USA

Objectives: MMPs have been recently claimed to activate autolytic processes that degrade the hybrid layers of bonded interfaces. Aim of this study was to investigate the effect of 0.2% chlorhexidine (CHX) used as additional primer on the long-term bond strengths of two etch-and-rinse adhesives.

Methods: Two adhesives were selected for the study: Scotchbond 1XT (SB, 3M) and XP-Bond (XP, Dentsply). Dentin specimens were etched with 35% phosphoric acid for 15 s, rinsed with water and then randomly and equally assigned to 4 treatment groups: (1) 0.2% CHX + SB; (2) SB; (3) 0.2% CHX + XP; (4) XP. In groups 1 and 3 CHX was applied onto the etched dentin surface for 1 min and gently air dried. After applying the bonding agent, Filtek Z-250 was used to create resin composite buildups. After 24 hours specimens were submitted to microtensile test. Beams were immediately pulled to failure at 1 mm/min or stored in artificial saliva for 270 days prior testing. Data were evaluated by three-way ANOVA (statistical significance was set at $a=0.05$).

Results: Both etch-and-rinse adhesives showed similar immediate bond strengths with or without CHX pre-treatment (SB=42.9±8.9 MPa; SB+0.2%CHX=43.7±8.9 MPa; XP=39.7±6.3 MPa; XP+0.2%CHX=38.2±7.1 MPa). However, after 270 days of water storage, the bond strengths of both untreated adhesives fell 59 and 61% respectively (SB=17.5±6.2 MPa; XP=15.4±5.2 MPa), while specimens pretreated with CHX fell 6-9% (SB+0.2%CHX=39.6±9.2 MPa; XP+0.2%CHX=35.9±8.9 MPa; p<0.05). Different superscript letters indicate statistical differences (p<0.05).

Conclusion: The use of a 0.2% of CHX as additional primer on etched dentin did not interfere with immediate bonding values for SB and XP. Long term bond strength was preserved in CHX-treated teeth in both SE and XP, but fell 60% in the controls suggesting that an endogenous factor inhibited by CHX, can lower bond strengths. Further in vivo trials should confirm the stability of the bond using CHX as additional primer.

Effect of Chlorhexidine on Long Term Bond Stability

Aim of the Study: The long-term bond of dental adhesives to dentin is a subject of debate, with several studies indicating degradation with time. This study was designed to evaluate the efficacy of chlorhexidine as a method to prevent bond degradation.

Results of the Study: Chlorhexidine applied to etched dentin prior to placement of the bonding agent proved very effective in increasing long-term bond stability.
Three Body in-Vitro Wear Test Method

A. KOBASHIGAWA, V. BUI, and E. SHELLARD, Kerr Corporation, Orange, CA, USA

Objectives: This study describes the development of a soft, three-body in-vitro wear test method that simulates oral wear by a mechanism similar to chewing.

Methods: Uses a slurry of PMMA beads, 50% in water, to simulate the food bolus and a Macor ceramic stylus, 1 cm dia., to simulate the opposing tooth. The stylus is aligned in a jig that allows periodical vertical motion, 0.3 Hz, and application of a 50 psi normal force onto the sample. Resin samples (3-5) were cured according to manuf. instr. into disks 50 mm dia. x 2 mm thick and stored 2 wks. in 37 ºC water. The samples were inserted into a chamber mounted normal to the stylus in a lathe that rotated at 2.6 Hz, for accelerated wear. The samples were tested in 10K cycles with fresh slurry for a total of 250K cycles; air dried and weighed to the nearest 0.0001 g. The mean vol. loss/cycle and s.d. were calculated and analyzed by Anova (p<0.05).

Results: The table compares the wear rates of first generation and current composites (superscripts indicate differences between the means). The wear rates of earlier composites were several orders of magnitude higher than current generation composites.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>Adaptic</th>
<th>Concise</th>
<th>Herculite</th>
<th>Filtek Supreme</th>
<th>Premise</th>
<th>Belleglass NG</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEAR RATE</td>
<td>290&lt;sup&gt;a&lt;/sup&gt;</td>
<td>140&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.7&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>(cc/cyc. x 10-9)</td>
<td>50</td>
<td>40</td>
<td>0.8</td>
<td>1.5</td>
<td>0.5</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Conclusions: The wear test method produced a range of wear rates with rankings similar to that observed clinically (research funded by Kerr Corp.)

Three Body Wear of Dental Composite Resins

Aim of the Study: This study was designed to evaluate the wear of composite resins in an in vitro setting.

Results of the Study: This study is of special interest because it includes composites of several generations. Clearly advances have been made in the reduction of wear.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

Color Stability of Filling Materials after Bleaching, Aging and Staining

Objective: The aim of this study was to determine the color stability of seven different tooth colored filling materials subject to artificial aging by thermocycling (TC), treatment with 10% carbamide peroxide (CP) and a severe staining challenge with Red Wine.

Methods: 12 specimens of each material (Filtek Supreme® (3M ESPE), Ecusite® (DMG), Filtek Z250® (3M ESPE), Herculite XRV® (Kerr), Durafill VS® (Heraeus Kulzer), Ketac Fil® (3M ESPE) and DyractXtra® (Dentsply) were identically fabricated and randomly assigned to five groups: group 1 control, group 2 no TC and no CP, group 3 no TC but CP, group 4 5000 TC and no CP, group 5 5000 TC and CP. Groups 2–5 underwent a wine-water-saliva cycle on seven consecutive days. Specimens were polished with Proxyt® (Vivadent) after the last discoloration cycle. Using CIE L*a*b* values, color readings were taken using a small-area colorimeter (ShadeEyeNCC®, Shofu) after final polishing, to differentiate between extrinsic and intrinsic stain. ∆L, ∆a, ∆b as well as ∆E values were calculated to determine the color change. Statistical evaluation (one-way ANOVA, unpaired t-test) was performed using SPSS version 12.0.

Results: Materials in group 1 showed the least change in color. Comparisons between group 2 and 3 (Filtek 4.04±1.5, 2.45±0.8; Ecusit 4.6±0.5, 2.8±1.1; Z250 5.1±1.2, 3.2±0.7; Herculite 3.2±1.1, 3.9±1.8; Durafill 5.5±1, 4.8±0.6) revealed significantly lower ∆E values for the bleached materials. Similar results were obtained between group 4 and 5. In these groups the average values of Ecusit, Z250, Herculite and Durafill were not affected by the CP, while the ∆E values for Filtek (5.6±0.8, 3.3±0.3), Dyract (5.9±1.1, 4.2±0.5) and Ketac (12.5±2.3, 19.4±2.1) differed significantly. TC significantly increased ∆E values for all materials. Groups with CP showed lower ∆E values.

Conclusion: Application of CP is able to reduce staining intensity of toothcolored resin based filling materials.

Aim of the Study: The aim of this study was to evaluate color stability of dental composite resins as a function of thermal cycling and staining, as well as the effect of carbamide peroxide bleach on the stained composites.

Results of the Study: Bleaching proved to reduce the staining effect of a dietary (red wine) challenge.
Objectives: Self etching adhesives are commonly used in restorative dentistry for bonding resin composite to Class V lesions. The aim of the study was to evaluate the clinical performance of adhesive Class V resin composite restorations utilized with two different self etching adhesives (Hybrid Bond/Sun Medical, Xeno III/ Dentsply) according to the Ryge/CDA-criteria.

Methods: In accordance to a split mouth study design, 50 patients (57.3 SD±13.5a) received two comparable Class V restorations. The cavities were randomly assigned to the two adhesives: Hybrid Bond lot GV2 and Xeno III lot 0310000129. To obtain comparability, Filtek Supreme was used as the only restorative material in both cases. VL-curing was conducted incrementally for 40 s each (independent of the restorative material). After two years, all of the restorations [100 %] were available for the follow up investigation.

Results: After two years the results [%] of the Ryge/CDA-evaluation for the two groups Hybrid Bond/Xeno III were: Marginal Adaptation: Alfa: 92/78, Bravo: 8/12, Charlie: 0/0, Delta: 0/10; Anatomic Form: Alfa: 92/82, Bravo: 8/8, Charlie 0/10; Secondary Caries: Alfa: 100/100, Bravo: 0/0; Marginal Discoloration: Alfa: 80/84, Bravo:20/12, Charlie: 0/0, not evaluable: 0/4; Surface: Romeo: 78/69, Sierra: 22/22, Tango: 0/0, Victor: 0/10; Color Match: Oscar: 39/47, Alfa: 51/45, Bravo: 10/4, Charlie: 0/0, not evaluable: 0/4; Toth Vitality: Alfa: 98/94, Bravo: 2/6; Postoperative Sensitivity: Alfa 1: 100/100, Alfa 2: 0/0, Bravo: 0/0, Charlie: 0/0, Delta: 0/0; Integrity of Tooth: Alfa 1: 96/96, Alfa 2: 4/4, Bravo: 0/0, Charlie: 0/0, Delta: 0/0. Five restorations where Xeno III was utilized were lost in part or in toto.

Conclusion: After two years, all Hybrid Bond restorations retained and showed clinically acceptable results, while 5 Xeno III restorations were lost in part or in toto. This study was supported by Sun Medical Co, Ltd., Japan.

Aim of the Study: While the aim of this study was to compare two dental adhesive systems, the use of Filtek Supreme as restorative also yields a glimpse into the performance of this universal composite system.

Results of the Study: The clinical parameters associated with Filtek Supreme, e.g. surface and color, continued to prove satisfactory at the 2 year recall.
Flexural Strength and Fractography of Microhybrid and Nanofilled Composites

S.A. RODRIGUES JUNIOR, Universidade Federal de Pelotas, Brazil, F.F. DEMARCO, Universidade Federal de Pelotas, Pelotas RS, Brazil, J.L. FERRACANE, Oregon Health & Science University, Portland, USA, and A. DELLA BONA, Universidade de Passo Fundo, Brazil

Objectives: The aim of the present study was to compare the flexural strength and the structural reliability of a microhybrid and a nanoparticulate composite by means of 3- (3P) and 4-point (4P) bending tests, and to microscopically identify the critical defects from the fracture surfaces.

Methods: Thirty specimens of Filtek Z250™ (3M/ESPE) and Filtek Supreme™ (3M/ESPE) were made for each test according to ISO 4049/2000 specifications. After 24h in distilled water at 37°C the specimens were submitted to 3- and 4-point bending tests using a universal testing machine DL2000 (EMIC) with a crosshead speed of 1 mm/min. Flexural strength data was calculated and submitted to student t-test (p<0.05) and Weibull statistics. The fractured surfaces were analyzed based on fractographic principles.

Results: The two composites had equivalent strength in both test methods. However, the test designs significantly affected the flexural strength of the microhybrid and the nanoparticulate composites. Weibull modulus (m) of Supreme was similar with both tests, while for Z250, a higher m was observed with the 3-point bending test. Fracture analysis showed critical defects most often associated with the specimen’s surface in all the groups. The critical flaws were similar in both materials and were characterized as surface scratches/grooves, non-uniform distribution of phases, inclusions and voids.

<table>
<thead>
<tr>
<th></th>
<th>Filtek Z250</th>
<th>Filtek Supreme</th>
</tr>
</thead>
<tbody>
<tr>
<td>3P</td>
<td>FS 154.0±13.6</td>
<td>FS 149.4±20.4</td>
</tr>
<tr>
<td>m</td>
<td>13.1</td>
<td>8.3</td>
</tr>
<tr>
<td>σ0</td>
<td>159.8</td>
<td>157.9</td>
</tr>
<tr>
<td>σ0r</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>4P</td>
<td>FS 140.7±19.9</td>
<td>FS 135.7±15.3</td>
</tr>
<tr>
<td>m</td>
<td>7.6</td>
<td>9.7</td>
</tr>
<tr>
<td>σ0</td>
<td>149.5</td>
<td>142.5</td>
</tr>
<tr>
<td>σ0r</td>
<td>0.99</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Conclusion: The 3-point bending test produced higher flexural strength in composites than the 4-point test. Despite the difference in average filler size of three orders of magnitude between the composites, the flexural strength and the fracture behavior were similar, probably due to similar overall filler levels and the presence of clusters in Supreme with similar average size as the individual particles in Z250.

Flexural Strength of Filtek Supreme and Filtek Z250 Universal Composites

Aim of the Study: This study was designed to compare different test methodologies for determination of flexural strength and also analyze fracture surfaces after the samples were broken. Microhybrid and a nanocomposite were evaluated.

Results of the Study: Microhybrid and nanocomposite displayed very similar flexural strengths.

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Variability of the deformation behaviour of nanoclusters of nanoparticles

P. MARQUIS, University of Birmingham, England, UK, G. PATEL, University of Birmingham, United Kingdom, and Z. ZHANG, University of Birmingham, School of Engineering

Objectives: The strength of the nanocomposite Filtek Supreme (3M ESPE) is comparable with conventional hybrid composites but the primary filler particles are highly porous clusters of individual silica and zirconia nano-particles, which would be expected to be significantly weaker than monolithic silica particles. The purpose of this study was to determine the deformation characteristics of individual nanoclusters in order to enhance understanding of the factors influencing the properties of nanocluster based dental composites.

Methods: Individual un-silanated nanoclusters between 3 and 5μ dia., supplied by 3M ESPE, were subjected to controlled deformation at 0.5 and 10 μ/min (10/set), using a micro manipulation technique (H. Mashmoushy et al, Biotechnology Techniques, V12, 12, 925, 1998). The monitored load deformation data was used to determine a pseudo elastic modulus for each nanocluster.

Results: During deformation the nanoclusters were found to progressively break down to smaller nanoclusters. The pseudo modulus (pE) of the primary nanocluster varied between 2.6 and 48 arbitrary units, although there was no significant impact of deformation rate. pE progressive increased as the nanoclusters broke into smaller clusters, with a maximum pE of 154 and was higher for the faster deformation rate.

Conclusion: There is a substantial variability in the elastic modulus of the nanoclusters studied which will lead to differential responses to applied stress and variation in mechanical properties, including the capacity to blunt or arrest cracks by nanocluster breakdown.

Aim of the Study: One of the key elements of Filtek Supreme is the inclusion of bonded clusters of nanometer sized fillers. These clusters have been termed nanoclusters. This study represents one of the first investigations into the physical properties of these nanoclusters.

Results of the Study: 3M ESPE designed the nanoclusters to break into smaller clusters during stress. This study confirmed this design objective, and concluded that this effect also served to blunt or arrest cracks during applied stress.
COLOR CHANGES of DIFFERENT TYPE COMPOSITE MATERIALS AGAINST CIGARETTE SMOKE

B. OZTURK1, S. AKMAN1, M. ULKER2, F. AYKENT2, and F. OZER2, 1Selcuk Universitesi, Faculty of Dentistry, Konya, Turkey, 2Selcuk Universitesi, Konya, Turkey

Objectives: The purpose of this study was to determine the color stability of 7 different composite materials against cigarette smoke.

Methods: Thirty five disc-shaped specimens (12 mm in diameter and 1.5 mm thick) were prepared by using PTFE mould with 7 different composite materials (TPH, Dentsply; Valux Plus, 3M ESPE; Clearfil ST, Kuraray; Filtek Supreme, 3M ESPE, Filtek Z250, 3M ESPE; Herculate XRV, Kerr; Tetric Ceram, Vivadent) according to the manufacturers’ instructions. Specimens were exposed to cigarette smoke in the periods of 10, 20, and 30 days. Color value (L*, a*, b*) of each specimen was measured with a colorimeter in the periods of 10, 20, and 30 days. Color changes (∆E) were calculated and data were analyzed with 2-way ANOVA and Tukey’s HSD test (α=.05).

Results: According to ANOVA, both of the composite materials, and time was showed statistically significant differences in color change (P = 0.0001). In terms of comparison among the seven restorative materials, the lowest DE value was observed in Valux Plus. The highest color difference was observed in Tetric ceram. Cigarette smoke increased discoloration of all composite groups up to 30 days.

Conclusion: All tested composite groups exhibited different color changes after exposure to the cigarette smoke. But, all composite materials showed unacceptable discolorations in all time periods.

Aim of the Study: While many studies are available on the effects of dietary challenge on composite discoloration, few are available on the effects of cigarette smoke. This study evaluated the effect of cigarette smoke on several current composites.

Results of the Study: All composites were discolored by exposure to cigarette smoke. Valux Plus displayed the least discoloration while Tetric Ceram displayed the highest.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.
Filtek™ Supreme and Z350 Flowable

Temperature rise during adhesive and composite-resin LED and QTH polymerization
A.P. SILVA1, L.A. CUNHA1, S.M. RODE2, and C. PAGANI1, 1Universidade Estadual Paulista, São Paulo, Brazil, 2Universidade Est. Paulista Julio Mesquita, Sao José dos Campos, Brazil

Objectives: Temperature rise of dental composites during the light-induced polymerization is considered to be a potential hazard for the pulp of the tooth. This study, therefore, evaluated the temperature rise in an adhesive system (Single Bond) and two different composite-resins (Filtek Z350 flow and Filtek Supreme), by the same manufacturer (3M Dental Products, St Paul, MN, USA) when polymerized by two different light sources: Light-emitting diode (LED: XL 3000, 3M Dental Products, St Paul, MN, USA) and Quartz-tungsten halogen (QTH: Biolux, Bioart, São Carlos, São Paulo, Brasil).

Methods: Class V cavities (2x2x2 mm) were prepared in 80 bovine incisors under standardized conditions. The dentin layer between the pulp chamber and the floor of the cavity was 1 mm thick. The groups were divided as following: G1: Control; G2: Single Bond (SB); G3: SB + Z-350 flow and G4: SB + Supreme. The groups were subdivided in 2 groups (A: polymerized with QTH and B: polymerized with LED). Light-curing took place for 40s and measurement of temperature changes during polymerization was performed with a T-type thermocouple positioned inside the pulp chamber. Data were statistically analyzed using ANOVA and Tukeyxs test.

Results: The factors material (p<0.00001) and curing unit (p<0.00001) had statistically significant influences on temperature rise. The lowest temperature increase (0.15°C) was recorded during adhesive polymerization with LED. The highest temperature increase was induced when using QTH unit directly over the untreated cavity (0.75°C, p<0.05). In all of the groups, lower pulp chamber temperature measurements were obtained when using LED as compared to QTH (p<0.05).

Conclusion: These results indicate that the QTH source caused greater increases in tooth temperatures than the LED source. However, in this study, no temperature rises exceed the critical 5.6°C value for pulpal damage.

Aim of the Study: Temperature rise of composite resins during polymerization is a parameter critical to pulpal health. This study measured the effect of curing methodology on both universal and flowable composite resins.

Results of the Study: LED curing resulted in less temperature rise than conventional quartz-halogen curing, but pulpal temperature increases were under 1 degree centigrade.
Filtek™ Supreme Plus

Polymerization Shrinkage and Hardness of New Low-Shrinkage Composites
A. PRESLAN, University of Michigan, Ann Arbor, USA, P. YAMAN, University of Michigan, Ann Arbor, and J.B. DENNISON, University of Michigan, Plymouth, USA

Objectives: To determine the percentage of polymerization shrinkage of three low-shrinkage composites compared to a standard composite (higher shrinkage) currently on the market during the setting reaction and to determine the depth of cure as a function of hardness of the composites twenty-four hours after polymerization.

Methods: Ten samples each of three different low-shrinkage composites (Premise by Kerr, Filtek Supreme Plus by 3M ESPE, and Tetric EvoCeram by Ivoclar) and one non-low-shrinkage composite (Esthet-X by Dentsply/Caulk) in dentin shade A2 were placed on a glass slide with an aluminum target on top of the composite and mounted in a vertical fashion. A sensor connected to the KµDATM linometer measurement system recorded polymerization shrinkage by a curing light over a 40-second period. For the hardness testing, ten samples of each composite were fabricated into uniform discs and allowed 24 hours to reach complete polymerization. Hardness measurements were made on the top and bottom of each disc with a 200-gram Tukon Tester diamond pyramidal indenter and filar units of the length of indentation were read under a 16 mm objective lens. Results were analyzed using two-way ANOVA and Tukey multiple comparison tests.

Results: The polymerization shrinkage values were: Premise-0.67%, Filtek Supreme Plus-1.09%, Tetric EvoCeram-1.12%, and Esthet-X-1.73%. The bottom-to-top hardness ratio was 0.77 for Premise, 0.57 for Filtek Supreme Plus, 0.68 for Tetric EvoCeram, and 0.53 for Esthet-X. There is a significant difference between the materials at p<0.05.

Conclusion: The standard composite exhibited significantly greater polymerization shrinkage than did the three low-shrinkage composites. All three low-shrinkage composites exhibited more favorable bottom-to-top hardness ratios than the standard composite. This project was funded by NIH Grant #DE007057.

Polymerization Shrinkage of Current Composite Resins

Aim of the Study: As dental composites continue to improve, polymerization shrinkage continues to decrease. This study measured the polymerization shrinkage of several current composites.

Results of the Study: Polymerization shrinkage of today’s composites is considerably lower than that of the previous generation of products.

**Filtek™ Supreme XT**

**Minimal exposure time of different LED curing devices**

A. Schattenberg, D. Lichtenberg, E. Stender, B. Willershausen, and C.-P. Ernst, Johannes Gutenberg-University, Mainz, Germany

**Objectives:** To investigate the shortest exposure time of different LED-curing devices for different resin composites in a clinically relevant in vitro-model, where a 7 mm distance from the light guide tip to the bottom side of the cavity was compiled.

**Methods:** Seven LED curing devices (Bluephase, Bluephase C8, Bluephase 16i/Ivoclar Vivadent, LEDemeton II/sds Kerr, Elipar FreeLight 2+3M ESPE, Smartlite PS/DENTSPLY, Translux Power Blue/Heraeus) were investigated to polymerize Tetric EvoCeram A3, Filtek Supreme XT A3B, Premise A3B, CeramX Mono M5, and QuiXfil. Stainless steel moulds (Ø=5 mm, h=6 mm, n=9) were filled in 3 increments of 2 mm thickness each and incrementally exposed with the light guide tip in a 7 mm distance from the bottom side to simulate a class II-curing situation. Surface hardness was measured (Zwick Z2.5/TS1S) 10 min post exposure at bottom surfaces of resin samples (n=6). A bottom/top-surface hardness ratio of 80% of a reference surface hardness cured in a zero-distance (40s) was defined as clinically acceptable for safe curing. A descriptive statistical analysis (Excel) was carried out.

**Results:** To ensure a ratio in surface hardness of at least 80% (test sample’s bottom surface hardness/ reference sample’s top surface hardness) the minimal exposure times [s] were:

<table>
<thead>
<tr>
<th>Resin Composite</th>
<th>Bluephase 16i</th>
<th>Bluephase C8</th>
<th>LEDemeton II</th>
<th>FreeLight 2+</th>
<th>Smartlite PS</th>
<th>Power Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>EvoCeram</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Supreme</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Premise</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>CeramX</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>QuiXfil</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

**Conclusion:** When incrementally exposed, all resin composites investigated, were polymerized sufficiently at a maximum of 20 s exposure time. The exposure time necessary to polymerize an increment sufficiently depended on the individual combination of curing device and resin composite. This study was supported by Ivoclar Vivadent, DENTSPLY and sds Kerr.

**Aim of the Study:** This study was designed to validate the curing of several current composite resins with a wide array of LED curing lights.

**Results of the Study:** LED curing of dental composites is well established. Using higher power units such as the FreeLight 2 can cure composites such as Filtek Supreme XT in a very time efficient manner.
Filtek™ Supreme XT

Color Stability of Nanocomposites Polished with One-Step Systems
Z. ERGÜÇÜ, L.S. TÜRKÜN, and A. ALADAG, Ege University School of Dentistry, Izmir, Turkey

Objectives: The aim of this study was to compare the color changes of five novel resin composites polished with two different one-step polishing systems when exposed to coffee solution.

Methods: Five resin composites containing nanoparticles were used in this study. The materials evaluated were Filtek Supreme XT (3M/ESPE, USA), Grandio (Voco, Germany), CeramX (Dentsply, Germany), Premise (KerrHawe, Switzerland) and Tetric EvoCeram (Ivoclar-Vivadent, Liechtenstein). A total of 100 discs (20/resin composites, 10x2mm) were fabricated. Five specimens/resin composite cured under Mylar strips served as a control. Samples were polished with PoGo and OptraPol discs for 30 sec at 15000 rpm with a slow speed handpiece. Five specimens for each material-polishing system combination were immersed in coffee (Nescafe, Nestle, Switzerland) for 7 days. Color measurements were made with Vita Easyshade (Vident, USA) at baseline; after 1 and 7 days. Comparisons of color differences (ΔE*) for materials and polishing systems were analyzed with ANOVA and Bonferroni tests (p=0.05).

Results: The differences between the mean ΔE* values for the resin composites polished with two different one-step systems were statistically significant (p<0.05). After 1 week, all materials exhibited significant color changes compared to baseline. Grandio showed the most intense staining while Tetric EvoCeram was stained the less. All Mylar-finished specimens showed the most intense staining. There were no significant differences between OptraPol and PoGo polished groups. Mylar-finished specimens of CeramX, Tetric EvoCeram, Premise and Filtek Supreme XT presented the greatest staining (p<0.05). For Grandio, there were no significant differences between Mylar and PoGo groups, while the most stain resistant surfaces were attained with OptraPol.

Conclusion: Removing the outermost resin layer by polishing procedures is essential to achieve a stain resistant and more esthetically stable surface. One-step polishing systems can be used successfully for polishing nanocomposites. The materials were donated by Voco, 3M/ESPE, Ivoclar-Vivadent, KerrHawe and Dentsply.

Aim of the Study: Surface finish and diet are known factors in staining composites. The aim of this study was to compare two polishing techniques and several universal composites with respect to staining after a coffee challenge.

Results of the Study: Removal of the outer layer of composite proved critical. All composite stained when exposed to coffee for a long (7 day) period.

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Aim of the Study: This important study follows the dimensional change of several types of restorative materials over a period of up to 7 years.

Results of the Study: While dimensional shifts have been measured in the literature, few studies are as comprehensive as this one. Filtek Z250 expanded by only 0.2% over the 7 year period.
Filtek™ Z250 and Filtek Z350™

**Flexural Strength and Hardness of Direct and Indirect Composites**

M. BORBA, Universidade De Passo, Cidade Passo Fund, Brazil, D. CECCHETTI, University of Passo Fundo, Brazil, and A. DELLA BONA, Universidade de Passo Fundo, Brazil

**Objectives:** Evaluate the flexural strength (σ) and hardness (H) of direct and indirect composites, testing the hypotheses that (1) indirect resin composites produce higher σ and H values than direct composites and that (2) these properties are positively related.

**Methods:** Ten bar-shaped specimens (25 mm x 2 mm x 2 mm) were fabricated for each direct (D250- Filtek Z250, 3M ESPE and D350- Filtek Z350, 3M ESPE) and indirect (ISin- Sinfony, 3M ESPE and IVM- Vita VM LC, Vita Zahnfabrik) systems, according to the manufacturer’s instructions and ISO4049 specifications. The σ was tested in three-point bending using a universal testing machine (EMIC DL 2000) at a crosshead speed of 0.5 mm/min (ISO4049). Knoop hardness (H) was measured on the specimens’ fragments (n=5) resultant from the σ test and calculated as $H = \frac{14.2P}{l^2}$, where P is the applied load (0.1 Kg; dwell time=15 s) and l is the longest diagonal of the diamond shaped indent (ASTM E384). Data were statistically analyzed using Anova and Tukey tests (α=0.05).

**Results:** The mean σ and standard deviation values (MPa) and statistical grouping were: D250-135.4±17.6(a); D350-123.7±11.1(b); ISin-98.4±6.4(c); IVM-73.1±4.9(d) and for H (Kgf/mm2) were: D250-98.1±2.8(a); D350-86.5±1.9(b); ISin-28.3±0.9(c); IVM-30.8±1.0(c).

**Conclusion:** The direct composite systems examined produced greater mean $\sigma$ and H values than the indirect composites, rejecting the first study hypothesis. However, the mean $\sigma$ and H values showed a positive relation for the direct composites, which partially confirmed the second study hypothesis. This study was partially supported by CNPq grant #135117.

**Flexural Strength of Direct and Indirect Composite Systems**

![Graph showing flexural strength of different composite systems](image)

**Aim of the Study:** Composite resins are used in both direct and indirect techniques. This study was designed to compare the flexural strength and other parameters of both direct and indirect composite systems.

**Results of the Study:** Filtek Z250 and Filtek Z350 displayed the highest flexural strength values in this study.

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**Results found in abstracts for Filtek™ Z250 also apply to products registered under the following name(s): Valux™ Plus.**

**Results found in abstracts for Filtek™ Z350 also apply to products registered under the following name(s): Filtek™ Supreme Plus Universal Restorative and Filtek™ Supreme XT Universal Restorative.**
New Low-Shrinkage Dimer Acid Based Microhybrid Composite Physical Properties
C. BRACHO-TROCONIS, S. RUDOLPH, A. GARNHART, and J. BOULDEN, Confi-Dental Products Co, Louisville, CO, USA

Objectives: A new “Low Shrinkage Microhybrid Composite (LSMHC)” was developed using a free radically polymerizable dimer acid based resin, designed at the University of Colorado, USA, which compensates for shrinkage by phase separation. The new dimer acid derived dimethacrylate readily copolymerizes with existing monomers to obtain dental composites using standard initiating systems. To determine the Physical Properties of the new LSMHC compared to commercially available products: Filtek Z100 (3M ESPE), Image® (Septodont Inc.) and Esthet-X (Caulk-Dentsply).

Methods: Compressive and flexural strength, flexural modulus, depth of cure, water sorption and solubility were determined according to the International Standard ISO 4049 and ADA specification 27. Diametral Tensile Strength (DTS) was measured using a similar test method as compressive strength. Monomer conversion was calculated by near-IR. The polymerization shrinkage was measured using a linometer. Shrinkage stress was measured with an ADAHF Tensometer. Specimens were polymerized using a visible light lamp with an intensity of 500 mW/cm², following the manufacturer instructions.

Results:

<table>
<thead>
<tr>
<th>Physical Criteria</th>
<th>LSMHC</th>
<th>Z100</th>
<th>Image®</th>
<th>Esthet-X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength, MPa</td>
<td>271±11</td>
<td>310±51</td>
<td>253±23</td>
<td>251±31</td>
</tr>
<tr>
<td>DTS, MPa</td>
<td>53±2</td>
<td>51±2</td>
<td>47±2</td>
<td>53±1</td>
</tr>
<tr>
<td>Flexural strength, MPa</td>
<td>114±6</td>
<td>160±26</td>
<td>113±11</td>
<td>102±8</td>
</tr>
<tr>
<td>Flexural modulus, MPa</td>
<td>6,520±577</td>
<td>12,882±2,375</td>
<td>6,870±1,386</td>
<td>7,725±1,795</td>
</tr>
<tr>
<td>Depth of cure, mm</td>
<td>2.30±0.02</td>
<td>2.70±0.03</td>
<td>2.50±0.04</td>
<td>1.97±0.02</td>
</tr>
<tr>
<td>C=C conversion, %</td>
<td>73.04±1.34</td>
<td>57.45±1.30</td>
<td>58.97±1.40</td>
<td>59.39±1.58</td>
</tr>
<tr>
<td>Polymerization Shrinkage, %</td>
<td>1.27±0.13</td>
<td>2.31±0.12</td>
<td>1.99±0.19</td>
<td>2.61±0.28</td>
</tr>
<tr>
<td>Shrinkage stress, MPa</td>
<td>1.65±0.07</td>
<td>2.37±0.12</td>
<td>1.97±0.06</td>
<td>2.26±0.07</td>
</tr>
<tr>
<td>Water sorption, mg/mm³</td>
<td>7.25±0.685</td>
<td>19.82±0.79</td>
<td>14.51±1.38</td>
<td>17.25±0.973</td>
</tr>
<tr>
<td>Water solubility, mg/mm³</td>
<td>0.61±0.08</td>
<td>0.24±0.07</td>
<td>0.91±0.625</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion: The Dimer Acid based monomer system contributes to lower volumetric shrinkage and reduced stress at the bonding interface with the tooth, maintaining the strength. The monomer conversion is also increased, leading to a decrease in the water uptake.

Aim of the Study: This study compared physical properties of several current universal composites with an experimental formulation.

Results of the Study: Z100 remains one of the strongest of the current hybrid composite resins.
Creep of solvent-aged silorane, Ormocer and dimethacrylate matrix composites
D.C. WATTS and H.Y. MARGHALANI, University of Manchester, United Kingdom

Objectives: The purpose was to study time-dependent viscoelastic deformation (creep and recovery) of new composite formulations with different matrix structures, under compressive load, after aging in food-simulating solvents of different solubility parameter. The hypotheses to be tested were that: (i) viscoelasticity would vary with solubility parameter and that (ii) materials with the newer matrix chemistries would be more dimensionally stable under load.

Methods: Four composite materials were studied, formulated with three different matrix structures. These were, respectively: silorane (Hermes, 3M ESPE); Ormocer (Experimental, Voco) and conventional dimethacrylate (Tetric-CeramHB, Ivoclar; X-trafil, Voco). Four groups of cylindrical specimens (4 x 6 mm) were prepared in molds, by complete light irradiation, and then aged in 3 solvents: methyl ethyl ketone (MEK), ethanol, and water for 1 month at 37˚C. The creep-strain under 35 MPa compressive stress in 37˚C water was recorded continuously for 2 h and then the unloaded recovery-strain for 2 h. The data were statistically analysed by ANOVA, Bonferroni’s test and by linear regression.

Results: The materials all exhibited classic creep and recovery curves. For all matrix structures, the principal creep parameters were significantly different (p = 0.001) for each solvent condition. All materials showed lower creep-strain in water than in ethanol or MEK solvents. Maximum creep-strain and permanent-set gave significant (p = 0.01) negative linear-regressions (r²>0.98) with logarithm of the solvent solubility-parameter. The percent mean (SD) creep-strain ranged from minima of 0.72 (0.01) for the silorane and 0.82 (0.01) for the Ormocer, both in water, to the maximum of 3.48 (0.30) for Tetric-CeramHB in MEK. Similar trends were found for permanent-set. The dimethacrylate-based composites X-trafil had similar stability to the Ormocer.

Conclusion: Two new-matrix composite types: silorane and Ormocer, exhibited viscoelastic stability in food-simulating solvents. But this behaviour was closely matched by one highly-filled dimethacrylate material.

Aim of the Study: Time-dependent viscoelastic deformation of composites with different matrix structures was compared after aging with food-simulating solvents.

Results of the Study: Filtek Silorane showed the least creep-strain and exhibited viscoelastic stability in food-simulating solvents.
Low shrinkage composite for dental application

N. ILIE, E. JELEN, and R. HICKEL, Ludwig-Maximilians-University Munich, Dental School, Germany

Objectives: The purpose of this study was to analyse the shrinkage behaviour of an innovative composite material for dental restoration based on a monomer with a new chemical formulation – Silorane.

Methods: The shrinkage behaviours of an experimental silorane based composite (Hermes, 3M ESPE, Seefeld, Germany, A3) was assessed by evaluating the shrinkage stress development during curing, the gel-point and the coefficient of near linear fit of contraction stress/time - after polymerizing the material with 10 curing regimes of two LED curing units (Table). The spectral distributions and irradiance of the tested curing units were determined by means of a calibrated fiber optic spectrally resolving radiometer equipped with an integrating sphere (S2000, Ocean Optics, USA).

Results: Shrinkage stress varied between 1.4 MPa after a 10s curing in a pulsed regime to 4.4 MPa after curing for 40 seconds with the high energy curing unit Bluephase. A Pearson correlation analysis showed that, for the tested curing units, the shrinkage stress correlates significantly with the energy density (0.89), curing unit irradiance (0.70), curing time (0.51), coefficient of near linear fit of contraction (0.70) and gel-point (- 0.60).

Conclusion: Silorane reveals low shrinkage stress values in comparison to regular methacrylate composites; nevertheless stress due to thermal contraction after the end of the light exposure is not negligible and can be additionally reduced by applying the appropriate curing strategy.
Filtek™ Silorane

Historical Evolution of Volumetric Polymerization Shrinkage of Restorative Composites

R. GUGGENBERGER, W. WEINMANN, O. KAPPLER, J. FUNDINGSLAND, and C. THALACKER, 3M ESPE AG, Seefeld, Germany

Objectives: The purpose of this study was to determine the polymerization shrinkage of filling composites of the last years to analyze the importance of this shrinkage to dentistry.

Methods: 22 restorative methacrylate composites and one experimental Silorane composite were tested according to the German Dental Standard DIN 13907:2005 (Archimedes method, n=6). All data were analyzed by One Way ANOVA/Fisher LSD test (p<0.05), means with the same letters are statistically the same.

Results:

<table>
<thead>
<tr>
<th>Material</th>
<th>Manufacturer</th>
<th>Shrinkage[%(Deviation)]</th>
<th>Year of Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herculite XRV</td>
<td>Kerr</td>
<td>2.78(0.10)ef</td>
<td>1993</td>
</tr>
<tr>
<td>Tetric Ceram</td>
<td>Ivoclar-Vivadent</td>
<td>2.98(0.08)fg</td>
<td>1996</td>
</tr>
<tr>
<td>Spectrum TPH</td>
<td>Dentsply</td>
<td>3.49(0.47)h</td>
<td>1996</td>
</tr>
<tr>
<td>Solitaire</td>
<td>Heraeus-Kulzer</td>
<td>3.71(0.09)h</td>
<td>1997</td>
</tr>
<tr>
<td>SureFil</td>
<td>Dentsply</td>
<td>2.36(0.05)bcde</td>
<td>1998</td>
</tr>
<tr>
<td>Definite</td>
<td>Degussa/Dentsply</td>
<td>2.45(0.19)cde</td>
<td>1998</td>
</tr>
<tr>
<td>Alert</td>
<td>Jeneric Pentron</td>
<td>2.48(0.16)cde</td>
<td>1998</td>
</tr>
<tr>
<td>Prodigy Condensible</td>
<td>Kerr</td>
<td>2.54(0.15)de</td>
<td>1998</td>
</tr>
<tr>
<td>P60</td>
<td>3M ESPE</td>
<td>2.13(0.13)abcd</td>
<td>1999</td>
</tr>
<tr>
<td>Z250</td>
<td>3M ESPE</td>
<td>2.14(0.04)abcd</td>
<td>1999</td>
</tr>
<tr>
<td>In-TenS</td>
<td>Ivoclar-Vivadent</td>
<td>2.14(0.02)abcd</td>
<td>2001</td>
</tr>
<tr>
<td>Aelite LS</td>
<td>Bisco</td>
<td>2.29(0.23)bcde</td>
<td>2002</td>
</tr>
<tr>
<td>Filtek Supreme</td>
<td>3M ESPE</td>
<td>2.32(0.03)bcde</td>
<td>2002</td>
</tr>
<tr>
<td>Venus</td>
<td>Heraeus-Kulzer</td>
<td>3.05(0.06)fg</td>
<td>2002</td>
</tr>
<tr>
<td>EstheDX</td>
<td>Dentsply</td>
<td>3.37(0.26)gh</td>
<td>2002</td>
</tr>
<tr>
<td>Grandio</td>
<td>VOCO</td>
<td>2.10(0.23)abc</td>
<td>2003</td>
</tr>
<tr>
<td>Quixfil</td>
<td>Dentsply</td>
<td>2.12(0.13)abcd</td>
<td>2003</td>
</tr>
<tr>
<td>ELS (Extra Low Shrinkage)</td>
<td>Saremco</td>
<td>2.39(0.32)bcde</td>
<td>2003</td>
</tr>
<tr>
<td>Solitaire 2</td>
<td>Heraeus-Kulzer</td>
<td>3.64(0.05)h</td>
<td>2003</td>
</tr>
<tr>
<td>Premiere</td>
<td>Karr</td>
<td>1.80(0.22)a</td>
<td>2004</td>
</tr>
<tr>
<td>TPH3</td>
<td>Karr</td>
<td>3.48(0.32)h</td>
<td>2004</td>
</tr>
<tr>
<td>Tetric EvoCeram</td>
<td>Ivoclar-Vivadent</td>
<td>2.03(0.02)ab</td>
<td>2005</td>
</tr>
<tr>
<td>Silorane</td>
<td>3M ESPE</td>
<td>0.99(0.07)</td>
<td>future</td>
</tr>
</tbody>
</table>

Conclusion: The development over the last decade reveals that the manufacturers are working on low shrink composites. However, only a slight decrease was achieved (average decrease 0.05%/year), because the chemical basis for all available composites remained unchanged with methacrylates. In contrast to that the Siloranes as a ring opening polymerization monomer enables significant shrinkage reduction.

Aim of the Study: The evolution of shrinkage in composites introduced over the last 12 years was evaluated.

Results of the Study: Only a slight decrease in shrinkage was achieved in methacrylate composites over the last 12 years whereas the ring opening polymerization of Filtek Silorane yields a significant shrinkage reduction.
Filtek™ Silorane

Shrinkage stress of new experimental low shrinkage resin composites
A. SCHATTENBERG, G.R. MEYER, B. WILLERSHAUSEN, and C.-P. ERNST, Johannes Gutenberg University, Mainz, Germany

Objective: Low shrinkage resin composites are in the focus of research in posterior resin composite restoratives. The aim of this study was to examine the polymerization shrinkage stress of experimental low shrinkage resin composites (K0152/Dentsply, NEUN/Heraeus, Hermes/3M ESPE) in comparison to new and established low shrinkage resin composites (Tetric EvoCeram/Ivoclar Vivadent, QuiXfil/DENTSPLY, Xtrafil/VOCO).

Method: Cylindrical cavities (Ø 5 mm) in Araldit B epoxide resin plates (40x40x3 mm) were pretreated with the Rocatec system to ensure a bonding of the resin composites. The resin composite specimens (n=10) were exposed for 60s with a QTH curing device (Translux Energy, Heraeus Kulzer, Germany). The samples were stored dark and dry (23°C). Polymerization shrinkage stress data [MPa] 5 min and 24 h post exposure were calculated based on the diameter of the isochromatic curves of first order, obtained from the Araldit-plates. Statistical analysis was carried out with the Wilcoxon-test (p = 0.002, Bonferroni adjustment).

Results: After 24h the following mean stress values were obtained: 3.7 ± 0.08 MPa for Tetric EvoCeram, 4.7 ± 0.2 MPa for QuiXfil, 4.6 ± 0.1 MPa for Xtrafil, 3.8 ± 0.1 MPa for K0152, 3.7 ± 0.05 MPa for NEUN and 2.9 ± 0.3 MPa for Hermes. After 24 h, due to post-exposure shrinkage, significantly higher polymerization stress values (p<0.001) were recorded for all materials, except for Hermes. After 24 h, significant differences (p<0.001, Bonferroni correction) were found between Hermes and all other composites while K0152 and NEUN showed significantly less shrinkage stress compared to QuiXfil and Xtrafil.

Conclusion: New low shrinkage resin composite formulations are able to show a significantly reduced shrinkage stress compared to most of the conventional resin composites investigated. After 24 h, the experimental silorane restorative Hermes showed the lowest polymerization shrinkage stress. This study was supported by DENTSPLY/Konstanz and Heraeus/Hanau.

Aim of the Study: Polymerization shrinkage builds up forces challenging the composite/adhesive interface and deforming the tooth. The resulting shrinkage stress of Filtek Silorane and further marketed and experimental materials was investigated.

Results of the Study: Filtek Silorane (Hermes) showed the lowest shrinkage stress of all material tested. Only Filtek Silorane did not develop additional shrinkage stress due to post-irradiation shrinkage.

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In contrast to BISGMA/TEGDMA resins, silorane-based resins have significantly less polymerization stress without proportional reduction in mechanical properties. Since biocompatibility, cytotoxicity, and genotoxicity are also superior, siloranes are currently being used as matrix resins for dental composites.

**Objectives:** The objective of this investigation was to compare the effect of silorane-based resins and BISGMA/TEGDMA on parameters of bone formation to determine if siloranes could be used as a bone cement. A new material is needed since current bone cements containing methacrylates are toxic, heat generating, and can induce anaphylactic shock.

**Methods:** The silorane-based resin, Sil-Mix (3M ESPE), was a 1/1 w/w mixture of a phenylmethyl diethylcyclohexyloxiranylsilane and a tetraethylcyclohexyloxiranyl cyclotetrasiloxane and cationic initiator system. Standard BISGMA/TEGDMA resin (B/T) was used. Osteoblast proliferation, differentiation, matrix formation, and mineralization was assessed using an *in vitro* culture model, the MLO-A5 bone cell line. Cells were plated on plastic in contact with polymerized resin. Proliferation, alkaline phosphatase activity, extracellular matrix collagen and mineralization was assessed using immunostaining, enzyme activity, von Kossa and alizarin red staining and scanning electron microscopy (SEM).

**Results:** MLO-A5 cells grown in the presence of Sil-Mix maintained their ability to proliferate and to produce matrix similar to controls. Alkaline phosphatase was comparable to control and collagen fibril formation in extracellular matrix was normal. Surprisingly, assessment of mineralization by von Kossa, alizarin red staining, and by SEM showed that MLO-A5 cells in contact with Sil-Mix produced more mineral than control cells at both 6 and 10 days of culture. The BISGMA/TEGDMA resin did not sustain mineralization due to toxicity.

**Conclusion:** The silorane-based resin system demonstrated its potential use as a bone cement due to its non-toxic effect on bone cells, no effect on proliferation or differentiation, and potentially the capacity to enhance mineralization. Study supported by NIH/NIDCR grants PPG DE09696 and T32 DE07294.
Aim of the Study: “Ring-opening” Silorane chemistry has been the most promising approach to tackle the shrinkage-related problems in posterior restorations. In this study the clinical performance of Filtek Silorane (Hermes) in combination with an experimental Silorane System Adhesive was evaluated.

Results of the Study: All Filtek Silorane fillings in combination with an experimental Silorane System Adhesive (Hermes Bond) performed clinically after 12 months with excellent and acceptable scores in all modified Ryge criteria.

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**Filtek™ Silorane**

**Film Thickness of Adhesives for Silorane and Methacrylate Restorative Composites**


**Objectives:** The goal of this study was to compare the film thickness of the filled two-step self-etch adhesive for a cationic curing Silorane based filling material with a polymerization shrinkage of <1% to that obtained with filled adhesives for conventional methacrylate composites.

**Methods:** On the exposed dentin surface of bovine incisors, the adhesives were applied according to the respective instructions for use. Air-thinning was done using a stream of 10 l/min exiting from an orifice of 1.4 mm diameter at a distance of 5 cm. After application of a 2 mm increment of composite (Silorane-Bond/Silorane, SIL-B/SIL, 3M ESPE; Clearfil SE Bond/Clearfil APX, CSE/APX, Kuraray; Optibond FL/Premise, OFL/PRE, Kerr), the teeth were cross-sectioned and the adhesive film thickness was measured at randomly selected places using optical microscopy (n=25/group).

**Results:** The following table shows the film thickness in microns. The standard deviations are given in parentheses. All data were analyzed by ANOVA and multiple comparisons using Fisher’s LSD procedure (p<0.05). Means with the same letters are statistically the same.

<table>
<thead>
<tr>
<th>Material</th>
<th>SIL-B/SIL</th>
<th>CSE/APX</th>
<th>OFL/PRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film Thickness</td>
<td>27.0 (13.7)a</td>
<td>28.0 (14.8)a</td>
<td>43.0 (20.7)b</td>
</tr>
</tbody>
</table>

**Conclusion:** Silorane Bond showed a comparable film thickness to Clearfil SE Bond and a significantly lower film thickness than Optibond FL. The filled adhesives investigated in this study provided relatively homogeneous films.

**Film Thickness of Silorane System Adhesive and Marketed Materials**

![Film Thickness Graph](image)

**Aim of the Study:** Fillers are added to adhesives in order to improve bond strength and mechanical properties. On the other hand, fillers might compromise film thickness. Therefore, the film thickness of the new experimental two-step self-etching Silorane System Adhesive (SIL-B) was compared to filled adhesives with a clinical history of several years.

**Results of the Study:** The new Silorane System Adhesive had a relatively homogeneous film with a thickness in the range of widely used adhesives.
Filtek™ Silorane

Reducing the depth of oxygen inhibition in resin-based composites
S. MOHAMMED¹, W.M. PALIN², and A.C. SHORTALL¹, ¹University of Birmingham, United Kingdom, ²University of Birmingham, School of Dentistry, United Kingdom

Objectives: To investigate the effect of monomer chemistry and filler content on oxygen diffusion and curing extent near to the irradiated surface of resin-based composites (RBCs).

Methods: 4 x 4 mm disc specimens of two commercial RBCs, Tetric Ceram (TC) and Tetric Flow (TF) (Ivoclar-Vivadaent, Liechtenstein) and an experimental RBC, Silorane (SIL) (3M ESPE, Germany) were prepared with either no mylar (NM), mylar (M) or glycerin (G) at the upper surface (n=3). Specimens were cured for 20s with an LED curing-unit (1147±23mW/cm²) at 1mm distance from the upper surface. Following dark storage for 24h at 23±1°C, each specimen was laterally mounted in die stone and allowed to set for 1h. Mounted specimens were ground and polished to the mid-saggital plane. The hardness of each specimen was measured from the upper (cured) surface at 5µm intervals to a depth of 50µm using a Vickers indenter (1.96N for 20s). For each specimen the average of 3 indents (which deviated<1 mm from the midline) was established for each depth. Data was analysed by ANOVA and post-hoc Tukey tests (P<0.05).

Results: Significant differences were established for each material type (TC>SIL>TF) at each depth (P<0.05). At 5, 10, 15 and 20µm, the hardness of TC cured with NM<M<G (P<0.05), whereas at 5, 10 and 15µm TF displayed no significant differences in hardness between any surface preparation type (P=0.339, 0.636, 0.059, respectively). At 5µm, the hardness of SIL cured with NM>M=G (P=0.007; P>0.05) and at subsequent depths from 10-20µm, NM=M=G (P>0.05). From 25-50µm depth, two-way ANOVA revealed no significant differences in hardness between NM, M or G for any material type (P>0.05).

Conclusion: SIL resin chemistry may eliminate oxygen inhibition near the cured surface. The depth of inhibition is complicated by filler content which may act as a diffusion barrier or adsorb oxygen onto the filler surface.

Aim of the Study: Oxygen inhibition layers of methacrylate composites and Filtek Silorane was determined.

Results of the Study: The data suggest that the Filtek Silorane resin may eliminate oxygen inhibition.

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Filtek™ Silorane

Degree of Conversion and Shrinkage Stress of Silorane Composite

H.M. EL-DAMANHOURY, Indiana University, Suez Canal University - Egypt, Indianapolis, USA, B.K. MOORE, Indiana University, Indianapolis, USA, A.N. HABIB, University of Cairo, Egypt, M.A. AL-HASSAN, Cairo University, Egypt, and N.M. ABOUL-ENEIN, Suez Canal University, Ismailia, Egypt

Silorane-Based composite were introduced as a restorative material with lower polymerization shrinkage stress.

Objectives: To evaluate the effect of utilizing two different light sources on the degree of conversion (DC) and the polymerization shrinkage stress of the silorane-based composite Filtek Silorane (SIL), and compare them to those of two low shrinkage composites; Prisme (PR) and Aelite LS (AL), using Filtek Z250 (Z) as a comparative control.

Methods: The DC measurement was conducted using FTIR in mid-range with a single-reflection ATR accessory and the shrinkage stress tests were conducted using a stress measurement device based on the cantilever beam deflection (Tensometer). Measurements were done after curing with either a QTH Unit, at 600 mW/cm² for 40 Sec, or a LED Unit, at 1400 mW/cm² for 20 Sec. Data were analyzed by two-way ANOVA followed by a Tukey multiple comparisons test (α=0.05).

Results: The following table shows mean degree of conversion (%), and shrinkage stress (MPa). Standard deviations are given in parentheses:

<table>
<thead>
<tr>
<th>Curing Method</th>
<th>Material</th>
<th>Degree of Conversion (%)</th>
<th>Shrinkage stress (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QTH</td>
<td>SIL</td>
<td>65.62 (1.8)</td>
<td>0.87 (0.1)</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>65.22 (1.6)</td>
<td>1.97 (0.1)</td>
</tr>
<tr>
<td></td>
<td>AL</td>
<td>67.02 (4.2)</td>
<td>1.97 (0.2)</td>
</tr>
<tr>
<td></td>
<td>Z</td>
<td>65.55 (3.2)</td>
<td>2.13 (0.1)</td>
</tr>
<tr>
<td>LED</td>
<td>SIL</td>
<td>68.78 (4.8)</td>
<td>1.14 (0.1)</td>
</tr>
<tr>
<td></td>
<td>PR</td>
<td>68.91 (2.9)</td>
<td>2.16 (0.1)</td>
</tr>
<tr>
<td></td>
<td>AL</td>
<td>59.22 (1.8)</td>
<td>2.07 (0.1)</td>
</tr>
<tr>
<td></td>
<td>Z</td>
<td>63.37 (6.4)</td>
<td>2.26 (0.2)</td>
</tr>
</tbody>
</table>

Conclusion: Silorane-based Composites showed significantly lower shrinkage stresses than any of the other tested materials, while the degree of conversion was not significantly different for all tested materials with either LED or QTH, except for AL which showed lower DC with LED. LED induced significantly higher polymerization stresses for all materials tested.

Aim of the Study: Shrinkage stress and conversion of resin monomers into polymers was tested for Filtek Silorane and methacrylate-based composites using two different curing systems.

Results of the Study: Compared to methacrylates, Filtek Silorane developed only about half the shrinkage stress with both QTH and LED curing systems while the degree of conversion was not different.
Ketac™ Molar

The clinical performance of GIC following 2% chlorhexidine treatment
A. AYKUT, N.K. ERSIN, U. CANDAN, C. ERONAT, and O. ONCAG, Ege Universitesi, Izmir, Turkey

Objectives: The purpose of this study was to investigate the effect of a chlorhexidine-gluconate-based cavity disinfectant on the clinical performance of high viscosity glass ionomer cement following the ART approach under field conditions during the 24 month evaluation period.

Methods: A total of 126 school children aged between 6–8 years old who had bilateral matched pairs of carious class I and II primary molars were included. A split mouth design was used in which Ketac Molar was randomly placed with or without the use of chlorhexidine-gluconate-based cavity disinfectant on controlateral sides by three dentists. The restorations were evaluated after 6, 12 and 24 months by two experienced examiners using USPHS-Ryge criteria.

Results: The 24 month mean cumulative survival rates of Ketac Molar without the use of disinfectant were 97.7% and 69.4% while in the disinfectant group, the survival rates were 95.2% and 63.9% in class I and II restorations, respectively with no significant difference between the groups in both class types. In the nondisinfected group, large class II cavities had significantly better survival rates than did small class II cavities (p=0.023). In the disinfected group, the failure rates in mean cumulative survivals from 6 to 12 months and 12 to 24 months were significantly increased with time (p=0.004 and p=0.016 respectively).

Conclusion: The application of 2% chlorhexidine-gluconate-based cavity disinfectant did not significantly influence the retentive properties of Ketac Molar adversely during 24 months, but no additional benefit of the disinfectant could be demonstrated.

Aim of the Study: In this study caries was treated according to the ART approach with an additional chlorhexidine cavity treatment in the study group. All teeth were restored with Ketac Molar.

Results of the Study: Ketac Molar was successfully used in combination with the ART technique. Chlorhexidin treatment did not increase filling retention.
Preventive Effect of Two Glass-ionomer Cements vs. Two Composite Materials

D. NEGHOVETIC-VRANIC, K. SKRINJARIC, D. GLAVINA, and I. SKRINJARIC, School of Dental Medicine, University of Zagreb, Croatia

Objectives: The aim of this study was to evaluate preventive efficacy of four materials and their ability to release fluoride. The study evaluated degree of demineralisation on hard dental tissues (enamel and cement) of two glass-ionomer cements and two composite materials.

Methods: Standardized 40 class V cavities were prepared on buccal and lingual surface of 20 extracted caries free premolars with one half in enamel and one half in cement. Ten cavities of each group were restored with glass ionomer cements Fuji IX (GC), Ketac Molar (3M ESPE), composite materials Esthet-x (Dentsply) and Filtek Z 250 (3M) according to manufacturer’s instructions. Teeth were thermocycled for 1800 cycles between 5–55°C with dwelling time of 10 s. After thermocycling teeth were immersed in demineralising solution (pH 4.95) for 4 weeks. After 4 weeks teeth were rinsed, enrobed in epoxy resin (Citofix Kit, Struers) and sectioned in 2–3 sections that were evaluated under polarized microscope (100x magnification) (Opton) and photographed (Camedia, Olympus). Demineralization of enamel and cement in contact with materials was measured applying Olympus DP soft, Version 3.2. Statistical analysis was performed using one factor ANOVA and Tukey HSD test.

Results: Lowest level of demineralization on enamel tissue showed Ketac Molar (707). On the cement lower level of demineralization showed Ketac Molar (734) than Esthet-x (1052) and Filtek Z 250 (893). Lower demineralization of enamel was observed considering all tested materials. There was no significant difference between tested materials.

Conclusion: Hard dental tissues show lowest level of demineralisation in contact with Ketac Molar restorations. Results show that good marginal adaptation is equally important as preventive properties of the material. Further laboratory evaluations are required to obtain more reliable results.
Clinical evaluation of two minimal interventional restorative approaches: 5-year follow-up

T.J.E. BARATA,1 E. BRESCIANI,1 T.C. FAGUNDES1, M.C.R. MATTOS1, J.R.P. LAURIS1, D. ERICSON2, and M.F.L. NAVARRO1, 1University of São Paulo, Bauru School of Dentistry, Brazil, 2Malmö University, Sweden

Objective: To compare the performance of two minimally invasive restorative treatment approaches for managing dental caries.

Methods: A total of 50 pregnant women (second trimester of pregnancy), mean age 22±5.30 years, were treated by two previously trained operators. The treatment approaches tested were: chemo-mechanical (Carisolv-MediTeam, Sweden) and mechanical (Atraumatic Restorative Treatment -ART) methods. A parallel-group study design was used in which the two treatments were randomly placed in 50 matched pairs of permanent teeth. The treatments were performed in Public Health Centers located in suburban areas of Bauru city in Brazil. The restorative material used was high strength glass ionomer cement (Ketac Molar, 3M ESPE). The restorations were evaluated by 2 calibrated independent double-blind examiners according to ART criteria. The inter examiner kappa was 0.93. The data were analyzed using 95% confidence interval on the binomial distribution and Fisher Exact test. A difference was statistically significant if p<0.05.

Results: In a 5-year follow-up, 34% of the restorations were evaluated. In the chemo-mechanical group 53% (CI=27-77%) of the restorations were considered as successful and in the mechanical group 60% (CI=33-83%). There was no statistically significant difference between the 5-year success rate for both groups (p=0.73).

Conclusion: The two minimal interventional restorative approaches showed similar clinical performance after 5 years.

Aim of the Study: This clinical study investigated minimal invasive caries removal in combination with Ketac Molar as the restorative material.

Results of the Study: Ketac Molar performed with both caries removal techniques.
Twelve months evaluation of Atraumatic Restorative Treatment (ART)


Objective: To compare clinical performance of two ionomeric conventional cements (ICC), Ketac Molar (K) and Fuji IX (F), used in ART technique.

Method: 79 schoolchildren aged from 6 to 9 years were selected in Piracicaba (Brazil) to participate in a split-mouth design experiment. They presented high caries activity on primary teeth and at least 2 permanent first molars erupted in opposite hemi arches. Infected dentin was handled removed from primary molars and affected dentin was maintained. 141 class I and II restorations were accomplished in primary molar teeth; 98 first permanent molars were sealed with F and 99 with K in a split mouth design randomly assigned in the same child. Relative isolation and press-finger technique was used. The follow-up was made at baseline, 3, 6, 12 month, and for the sealants, caries lesion absence was considered successful. Wilcoxon, Mann-Whitney and Log-Rank Tests (p<0.05) were used for statistical analysis.

Results: For class I, there was no statistical difference concerning F restorations among examinations, but for K restorations there was a significantly statistically decreasing among the evaluations. Regarding class II there was initial success decrease for both materials, which was maintained for K, while F decreased in the first 6 months. No statistical difference was found between both materials, in the same period, for restorations and the success index (survival) was similar. For the sealants, at 3-month, both materials showed statistically significant decline of the success ratio compared to baseline, remaining until the end of the experiment for F. There was no statistically significant difference between materials regarding success in the evaluation period, neither regarding the sealant’s survival (success).

Conclusion: Both materials showed high and similar survival (success) rates after 12 months. F and K can be used for occlusal sealing and restorative treatment using press-finger technique.

Aim of the Study: In this study the performance of two glass ionomers in combination with ART technique was evaluated.

Results of the Study: Ketac Molar is suitable to be used in combination with the ART technique.
Ketac™ Molar

Sonication of highly-viscous glass-ionomer: effect on interface with dentin
K.E. MIETTUNEN, E. BRESCIANI², J.A. BARROS¹, F. GU¹, and M.C. PETERS¹, ¹University of Michigan, School of Dentistry, Ann Arbor, USA, ²U of Michigan/CRSE – U of Sao Paulo, Faculdade Odontologia Bauru, Bauru, Brazil

Sonication has shown to improve mechanical characteristics of highly-viscous glass-ionomers (HV-GIC) but the effect on the interface with dentin is not yet known.

Objective: We investigated the effect of ultrasonic accelerated setting of HV-GIC restorations on the microtensile bond strength (MTBS) of HV-GIC to dentin.

Method: After cuspal reduction and occlusal preparation, 45 extracted 3rd molars were randomly distributed over three groups (N=15) and restored, according to manufacturers’ instructions, with either (A) Ketac Molar Aplicap (3M/ESPE), (B) Fuji IX GP (GC Corp), or (C) Ketac Molar EasyMix (3M/ESPE). Application of direct (DU), indirect (IU), or no ultrasound (NU) was randomly assigned to each subgroup (N=5) as part of the restorative insertion process. After setting, the restoration build-ups were covered with vaseline and the teeth were stored in 100% humidity at 4°C for seven days. MTBS specimens were prepared and tested to compare the strength of HV-GIC in the interfacial region with dentin in all subgroups. Fracture mode was recorded.

Results: The data showed a statistical difference (p<0.0001) between treatment groups: mean MTBS for DU=3.82 MPa, IU=6.47 MPa, and NU=5.12 MPa. No statistical difference was found between the three materials tested (p=0.8495).

Conclusion: Indirect sonication of HV-GIC restorations resulted in a 26% increase in strength in the interfacial region. Supported in part by NIDCR/NIH DE007057; complimentary materials provided by GC Corp and 3M/ESPE.

Aim of the Study: The study was designed to evaluate the influence of sonication on setting behavior of glass ionomers.

Results of the Study: Sonication increased bond strength in Ketac Molar Aplicap and Ketac Molar EasyMix.
Fluoride Uptake from Refluoridated Glass-Ionomer-Cement in and on Enamel

S. EFFENBERGER1, J.-H. PHARK2, J. JENSEN1, I. KOHRMEYER1, and U. SCHIFFNER1, 1University of Hamburg, Dental School, Germany, 2Case Western Reserve University, School of Dental Medicine, Cleveland, OH, USA

Objective: Fluoride release from glass-ionomer-cement (GIC) is one reason to choose these materials for tooth restoration. The “rechargement” of GIC by topical fluoride applications is stated to enhance the GIC fluoride releasing effect. Aim of this study was to compare the fluoride uptake by deciduous and permanent enamel with or without fluoridation of adjacent GIC samples.

Methods: From 20 exfoliated deciduous molars and 24 surgically removed third molars each two enamel samples were cut. One sample served as control to examine the fluoride uptake, the other one was fixed next to a standardized GIC sample (Ketac fil™, 3M ESPE) into a vessel with 2.5 ml regularly changed artificial saliva. On each sample pellicle with human whole saliva was formed. Test specimens were divided into two groups. The specimens of group A were not fluoridated, while the GIC-samples of group B received a sodium fluoride solution twice daily for 3 min, with 100 ppm fluoride for deciduous and 200 ppm fluoride for permanent enamel. After 28 days, loosely bound and structurally incorporated fluoride were determined and statistically compared between control and test enamel samples (Wilcoxon-Test).

Results: In deciduous teeth, loosely bound fluoride was increased from 0.29 ± 0.09 to 0.42 ± 0.17 µg/cm² in group A, and from 0.21 ± 0.08 to 0.44 ± 0.27 µg/cm² in group B, the latter uptake being significant. The gain of structurally bound fluoride was from 1145 ± 450 to 1629 ± 382 ppm (group A) and from 869 ± 291 to 1444 ± 616 ppm (group B), p<0.05 for both groups. In permanent teeth, only the increase of structurally bound fluoride in group B was significant.

Conclusion: The study shows that regular refluoridation of GIC may contribute to an accumulation of fluoride in and on enamel which is particularly meaningful in deciduous enamel.

Aim of the Study: Glass ionomers like Ketac Fil have the benefit of fluoride release. In this study it was investigated whether “recharging” of Ketac Fil with topical fluoride may contribute to tooth fluoridation.

Results of the Study: Refluoridation of Ketac Fil may increase accumulation of fluoride in enamel.
Vitrebond™ Plus

In Vitro Microleakage of Two Glass Ionomer Cements

Z.R. DONLEY¹, A. SEGURA¹, and K.J. DONLEY², ¹University of Texas - San Antonio/Health Science Ctr, USA, ²University of Texas San Antonio/Health Science Ctr

Objectives: The purpose of this study was to evaluate the microleakage of restorations, comparing two resin-modified glass ionomer cements placed only over the pulpal floor and placed to cover all prepared dentin to a dentin adhesive.

Methods: Fifty human molars had standardized Class V preparations, the occlusal margin in enamel and gingival margin in cementum/dentin. Ten each were restored with Vitrebond (3M ESPE) and Vitrebond Plus (3M ESPE) lining only the pulpal floor and lining all prepared dentin. Another 10 specimens had Single Bond (3M ESPE) placed over all prepared dentin. All teeth had the enamel margin etched with 35% phosphoric acid and Z 100(3M ESPE) restorations were placed. All teeth were thermocycled between 5° and 55°for 500 cycles. Teeth were serially sectioned and evaluated for microleakage. ANOVA and Tukey Test (p< 0.05) were used for statistical analyses.

Results:

<table>
<thead>
<tr>
<th>Material</th>
<th>Dentin Location</th>
<th>Enamel Microleakage (± SD) in µ*</th>
<th>Dentin Microleakage (± SD) in µ**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitrebond Plus</td>
<td>Pulpal</td>
<td>1562 ± 2075</td>
<td>3111 ± 1249</td>
</tr>
<tr>
<td>Vitrebond Plus</td>
<td>All</td>
<td>1092 ± 1026</td>
<td>2347 ± 1032</td>
</tr>
<tr>
<td>Vitrebond</td>
<td>Pulpal</td>
<td>743 ± 928</td>
<td>2637 ± 1013</td>
</tr>
<tr>
<td>Vitrebond</td>
<td>All</td>
<td>355 ± 477</td>
<td>1560 ± 799</td>
</tr>
<tr>
<td>Single Bond</td>
<td>All</td>
<td>213 ± 381</td>
<td>2979 ± 1471</td>
</tr>
</tbody>
</table>

* There are no statistically significant (p>0.148) differences between enamel groups.
** There are statistically significant (p=0.030 to p=0.039 range) differences between dentin groups that do not share the same letter.

Conclusion: There were no statistically significant (p< 0.148) differences in enamel microleakage when groups were compared, however, glass ionomer liners covering all dentin and Vitrebond liner covering only pulpal dentin demonstrated significantly less microleakage than the Single Bond adhesive and Vitrebond Plus that only covered pulpal dentin.

This research was supported, in part, by 3M ESPE.
How liners affect residual shrinkage stresses in composite restorations

A. VERSLUIS, D. TANTBIROJN, R. RUSIN, S. MITRA, J.C. ROLF, H.T. BUI, and K.M. CUMMINGS,
University of Minnesota, Minneapolis, USA, 3M ESPE Dental Products, Saint Paul, MN, USA

Objectives: This study investigated the effect of the relative compliance of liner materials on the level of residual polymerization shrinkage stresses in restored teeth.

Methods: Residual stresses were calculated using a finite element simulation of a 0.5 mm thick liner under a Class I composite restoration (Z250, 3M™ ESPE™, St Paul, MN). The restoration was placed in two increments for which pre- and post-gel polymerization effects were simulated. Shrinkage and elastic modulus were measured for five glass ionomer materials and two flowable composites and applied in the analysis. A restoration without liner was used as control. Stresses were analyzed in the enamel, dentin, composite, liners, and along tooth-restoration interfaces.

Results: The distribution of the stresses and the location of stress concentrations were evaluated from stress distribution plots. Although these distributions cannot be expressed into single values, mean stress ± standard deviation of the Von Mises equivalent stresses (MPa)—modified for the compressive/tensile strength differential—show the general trend for the residual stress levels in the tooth and at the restoration interface:

<table>
<thead>
<tr>
<th>Liner</th>
<th>Enamel</th>
<th>Dentin</th>
<th>Along composite-tooth interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>no liner</td>
<td>0.9±1.8</td>
<td>2.1±3.0</td>
<td>66.3±16.3</td>
</tr>
<tr>
<td>3M™ ESPE™ Vitrebond™ Plus Liner/Base</td>
<td>1.2±2.3</td>
<td>1.4±2.2</td>
<td>59.7±9.4</td>
</tr>
<tr>
<td>3M™ ESPE™ Vitrebond™ Liner/Base</td>
<td>1.2±2.2</td>
<td>1.4±2.1</td>
<td>59.9±9.0</td>
</tr>
<tr>
<td>GC™ Fuji™ Lining Paste Pak</td>
<td>1.4±3.4</td>
<td>2.6±3.9</td>
<td>67.4±23.7</td>
</tr>
<tr>
<td>GC™ Fuji™ Lining LC</td>
<td>1.2±2.4</td>
<td>1.7±2.5</td>
<td>62.0±12.5</td>
</tr>
<tr>
<td>3M™ ESPE™ Ketac-Bond Liner</td>
<td>1.1±1.9</td>
<td>1.9±2.6</td>
<td>64.8±14.3</td>
</tr>
<tr>
<td>Ivoclar™ Tetric™ Flow</td>
<td>1.4±3.1</td>
<td>2.9±4.0</td>
<td>70.0±27.3</td>
</tr>
<tr>
<td>Kerr™ Revolution™</td>
<td>1.3±2.9</td>
<td>2.4±3.5</td>
<td>66.8±21.2</td>
</tr>
</tbody>
</table>

Conclusion: In this Class I configuration, all glass ionomer liners except Fuji Paste Pak resulted in lower stresses along the tooth-restoration interface. Glass ionomer liners produced lower stress levels in the dentin, although some stress concentrations increased. The flowable composite liners consistently caused higher residual stresses in the tooth as well as along the tooth-restoration interface.

Acknowledgments: Supported by the Minnesota Dental Research Center for Biomaterials and Biomechanics and 3M ESPE.
Radiopacity of 34 Flowable Resins and Base/Liner Controls

J. ANDELIN, T.S. RANDALL, and M. ELLIS, CRA Foundation, Provo, UT, USA

Radiopacity is an important characteristic of materials used as bases/liners.

Objectives: Compare radiopacity of 34 flowable resins to 5 base/liner materials and 3 controls.

Methods: Determined radiopacity of 34 flowable resins, 1 zinc-oxide-eugenol (ZOE), 1 calcium hydroxide (Ca(OH)2), 1 compomer, 2 resin-modified glass ionomers (RMGI), 1 radiolucent flowable (negative control) and dentin/enamel (positive controls) per ISO 4049:2000. Analyzed data using Tukey’s HSD Multiple Comparison (p<0.0001). Made radiographs of class II restorations in extracted teeth where 1 of 4 different base/liner materials of varying radiopacities (2 restorations per base material) was used and categorized radiopacity as high, moderate, or low.

Results: Radiopacity of flowable resins tested ranged 1.0–3.3 mm equivalent thickness of aluminum, were at least as radiopaque as dentin, and passed ISO requirement. 9 of 34 flowable resins were the same as or more radiopaque than enamel control and are shown in graph below with 3 controls and 5 base/liner materials. Horizontal bars show statistical groups. Example images of high, moderate, and low radiopaque base/liner materials are shown.

Cavitec (ZOE) was most radiopaque material tested. Accolade SRO was most radiopaque flowable resin tested. Bases with moderate radiopacity were hard to distinguish from dentin. Bases with low radiopacity could be perceived as carious lesions.

Conclusion: Although flowable resins tested passed ISO requirement, moderate-to-low radiopaque bases/liners did not differentiate sufficiently from dentin. Minimum radiopacity requirement per ISO 4049:2000 may be too low for base/liner applications where differentiation from tooth is desired.

Text and graphics above refer to branded products offered by various companies. For trademark information, see the back page of this brochure.

**Vitrebond™ Plus**

**Adhesion of a New Liner with Resin Cements**

J.-L. RUIZ1, K.M. CUMMINGS2, S. MITRA2, J.C. ROLF2, H.T. BUI2, R. RANDALL2, and R. RUSIN2, 1University of Southern California, Los Angeles, USA, 23M ESPE Dental Products, Saint Paul, MN, USA

**Objectives:** Evaluate the effect of a new resin modified glass ionomer (RMGI) liner on the adhesion of two commercially available resin cements. The RMGI liners were 3M™ ESPE™ Vitrebond™ Plus Liner/Base (VBP), and 3M™ ESPE™ Vitrebond™ Liner/Base (VB); the resin cements were 3M™ ESPE™ Unicem™ Self-Adhesive Resin Cement (UNI), and 3M™ ESPE™ RelyX™ ARC Adhesive Resin Cement (RXA). VBP is a new resin-modified glass ionomer material in a paste/paste delivery, which exhibits the aluminum-carboxylate crosslinking reaction and fluoride release of a true glass ionomer.

**Methods:** Shear bond strength was measured on bovine dentin using the wire loop method (crosshead speed 1 mm/min) on an Instron 1123. A 0.3 mm tape spacer ensured a reproducible, uniform layer of the liner on the dentin; the mixed cement was applied to silanated surface (3M™ ESPE™ RelyX™ Ceramic Primer) of composite buttons (3M™ ESPE™ Paradigm™ MZ100 blocks), which were then pressed firmly onto the liner, and then light cured. The samples were immersed in 37°C deionized water for 24h before testing. The material combinations are shown in the Table. The data were analyzed via one-way ANOVA and compared with Tukey’s T-test (p=0.05).

**Results:**

<table>
<thead>
<tr>
<th>Resin Cement</th>
<th>Liner</th>
<th>n</th>
<th>Shear Bond Strength, MPa (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNI</td>
<td>no liner</td>
<td>9</td>
<td>8.9 (2.2)</td>
</tr>
<tr>
<td>UNI</td>
<td>VBP</td>
<td>9</td>
<td>8.7 (1.6)</td>
</tr>
<tr>
<td>UNI</td>
<td>VB</td>
<td>9</td>
<td>5.9 (2.0)</td>
</tr>
<tr>
<td>RXA</td>
<td>VBP</td>
<td>10</td>
<td>8.3 (2.4)</td>
</tr>
<tr>
<td>RXA</td>
<td>VB</td>
<td>10</td>
<td>5.8 (2.8)</td>
</tr>
</tbody>
</table>

All groups were statistically equivalent (p>0.05).

**Conclusions:** The shear bond strength to dentin of RelyX™ Unicem™ and RelyX™ ARC with Vitrebond™ Plus or Vitrebond™ RMGI liner was equivalent to the adhesion without the liner.
Effect of New Liner on Polymerization Shrinkage of Resin Cements

J.-L. RUIZ, University of Southern California, Los Angeles, USA

Objectives: Evaluate the effect of a new resin-modified glass ionomer (RMGI) liner on the polymerization shrinkage stress of two commercially available resin cements. The RMGI liners were Vitrebond™ Plus Liner/Base (VBP), and Vitrebond™ Liner/Base (VB); the resin cements were Unicem™ Self-Adhesive Resin Cement (UNI), and RelyX™ ARC Adhesive Resin Cement (RXA) (All materials from 3M ESPE). VBP is a new light-curing RMGI material in a paste/liquid delivery, which exhibits the aluminum-carboxylate crosslinking reaction and fluoride release of a true glass ionomer.

Methods: Volumetric polymerization shrinkage by the deflecting disc method [Watts & Cash. Dent Mater 1991;7:281] was used to measure polymerization shrinkage of a 2 mm thickness of each cement alone, and in combination with 0.5 mm thickness of liner. The material combinations are shown below (n=3) along with percent shrinkage reduction for each cement—liner combination. Data were analyzed via one-way ANOVA Tukey’s T-test (p=0.05).

Results: Resin Cement Liner Mean volumetric shrinkage % (sd) of cement with liner. % reduction in shrinkage over cement alone UNI no liner 4.0 (0.1)—UNI VB 2.1 (0.1) 47% UNI VBP 2.1 (0.2) 47% RXA no liner 5.5 (0.1)—RXA VB 3.1 (0.2) 43% RXA VBP 2.5 (0.4) 55%. Use of RMGI liners VBP and VB resulted in a statistically significant reduction in the volumetric shrinkage of RXA and UNI (p<0.05). The shrinkage of UNI/VB is statistically equivalent to UNI/VBP; all other groups are statistically different.

Conclusions: VB and VBP reduced the volumetric polymerization shrinkage of two resin cements as measured in the study by 43% to 55%. Since this method of measuring shrinkage reflects the stress due to polymerization, it can be concluded that the liners buffer this effect.
Post-Cure Flexural Modulus in a New Liner Material

Dental Products, Saint Paul, MN, USA

Objectives: Evaluate post-cure flexural modulus of a new liner material, 3M™ ESPE™ Vitrebond™ Plus Liner/Base (VBP), compared to glass ionomer and flowable composite materials. Low modulus materials can reduce stress from polymerization shrinkage of composites by distributing it more uniformly along the cavity wall. VBP is a new resin-modified glass ionomer in a paste/paste delivery, which exhibits the aluminum-carboxylate crosslinking reaction and fluoride release of a true glass ionomer.

Methods: Flexural strength (FS) and modulus (FM) were measured per ISO 9917-2. For each material, one group was tested about 1 hr post-cure, another group was stored 1d in deionized water at 37°C (n=5-12). Other materials tested were 3M™ ESPE™ Vitrebond™ Liner/Base (VB), GC™ Fuji™ Lining Paste Pak (FPP), GC™ Fuji™ Lining Light Cure (FLC), 3M™ ESPE™ Ketac-Bond™ (KB), 3M™ ESPE™ Filtek™ Supreme Flow (FSF), Kerr™ Revolution™ (RV), Ivoclar™ Tetric™ Flow (TF). Data were analyzed via one-way ANOVA and compared with Tukey’s T-test (p<0.05).

Results:

<table>
<thead>
<tr>
<th>Material</th>
<th>FS post-cure, MPa (stdev)</th>
<th>FS 1d, MPa (stdev)</th>
<th>FM post-cure, MPa (stdev)</th>
<th>FM 1d, MPa (stdev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBP</td>
<td>25.1(1.6)a</td>
<td>37.2(5.7)a</td>
<td>499.7(47.9)a</td>
<td>1422(43)a</td>
</tr>
<tr>
<td>VB</td>
<td>22.6(1.3)ab</td>
<td>30.1(3.2)a</td>
<td>642.9(37.6)a</td>
<td>1249(74)a</td>
</tr>
<tr>
<td>FPP</td>
<td>36.7(7.2)c</td>
<td>48.2(9.6)c</td>
<td>1553.7(242.0)c</td>
<td>2998(397)c</td>
</tr>
<tr>
<td>FLC</td>
<td>26.5(3.8)c</td>
<td>38.3(6.3)c</td>
<td>880.3(224.5)c</td>
<td>2418(354)c</td>
</tr>
<tr>
<td>KB</td>
<td>14.7(3.5)c</td>
<td>32.6(2.2)c</td>
<td>4917.5(644.5)c</td>
<td>15706(593)c</td>
</tr>
<tr>
<td>FSF</td>
<td>114.8(6.2)e</td>
<td>126.6(8.7)e</td>
<td>3863.8(179.4)e</td>
<td>5675(211)e</td>
</tr>
<tr>
<td>RV</td>
<td>78.7(4.8)d</td>
<td>112.8(7.0)d</td>
<td>2115.3(136.1)d</td>
<td>5349(530)d</td>
</tr>
<tr>
<td>TF</td>
<td>114.3(6.0)e</td>
<td>134.3(5.8)e</td>
<td>3967.8(129.5)e</td>
<td>5582(160)e</td>
</tr>
</tbody>
</table>

Superscript letters indicate statistically equivalent groups. Post-cure FM of VBP was statistically equivalent to VB and FLC; VBP and VB were lower than FPP, KB, FSF, RV, and TF. 1d FM of VBP was statistically equivalent to VB and VB were lower than FPP, FLC, KB, FSF, RV, and TF. Post-cure FM was statistically lower than 1d for all materials.

Conclusions: The lower FM of RMGI materials compared to flowable composite and conventional GI materials are expected to provide the best stress relief as lining materials.
Vitrebond™ Plus

Long Term Bond Strength of a New Liner
S. MITRA1, J.C. ROLF1, E.A. CRAWFORD1, K.M. CUMMINGS1, H.T. BUI1, D. TANTBIROJN1, and R. RUSIN1; 13M ESPE Dental Products, Saint Paul, MN, USA, 2University of Minnesota, Minneapolis, USA

Objectives: Evaluate the long-term bond strength of a new resin modified glass ionomer (RMGI) liner. The liners tested were 3M™ ESPE™ Vitrebond™ Plus Liner/Base (VBP), 3M™ ESPE™ Vitrebond™ Liner/Base (VB), and Fuji™ Lining Paste Pak (FPP). VBP is a new resin-modified glass ionomer material in a paste/paste delivery, which exhibits the aluminum-carboxylate crosslinking reaction and fluoride release of a true glass ionomer.

Methods: Shear bond strength was measured on bovine dentin and enamel using the wire loop method (crosshead speed 1 mm/min) on an Instron 1123. A 0.3 mm tape spacer ensured a reproducible, uniform layer of the liner on the dentin. After etching the cured liner with 3M™ Scotchbond™ etching gel, 3M™ Single Bond™ Plus adhesive was applied and cured. A cylinder of 3M™ ESPE™ Filtek™ Z250 was cured onto the sample. The samples were immersed in 37C deionized water before testing; storage times were 1d, 1mo, 3mo, and 6mo (n=5 for each group). The data were analyzed via one-way ANOVA and compared with Tukey’s T-test (p=0.05). Microleakage was also studied; it was found that restorations placed using VBP exhibited low microleakage that was comparable to VB.

Results:

<table>
<thead>
<tr>
<th>Time</th>
<th>Dentin Adhesion, MPa(stdev)</th>
<th>Enamel Adhesion, MPa(stdev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBP</td>
<td>1d  11.2(1.9)</td>
<td>10.7(4.2)</td>
</tr>
<tr>
<td>VB</td>
<td>1d  11.4(1.7)</td>
<td>11.7(0.7)</td>
</tr>
<tr>
<td>FPP</td>
<td>1d  7.3(3.1)</td>
<td>3.6(2.4)</td>
</tr>
<tr>
<td>VBP</td>
<td>1mo 14.1(1.4)</td>
<td>16.8(5.2)</td>
</tr>
<tr>
<td>VB</td>
<td>1mo 14.0(1.9)</td>
<td>14.1(3.0)</td>
</tr>
<tr>
<td>FPP</td>
<td>1mo 8.6(2.2)</td>
<td>10.2(2.7)</td>
</tr>
<tr>
<td>VBP</td>
<td>3mo 14.6(2.3)</td>
<td>10.8(3.8)</td>
</tr>
<tr>
<td>VB</td>
<td>3mo 14.7(5.0)</td>
<td>13.1(3.2)</td>
</tr>
<tr>
<td>FPP</td>
<td>3mo 4.8(3.2)</td>
<td>11.3(5.4)</td>
</tr>
<tr>
<td>VBP</td>
<td>6mo 14.0(2.6)</td>
<td>18.4(0.4)</td>
</tr>
<tr>
<td>VB</td>
<td>6mo 12.3(1.5)</td>
<td>16.0(1.5)</td>
</tr>
<tr>
<td>FPP</td>
<td>6mo 6.7(3.1)</td>
<td>8.5(1.6)</td>
</tr>
</tbody>
</table>

Conclusions: The 1d, 1mo, 3mo, and 6mo dentin adhesions were statistically equivalent within each material group; the 1d, 1mo, 3mo, and 6mo enamel adhesions were statistically equivalent within each material group. The dentin adhesion of VBP was statistically higher than FPP at 3mo and 6mo.
Shear bond strength of Vitrebond Plus to dentin and enamel
A.J. DE GEE, and A.J. FEILZER, ACTA, Universiteit van Amsterdam and Vrije Universiteit, Netherlands

Vitrebond Plus has been introduced as a new cement based partly on original Vitrebond and RelyX Luting Cement Plus. It contains the same Fluoro-Alumina-Silica glass as used in Vitremer Restorative and RelyX Luting Plus.

Objective: The aim of this study was to determine the shear bond strength to human dentin and enamel of Vitrebond Plus and to compare this with Vitrebond and Ketac Bond.

Methods: The coronal section of human molars was cut from the roots at the cemento-enamel junction and embedded in PMMA as flat disks. Flat enamel surfaces were created by wet grinding (180 to 600 grit SiC) the occlusal part of each disk to a depth not to expose dentin. Flat dentin surfaces were created by wet grinding the cervical part to a level just above the pulp horns. A flexible polyethylene (PE) disk (diameter x thickness=9.5 x 1.3 mm) was positioned with its 2.5 mm hole on enamel or dentin and fixed with two clamps. After mixing the materials a small amount was brought into the PE mould and light-cured for 30 s (Vitrebond Plus, Vitrebond) or allowed to self-cure (Ketac Bond). The PE cavities were then filled with Z250 and light-cured for 20 s. After 24 hours of storage in water at 37°C the PE mould was removed and the PMMA disk placed in vertical orientation in a special device to shear off the specimen (0.5 mm/min).

Results: Mean shear bond strength and (sd) to enamel and dentin (MPa).

<table>
<thead>
<tr>
<th></th>
<th>n=10 Vitrebond Plus</th>
<th>n=10 Vitrebond</th>
<th>n=10 Ketac Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enamel</td>
<td>12.6(1.3)</td>
<td>9.7(1.0)</td>
<td>8.0(1.1)</td>
</tr>
<tr>
<td>Dentin</td>
<td>6.8(1.5)</td>
<td>6.8(1.3)</td>
<td>6.2(1.6)</td>
</tr>
</tbody>
</table>

Conclusion: While the bond to dentin was the same for all three materials the bond of Vitrebond Plus to enamel was significantly stronger than that of Vitrebond and Ketac Bond. Materials were supplied by 3M ESPE St. Paul, MN.
Dentin Caries Inhibition Adjacent to Composite-Glass Ionomer Sandwich Configuration

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Objectives: To evaluate dentin caries inhibition ability of a composite restoration with a new paste-liquid resin-modified glass ionomer (RMGI) liner 3M ESPE Vitrebond Plus in an open-sandwich configuration in vitro and to compare the results with other liners.

Methods: Rectangular slots (6x3x1.5 mm) were prepared in 20 dentin blocks cut from 5 bovine roots. GI liners were applied up to the cavity margin. The preparations were filled with Z250 composite/SingleBond (ZS) in an open-sandwich configuration. Liners were RMGIs (3M ESPE Vitrebond Plus, VP; GC Fuji Paste Pak, FJ) and a conventional GI (3M ESPE Ketac Bond, KB). The control group was ZS without liner. Specimens were immersed in 20 ml lactic acid gel pH 5.1 (37°C, 3 wks), then sectioned into 400 μm slices for microradiography. Microradiographs were converted to 8-bit gray scale images. Width of inhibition zone was measured. DeltaZ (%mineral-μm) was calculated from mineral profiles converted from gray scale, measured at 0.25 and 1.0 mm from the cavity margin (n=10).

Results: Inhibition zone and DeltaZ 0.25 mm of all groups with composite-GI sandwich configuration were significantly different from ZS (ANOVA, Scheffe’s, p<0.05). DeltaZ 1.0 mm of VP was significantly different from ZS. Superscript letters in the same row represent values that are not statistically different.

<table>
<thead>
<tr>
<th></th>
<th>ZS</th>
<th>KB</th>
<th>FJ</th>
<th>VP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibition zone (μm)</td>
<td>0(^{a})</td>
<td>29±13(^{b})</td>
<td>35±8(^{b+1})</td>
<td>44±11(^{c})</td>
</tr>
<tr>
<td>DeltaZ 0.25 mm</td>
<td>6696±881(^{a})</td>
<td>5099±1031(^{b})</td>
<td>4551±535(^{b})</td>
<td>4237±473(^{c})</td>
</tr>
<tr>
<td>DeltaZ 1.0 mm</td>
<td>6107±1130(^{a})</td>
<td>5652±772(^{b+3})</td>
<td>5107±484(^{c})</td>
<td>4931±574(^{d})</td>
</tr>
</tbody>
</table>

Conclusion: Restorations with Vitrebond Plus RMGI liner in the open-sandwich configuration exhibited pronounced inhibition zone similar or better than other GI liners and lowered the mineral loss up to 0.25 mm from the cavity margin.

Supported by the Minnesota Dental Research Center for Biomaterials and Biomechanics and 3M ESPE.
Clinpro™ Prophy Powder

Bovine Dentin Air-Polishing Study with a Glycine Based Prophy Powder

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A glycine-based prophy powder that safely and effectively removes both supragingival and subgingival plaque (Clinpro™, 3M ESPE) has been developed for use with EMS Air Flow® devices.

Objectives: The objective of this study was to compare the abrasivity of the glycine powder when delivered from 8 different handpieces.

Methods: To determine experimental parameters, bovine dentin samples were air polished using the prophy powder and an EMS Air Flow Handy 2 handpiece at a distance of 3 mm for a period of 5 seconds at 30°, 60° and 90° angles. 5 samples bovine dentin were polished at each angle. Following polishing, impressions of the bovine dentin were made using Impregum™ Garant™ L Duo Soft™. The volume of dentin lost was measured from the impressions using a stereo microscope. Data were analysed using Tukey One-Way Anova (p=0.05). Because 60° exhibited the highest abrasion, this angle was used to compare the 8 different handpieces. Again, 5 bovine dentin samples were polished, impressions were made and the volume of dentin removed was measured under a stereo microscope.

Results: Abrasion was greatest at 60° (0.038 mm³/5 sec), followed by 90° (0.016 mm³/5 sec) then 30° (0.008 mm³/5 sec) with 60°>90°>30°. The 8 air polishing devices were compared at 60° for 5 seconds. EMS Handy 2 exhibited the lowest abrasion (0.004 mm³/5 sec; 60°). Only one of the air polishing devices exhibited abrasion above the critical threshold of 0.1 mm³/5 sec (1.53 mm³/5 sec).

Conclusion: These results show that the glycine-based prophy powder exhibits very low abrasion and can be safely delivered from a number of different airpolishing devices.

Dentin Abrasion Volume Removed (60° angle, 5 seconds)
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Based on the data contained in the abstracts, 3M ESPE has provided graphics, “Aim of the Study” and “Results of the Study” to visualize and summarize the results.